

REGIONAL PROJECT – ASIA-PACIFIC

Guidelines for the TRANSITION FROM ANALOGUE TO DIGITAL BROADCASTING



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Guidelines for the Transition from Analogue to Digital Broadcasting *- including the Asia-Pacific Region*

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The International Telecommunication Union (ITU) would like to express sincere gratitude to Mr Jan Doeven, Mr Peter Walop and Mr Gu-Yeon Hwang who developed the original Guidelines and to Mr Colin Knowles and the Asia Pacific Broadcasting Union (ABU) who worked together under the supervision of Mr Kikwon Kim and the ITU Regional Office for Asia and the Pacific to update the Guidelines with the Asia-Pacific region in mind. Special thanks are offered to the Korea Communications Commission (KCC), Republic of Korea, for their contribution and support for the development of the Guidelines.

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Foreword

The broadcasting revolution is well-underway, and the transition from analogue to digital broadcasting is not only creating opportunities for the provision of ICT applications and multimedia services but is also contributing to the efficient use of spectrum through the digital dividend and the release of spectrum for other uses such as wireless broadband communications.

The transition to digital terrestrial television broadcasting (DTTB) and the introduction of mobile television broadcasting (MTV) services is already benefiting regulators, service providers, network operators and consumer electronics manufacturers but it is a complex process. This is in part due to different national regulatory frameworks, service offerings and network configurations another, but is also due to national priorities, market circumstances, geography, and population distribution.

However, independent of national variations, I believe that this publication can lead to firm decisions on the analogue TV switch-off date, close cooperation between the regulator and market players, clear and timely regulatory frameworks, including decisions on the digital dividend, and adequate information and assistance to viewers.

The Guidelines for the Transition from Analogue to Digital Broadcasting is intended for a global audience to provide information and recommendations on policy, regulation, technologies, network planning, customer awareness and business planning for the smooth transition to DTTB and introduction of MTV. This publication is the implementation of the decisions of GE06 Plan, for which the original Guidelines were prepared specifically for the Africa region, and for which the current revision includes the needs of the Asia-Pacific region by incorporating more complete examples, technology options, and regulations relevant to this region.

This updated version also includes the Guidelines for Migration of Broadcast Archives from Analogue to Digital. Much of the material contained in such archives may be of significant historical and cultural significance to the countries in which they were created. ITU and other UN agencies have long recognized the importance of preserving this material, and the World Telecommunications Development Conference (WTDC 10) identified assistance to broadcasters in the migration of archives from analogue to digital as a broadcasting development priority. The section on the migration of analogue archives is intended as a basis upon which the ITU Membership can develop a roadmap for the migration of their archives from analogue to digital. These guidelines focus on the broader strategic and operational questions of archive migration, including the benefits that can flow from migration in addition to the basic proposition of preservation of historical programme content.

ITU is promoting the DTTB transition and has developed frequency plans for digital terrestrial broadcasting (GE 06 Plans) for Region 1 and Iran, which should be implemented by 17 June 2015, with the exception of some developing countries for which the transition period will end on 17 June 2020. We are also in the process of assisting developing countries and least developed countries (LDCs) in the smooth transition from analogue to digital broadcasting through the development of several projects and I hope that this updated version of the Guidelines will help continue to support the work on defining country specific roadmaps for the transition that will benefit consumers, and both the public and private sectors.

I would like to commend the experts, Mr Jan Doeven, Mr Peter Walop and Mr Gyeon Hwang who have developed the Guidelines with their expertise and experience. I would also like to extend special thanks to the Korean Communications Commission (KCC), Republic of Korea, for their contribution to the development of the Guidelines, and to Mr Colin Knowles and the Asia Pacific Broadcasting Union (ABU) who have worked together to update the Guidelines with the Asia-Pacific region in mind.

Brahima Sanou
Director
Telecommunication Development Bureau

Executive Summary

1 Introduction to the Guidelines

The broadcasting industry and regulators face both opportunities and challenges in dealing with the transition from analogue to digital broadcasting. The transition requires decisions to be made on a great number of political, social, economic and technological issues. Therefore, it is necessary to develop a well-defined roadmap covering national strategies and key decisions.

The Guidelines on transition to Digital Terrestrial Television Broadcasting (DTTB) and introduction of Mobile Television (MTV) are intended to provide information and recommendations on policy, regulation, technologies, network planning, customer awareness and business planning for the smooth introduction of DTTB and MTV. Included in the Guidelines are:

- options for policy and technology choices;
- context and introduction to the policy and technology choices;
- relevancy and impact of choices;
- cost/benefit analysis;
- implementation guidelines;
- generic roadmaps and main activities;
- documentation references.

The Guidelines have been developed on the basis of the World Telecommunication Development Conference (WTDC-06) instructions and with the support of ITU and Korea Communications Commission (KCC), Republic of Korea. The Guidelines were drafted by a group of international experts under the supervision of the ITU BDT Project Manager Mr Gue-Jo Jo. Each expert was responsible for drafting specific parts of the Guidelines:

- Mr Jan Doeven: coordinator and DTTB networks;
- Mr Peter Walop: Policy and Regulation, Analogue Switch-Off, Market and Business development;
- Mr Gu-Yeon Hwang: MTV networks.

The Guidelines were originally prepared for Africa and take into account the provisions of the GE06 Agreement. In principle, the original Guidelines are applicable within the whole of the GE06 planning area¹ and could also be applied in countries outside the GE06 planning area, but provisions of other applicable regulations, instead of GE06, should be taken into account in that case. GE06 does not apply to the Asia-Pacific region; however, as part of the WTDC 10 action plan, digital migration development in the Asia-Pacific region was given priority. As part of this initiative, ITU in collaboration with the Asia Pacific Broadcasting Union (ABU) arranged for ITU expert Mr Colin Knowles to revise/adapt the Guidelines for use in the Asia-Pacific region, by incorporating additional material, and highlighting the different or additional factors that Asia-Pacific countries may need to consider in developing digital migration in their region. As part of this project Mr Knowles

¹ The planning area of GE06 Agreement covers Region 1 (parts of Region 1 situated to the west of meridian 170° E and to the north of parallel 40° S, except the territory of Mongolia) and in the Islamic Republic of Iran.

also prepared a new annex on the migration of analogue broadcast archives to digital media under the direction of the ITU BDT project manager Mr K.K. Kim with the assistance of Ms S. Bunnag from the ITU Asia-Pacific regional office.

The revisions incorporated into this revised version cover:

- Inclusion of references to digital system standards specific to the Asia-Pacific region, in particular the systems developed and used in China and Japan.
- References to Regulations, Initiatives and Obligations applicable to the Asia-Pacific region.
- The inclusion of additional implementation examples from the Asia-Pacific region.
- Guidelines for the migration of analogue broadcast archives to digital media.

The revisions have been incorporated into the text in a way which preserves the integrity of the original text.

2 Functional framework of the Guidelines

The Guidelines follow a comprehensive functional framework indicating the decisions to be considered for the introduction of DTTB and MTV. It consists of five functional layers:

A	Policy and Regulation;
B	Analogue Switch-Off (ASO);
C	Market and Business development;
D	Networks (DTTB and MTV);
E	Roadmap development.

In each layer a number of functional building blocks have been identified (see Figure 1).

The yellow and blue functional building blocks are respectively for the regulator and DTTB and MTV network operator and service provider to be addressed. It should be noted that in some countries different roles and tasks can be assumed by the different players.

For each of the functional building blocks shown in Figure 1, guidelines on key topics and choices are provided. These guidelines are described in chapters with corresponding numbers. Each chapter includes implementation guidelines assisting in making the right trade-offs, applicable to the local situation.

Many of the key topics and choices identified for each of the functional building blocks are interrelated to other functional building blocks in the functional framework. In a number of cases a trade-off should be made between several key topics or choices. The final choice can often only be made after several iterations.

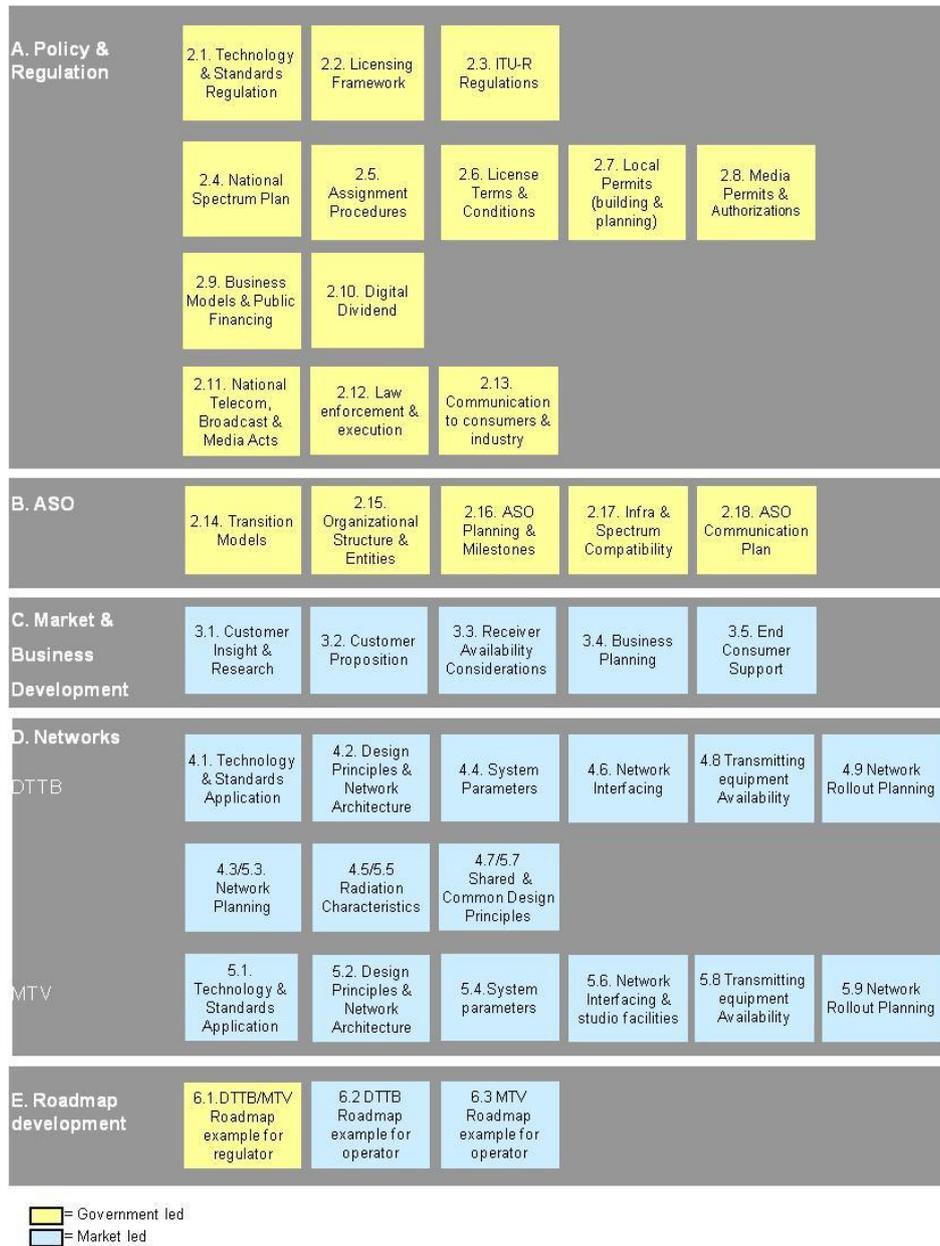


Figure 1: Functional framework of the Guidelines

3 Brief description of each part

The report has been structured in six parts. A brief description of each of the six parts is given in the following paragraphs.

Part 1 (Introduction) provides general information on the functional framework of the Guidelines, guidance to readers, advantages of digital switch-over and references to the status of digital switch-over.

Part 2 (Policy and regulation) provides an overview of the key issues and choices the regulator faces when formulating DTTB, MTV or ASO policy objectives. In striving for a rapid service up-take and development of the DTTB and MTV markets, the regulator will implement such policies by issuing information, funds, rights, licences and permits to (qualified) market parties in compliance with the relevant Legislation. Because of the specific nature and the one-off character of the ASO, this process

is dealt with in five separate and consecutive chapters (relating to functional building blocks 2.14 to 2.18), which can be read independently from the other chapters in this part.

Part 3 (Market and business development) provides an overview of the key business issues and choices DTTB and MTV Service Providers/Broadcast network operators face when planning the commercial launch of these services. This part includes a set of business activities and tools for defining the DTTB/MTV service proposition and associated business case and plan, taking into account identified demand drivers, service barriers, financial feasibility and more specifically receiver availability and customer support issues.

This part is not only intended for commercial market parties seeking an acceptable return on their investments, such as DTTB/MTV Service Providers and Broadcast network operators. Also, regulators should acquire an understanding of the key business issues and choices at hand as to define realistic DTTB/MTV policies and licence conditions.

Commercial parties will seek a DTTB or MTV Service Proposition which fulfils a consumer demand, generating sufficient revenues (either advertising or subscription based). In contrast, Public Service Broadcasters (PSB) normally fulfil objectives of public interest in the field of information and culture.

That is why they are interested in viewing ratings, high population coverage and mainly prefer unencrypted broadcasting. Market and business development works differently as they have to fulfil primarily these 'information and culture' objectives. However, PSBs can also have advertising-based income and some of the topics addressed in this section might also be relevant for PSBs.

Parts 4 and 5 (DTTB networks and MTV networks respectively) cover functional building blocks 4.1 to 4.9 and 5.1 to 5.9 (see Figure 1) and contain guidelines on key issues and choices operators face when planning transmitter networks for broadcasting DTTB and MTV services. Choices in network architecture, frequency planning, network planning, roll out planning and network operation should be made in such a way that the licence conditions are fulfilled and that the business objectives are met. In doing so, optimum solutions should be found between, often conflicting, requirements regarding picture and sound quality, coverage quality and transmission costs.

Some of the issues regarding technology choices, frequency planning and network planning may also be relevant to regulators, depending on the roles and responsibilities of regulator and network operator in a country.

DTTB and MTV networks are described in separate Parts because in general there are different key topics and choices involved regarding technology, regulation and business aspects. However, because of the similarity of the issues, guidelines regarding functional building blocks 5.3, 5.5 and 5.7 (see Figure 1) relating to MTV networks, are described in the corresponding chapters in Part 4 (DTTB networks).

Part 6 (Roadmap development) deals with the development a set of generic roadmaps regarding the whole process of transition to DTTB and introduction of MTV by the regulator and DTTB and MTV Network Operator and Service Provider. This Part covers functional building blocks 6.1 to 6.3 (see Figure 1).

A roadmap is a plan that matches short-term and long-term goals and indicates the main activities needed to meet these goals. Developing a roadmap has three major uses:

- 1 It helps to reach consensus about the requirements and solutions for transition to DTTB and introduction of MTV;
- 2 It provides a mechanism to help forecast the key milestones for the transition to DTTB and introduction of MTV.

- 3 It provides a framework to help plan and coordinate the steps needed for transition to DTTB and introduction of MTV.

The roadmap for regulator, DTTB and MTV operator consists of a number of phases. Figure 2 shows these phases and the order of the phases. The roadmap is constructed by placing the relevant functional building blocks in each phase in a logical order and in a time frame. In practice the selection of functional building blocks may differ from country to country, depending on the roles of the regulator, Network Operator and Service Provider, in particular regarding the responsibility for technology choices and network planning.

It is important to adopt realistic time schedules, noting that in Europe the period between DTTB launch and completion of analogue TV switch-off ranges from 3 to 14 years.

There is no clear marker that will indicate the start of the process. The start could be triggered by the wish of broadcasters to introduce DTTB or MTV services, or by mobile operators wishing to use part of the “Digital Dividend” for mobile services. Sometimes governments initiate the process, taking into account that the Geneva 2006 Agreement stipulates that the transition period ends on 17 June 2015 and for a number of countries² on 17 June 2020 with regard to Band III. The process ends when all analogue television services are switched-off and all DTTB and MTV stations are in operation without any restrictions that were necessary to protect analogue television services. However, further evolution of DTTB and MTV networks is likely to take place resulting from the introduction of new services, regulatory obligations or technology changes.

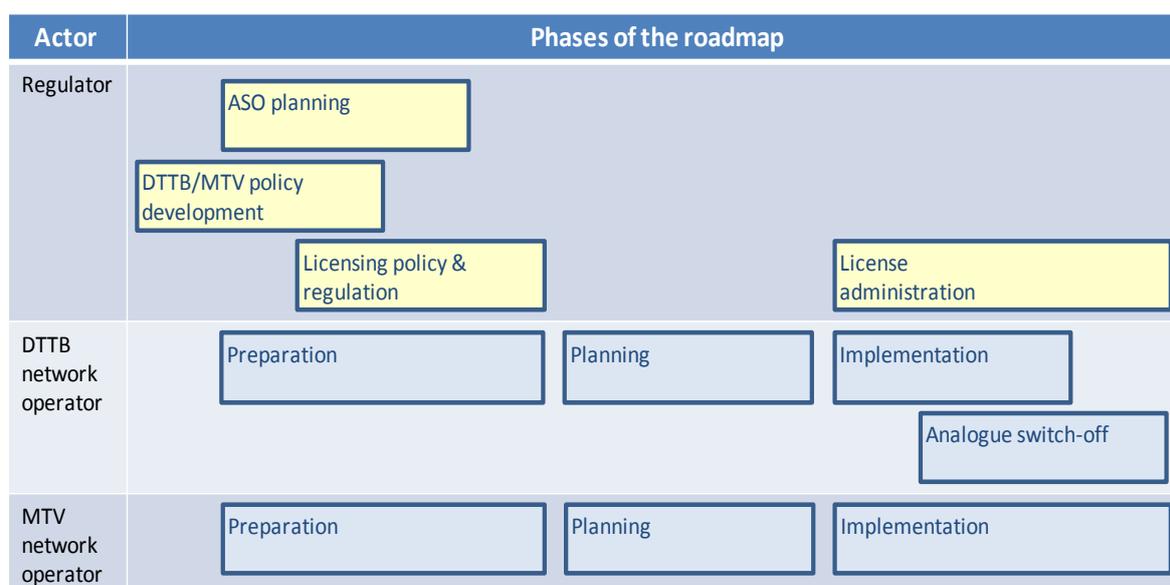


Figure 2: Phases of the roadmap of the regulator and DTTB and MTV network operator and service provider

² The countries with a prolonged transition period in Band III are listed in footnote 7 related to Article 12 of the Geneva 2006 Agreement.

4 Conclusions

The transition to DTTB and the introduction of MTV services is a complex process, involving decisions on key topics and choices of 41 functional building blocks. In a practical situation, a number of decisions may have already been taken. Perhaps some decisions may need to be reviewed when applying the Guidelines.

When implementing the Guidelines it should be taken into account that:

- Transition to DTTB and introduction of MTV will benefit regulators, service providers, network operators and consumer electronics manufacturers. However, ultimately the market will determine the success of the services that are offered;
- DTTB and MTV networks may need to be modified in the future because of changing viewer needs, new technologies and services;
- Regulatory frameworks, service offerings and network configurations are likely to be different from country to country, taking into account national (political) priorities, market circumstances, geography, and population distribution.

Independent of national variations, experience has shown that it is essential to meet a number of conditions to achieve a successful transition to DTTB and the introduction of MTV services, including:

- Strong leadership from government;
- Firm decision that sets the analogue TV switch-off date;
- Close cooperation between the regulator and market parties;
- Clear and timely regulatory framework (including decisions on the “Digital Dividend”);
- Adequate information and assistance to viewers.

ANNEX A: Guidelines for Migration of Broadcast Archives from Analogue to Digital

Much of the material contained in these archives may be of significant historical and cultural significance to the countries in which it was created. ITU and other UN agencies have long recognized the importance of preservation of this material, and the World Telecommunications Development Conference (WTDC 10) identified assistance to broadcasters in the migration of archives from analogue to digital as a broadcasting development priority.

The Guidelines for Migration of Broadcast Archives from Analogue to Digital is intended as a basis upon which users can develop a roadmap for the migration of their archives from analogue to digital.

These guidelines focus on the broader strategic and operational questions of archives migration, including the benefits that can flow from migration in addition to the basic proposition of preservation of historical programme content. These guidelines do not attempt to provide the technical solutions to archives migration because those solutions will depend very much on local needs, resources, and available funds.

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Part 1

Introduction

1.1 General introduction

This report contains guidelines on migration from analogue television to Digital Terrestrial Television Broadcasting (DTTB) and introduction of Mobile Television Broadcasting (MTV). The guidelines identify the policy, economic and technology choices to be made and their potential impact on the transition to DTTB and introduction of MTV in the Asia-Pacific region. Included in the guidelines are the elements related to the choices and information regarding the cost benefit analysis of policy decisions and best practices.

The guidelines were originally developed in the framework of an ITU project on the transition from analogue to digital broadcasting in Africa as a part of ITU/BDT activities on the implementation of regional initiatives projects approved by WTDC-06.

The objective of the original guidelines is to assist the African countries in making their own roadmap to shift smoothly from analogue to digital terrestrial TV (DTTB) and on the use of mobile TV (MTV).

The report was prepared under the direction of Mr Gue-Jo Jo (ITU-D) by a team of experts. Each expert was responsible for drafting specific parts of the guidelines. The team consisted of:

- Peter Walop, who prepared the guidelines regarding policy and regulatory matters;
- Gu-Yeon Hwang, who prepared the guidelines regarding mobile TV networks;
- Jan Doeven, who prepared the guidelines regarding DTTB networks and coordinated the work.

Although the guidelines were developed through an ITU project on the transition from analogue to digital broadcasting in Africa under initiatives approved by WTDC-06 they are, apart from the references to GEO6 and some technology choices, equally applicable to the Asia-Pacific region. The Initiatives approved by WTDC-10 for the Asia-Pacific region, and set out in Annex 4 to the Final Report, establish the basis for the work in the Asia-Pacific region.

The Final Acts of the World Telecommunication Development Conference (WTDC-10) stated:

“Given the increasing demand for limited radio-frequency resources, efficient spectrum management and the transition from analogue to digital broadcasting are critical issues for policy makers, regulators broadcasters and other stakeholders³

The report also noted that “Countries will continue to implement the transition from analogue to digital broadcasting and timescales according to the national priorities as well as, where applicable, the deadlines set by the ITU regional radio communications conference and its associated plan and agreement during the period of the strategic plan there will be a continuing need as a high priority,

³ WTDC Draft Final Acts p30

to assist administrators, regulators, broadcasters and other stakeholders in developing countries in researching and supporting introduction of digital broadcasting.”⁴

1.2 Functional framework

The guidelines on migration from analogue television to (DTTB) and introduction of (MTV) were developed on the basis of a functional framework indicating the functional building blocks to be considered for the transition to DTTB and introduction of MTV. This framework consists of five functional layers:

- A. Policy and regulation;
- B. Analogue switch-off (ASO);
- C. Market and business development;
- D. Networks (DTTB and MTV);
- E. Roadmap development.

In each layer a number of functional building blocks have been identified (see Figure 1.2.1). For each of the functional building blocks guidelines on key topics and choices are given in the chapters of Part 2 to 6.

In general, Layers A to E are either government led or market led. However, in some countries government departments or agencies have a broader role than in others. The functions in each layer are described for the situation that exists in most countries that have introduced digital television services. If government departments or agencies have responsibilities for one or more of the functions in Layer C or D, the relevant guidelines in these layers should be followed.

Government departments or agencies not having direct responsibility for functions described in Layer C or D should nevertheless be aware of the complexity of these functions and the impact government decisions may have on it.

Layer E (Roadmap development) relates to government as well as market led functions.

Figure 1.2.1 provides an overview of the functional framework.

⁴ WTDC Draft Final Acts p18-19

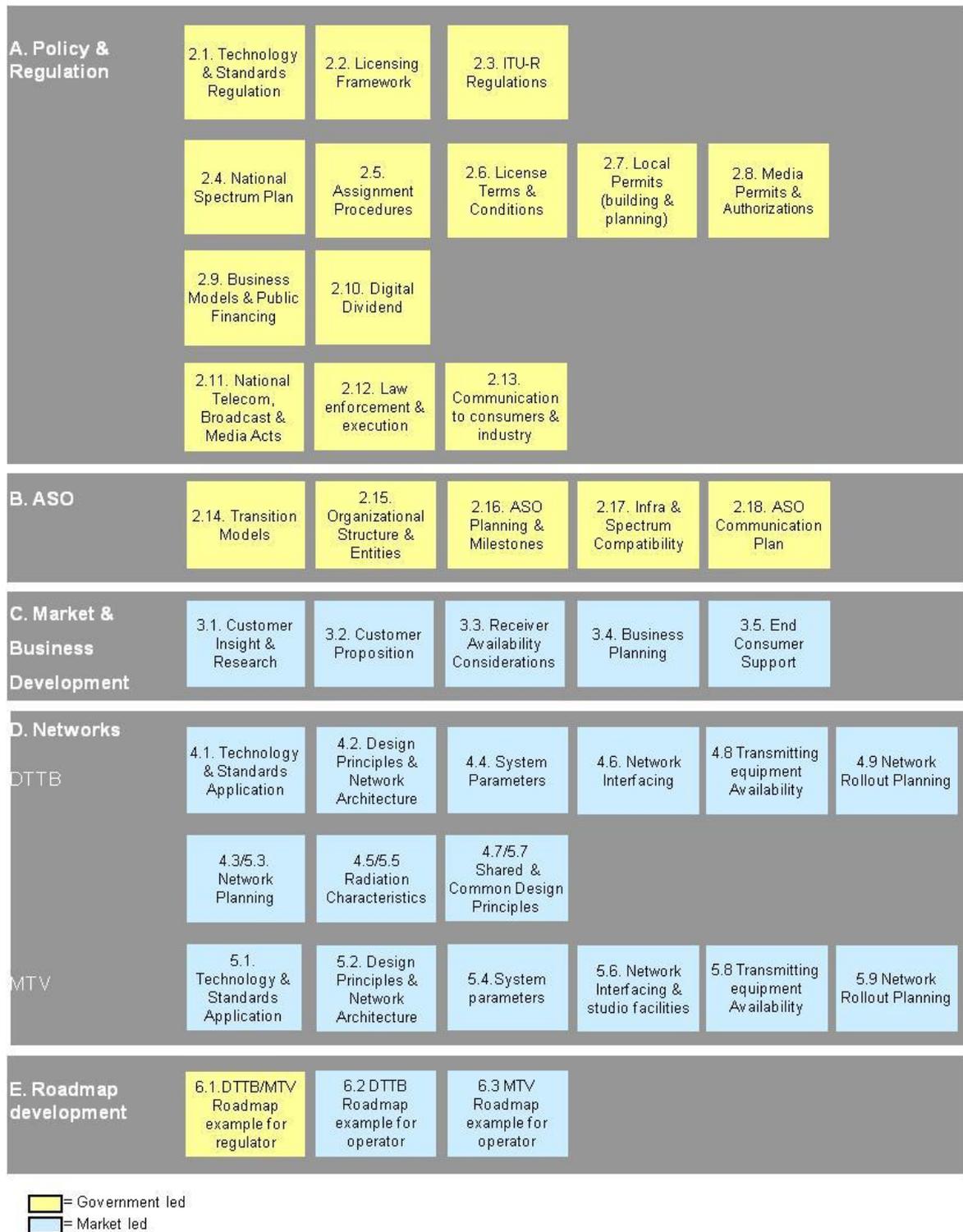


Figure 1.2.1: Functional framework of guidelines for the transition to DTTB and introduction of MTV

The description and objectives of each of the five layers of the functional framework is included in the subsequent paragraphs.

Layer A: Policy and regulation

Layer A deals with the key issues and choices the regulator faces when either formulating DTTB, MTV or ASO policy objectives. In striving for a rapid service up-take and development of the DTTB and

MTV markets, the regulator will implement such policies by issuing information, funds, rights, licences and permits to (qualified) market parties in compliance with the relevant legislation.

Layer B: Analogue switch-off (ASO)

Analogue switch-off (ASO) is the process of turning off the analogue terrestrial television signal and replacing it with a digital signal. It will basically require changing existing television broadcast networks and changing end-consumer television receiver equipment (either connecting a digital converter to the existing television set/recorder or replacing the existing television set for an integrated digital television set and/or digital recorder).

The ASO is a government initiated policy, aiming at gaining spectrum efficiency which will bring consumer benefits (more choice in television channels and services) and industry benefits (new revenue streams and business models). The key objective in the ASO process is reducing the risks of disenfranchising viewers.

Layer C: Market and business development

Layer C deals with key business issues and choices that Service Providers/Broadcast network operators face when planning the commercial launch of DTTB and MTV services.

It includes a set of business activities and tools for defining the DTTB/MTV service proposition and associated business case and plan, taking into account identified demand drivers, service barriers, financial feasibility and more specifically receiver availability and customer support issues.

This layer is not only intended for *commercial* market parties seeking an acceptable return on their investments, such as DTTB/MTV Service Providers and Broadcast network operators. Also, regulators should acquire an understanding of the key business issues and choices at hand to enable them to define realistic DTTB/MTV policies and licence conditions.

Commercial parties will seek a DTTB or MTV Service Proposition which fulfils a consumer demand that generates sufficient revenues (either advertising or subscription based). In contrast, Public Service Broadcasters (PSB) normally fulfil objectives of public interest in the field of information and culture. That is why they are interested in viewing ratings, high population coverage and mainly prefer unencrypted broadcasting. Market and business development works differently as it has to fulfil primarily 'information and culture' objectives. However, PSBs can also have advertisement-based income so some of the topics addressed in this section might also be relevant for PSBs.

Layer D: Networks

Layer D deals with key issues and choices operators face when planning transmitter networks for broadcasting DTTB and MTV services. Choices in network architecture, frequency planning, network planning, roll out planning and network operation should be made in such a way that the licence conditions are fulfilled and that the business objectives are met. Optimum solutions should be found between, often conflicting, requirements regarding picture and sound quality, coverage quality and transmission costs.

Some of the issues regarding technology choices, frequency planning and network planning may also be relevant to regulators, depending on the roles and responsibilities of the regulator and network operator in a country.

Layer E: Roadmap development

Layer E deals with the development a set of generic roadmaps regarding the whole process of transition to DTTB and introduction of MTV. A roadmap is a plan that matches short-term and long-term goals and indicates the main activities needed to meet these goals.

Developing a roadmap has three major uses:

1. It helps to reach consensus about the requirements and solutions for transition to DTTB and introduction of MTV;
2. It provides a mechanism to help forecast the key milestones for the transition to DTTB and introduction of MTV;
3. It provides a framework to help plan and coordinate the steps needed for transition to DTTB and introduction of MTV.

In the description of the guidelines, a common set of definitions is used with regards to different involved players. Figure 1.2.2 shows the players and related key activities of the government led layers. Figure 1.2.3 shows the value chain of the market players and their related key activities.

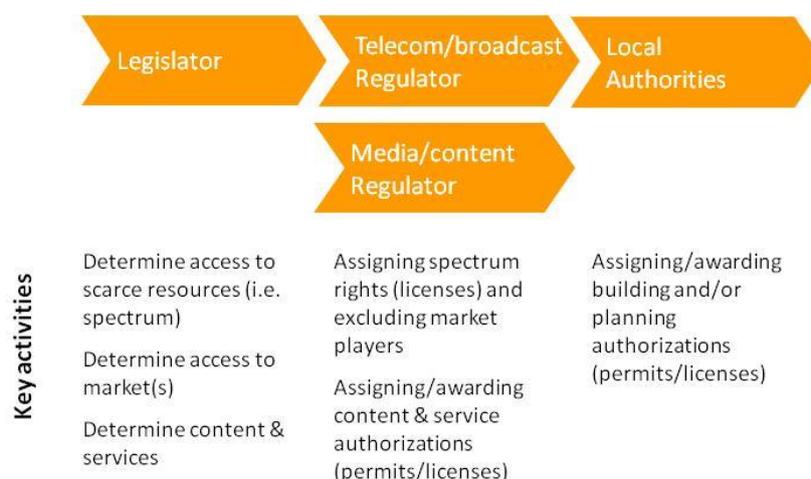


Figure 1.2.2: Players in the government led layers



Figure 1.2.3: Players in the market led layers

It is important to note that in practice one organization may encompass more than one role. For example a broadcaster could carry out all activities of a content creator, content aggregator, multiplex operator, service provider and content distributor. Alternatively, a network operator could have for instance the role of multiplex operator, service provider and content distributor.

1.3 Guidance to readers

1.3.1 Relation between chapters and functional building blocks

The guidelines for the transition to DTTB and introduction of MTV are based on a functional framework consisting of five functional layers:

- A. Policy and regulation;
- B. Analogue switch-off;
- C. Market and business development;
- D. Networks (DTTB and MTV);
- E. Roadmap development.

In each layer a number of functional building blocks have been identified (see chapter 1.2, Figure 1.2.1). For each block, guidelines are described in the chapters of Part 2 to Part 6. Chapters in Part 2 to 6 and the related functional blocks have corresponding numbers.

1.3.2 Structure of the chapters

The report consists of six Parts. Table 1 shows the relation between the Parts and the functional framework as shown in Table 1.3.1.

Table 1.3.1: Structure of the report

Part	Subject	Related layer of functional framework
1	Introduction	–
2	Policy and regulation issues	A and B
3	Market and business development	C
4	DTTB networks	D regarding DTTB
5	MTV networks	D regarding MTV
6	Roadmap development	E

The chapters in Part 2 to Part 6 are structured as follows:

- An introduction of the functional block;
- Sections addressing:
 - ✕ Key topics and choices identified for the functional block;
 - ✕ Implementation guidelines.

In Part 2, 3 and 6 the implementation guidelines have been placed in a section at the end of each chapter. Part 4 and 5 contain a multitude of choices, therefore the implementation guidelines have been placed at the end of each section. In the chapters many examples are given and the provided footnotes give references to sections or paragraph of documents for additional or more detailed information. These documents are also listed in the Bibliography at the end of the report. In addition, some chapters contain one or more appendices, providing more details on certain related issues.

The chapters identify the policy, economic and technology choices to be made and their potential impact on the transition to DTTB and introduction of MTV. The chapters also include practical guidance on the choices to be made. The guidelines are of a general nature and cannot be applied without considering local circumstances and the status of DTTB or MTV implementation in each individual country. Nevertheless, in a number of cases a generic choice is given that suits best in most practical circumstances, or alternatively, the best model is provided for some practical circumstances.

1.3.3 Use of the Guidelines

In developing the national roadmap, the relevant functional building blocks should be selected taking into account the local situation, the responsibility of the players involved and the status of DTTB and MTV implementation.

The last three chapters (6.1, 6.2 and 6.3) provide roadmaps for the following generic cases:

- Transition to DTTB and introduction of MTV by a regulator;
- Transition to DTTB by an operator;
- Introduction of MTV by an operator.

Finally the choices identified in the relevant guidelines should be considered and the associated activities carried out. In the description of the roadmaps in chapters 6.1, 6.2 and 6.3 the main activities related to the selected functional blocks are indicated.

Figure 1.3.1 shows a conceptual block diagram of the Guidelines.

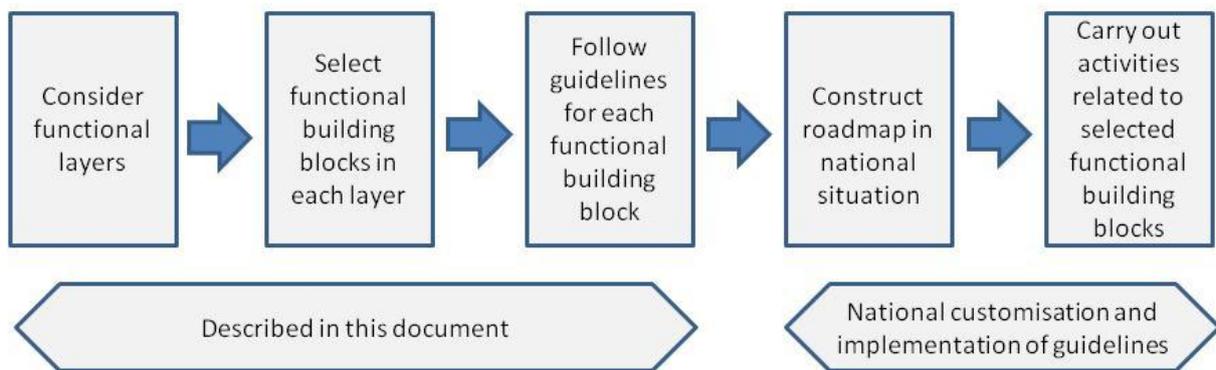


Figure 1.3.1: Conceptual block diagram of the guidelines

There is no need to read the guidelines in Part 2 to 6 in sequential order. The reader can take the chapters or functional blocks of his or her interest. Relationships with other chapters are indicated in the text. Furthermore the example roadmaps in Part 6 show how the various functional building blocks interrelate.

1.3.4 Application of the Guidelines to other regions

The Guidelines prepared for Africa take into account the provisions of the GE06 Agreement. In principle the Guidelines are applicable in the whole of the GE06 planning area⁵. The Guidelines could also be applied in countries outside the GE06 planning area, but provisions of other appropriate regulations, instead of GE06, should be taken into account.

The amendments to these guidelines in this report address the different digital migration considerations applicable to the Asia-Pacific region.

Furthermore, it is noted that:

- Many of the referenced documents originate from Europe (EBU, DVB, DigiTAG);

⁵ The planning area of GE06 Agreement covers Region 1 (parts of Region 1 situated to the west of meridian 170° E and to the north of parallel 40° S, except the territory of Mongolia) and in the Islamic Republic of Iran.

- In Region 2 and 3, DTTB systems and some technical parameters may be different e.g. channel bandwidth;
- A number of guidelines are based on the transmission standards for DVB-T, DVB-H or T-DMB. The revisions contained in this version of the Guidelines incorporate references to the other systems used in the Asia-Pacific region (notably China DTV standard, ISDB-T used in Japan and many parts of South America, and the ATSC standard used in the Democratic Republic of Korea).

The table below shows the applicability of the chapters outside the GE06 planning area by categorizing the chapters into three types:

1. Chapter fully applicable, guidelines are independent of the GE06 provisions;
2. Chapter applicable, but contains examples that relate to GE06, these examples may not be relevant outside the GE06 planning area;
3. Chapter partly applicable, some of the guidelines are based on the application of GE06 provisions.

Table 1.3.2: Applicability of guidelines outside the GE06 planning area

Part	Chapter	Title	Application category From Original Guidelines	Application category of the version adapted for the Asia Pacific Region
2	Guidelines regarding policy and regulation issues			
	2.1	Technology and standards regulation	1	1
	2.2	Licensing framework	1	1
	2.3	ITU-R regulations	3	3
	2.4	National spectrum plan	2	2
	2.5	Assignment procedures	1	1
	2.6	License terms and conditions	1	1
	2.7	Local permits (building and planning)	1	1
	2.8	Media permits and authorizations	1	1
	2.9	Business models and public financing	1	1
	2.10	Digital dividend	2	2
	2.11	National telecom, broadcast and media acts	1	1
	2.12	Law enforcement and execution	1	1
	2.13	Communication to consumers and industry	1	1
	2.14	ASO transition models	1	1
	2.15	ASO organizational structure and entities	1	1
	2.16	ASO planning and milestones	1	1
	2.17	ASO infra and spectrum compatibility	1	1
	2.18	ASO Communication plan	1	1
3	Guidelines regarding market and business development			
	3.1	Customer insight and research	1	1
	3.2	Customer proposition	1	1
	3.3	Receiver availability considerations	1	1

Part	Chapter	Title	Application category From Original Guidelines	Application category of the version adapted for the Asia Pacific Region
	3.4	Business planning	1	1
	3.5	End consumer support	1	1
4	Guidelines regarding DTTB networks			
	4.1	Technology and standards application	3	3
	4.2	Design principles and network architecture	3	3
	4.3	Network planning	3	3
	4.4	System parameters	2	2
	4.5	Radiation characteristics	2	2
	4.6	Network interfacing	1	1
	4.7	Shared and common design principles	1	1
	4.8	Transmitting equipment availability	1	1
	4.9	Network roll-out planning	1	1
5	Guidelines regarding MTV Networks			
	5.1	Technology and standards application	2	2
	5.2	Design principles and network architecture	3	3
	5.3	Network planning	3	3
	5.4	System parameters	1	1
	5.5	Radiation characteristics	2	2
	5.6	Network interfacing and studio facilities	1	1
	5.7	Shared and common design principles	1	1
	5.8	Transmitting equipment availability	1	1
	5.9	Network roll-out planning	1	1
6	Roadmap development			
	6.1	Roadmap example for regulators	2	2
	6.2	Roadmap example for transition to DTTB by a network operator	2	2
	6.3	Roadmap example for introduction MTV by a network operator	2	2

1.4 Advantage of digital broadcasting transition

Transition to digital TV is a government initiated policy, aiming at gaining *spectrum efficiency*⁶ which will bring *consumer benefits* (more choice in television channels and services) and *industry benefits* (new revenue streams and business models):

⁶ ASO spectrum efficiency may result in freeing up spectrum, the so-called Digital Dividend (see section 2.10).

by digital technology. In a given frequency channel, it is possible to broadcast between four to eight programme channels (as compared to one in an analogue network)⁷. The more efficient use of spectrum means that some capacity is freed up, the so-called digital dividend⁸, and is available for new services (either new broadcast services or fixed/mobile services). To ensure the maximum benefits of digital switchover, countries in a given region should agree to convert to digital broadcasting, if possible through a coordinated frequency plan. Europe, Africa and parts of Asia have agreed to such a plan: the Geneva 2006 agreement (GE06)⁹.

2. *Customer benefits*: The customer benefits derive primarily from the possibility of digital processing and compression, making much more efficient use of the network's capacity. The key benefits include (as compared to analogue television broadcasts):
- *Wider choice* in TV and radio channels;
 - *Improved picture* and sound quality (depending on the system settings);
 - *Greater flexibility* due to portable and mobile reception (in case of a DTTB network designed for indoor-reception only a 15 cm small receiver antenna is needed; in case of a MTV network the antenna is 'folded-up' into the battery pack of the mobile phone);
 - *Enhanced information services* including the Electronic Programming Guide, enhanced 'teletext' services (with enhanced graphics)¹⁰ and, where a return path is available, a wide range of interactive services like video-on-demand, e-banking, e-learning, etc.¹¹;
 - *Future innovative services and lower prices*: increasing market competition and innovation thanks to the potential arrival of new entrants at different levels in the value-chain, for instance new service providers, broadcasters, network operators or developers of interactive applications. In addition, switchover implies specific benefits for some categories of market players: easier storage/processing of content and reduction of transmission costs. Lower prices (per channel) for the end-consumer are possible. International studies have shown that DTTB networks are inherently cheaper than the other two major competing platforms satellite and cable, depending on:
 - The required geographical coverage: near 100 per cent coverage will exorbitantly drive-up the DTTB network costs;
 - Market structure: i.e. will the DTTB provider pass on the improved margin to the end-consumer), and;

⁷ The exact number of channels depends mainly on the desired picture quality, robustness of the signal, compression technology and type of multiplexing (constant bit rate or statistical multiplexing). For more details see sections 4.1 and 4.4.

⁸ See section 2.10 "Digital Dividend".

⁹ See section 2.3 "ITU-R Regulations".

¹⁰ See for more details section 4.1 "Technology and Standards Application".

¹¹ Several set-top-boxes are available on the market with a combined DTTB tuner (e.g. DVB-T) and xDSL modem. The return traffic is handled through the xDSL modem. Especially triple-play providers, like telecom providers, are looking into the possibilities of such an integrated approach. For example, the most popular television channels are delivered through the DTTB network and more individual service, like video-on-demand or theme channels, are delivered through the xDSL network.

- Type of network roll-out: a network designed for rooftop antennas is cheaper than an indoor-antenna based network¹².
3. *Industry benefits:* With the introduction of DTTB networks a new industry has arisen. A new industry producing:
- Pay-tv services: DTTB networks can easily facilitate a full bouquet of services and incorporate a paying/billing system (i.e. Conditional Access System);
 - New transmitter networks: including new transmitters, antennas and transport networks;
 - New receiver devices: several devices are being produced in the current market, including set-top-boxes, PC-card integrated receivers, USB-based receivers and Integrated Digital Television sets (IDTVs). The growth and size of the global set-top-box market is represented in the figure below¹³;
 - Conditional Access Systems: the market comprises already 10 global players delivering integrated systems (head-end encryption and smart-card decryption)¹⁴.

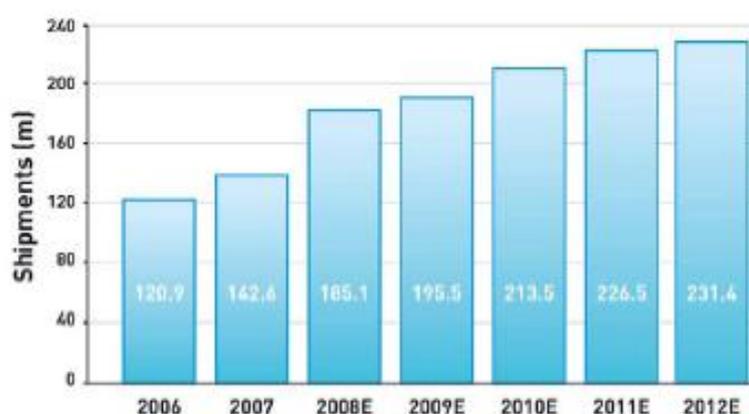


Figure 1.4.1: Global set-top-box market

1.5 Status of digital switch-over

Digital terrestrial television has been introduced in many countries in all Regions and several countries have started switching off analogue TV services. In a number of countries switch-off of analogue terrestrial TV services has been completed, notably:

- The Netherlands (2006);
- Sweden (2007);
- Finland (2007);
- Germany (2008);
- Switzerland (2008);
- USA (2009).

At the time of writing the revisions for the Asia Pacific region (November 2010), no country in the Asia Pacific had completed analogue switch off. Australia has commenced switch-off and both Australia and New-Zealand have targeted switch off to be completed by the end of 2013. South

¹² CDG Eurostudy, "Digital Terrestrial Television in Europe, the Dynamics of Transition", 1998.

¹³ See Pace corporate website: "Analyst briefing of 19 June 2008".

¹⁴ See footnote 13.

Korea was amongst the earliest adopters of digital transmission and uses the ATSC system; Singapore was also amongst the early adopters of digital broadcasts. Others such as China, and Japan have taken longer and have developed systems suited to their specific needs (China DTV, and ISDB - Japan). Other countries have commenced trials or simulcast (e.g. Cambodia, Sri Lanka, Marshall Islands, Malaysia, and Brunei) and a number have set provisional dates for completion of switch-over.

The digital terrestrial television market is growing fast and information on the status of digital switch-over needs regular updates. For up to date and detailed information on DTTB and MTV implementation in a great number of countries the following websites can be consulted:

- DVB¹⁵
Information on adoption and deployment of DVB-T, in some cases information regarding other DVB standards is also provided.
- DVB¹⁶
Information on DVB-H implementation.
- DigiTAG¹⁷
Information on DTTB and MTV implementation.
- WorldDMB¹⁸
Information on implementation of DAB, DAB+ and DMB .
- China DTV System.¹⁹
- ISDB-T (Japan)²⁰

Detailed technical information on DTTB implementation in a number of countries in Region 1, 2 and 3 is also given in Report ITU-R BT. 2140²¹.

In addition to the information that can be obtained from the sources indicated above, information on digital switch-over in Africa is available from feasibility studies on DTTB and MTV that were carried out from January 2008 to July 2008. To this end a questionnaire was developed and circulated within African countries to explore the African Broadcasters requirements and programmes in shifting from Analogue to DTTB and MTV Broadcasting. ITU has received positive reply from 22 countries. The results are summarized below:

Table 1.5.1: DTTB and MTV implementation in Africa

Time period	Number of countries		
	DTTB introduction	MTV introduction	End of transition
Until 2010	9	6	1
Until 2015	1	0	8
Until 2020	1	1	9

¹⁵ See www.dvb.org/about_dvb/dvb_worldwide/index.xml

¹⁶ See www.dvb-h.org/services.htm

¹⁷ See www.digitag.org/

¹⁸ See www.worlddab.org/country_information

¹⁹ See <http://sac.gov.cn> also www.dvb.org country updates

²⁰ See <http://dibeg.org.jp> for deployment and other information about ISDB-T and One Seg (the MTV implementation of ISDB-T)

²¹ Report ITU-R BT.2140, Transition from analogue to digital terrestrial broadcasting; appendix 1 to part 1 and appendix 1 to part 2.

From a similar survey carried out in the Asia–Pacific region the following results were obtained: information on the digital switch-over in the Asia-Pacific region has been compiled from a questionnaire circulated within Asia-Pacific countries in October 2011 to explore Asia-Pacific governments and broadcasters requirements and programmes in shifting from analogue to DTTB and MTV broadcasting. ITU received useful responses from 17 countries but received few responses from the largest countries in the region. Particularly those which have already established digital services and are well advanced with migration planning. Information on the current state of migration in the following tables is therefore incomplete and mostly reflects the position of developing countries in the region. Some adjustments have been made to reflect known status of other countries in the region.

Table 1.5.2: DTTB and MTV implementation in Asia-Pacific

Time Period	Number of Countries		
	DTTB Introduction	MTV Introduction	End of Transition
Until 2010	10	5	0
Until 2015	4 (Number of starts may be higher)	?	5
Until 2020	10 (Speculative estimate)	?	3
Beyond 2020	Some very small countries may be	?	10

Only a few countries have commenced or have considered MTV services, amongst the majority of those responding to the survey, MTV has lower priority than migration of analogue services at this time. As MTV is more likely to interest the more advanced countries, the lack of responses in the above table simply reflects the absence of responses from those countries.

Note that the end of transition stipulated in the Geneva 2006 Agreement does not apply to the Asia-Pacific region. No end of transition date has yet been agreed for the Asia-Pacific. Many of the smaller countries have yet to address the question and lack the resources to progress migration. The above table is somewhat speculative on later years and assumes that the pressure to migrate will come from the eventual difficulties in obtaining analogue receivers amongst other things, even where there are no other pressures. In many of these countries spectrum demand is not a driving factor as they use small local transmitters, have no close neighbours, and their immediate economic priorities lie elsewhere. For many satellite delivery may eventually prove to be the most cost effective option.

From the information on DTTB and MTV implementation referred to above, it can be concluded that digital terrestrial broadcasting is implemented in all Regions. In a number of countries analogue switch-off process has started and in some countries analogue switch-off has been completed.

The implementation differs from country to country. In most countries a large package of television services, sometimes extended with digital radio services, is offered with fixed antennas on the roof.

In other countries, the emphasis is on portable indoor reception. Some countries have started HDTV services on the terrestrial platform and many countries plan to do so in the coming years.

Digital terrestrial television has proven its success. Those countries that have not started yet to prepare DTTB and MTV introduction are advised to do so, sooner rather than later, taking into account the end of transition stipulated in the Geneva 2006 Agreement (for those countries covered by this agreement).

Noting the priority given by WTDC-10 for the development of migration plans for the Asia-Pacific, countries in the Asia-Pacific need to formulate their plans around economic, service, and spectrum considerations discussed later in these guidelines. With the rapid transition of many countries to digital, the pace of migration of professional and consumer equipment to digital will accelerate, and analogue equipment will become progressively more expensive and less readily available. Already, rapid falls in the price of digital equipment have taken place as more countries move to digital technology.

Glossary of abbreviations

ASO	Analogue Switch-Off
CAS	Conditional Access System
DAB	Digital Audio Broadcasting
DAB+	Digital Audio Broadcasting, improved system
DigiTAG	Digital Terrestrial Action Group
DMB	Digital Multimedia Broadcasting
DTTB	Digital Terrestrial Broadcasting
DVB	Digital Video Broadcasting
DVB-T	Digital Video Broadcasting - Terrestrial
DVB-H	Digital Video Broadcasting - Handheld
EBU	European Broadcasting Union
GE06	Geneva Agreement of 2006
IDTV	Integrated Digital TV set
ITU	International Telecommunication Union
ITU/BDT	International Telecommunication Union/Telecommunication Development Bureau
ITU-D	International Telecommunication Union – Development sector
MTV	Mobile Television
PSB	Public Service Broadcaster
SMS	Subscriber Management system
T-DMB	Terrestrial – Digital Multimedia Broadcasting
USB	Universal Serial Bus
WTDC-06	World Telecommunication Development Conference in 2006

Part 2

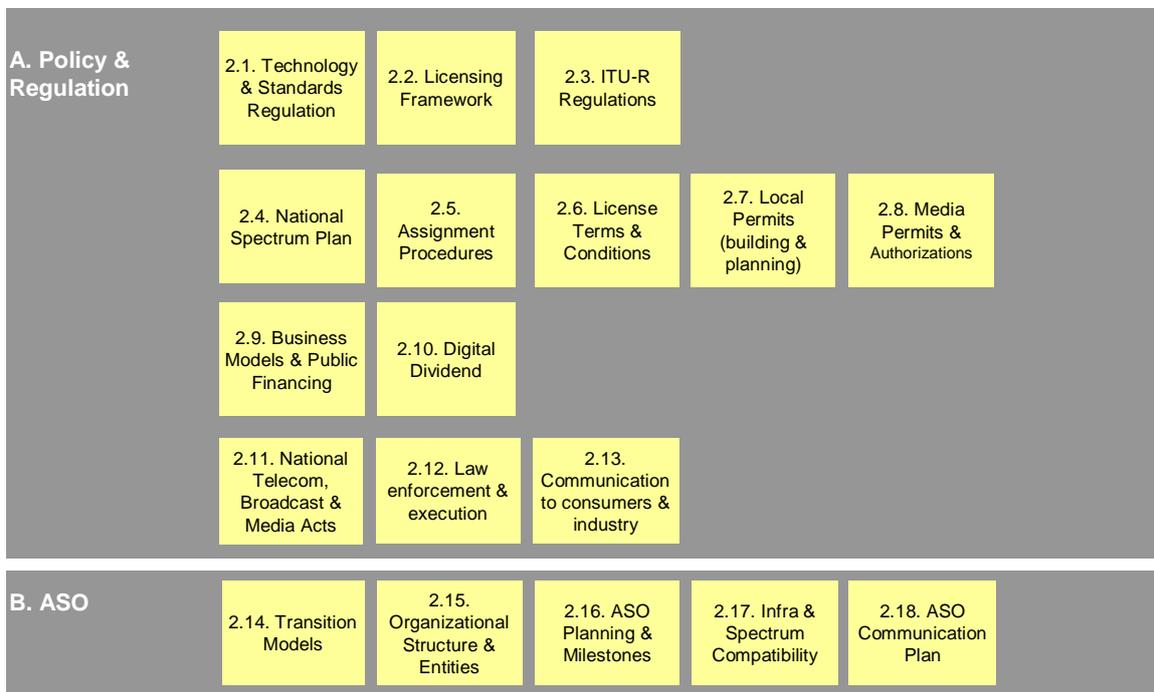
Policy and regulation

Introduction

This part of the Guidelines will provide an overview of the key issues and choices the regulator faces when either formulating Digital Terrestrial Television Broadcasting (DTTB), Mobile Television (MTV) or Analogue switch-off (ASO) policy objectives. In striving for a rapid service up-take and development of the DTTB and MTV markets, the regulator will implement such policies by issuing information, funds, rights, licences and permits to (qualified) market parties in compliance with the relevant Legislation.

This part comprises 18 chapters and each chapter corresponds with the sections of the detailed functional framework, as depicted in the figure below. Each chapter is concluded with implementation guidelines assisting the regulator in making the right trade-offs, applicable to the local situation.

Because of the specific nature and the one-off character of the ASO, this process is dealt with in five separate and consecutive chapters (sections 2.14 – 2.18), which can be read independently from the other chapters in this part.



2.1 Technology and standards regulations

In this section the key *policy* decisions are outlined on adopting or promoting DTTB/MTV technology and associated standards.

Regulators setting standards for DTTB/MTV services aim to achieve interoperability, economies of scale or safeguarding *Universal Services* (for example High Definition Television – HDTV has to be provided)¹. However, setting standards can have a downside too. Careful consideration is required, taking into account local market dynamics and balancing the different pros and cons.

In any policy decision on setting standards, a technical evaluation of the different options available, should be included. For this technical evaluation we refer to section 4.1 for DTTB networks and 5.1 for MTV networks. This section deals with the question whether a standard should be prescribed/promoted and for what system/network elements.

This section is split into three parts:

1. Technology and standards policy trade-offs: policy considerations on DTTB and MTV standards;
2. Technology and standards choices for DTTB and MTV: specific technology choices to be made in regulating the DTTB and MTV markets;
3. Implementation guidelines.

2.1.1 Technology and standards policy trade-offs

Although choosing one single model for setting standards has the benefit of clarity, regulators must very often strike a balance between two basic models:

1. Mandating single technologies and standards: this model will deliver full harmonization and hence the largest possibilities for reaping the benefits of economies of scale and interoperability, or;
2. Leaving service development entirely to the market: this model will deliver maximum consumer choice.

Traditionally there is strong pressure on regulators for both models, from different sides of the industry. However, between the advocates of both strands there is also a common recognition of the downside of both options:

1. The mandating of technologies and standards – picking a winner by regulation – presents high risks of selecting the wrong standard and hence hampering innovation as well as service roll out and take up;
2. Complete absence of harmonization can increase the risks of unduly favouring first-movers (e.g. those acquiring a licence first) and technology-led market power. Once such market power is established, regulation can be imposed only by bearing high costs (e.g. for expropriating investors). Moreover, absence of harmonization can lead to (too) fragmented markets, especially for small home markets (and this applies to almost any country considering the global scale of broadcast and telecoms markets for receiver equipment).

¹ For more details on Universal Service and Universal Access see www.ictregulationtoolkit.org, module 4, *Infodev/ITU*.

As a DTTB or a MTV network comprises several elements, it is important to distinguish the key system elements (see also section 4.1). The following key network elements can be distinguished:

1. *Television presentation formats*: for DTTB platforms either Standard Definition Television (SDTV) and/or High Definition Television (HDTV) and for MTV platforms a minimum bit rate per service;
2. *Transmission standard*: for DTTB platforms e.g. DVB-T, ATSC China DTV, or ISDB-T and for MTV platforms DVB-H T-DMB, OneSEG, or MediaFlo;
3. *Compression technology*: for DTTB platforms MPEG2 or MPEG4 and for MTV platforms e.g. H264/MPEG-4 AVC or open;
4. *Conditional Access (CA) system and Digital Rights Management (DRM)*: interoperability between deployed systems for respectively DTTB and MTV platforms;
5. *Application Programming Interface (API)* for additional and interactive services: for DTTB platforms e.g. MHP or proprietary and for MTV platforms specific technical requirements to support integration between broadcast TV and 3G mobile TV networks.

Observing the different DTTB and MTV markets, it can be concluded that, in most cases, the regulator strikes a balance by not prescribing or recommending technologies/standards for all system/network elements but only for selected elements. For example, the regulator only prescribes the transmission standard (e.g. DVB-T) but leaves the television presentation format (either SDTV or HDTV) to the market to decide. The regulator tends to prescribe a minimum set of standards so as to leave room for entrepreneurship in developing new services.

In addition, the regulator may not lay down standards for all multiplexes but only for a selected number of multiplexes. For example, the regulator prescribes one multiplex to be operated on the basis of the DVB-H transmissions standard (for the provision of a MTV service) and leaves the rest of the available multiplexes technology neutral. In such a case the licence holder is free to allocate the remaining multiplexes either to a DTTB service or to the MTV services for additional capacity (e.g. more services/channels, better picture quality, etc). Although unlikely, the licence holder could possibly decide to allocate the remaining capacity for MTV services on the basis of a different standard (e.g. like T-DMB).

Observing the licensing of DTTB and MTV services, the intervention of regulators is still justified if:

1. There is a serious risk of *market failure*. The risk of market failure can be higher in situations when:
 - a. Market fragmentation results in too small *local* markets (especially relevant for relatively small local markets), the following examples can be given:
 - i. Early market launches with set standards could result in a market with multiple standards with high consumer switching costs;
 - ii. Lack of co-ordination between operator bids – for example each bidder will not know the technology choice of others and this could lead to an outcome where there are two different technologies used in the market. This could reduce competition between service providers by increasing end-user switching costs. Customers would need to buy a terminal which uses a rival standard when switching service provider;

- b. Lack of competition², the following examples can be given:
 - i. No open wholesale model and/or lack of several licences – for example if there is only spectrum available for one licence holder and no specific rules are in place for open and fair access to the DTTB/MTV platform (i.e. wholesale model). Such a situation could limit competition between DTTB/MTV service providers as they do not have equal or fair access to the DTTB/MTV platform;
 - ii. Manufacturers of a technology are heavily subsidizing network equipment prices as to chance technology choices. While there may be short term benefits, this may not be, in the longer term, in the interests of consumers if the technology is not open or well supported;
- 2. There are significant *public interest* considerations. Protecting the public interest can play an important role if:
 - a. DTTB or MTV services are defined or considered as a Universal Service and there is a risk of *consumer confusion*. In general DTTB services are considered to be a Universal Service. In contrast, in most cases, MTV is not considered to be Universal Service (yet), even in countries like Japan and Korea where MTV services are provided free-to-air³. The risk of consumer confusion is especially high if:
 - i. DTTB licensing is linked to the Analogue switch-off (ASO), the process of turning off the analogue terrestrial television signal and replacing it with a digital signal. In these circumstances, the viewers have to choose a new digital television service and consumer choice should be limited;
 - ii. Other digital services are already operational – for example, the public broadcaster already broadcasts a DTTB service and has adopted a transmission standard. Launching commercial DTTB service on a different standard could seriously confuse the viewer as they expect a comprehensive television offering including both public and commercial channels;
 - b. DTTB (or MTV) services are defined or considered as a Universal Service and the service should be affordable for the largest population possible (hence the lowest prices). Especially in small local markets this could be an important consideration. Setting a standard could help to avoid local market fragmentation and to reap the benefits of a worldwide adopted standard (i.e. economies of scale);
 - c. Spectrum efficiency is required. Although regulators always strive for spectrum efficiency, setting a standard might be considered if:
 - i. An inappropriate standard would result in significant spectrum loss – for example adopting a certain standard in Region 1 (which includes Africa) leads to spectrum inefficiencies if the standard uses a different channel raster and carrier type (see for more details section 4.1);
 - ii. Multiple standards would result in significant spectrum inefficiencies. For example, in the case no wholesale model is in place and content is duplicated on different DTTB/MTV multiplexes. Especially when available

² It is important to define the relevant market. This could be different between the DTTB and MTV markets. In general, the DTTB services operate in a market with several other players/platforms offering similar services. In the MTV market the relevant market is considered to be smaller.

³ For guidelines on defining DTTB and MTV as Universal Services see section 2.1 and 2.2.3.

spectrum is very limited, given the demand of broadcasters, setting a single standard could be considered.

2.1.2 Technology and standards choices for DTTB and MTV

The table below provides an overview of the different technology/standards choices regulators made when licensing *DTTB* services. The following key network elements have been distinguished (see also section 4.1):

1. Television presentation formats (i.e. SDTV and/or HDTV or neutral);
2. Transmission standard (e.g. DVB-T or neutral);
3. Compression technology (i.e. MPEG2 and/or MPEG4 or neutral);
4. Digital Rights Management (DRM) or Conditional Access (CA) system (i.e. interoperability between deployed systems);
5. Application Programming Interface (API) for additional and interactive services (e.g. MHP).

Table 2.1.1: Technology regulation for DTTB networks.

Country	TV presentation format	Transmission standard	Compression technology	DRM/CAS	Additional Services
Belgium ⁴	Neutral	S	Neutral	Neutral	Neutral
Denmark ⁵	R	S	Neutral	Neutral	Neutral
Finland ⁵	Neutral	S	Neutral	Neutral	Neutral
France ⁵	S	S	S	Neutral	Neutral
Germany ⁵	Neutral	S	Neutral	Neutral	Neutral
Korea	S	S	S	Neutral	Neutral
Netherlands ⁶	Neutral	S	Neutral	Neutral	Neutral
Spain ⁵	Neutral	S	Neutral	Neutral	R
Sweden ⁵	Neutral	S	Neutral	Neutral	S
UK ⁷	Neutral	S	Neutral	Neutral	Neutral
US ⁸	S	S	Neutral	Neutral	Neutral
S = Stipulated R = Recommended					

As the above table shows, regulators only tend to set standards for television presentation formats and transmission standards. Please also note that the introduction dates of the DTTB services in the various countries vary significantly. Countries like Sweden, UK, Spain and the Netherlands were

⁴ See State publications in 'Belgisch Staatsblad' no 2008-3603 (Decision of 18 July 2008) and no. 2008-4155 (Decision of 17 October 2008), respectively the licensing procedure and licence terms and conditions.

⁵ See country reports on www.digitag.org and www.dvb.org

⁶ See State publications in 'Staatscourant' of 4 July 2001 (no. MLB/JZ/2001/28.179) and 31 January (no. 2002/IVWT/691808), respectively the licensing procedure and licence terms and conditions.

⁷ See multiplex licences on www.ofcom.org.uk/tv/ifi/tvlicensing/muxlicensees/.

⁸ See FCC's Third Periodic Review of the Commission's Rules and Policies Affecting the conversion to Digital Television, December 31, 2007 on www.fcc.gov.

countries to introduce early (before 2004 and GE06). At that time discussions on television presentation formats and compression technologies were not contemporary topics.

The table below provides an overview of the different technology/standards regulations for MTV services. The following key network elements have been distinguished (see also section 5.1):

1. Television presentation format (i.e. minimum required bit rate per service);
2. Transmission standard (e.g. DVB-H and/or T-DMB or neutral);
3. Compression technology (e.g. H264/MPEG-4 AVC or neutral)
4. Digital Rights Management (DRM) or Conditional Access (CA) system (i.e. interoperability between deployed systems);
5. Service integration and additional services (i.e. technical requirements to support integration between broadcast TV and 3G mobile TV and for development of additional/interactive services).

Table 2.1.2: Technology regulation for MTV networks

Country	TV presentation (min. bit rate)	Transmission standard	Compression technology	DRM/CAS	Service Integration
Austria ⁹	S ¹⁰	R	Neutral	Neutral	Neutral
Belgium ¹¹	Neutral	S	Neutral	Neutral	Neutral
Denmark ⁹	Neutral	S	Neutral	Neutral	Neutral
Finland ⁹	Neutral	S	Neutral	Neutral	Neutral
France ⁹	S ¹²	S	Neutral	Neutral	Neutral
Germany ⁹	Neutral	S ¹³	Neutral	Neutral	Neutral
Italy ¹⁴	Neutral	S	Neutral	Neutral	Neutral
Korea	S	S	S	R	Neutral
Netherlands	Neutral	S ¹⁵	Neutral	Neutral	Neutral
Switzerland	Neutral	R	Neutral	Neutral	Neutral
US	Neutral	Neutral	Neutral	Neutral	Neutral
S = Stipulated R = Recommended					

⁹ See country information on Services on www.dvb-h.org/services.htm.

¹⁰ In Austria, the regulator required a description of minimum bit rate per service in the tender. Any change of the system parameters has to be announced to the regulator

¹¹ See State publications in 'Belgisch Staatsblad' no 2008-3603 (Decision of 18th of July 2008) and no. 2008-4155 (Decision of 17th of October 2008), respectively the licensing procedure and licence terms and conditions

¹² In France, the regulator specified the modulation profile and the number of TV programs (16) assuming an average of 250 kbps for each. But this has been the result of a consensus among interested parties resulting from the consultation phase prior to the tender.

¹³ In Germany, two technology-specific licences have been granted, one for T-DMB and the other for DVB-H.

¹⁴ In both Italy and the Netherlands, no special MTV licences were assigned as the current DTTB licences could be used to deploy MTV services.

¹⁵ In such a way that the DTTB licence was a licence to operate a DVB system and hence the DVB-H standard had to be adopted.

As the above table shows, regulators tend to stipulate only the transmission standard for MTV services. Also, in some cases, the minimal bit rate per service is regulated (as in Austria, France and Korea).

2.1.3 Implementation guidelines

The following *general* guidance can be provided for regulating technologies and standards for DTTB and MTV services:

1. In general, when licensing DTTB and MTV services only set standards, if:
 - a. A significant risk of market failure is expected (see above text), and/or;
 - b. Safeguarding public interests/Universal Services is required (see above text);
2. If deemed necessary to stipulate standards, only set a minimum of standards closely related to the policy objectives and only for those system elements that support the set objectives. Setting standards is aimed at achieving interoperability, economies of scale, and safeguarding Universal Services. Consequently, regulate only the system elements that contribute to those objectives. Such an approach implies for example:
 - a. Regulating only the transmission standard and not the television presentation format, if HDTV is deemed not to be part of the Universal Service. For example, in several countries, the licence holder is free to determine whether HDTV services are going to be included in the service bouquet. In contrast, in France one of the DTTB multiplex (for pay television services) was required to carry HDTV services;
 - b. Regulating only the Application Programming Interface (e.g. MHP for DTTB platforms), if additional services (like interactive applications such games, enhanced EPGs and banking services) are required to operate across DTTB multiplexes and even across platforms. In Spain and Sweden such requirements were respectively recommended or stipulated¹⁶;
3. Check the necessity of (additional) standard setting. Check the applicable (international) regulatory framework on interoperability and open access to platforms. For example, in Europe the Regulatory Framework for Electronic Communications provides already a good basis for regulating interoperability and open access, limiting the necessity for local regulators to set standards for achieving these objectives;
4. Consider other regulatory instruments as well. For example, it might be uncertain whether market distortions will occur (fragmented markets and high switching costs). One way of addressing these problems without prescribing operators' choices would be to evaluate multiplex licence bids with reference to criteria such as:
 - a. The promotion of service competition;
 - b. Low end user switching costs and;
 - c. The existence of competitive, low cost, handsets;

¹⁶ The current trend on setting API standards is that they are considered unnecessary for DTTB services as the uptake and possibility of additional services is limited and DTTB multiplexes are very often operated by a single operator having a common API across the multiplexes.

5. Either set a standard or do nothing. Avoid actively *promoting* standards as industry pressure will unavoidably force the regulator in the situation to promote all standards and this will increase¹⁷:
 - a. Confusion in end-consumer markets and;
 - b. Confusion in the market for network equipment and content/service providers.

The following *specific* guidance can be provided for regulating technologies/standards for DTTB services:

1. In the area covered by GEO6, stipulate the DVB-T transmission standard for new DTTB services because safeguarding the public interest (Universal Service) will be required *and* there is only a small down side risk of setting the wrong DTTB transmission standard:
 - a. Setting a single standard will provide clarity in the market and will reduce consumer confusion as most African countries still have to realize the ASO. For a successful ASO consumer choice should be limited and the ASO process itself manageable (not two or more DTTB transmission standards);
 - b. Stipulating the DVB-T standard is in line with GEO6 Agreement. Although different standards are possible under the GEO6 Agreement, some standards will require extra spectrum coordination efforts (which will be lengthy and require cooperation of neighbouring countries) and may result in spectrum inefficiencies. Consequently, setting a different standard may result in DTTB service delays and hamper the continuation of the Universal Service for television;
 - c. Setting the DVB-T standard will provide the largest possible economies of scale as DVB-T is the most widely adopted standard for DTTB services¹⁸. Consequently, this will result in:
 - i. The lowest equipment prices (transmitter networks and receivers), making DTTB services affordable for the largest population possible;
 - ii. The largest receiver availability: offering consumer choice for viewers and receiver choice for service providers (especially for having various options for embedded conditional access system¹⁹);
- 1A. In the Asia Pacific, China, Japan, and Korea have adopted systems other than DVB-T and have substantial consumer equipment markets that make these choices effective. Outside of these areas DVB-T is the most widely adopted standard. Countries in the Asia Pacific region can be guided by the principles stated in paragraph 1 a-c above when making system choices. Smaller countries within the Asia Pacific region will need to consider decisions made by larger bordering neighbours, the costs to consumers, and the availability of professional and consumer technical supply, maintenance and spares support in their country.

¹⁷ See the EC Commission statements around the introduction of mobile television in Europe. Initially the statement was “Member States will be required to encourage the use of DVB-H”. Under industry pressure, this statement was changed into “The objective of full interoperability across networks and devices remains important. Developments in the market have shown that interoperability can be achieved when stakeholders act together with a common aim of implementing a technical standard such as DVB-H”.

¹⁸ See the websites of Digitag and the DVB organization, respectively www.digitag.org and www.dvb.org.

¹⁹ Embedded Conditional Access Systems are cheaper than having the Common Interface solution (see also section 4.1.).

2. Reconsider setting the DVB-T transmission standard only in circumstances where:
 - a. The planned time of licensing new DTTB services (perhaps as far as beyond 2015/20) is close to the time that different standards will be available and are proven technologies (e.g. DVB-T2 receivers, mass market quantities are expected as from 2012);
 - b. One or more market players, having a significant market share, operate their DTTB service on a different transmission standard and the regulator requires an integrated bouquet of services in the market (i.e. consumers can view all the available DTTB channels with one single receiver), or;
 - c. The local market is considered large enough to offer economies of scale, even with two or more different standards in the market and the regulator considers consumer choice of paramount importance;

These factors have direct relevance to countries in the Asia Pacific when considering any of the available standards used in the region. For many countries in the Asia Pacific their expected timetables for their migration will allow them to make a better assessment about the take-up costs and other factors that may influence them to consider alternatives to the DVB-T standard or its later variants (e.g. DVB-T2);

3. In markets where only one DTTB multiplex operator will be operational (as for example in Finland and Belgium), the risk of having a fragmented local market is less likely and from this point of view setting a transmission standard might not be necessary (not considering avoiding consumer confusion). In such circumstances, the regulator could consider a more technology neutral stance. For example, the regulator could issue a DVB licence. Allowing the licensing holder to deploy a network on the basis of newly released standards like the DVB-T2 transmission standard²⁰. However, regulators should in general adopt a single consumer standard for DTTB for free-to-air services so that consumers can gain access to these services at lowest cost and inconvenience;
4. Only set additional standards for the television presentation format (i.e. HDTV) and compression technology when these are deemed to be necessary because:
 - a. The regulator considers HDTV formats an essential part of a Universal Service and does not believe market players will introduce these services autonomously (given the local market structure), and;
 - b. The regulator believes that having different non-compatible compression technologies (like MPEG 2 and 4)²¹ in the market, will result in consumer confusion²²;
 - c. For countries in the Asia Pacific who have not yet adopted a compression standard, the fairly rapid development of MPEG4 equipment, which can also receive MPEG2 is likely to open up the opportunity for them to consider whether the higher bandwidth efficiency of MPEG4 should be adopted (given the cost differentials will fall rapidly as this technology becomes widespread). Cost and the availability of consumer equipment at lowest cost should be major considerations in this choice for most countries in the region.

²⁰ Such a new deployment would require the Regulator to check whether the network is in line with the assigned spectrum as indicated in the issued DVB licence.

²¹ MPEG 2 receivers cannot handle DTTB services compressed in MPEG4 format.

²² In France, the regulator assigned licences with the requirement to provide television channels in HDTV quality and laid down mandatory standards for integrated digital television sets to include a DVB-T receiver (1st phase) and MPEG4 compression technology (2nd phase). For more detailed information see the website of the Regulator CSA www.csa.fr.

5. Avoid prescribing API standards (like MHP) because (see also Implementation guidelines in previous section):
 - a. The DTTB platform has proven not to be very attractive for developing interactive services. Especially with the increasing number of broadband connections and services in the world, application developers do not tend to develop interactive services for the DTTB platform;
 - b. Laying down such standard requirements will increase receiver prices and might hamper DTTB uptake.
 - c. In Japan requirements such as Content Protection (Digital Rights Management) have been standardized and applied.

The following *specific* guidance can be provided for regulating technologies/standards for *MTV* services:

1. Setting a MTV transmission standard might be justified if:
 - a. In the market several service providers will be or are operational and the risk of local market fragmentation is high because:
 - i. MTV licences are assigned to multiple mobile operators or other service providers (like in Italy), and not to a single multiplex operator having one transmission standard (like in Finland), and;
 - ii. Cooperation between providers is expected to be low and will not be stipulated in the licensing procedure (e.g. in the public tender);
 - b. Interoperability is at risk (i.e. if consumers cannot 'roam' their MTV enabled mobile phone between service providers). Interoperability is important in situations where the market is predominantly a pre-paid market (as opposed to post-paid markets where mobile operators can subsidize handsets to an acceptable retail price level);
2. Provide room for the MTV licence holder to change/alter transmission technology during the course of the licence period because:
 - a. Currently there are several competing transmission standards (like DVB-H, T-DMB OneSEG and MediaFlo) and there is no clear technology 'champion' (yet), and;
 - b. Most of the standards don't have production numbers in place to bring consumer prices down for mass market consumption. Although there are some exceptions like T-DMB and One-Segment terminals which have reached mass numbers in, respectively, Korea and Japan²³;
3. In markets with only one MTV service provider or one MTV multiplex operator (with several service providers), the need for setting a MTV standard so as to avoid *consumer confusion*, increase *interoperability* and *economies of scale* is limited because:
 - a. Almost without exception most MTV services are launched on the 'back' of a mobile phone offer and hence are launched by mobile operators. Mobile users tend to select a mobile operator/phone (as opposed to consumers purchasing a television set for DTTB service without considering the provider), and;

²³ Some of the largest MTV markets are reported to be in Italy and Korea with, respectively, 8.3 million DVB-H subscribers in 2008 Q3 (mobile operator 3i only) and 21.6 million T-DMB subscribers in 2009 Q2. Please note that, although 78 per cent of the global mobile TV audience, some 38 million viewers, is located in just two countries – South Korea and Japan – in those countries, the viewers have access to the mobile service free of charge.

- b. In post-paid/subscription based MTV markets, the phone is supplied by the mobile operator and interoperability with the MTV network is guaranteed. Mobile users switching between providers will be provided with a new mobile handset. This situation might be different in predominantly pre-paid/'SIM-only' markets (see guidelines below);
 - c. At this stage of the MTV market development without a clear 'winner', economies of scale cannot be promoted by setting a standard. The worldwide handset production volumes are still limited (in absolute numbers and in terms of the different handset models). In such a situation, the risk of picking the wrong standard can be high. Moreover, avoiding local market fragmentation could also be avoided by licensing only a single multiplex operator (especially when there is only limited spectrum available);
4. When setting a standard for the bearer level (i.e. transmission standard), the regulator could consider combining this with a wholesale model²⁴, as this will reap the most economies of scale and spectrum efficiency due to²⁵:
 - a. One single infrastructure;
 - b. sharing broadcast content, common between the various MTV service providers (while at the same time tailoring the service offering/content to the conditions of the individual provider, thereby leaving room for service differentiation);
5. In case an operational DTTB licence holder is also allowed to offer MTV services on the basis of his assigned licences (as in Italy and the Netherlands), then depending on the DTTB licence terms and conditions, the MTV standard might be set automatically. In order to promote a rapid MTV service introduction, setting a standard is not advisable. Moreover, the licence holder will seek synergies as much as possible. For example, the DTTB licence holder would like to apply *hierarchical* modulation²⁶ to launch the MTV service, saving spectrum and reusing existing infrastructure. Setting a (different) standard might jeopardize these synergies;
6. If standard setting is deemed necessary, only set a standard for the bearer level (transmission standard) and not for other network elements because:
 - a. To resolve interoperability issues between service providers due to the application of proprietary DRM solutions, setting a DRM standard is not necessary. For the regulator, it is better to stipulate the application of open standards for DRM (either in the licence terms or the assignment procedure), i.e. the selected DRM solution is not allowed to be embedded in the handset²⁷;
 - b. To resolve interoperability issues between service providers for the operations of additional/interactive services, setting an 'API' standard is also not necessary. It will suffice for the regulator to stipulate open standards (not handset embedded);

²⁴ A model in which only one MTV multiplex operator will be allowed to operate MTV networks, offering all available MTV capacity to any interested MTV service provider.

²⁵ See TNO study for the European Parliament, "Mobile TV (IP/A/ITRE/FWC/2006-087/LOT 2/C1/SC2)", October 2007.

²⁶ For example within the framework of the DVB standard it is possible to split the same multiplex into a DVB-T part and a DVB-H part. For more details see section 4.2.

²⁷ Please note that CAS based solutions tend to be handset embedded, making the handset provider specific. For example the DRM OMA B-cast solution is SIM card based and does allow handset roaming between service providers.

7. Do not propose to mandate inputs to *picture quality* such as frames per second and picture resolution (which is not uncommon in DTTB markets). Different picture formats are appropriate for different services. For example, sports channels may require high resolution and a high number of frames per second while low resolution and low frame rates may be acceptable for news broadcasts. These trade-offs are best to be left to the operator's judgment. It is in the operators' interest to provide good picture quality. Any mandate on picture quality in this instance would limit the flexibility of the mobile TV operator to develop the optimal mix of formats.

2.2 Licensing framework

The licensing framework is the comprehensive set of required licences, authorizations and permits for a market and public introduction of DTTB and MTV services. The objective of any licensing framework should be to actually implement the defined policy objectives for the introduction of DTTB and MTV services, including the Analogue Switch-Off (ASO). While the examples set out in this section are drawn from Europe, they are used to illustrate considerations that are common to all regions including the Asia-Pacific.

This section is split in four parts:

1. *General licensing framework for television services*: the three types of rights and associated obligations to assign to market parties. Followed by the key differences between assigning rights for analogue and digital television services (i.e. DTTB and MTV services) and the two basic assignment models;
2. *Licensing framework for DTTB and MTV*: the various applied assignment models for DTTB and MTV services in the commercial market (as opposed to assigning rights to Public Broadcasters). Followed by the key drivers behind the framework/model choices;
3. *Licensing Public Broadcasters for DTTB and MTV*: issuing licences to Public Broadcasters is very often based a separate licensing framework as these rights are assigned by priority (embedded in a separate legal framework/Act);
4. Implementation guidelines.

After determining the licensing framework (which rights will be assigned to which entity), the regulator has to design an assignment procedure and execute this procedure. In section 2.5 (Appendix) a general assignment procedure with detailed steps (for either a public tender or beauty parade) is included.

2.2.1 General licensing framework for television services

A licensing framework for *any* television services comprises the assignment of three sets of rights (and obligations). These three types of rights apply to analogue and digital television services. However the distribution of those rights over the various market players might be different for digital platforms. The following types of rights can be distinguished:

1. *Spectrum rights*: the right to have access and use a defined part of the radio spectrum in a designated geographical area for a specified time period, which may include obligations such as:
 - a. The obligation to provide television services within a certain time frame (roll-out obligations);
 - b. The obligation to provide a defined portfolio of television services;
 - c. Service level obligations, including aspects like broadcast standards, geographical/population coverage, service/network availability, allocated bandwidth/multiplexes per service, etc.;

2. **Broadcast rights:** the right or permission to broadcast television content²⁸ on a defined broadcast DTTB/MTV platform in a designated geographical area and for a specified time period, very often both at a *programme level* (for specific programmes or services – often referred to as media/broadcast permit or authorization) and a *platform level* (i.e. for a bouquet of channels and services – often referred to as a broadcast licence). These rights may also have associated obligations such as:
 - a. The obligation to provide a defined portfolio of television services (including ‘must carry’ and ‘price cap’ rules);
 - b. The obligation to provide Public Service Broadcasting (PSB)²⁹ services (such as a certain level of local news coverage, arts, religious programming, maximum limits on the number of repeats and to be viewed freely);
 - c. Service level obligations, including aspects like broadcast standards, geographical/population coverage, service/network availability, allocated bandwidth/multiplexes per service;
3. **Operating rights:** the right to erect and operate a broadcasting infrastructure in a defined geographical area for a specified time period, including aspects such as horizon pollution, environmental and health hazards. These rights can be accompanied by:
 - a. Site sharing obligations: network operators or infrastructure holders (e.g. tower companies) have to provide antenna space (under certain conditions³⁰);
 - b. Antenna sharing obligations: network operators have to provide access to broadcast antennas (provided this is technically possible³¹).

It is important to note that these rights can have different licence forms and definitions. The table below provides an overview of terminology used for the DTTB and MTV licences across the world.

Table 2.2.1: DTTB and MTV licensing terminology

Type of right	License/permit reference	Reference used in this report
Spectrum rights	Frequency/Spectrum licence	X
	Multiplex licence	
	Platform licence	
	Broadcast licence	
	Network operator licence	
Broadcast rights	Media/broadcast authorization/ permit (programme level)	X
	Broadcast licence (platform level)	X

²⁸ Including linear broadcasting of television programs and associated services such as the EPG, subtitling.

²⁹ Refers to broadcasting intended for the public benefit rather than for purely commercial concerns. The Regulator requires that certain television broadcasters fulfil PBS requirements as part of their licence to broadcast.

³⁰ In defined cases the network operators are exempt from providing access. For example, in the case where there is no capacity left and/or intended space is reserved/planned for own future operations. For more details on site sharing rules see, for example, the EU Directive 2002/19/EC of the European Parliament and of the Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive).

³¹ In general, such antenna sharing rules are unknown in the telecommunications market. However, such rules do exist in some broadcast markets (for example in the UK and the Netherlands).

Type of right	License/permit reference	Reference used in this report
Operating rights	Building/Planning permit	X
	Transmitter/EMC licence/permit	X
	Broadcast licence	
	Platform licence	

As described in the Introduction (Part I) of these guidelines, the value chain for DTTB/MTV services comprises six basic functions which are the responsibility of associated “players” (as depicted in the figure below)³². Compared to an analogue television service the digital value chain has an extra function/player: the multiplex operator. By nature of the digital broadcast technology, where multiple programmes or services can be carried on one frequency (i.e. multiplex), assigning the multiplex capacity to the various services is an extra function compared to the analogue broadcast value chain³³. This extra function is also referred to as managing the functional bandwidth of the multiplex, i.e. assigning access and available capacity to each service. The technical operation of the multiplex can be outsourced to a content distributor (i.e. the broadcast network operator).



Figure 2.2.1: Function/players in the digital value chain

By having this extra function of the multiplex operator in the value chain, two basic licensing models can be distinguished for DTTB and MTV services:

1. *Model A*: the spectrum rights are assigned to the multiplex operator *and* this entity can decide the allocation of the available capacity to the various services. In this model the frequency licence holder is allowed to use the defined spectrum *and* can decide the loading of the multiplex(es), e.g. which broadcasters can get access to the platform. The function of multiplex operator and service provider can be aggregated into one entity/organization. In turn, this organization can outsource the technical operations to a

³² Please note that some functions/players in the value chain can be combined in one company or entity. For example cable companies and mobile operators combine service provisioning and content distribution. But also for DTTB/MTV platforms, the multiplex operator function can be combined with content distribution function or the service provisioning function with multiplex operator function.

³³ In the analogue value chain, each frequency can carry only one service (1-to-1 relationship) and the frequency licence holder is very often the broadcaster. In the digital value chain the relationship is 1-to-N and the broadcaster is not necessarily the frequency licence holder.

specialized content distributor (i.e. a broadcast network operator). In this model, it can still be required for the individual broadcaster or service provider to get a general broadcast authorization (e.g. by a media authority) for broadcasting television content (very often not defined for a specific platform). This model was applied in countries like the Netherlands (for DTTB and MTV), Belgium (for DTTB and MTV) and the UK (for DTTB and MTV);

2. *Model B*: the spectrum rights are assigned to the content distributor and this entity *cannot* decide the allocation of the available capacity. In this model the frequency licence holder is *only* allowed to use the defined spectrum. The regulator decides the loading of the multiplexes by assigning broadcast licences/rights for the DTTB/MTV platform to individual broadcasters and/or service providers (bundling the various broadcast channels into one or several packages, in a separate assignment procedure (very often a public tender/beauty parade). In this model the regulator is the actual multiplex operator, or in other words the functional bandwidth manager. In this model the service provider can be a separate entity from the content distributor (i.e. broadcast network operator). This model was applied in countries like Germany (for MTV) and Sweden (for DTTB).

Most DTTB/MTV assignment models are derived from these two basic models and vary in the degree to which the frequency licence holder can also manage the capacity of the multiplex. Deciding this degree of freedom is mainly a political decision and depends on the policy objectives. For example in Model B, a stricter regime could be applied by excluding the spectrum licence holder also from offering DTTB/MTV services himself. Or in model A, the frequency licence holder has to offer some specific content ('must carry') and is just free in allocating the remaining capacity.

Please note that in the case of free-to-air television the service provisioning function is very limited and basically comprises the promotion of the digital platform and providing information about the platform. This service provisioning function is then carried out either by the content aggregator or the content distributor.

The table below provides a schematic overview of possible licensing frameworks.

Table 2.2.2: Possible licensing frameworks

Type of right	DTTB and MTV Value Chain					
	Content Creator	Content Aggregator	Multiplex Operator	Service Provider	Content Distributor	Device Creator
<i>Spectrum rights</i>			X	X	X	
<i>Broadcast rights</i>		X	X	X		
<i>Operating rights</i>				X	X	

2.2.2 Licensing framework for DTTB and MTV

Licensing DTTB and MTV services will involve assigning *all* three types of rights (see previous paragraph). The regulator will basically check compliancy with the applicable legislation and in turn this will:

1. Ensure uninterrupted DTTB and MTV broadcasts with minimum service levels (e.g. availability and coverage). Considering the relatively high level of required investments, such assurance should be provided;
2. Ensure that DTTB and MTV broadcasts comply with media legislation. Television broadcasts do have political attention and varying degrees of control are exercised over broadcast content;

3. Ensure that DTTB and MTV comply with environmental and health legislation. As DTTB services require relatively large transmitter sites (in some cases to a lesser extent for MTV services)³⁴, environmental and health issues will become publicly apparent and have to be dealt with carefully.

Regulators can balance the importance of these rights in different ways, depending on the local situation and objectives. Hence, the applied licensing framework for DTTB and MTV varies from country to country and comes in many different forms and definitions. The table below includes some examples of DTTB and MTV licensing in Europe (initial licensing)³⁵.

Table 2.2.3: Example DTTB and MTV licensing

Country	DTTB/MTV	Type of right	Content Creator	Content Aggregator	Multiplex Operator	Service Provider	Content Distributor	Device Creator
Finland	DTTB (model A) ³⁶	Spectrum			X		X	
		Broadcast		X				
		Operating					X	
Sweden	DTTB (model B) ³⁷	Spectrum			X			
		Broadcast		X				
		Operating					X	
The UK	DTTB (model A) ³⁸	Spectrum			X	X		
		Broadcast		X				
		Operating					X	

³⁴ Broadcast sites will require antenna heights of over 80-100 meters and relatively large transmitter powers (as compared to GSM or UMTS networks). However, MTV networks especially have been rolled out over typical GSM/UMTS infrastructure as well (for example as the mobile operator 3i did in Italy).

³⁵ For a more comprehensive overview for DTTB see the website of Digitag (www.digitag.org) and for MTV see the website of BMCO (www.bmco-berlin.com) and the BMCO report, "The status of National Licensing frameworks for mobile TV", March 2008.

³⁶ In Finland (initial licensing), the spectrum rights were assigned to a multiplex operator who was also the content distributor (the national broadcast network operator Digita), hence the two crosses at the same line. However, strict rules applied to Digita for providing non-discriminatory access and fair pricing.

³⁷ In Sweden (initial licensing), the spectrum rights were assigned to a multiplex operator (Senda, later Boxer) and the Regulator determined the assignment of the broadcast rights for the DTTB platform. Senda outsourced the content distribution to Teracom (the national broadcast network operator). Senda had a difficult start as the broadcast rights were assigned to parties with vested interests in other platforms and consequently a large portion of the platform capacity remained unused. The Regulator had to intervene to resolve the problems.

³⁸ In the UK (initial licensing), the spectrum rights were assigned to a multiplex operator who was also the service provider (Ondigital, later ITV Digital), hence the two crosses at the same line. The content distribution and technical multiplex operations was outsourced to a specialized broadcast network operator NTL Broadcast (later Arqiva).

Country	DTTB/MTV	Type of right	Content Creator	Content Aggregator	Multiplex Operator	Service Provider	Content Distributor	Device Creator
Germany	MTV (Model B) ³⁹	Spectrum					X	
		Broadcast			X			
		Operating					X	
Italy	MTV (Model A) ⁴⁰	Spectrum				X		
		Broadcast		X				
		Operating				X	X	

The following underlying factors can be identified for having different licensing frameworks, including:

1. *Spectrum management objectives*: In order to increase spectrum efficiency the regulator would like to avoid content duplication. This would argue for a licensing framework in which either:
 - a. The spectrum rights are awarded in combination with an obligation to provide a defined bouquet of channels, for example as proposed in the bid book in a beauty parade (variant of model A), or;
 - b. The spectrum rights are award to an independent multiplex operator (functional bandwidth manager) who grants capacity to individual content aggregators in a transparent and non-discriminatory way. Depending on the stipulated capacity assignment rules, control over content could be less (variant of model A or towards model B);
2. *Competition rules and objectives*: the regulator would like to see the introduction of a new competing platform next to a dominant (e.g. satellite or cable) platform. This would argue for a licensing framework in which either:
 - a. The spectrum rights are assigned to an independent multiplex operator and/or service provider (by excluding market parties which already offer television and/or telecommunication service in the end market) and with enough capacity to provide a competitive offering, by aggregating several multiplexes (variant of model A), or;
 - b. The broadcast rights and obligations for the DTTB platform are relaxed as compared to the dominant platform. For example, the DTTB service provider is exempt from 'must carry' or 'price cap' rules⁴¹ (variant of model A);

³⁹ In Germany (initial licensing), first the broadcast rights for the MTV service were assigned to a multiplex operator, a consortium of investors called Mobile 3.0. Who outsourced its service provisioning to a virtual mobile network operator (Debitel). The spectrum rights were assigned to Media Broadcast (TDF group). Because the consortium did not have the support of the mobile operators nor content providers the launch failed and the broadcast licence was returned to the government.

⁴⁰ In Italy, the spectrum rights were assigned to the multiplex operator, who also carried out the service provisioning. In the case of the multiplex operator 3i, the content distribution was carried out by the same company. In the case of TIM and Vodafone, the broadcast network operations were outsourced to Mediaset (a national broadcast network operator).

⁴¹ For details on 'must carry rules' or 'signal carriage obligations' see for example the United States' Telecommunications Act on www.fcc.gov/Reports/tcom1996.pdf and for 'price cap' rules see for example European roaming prices for mobile operators on http://ec.europa.eu/information_society/activities/roaming/regulation .

3. *Market structure and environmental objectives*: in order to avoid duplication of infrastructure, the regulator can decide to structure the licensing framework in which either:
 - a. The broadcast rights (for distributing television content on the DTTB or MTV platform) and frequency rights are awarded to separate entities. By assigning only one licence for the frequency and operating rights, the regulator ensures that only one network will be rolled-out (variant of model B), or;
 - b. The operating rights are put into operation by laying down site and, possibly, antenna sharing obligations. Such an arrangement only 'loosely' avoids infrastructure duplication as, in most cases, it creates only a possibility and not an obligation to share infrastructure (in a variant of model A);
4. *Media rules and objectives*: several objectives are possible. First, the regulator could strive to maintain a 'level playing field' in a defined television market (this may run across the different broadcast platforms, including cable, satellite and terrestrial platforms) and would like to see the same rules applied to each market entrant. Secondly, the regulator would like to see the analogue television services continued onto the digital platform(s). The two different objectives would result in respectively:
 - a. General broadcast authorizations are assigned to content aggregators/broadcasters with the same terms and conditions applicable to the each platform (variant of model A), or;
 - b. The frequency rights are assigned to the same entities as the holders of the analogue frequency rights. Please note that, although this may not be uncommon for assigning digital frequency rights (see, for example, the DTTB spectrum rights in the United States and the digital spectrum rights to existing analogue FM licence holders in the UK), this licensing practice can be a legal pitfall (as new entrants are excluded) and may result in frequency inefficiencies (a variant of B or a form of assigning by priority, see next paragraph).

Convergence trends (i.e. industry convergence, referring to the process by which boundaries become blurred between the Media, Communications and Device industries) do have an impact on the current licensing frameworks. Especially in the case of MTV (as it is a form of industry convergence between all three industries), the licensing framework changes towards:

1. Broader market definitions: the definition of the *relevant* television market needs to be redefined and hence the applicability of the spectrum and broadcast rights/obligations changes. Also the licensing procedures need to be aligned;
2. Less strict rules on the standards and technologies: the spectrum licence holder will have more freedom in the choice of service (for example between DTTB and MTV service), the allocated capacity per service and the applied standards (although the latter is more related to shortening technology life cycle as compared to the spectrum licence duration⁴²).

2.2.3 Licensing public broadcasters for DTTB and MTV

In general, Public Service Broadcasting (PSB) refers to broadcasting intended for the public benefit rather than for purely commercial objectives. In most cases the broadcast content is specified in a media or broadcast act and includes aspects such as:

1. Number of channels and programming hours;

⁴² See also sections 2.1 and 2.4.

2. Composition of programming (for example, level of local news coverage, arts and religious programming, maximum limits on the number of repeats, languages, etc.);
3. Coverage in terms of population and/or geographical areas (very often platform dependent or non-specified);
4. Access to the PSB content (including cost of reception, may include 'Free-to-Air' concepts).

The regulator can organize PSB in different ways, depending on the way (a part of) the PSB is funded⁴³. In practice two basic forms can be found, which can change or be combined over time:

1. A PSB entity is established by government, with defined PSB services, fully or partly funded by public sources (either licensing fees and/or general taxes);
2. A commercial/private broadcaster was established, (fully) funded by commercial income (either advertising based and/or subscription based) and has a PSB obligation assigned (either when the broadcast or spectrum rights were granted) which can be funded by the government.

Observing the licensing of DTTB and MTV services across the world, PSB on these new platforms is arranged in the following way:

1. The PSB entity (i.e. the national public broadcaster) is assigned one or two DTTB multiplexes by *priority* (i.e. without any duty to apply for a licence in a competitive bidding procedure like an auction or beauty parade). Please note that this does not include commercial/private broadcasters with a PSB obligation (see above three categories)⁴⁴;
2. The PSB DTTB multiplexes are assigned at the same time as the time of assigning (a part of) the remaining commercial multiplexes, so as to ensure a complete bouquet of channels (depending on the competitive environment) and to facilitate a joined-up network roll-out and possibility to increase frequency efficiency, or alternatively;
3. The PSB DTTB multiplexes are assigned first so as to ensure PSB on the new DTTB platform and to determine the actual roll-out of this platform, independently from any commercial initiatives;
4. The PSB channels on the DTTB platform are in most cases Free-to-Air, although this does not necessarily imply that no conditional access system is applied⁴⁵
5. For commercial content aggregators (i.e. individual commercial broadcasters) on the DTTB platform no PSB or any other broadcast obligations are levied (as, in most cases, the existing broadcast licence for the analogue service suffices)⁴⁶.

⁴³ See also section 2.9 for more details on financing PBS.

⁴⁴ Assigning priority rights to commercial entities can lead to serious market distortions. Moreover, it is argued that any PSB entity with advertising income distorts the market and hence should not acquire any priority rights.

⁴⁵ A conditional access system is applied and the end-consumer needs a smart card although the PSB content can be viewed without paying an access fee for this content. Especially for satellite distribution this is not uncommon (for the purpose of respecting content rights arrangements).

⁴⁶ This may cause market distortions in case of DTTB only broadcasters. After ASO, these channels may have the same coverage as the analogue commercial broadcasters with possibly expensive PSB obligations. This will raise the question of how these analogue commercial broadcasters will compete on a level playing field with such DTTB only channels. For more details see the Ofcom review of Public Service Broadcasting Television (www.ofcom.org.uk).

6. No PSB obligations are assigned to any MTV service provider, nor are MTV multiplexes assigned by priority to the PSB entity as, in most countries, these new MTV services are considered to be either:
 - a. Not a part of a Universal Service, and/or;
 - b. Still to be in the early stages of development.

It goes almost without saying, that defining PSB on a DTTB (or MTV if desirable) platform will cost money, especially when coverage obligations are included and the PSB entity rolls out its network first and independently from any commercial initiative.

In the case of DTTB and MTV platforms cost efficiencies can, however, be gained by shared roll-out plans, including:

1. Sharing multiplex capacity between the PSB entity and the commercial channels. Depending on the defined PSB content the public broadcaster might not utilize the complete PSB multiplex and remaining capacity can be assigned to commercial channels⁴⁷;
2. Sharing sites and other common infrastructure like antennas and back-up transmitters;
3. Applying jointly for building and other local permits.

2.2.4 Implementation guidelines

The following guidance can be provided for licensing *DTTB* services:

1. Provide a coherent licensing framework in which all three type of rights and obligations are addressed⁴⁸ (see section 2.2.1);
2. Deciding for either model A or B (see above), depends heavily on the policy objectives:
 - a. Model A provides more room for the spectrum licence holder to leverage its investments as he can change the service bouquet quickly to meet changing market conditions. Please bear in mind that in this model the regulator can still exercise control over the content on the DTTB platform by:
 - i. Reserving capacity for the Public Broadcaster (see next paragraph);
 - ii. Selecting the 'best' content offering in case of public tender/beauty parade (assigning the spectrum rights);
 - iii. Setting 'must carry' rules for a minimum package of channels;
 - iv. Providing general broadcast authorizations to individual broadcasters.
 - b. Model B provides the most control over the content and the regulator has a direct say in the DTTB service. Past experiences have shown that some risks can be attached to this approach. Especially the risk of selecting the 'wrong' content which can result in failing to have the full capacity utilized (by strategic blocking or no agreement on pricing or service levels of the content distribution) or not be able to change the content quickly (this will require a new assignment procedure). Applying this model is more complex and would require:
 - i. Reciprocal assignment procedures for the spectrum and broadcast rights: assign the broadcast rights with the obligation to outsource the roll-out of

⁴⁷ Including the PSB multiplex in a statistical multiplexing scheme with commercial multiplexes can further increase operating efficiencies.

⁴⁸ For example, in several European countries the DTTB spectrum licence holder has a roll-out obligation without any provisions for acquiring (local) operating rights, resulting in severe roll-out delays as local building permits may not be granted.

- the network to the ‘winner’ of the spectrum rights. And the assignment of the spectrum rights with the obligation to roll-out the network;
- ii. A broadcast assignment procedure in which the applicants include in their bid, ‘Letters of Intent’ with content providers that they will provide the content when the applicant wins the licence;
 - iii. A rapid procedure for reassigning multiplex capacity.
3. Assign, if (legally) possible, the spectrum rights to the entity which bears the network infrastructure investment risks⁴⁹. For investors this will lower the investment risk as they will get control over vital assets and, depending on the licence terms and conditions, could use the rights for alternative purposes;
 4. Promote a level playing field across the defined television market by requiring the same media authorizations (broadcast rights) for each content aggregator/broadcaster either⁵⁰:
 - a. Independently of the applied broadcast platform or distribution technology, or;
 - b. For each platform;
 5. Avoid a ‘deadlock’ situation, by assigning spectrum rights for only parts (or slots) of a single multiplex to content aggregators (i.e. television broadcasters). Especially when these spectrum licence holders are then free to choose a network provider⁵¹;

The following guidance can be provided for licensing *MTV* services:

1. As above for licensing DTTB service, plus;
2. Ensure the involvement of the mobile operators in the case of pay or subscription based services⁵², by either:
 - a. Assigning the spectrum rights directly to mobile operators, provided there is enough spectrum availability and such a policy is in compliance with competition rules, or;
 - b. Requiring that the bidder for the spectrum rights and/or broadcast rights, provides in its bid a contract or letter of intent with one or more mobile operators who will provide the *MTV* service in the end-market⁵³;
3. Ensure the involvement of content aggregators or providers by stipulating enclosure of a contract or letter of intent with content aggregators in the bid documents⁵⁴;
4. Promote shared multiplex capacity for common broadcast channels in case of frequency scarcity. This will require an independent spectrum licence holder (and network provider) who will assign *MTV* capacity for at least one multiplex (i.e. the functional bandwidth

⁴⁹ This is not necessarily the provider of the transmitter network infrastructure. This may also be the service provider with a long-term distribution contract.

⁵⁰ Please note that competition considerations could create exemptions for market parties with significant market power. Especially for parties with significant market power (and with a credible risk of market power abuse) asymmetric rules can be applied such as ‘must carry’ and ‘price cap’ rules.

⁵¹ For example, in Spain a deadlock situation arose when partial spectrum rights (i.e. slots on a DAB multiplex) were assigned to various broadcasters, selecting different network operators. An extra intervention was needed to resolve the situation.

⁵² Involvement of the mobile operators is crucial as they have control over the client base and the *MTV* service is provided through the conditional access system (SIM card based) of the mobile operator in the case of pay-per-service models.

⁵³ Such a requirement was included in the Austrian *MTV* assignment procedure. Please note that such a requirement did not entail excluding the mobile operators from putting in a bid themselves.

⁵⁴ Such a requirement was included in the Belgium *MTV* assignment procedure.

manager or multiplex operator). In this multiplex the common channels across the different MTV service providers can be facilitated. Any additional capacity should be created to offer the different mobile operators exclusive capacity on the MTV platform for offering their specific or exclusive content;

5. Avoid 'vertical integration' by assigning all MTV spectrum rights to one mobile operator. This will create a major barrier for any other mobile operator in the market or entering the market (at a later date). These other operators will be very reluctant to join the MTV platform of their competitor. Regulatory counter measures such as stipulating transparent /non-discriminatory access and fair pricing will not overcome this obstacle⁵⁵.

The following guidance can be provided for assigning PSB obligations for *DTTB* services:

1. Assign by priority at least one DTTB multiplex to the PSB entity so as to safeguard the PSB after ASO. Special attention should be paid to:
 - a. Number of channels and their individual coverage percentages, as this might vary compared to the coverage percentages of the analogue PSB channels;
 - b. Any requirements for HDTV content and/or compression schemes (like MPEG4), as this will determine either the picture quality per channel or the number of required multiplexes for the PSB channels (see also section 4.1);
 - c. Receiver installation implications as PSB viewers might have to change their antenna installations. If possible, assign the PSB multiplex to an adjacent channel close to the analogue channels;
2. Check the media and/or broadcast legislation for whether this PSB multiplex assignment is compliant with current PSB definitions. Very often the PSB obligation is defined for the analogue terrestrial platform and hence it is legally unclear to what extent such PSB obligations are applicable to DTTB platform;
3. Promote joint network roll-outs by assigning the commercial multiplexes at the same time (or closely after) as the time of assigning the PSB multiplexes;
4. Carefully define the picture quality of the PSB channels when multiplex capacity is shared with commercial parties (for example by stipulating a minimum constant bit-rate/bandwidth per channel). Because commercial parties generally sacrifice picture quality for an extra number of channels⁵⁶;
5. Consider the 'level-playing-field' after ASO for commercial broadcasters with and without PSB obligations;
6. Consider the impact of having 'Free-to-Air' PSB multiplex/channels on the commercial multiplexes. Especially in the case of having a commercial pay DTTB service, a 'Free-to-Air' PSB package can result in:
 - a. A lower uptake for the commercial DTTB operator, as consumers only view the PSB channels;
 - b. Commercial broadcasters (on an advertising business model) in the commercial pay package may claim also a position before the conditional access (i.e. 'Free-to-Air');
7. Check any 'Free-to-Air' definition in current media or broadcast legislation as this definition might be reconsidered. In the analogue situation 'Free-to-Air' is often explained

⁵⁵ For example, in the Netherlands a vertical market arose when KPN, the incumbent mobile operator, took over Nozema/Digitenne, the DVB licence holder.

⁵⁶ This might require changing the settings of the entire multiplex from statistical multiplexing to constant bit rate with loss of transport efficiency.

as the case where viewers have just to purchase an analogue television set with an antenna in order to receive the PSB channel freely without any extra charge. For a DTTB platform this will change as people will have to purchase a decoder and possibly a smart card. Without any adjustments this situation could inflict extra obligations for the government.

The following guidance can be provided for assigning PSB obligations for *MTV* services:

1. Apply or keep the option open for imposing ‘must carry rules’. This may or might become relevant for countries where the mobile platform is or will be the single platform to reach significant portions of the populations.

2.3 ITU-R regulations

ITU-R regulations entail the Radio Regulations (RR) and in particular the Table of Frequency Allocations (Region 1) and the relevant provisions of the World Radiocommunication Conference 2007 (WRC-07). As well as the Geneva Agreement 2006 (GE06) and the entries in the associated plans for the use of African Administrations.

With these regulations ITU strives to ensure the compliancy with the international RR and the GE06 agreement so as to avoid harmful interference, achieve equipment compatibility and to ensure future spectrum availability for DTTB and MTV. The regulator should formulate its DTTB/MTV policy and regulations to be compliant with these ITU regulations.

While GE06 does not apply to the Asia-Pacific, the normal provisions of the Radio Regulations do apply to coordination of frequency allocations with neighbouring countries etc. This is somewhat more complex where there is no regional plan for DTTB services against which to plan assignments. This becomes increasingly important where the potential for transborder interference exists. In the Asia-Pacific, the coordination of such plans is further complicated by the existence of ATSC (Korea), CDMB (China) and ISDB (Japan) and DVB-T (other places) where there may be different protection criteria compared with a homogeneous standard. However, for many countries in the Asia-Pacific, oceans, mountains, and sparsely populated areas (using low power local transmitters) often separate one country from another and provide natural protection for transborder coordination. In this section Asia-Pacific readers should take the references to GE06 to read as “the applicable regulations”.

This section includes the following paragraphs:

1. The international context of the ITU-R regulations;
2. Applicability and implications of the GE06 plan and ITU-RR;
3. Implementation guidelines.

2.3.1 The international context of the ITU-R regulations

The ITU regulations, comprising the Constitution and Convention, Radio Regulations, Regional Agreements, provide the framework for the global coordination and management of the radio-frequency spectrum.

The ITU Radio Regulations (RR) constitutes the principle regulatory framework for spectrum management⁵⁷. In compliance with these RR, the Member States undertake to operate and manage radio services in their country. The RR have international treaty status and are periodically reviewed (about every three to four years) by World Radiocommunication Conferences (WRC) and Regional Radio communication Conferences (RRC).

Relevant for the introduction of DTTB and MTV services, the RR specifies, among other regulations:

1. The Table of frequency allocations for the different radio services and their relative status (Article 5);
2. The maximum values of the power radiated by the radio stations (Articles 21 and 22) and the regulatory procedures (Articles 9, 11, 12) for ensuring compatibility through coordination and notifications;
3. The Plans giving each country guaranteed access to the spectrum for the operation of certain services. In particular for DTTB and MTV services, the recent GE06 Agreement adopted at Regional Radiocommunication Conference 2006 (RRC-06) including all African countries⁵⁸, contains:
 - a. Provisions for the terrestrial broadcasting service and other terrestrial services;
 - b. A Plan for digital TV and the List of other primary terrestrial services;
4. The various administrative provisions, including Article 18 which requires each Member State to grant a licence to any transmitting station to be operated by any private person or any enterprise.

For determining the applicability and implications of the GE06 plan on the planned *national* DTTB and MTV services, the different entries in the GE06 plan should be considered. In this context it is important to distinguish the different types of entries:

1. *Assignments*: in assignment planning, a specified channel is assigned to an individual transmitter location with defined transmission characteristics (for example, Effective Radiated Power – ERP, antenna height, etc.);
2. *Allotments*: in allotment planning, a specific channel is “given” to an administration to provide coverage over a *defined area* within its service area, called the allotment area. Transmitter sites and their characteristics are unknown at the planning stage and should be defined at the time of the conversion of the allotment into one or more assignments (e.g. when the regulator provides a licence with the actual assignments or when the licence holder, with assigned allotments, is intended to take a transmitter location into operation);
3. Combinations of both.

In case of an *allotment* entry in the GE06 plan the following additional information is also provided:

1. A description of the specified geographical area;
2. Reference network (RN) in four different types⁵⁹;
3. Reference planning configuration (RPC) in three different types⁶⁰.

⁵⁷ In addition to the RR, the ITU framework for spectrum management also comprises the Constitution and Convention, stipulating the organizational and administrative procedures and rules between member States. For more detailed information see Report ITU-R SM.2093, “Guidance on the regulatory framework for national spectrum management.

⁵⁸ On the 16th of June 2006, the GE06 plan was signed by more than 100 countries.

⁵⁹ See The Final Acts of the RCC-06 Conference, ANNEX 2, Chapter 3, Appendix 3.6, Reference Networks.

The combination of RN and RPC will result in the actual allowed Effective Radiated Power (ERP) and consequently the density of the network, given the type of service desired (e.g. either rooftop or indoor coverage). An allotment entry in the Plan may not always constitute a spectrum right that can be deployed into an economical feasible service.

For example, very low powers might result in a required network implementation of many transmitter sites. Depending on several operational factors, such as earning capacity of the intended service, cost sharing with other revenue streams/business, re-use of existing infrastructure, an allotment may not be put into operation in an economically feasible way.

Hence, local regulators should first assess the usability of the various entries in the GE06 plan. As a next step the regulator should determine what spectrum it is going to assign for DTTB and MTV, by answering the following three key questions:

1. What frequencies or allotments will be assigned for what type of service (for example two allotments/multiplexes for DTTB services and one for MTV services);
2. In what combinations these frequencies or allotments will be assigned (for example two separate allotments/multiplexes to be licensed to two different licence holders or two allotments to one single licence holder);
3. When these frequencies or allotments will be licensed or can be taken into operation.

2.3.2 Applicability and implications of the GE06 Plan and ITU-RR

As there is no equivalent of the GE06 plan in the Asia-Pacific, planners in the Asia-Pacific need to consider international coordination and their own national plans when conducting the following analysis, as well as any future coordination plans that may emerge as more countries in the region make decisions about digital migration. This section should be read accordingly noting that GE06 does not apply in the Asia-Pacific region.

In determining the application and implications of the GE06 plan and the ITU-RR, the regulator should define the spectrum available for DTTB and MTV services. In defining this available spectrum three basic steps are being carried out:

1. Analysing and making an inventory of the acquired administrative rights (assessing usability);
2. Determining the application of these acquired rights in terms of:
 - a. What frequencies or allotments will be assigned for what type of service;
 - b. In what combinations these frequencies or allotments will be assigned;
 - c. When these frequencies or allotments will be assigned or can be taken into operation;
3. Assessing the service coverage of the frequencies to be assigned⁶¹

Step 1

It is important to realize that the included spectrum rights in the GE06 plan are of administrative nature and they are the result of international negotiations. Hence a proper analysis is necessary to determine the applicability of these rights, i.e. whether it is technically and financially feasible to roll-out DTTB and/or MTV networks on the basis of these rights.

⁶⁰ See The Final Acts of the RCC-06 Conference, ANNEX 2, Chapter 3, Appendix 3.5, Reference Planning Configurations.

⁶¹ Only in the case where the Regulator would like to stipulate upfront service coverage requirements in the License Terms and Conditions.

Four main sources provide input for making a comprehensive inventory of the included spectrum rights:

1. The GE06 plan. The plan includes important restrictions and conditions. For example, spectrum rights that can only be assigned or taken into operation after bi-lateral negotiations or discussions with neighbouring member States⁶²;
2. Bi-lateral or multi-lateral agreements. Next to the GE06 plan various bi-lateral agreements between member States can be present. These bi-lateral agreements are not known to ITU and hence not included in the GE06 plan. In Europe, for example, some countries agreed bi-laterally the usage of digital broadcast spectrum before the GE06 plan was agreed. Very often these intermediate bi-lateral plans were introduced to make a rapid introduction of DTTB and/or MTV services possible⁶³;
3. Provisions in the RR for other services (i.e. other than broadcasting services). Very often special provisions apply, protecting defined services in the broadcast bands. For example, Radio Astronomy might have the status of primary use and is protected from interference from broadcast services (band V channel 38). This protection could apply in the country itself as well as abroad. It is important to determine in which geographical area this protection applies, this could be a limited area. Outside this area a broadcast service can operate, possibly without restrictions;
4. An assessment of future WRC or RRCs. For DTTB and MTV services the WRC of 2012 should especially be considered. Some major changes are to be expected for all frequencies in band V above channel 60. One of the possible scenarios is that these frequencies will be dedicated for Mobile services⁶⁴.

Step 2

In this step the regulator “translates” the administrative rights into assignable packages of spectrum rights (e.g. several multiplexes per package or specific assignments for each transmitter location). The main factor determining this assembly of packages is the regulator’s objectives. These objectives can be categorized as follows:

1. The realization of a (DTTB) Universal Service. For example, the regulator has the objective to provide a licence for the realization of a (near) nationwide multiplex for the Public Broadcaster. This would result in selecting lower frequencies (in Band III or IV) for a spectrum package reserved for the Public Broadcaster⁶⁵;
2. Introduction speed: The regulator might strive for a rapid service roll-out and is intended to include strict roll-out obligations in the spectrum licence. Such an objective would result in including frequencies in a single package without any current restrictions (For

⁶² For guidelines and help on the interpretation of the GE06 plans, please refer to EBU report, EBU Technical Department, “GE06 – Overview of the second session (RRC-06) and the main features for broadcasters, by Terry O’Leary, Elena Puigrefagut and Walid Sami or EBU report, EBU BPN 083, “Broadcasting aspects relating to the procedures for coordination and plan conformity agreement in the GE06 agreement”, November 2007.

⁶³ See for example the multi-lateral Chester Agreement of 1997 on the website of ERO: www.ero.dk/132D67A4-8815-48CB-B482-903844887DE3.

⁶⁴ The assignment of these frequencies to Mobile services could be a direct result of the current debate on the Digital Dividend. For more detail see section 2.10.

⁶⁵ Depending on the local (spectrum) situation, this package could comprise a Single Frequency Network – SFN – (i.e. assignment of one frequency in a single geographical area) or a Multi Frequency Network – MFN – or a combination of both. For more details on SFN/MFN planning see section 4.2 and 4.3.

- example, excluding frequencies that are still in use by other users and the termination of use is dependent on negotiations);
3. Service package composition: The regulator aims to provide a spectrum licence on the basis of which the licence holder can compete with other television providers (like cable companies or satellite operators). Such an objective would bring several multiplexes together in one spectrum package so as to have for each transmitter site the same number of frequencies available (and hence to be able to broadcast the same channels across the service area);
 4. Type of service: For example in the case of MTV in the UHF band⁶⁶, the objective to launch a MTV service would argue for assembling a package comprising only of frequencies below channel 57 because this would avoid interference on the handset with the GSM/UMTS receiver and would avoid a future spectrum management conflict related to the Digital Dividend discussion. Alternatively, the objective to launch a DTTB on the basis of (existing) rooftop antennas, would require packaging frequencies close to the analogue television channels. Having the digital frequencies close to the analogue frequencies on each transmitter station, would avoid viewers to retune or redirect their receiver/antenna installation⁶⁷.

In this assembly exercise one should consider carefully the Reference Networks (RN) and Reference Planning Configurations (RPC) as they determine for a large extent the possibilities. For example, a RPC 3 with a RN1/3 would provide the most available power in the network. In contrast, RN2 for a MTV service might not provide enough power in the network. This can only be compensated by designing a (too) dense(r) network.

Step 3

This step is optional and depends mainly on whether the regulator would like to award precisely defined assignments. It is not uncommon that the regulator only carries out an initial network planning and leaves the detailed network planning to the licence holder⁶⁸.

A detailed network planning to predict the network coverage requires considerable resources and knowledge. The calculation should be as accurate as possible otherwise the regulator has to allow a large safety margin in order to avoid unachievable requirements. In this way, drafting a detailed network planning seems only justified for the situation where the regulator would like to award exact assignments rather than allotments. For a detailed network planning some minimal resources are required:

1. An accurate and up-to-date population database (i.e. with sufficient accuracy that it can be used to inform the public/viewers whether they will have DTTB/MTV reception, hence the database should be at the level of individual addresses or postcodes);

⁶⁶ Frequency bands for MTV are different according to standards. For example T-DMB is implemented in the VHF band.

⁶⁷ A special case for planning a DTTB/MTV service, is to select a DAB allotment/assignment. Transforming a DAB allotment to a DVB allotment is almost impossible. However a DVB allotment can be converted to a DAB allotment. For guidance on this see ECC report 166, "The possibilities and consequences of converting GE06 DVB-T allotments/assignments in Band III into T-DAB allotments/assignments including adjacent channel issues", February 2008.

⁶⁸ No exact definitions exist for a detailed network planning. However as a working definition one could say that a detailed network planning, is the planning on which basis the licence holder will order its transmitter equipment (i.e. the exact transmitter configuration in terms of antenna diagram and ERP is known).

2. Planning software and expertise (capable of carry out calculations for either SFN and/or MFN topologies);
3. Detailed information on existing sites in operation either currently or in the future (not only in the country but also abroad and also including other services in the broadcast bands).

2.3.3 Implementation guidelines

The following guidance can be provided for determining the applicability and implications of the GE06 plan:

1. Carry out a step-by-step approach as described in section 2.3.2.
2. As a regulator, determine and define your objectives clearly before you start to assemble frequency packages. Otherwise such an assembly exercise will become a pure technical exercise which will not service the public interests.
3. Consider carefully the permitted powers and planning/reception conditions. In the case of an allotment planning refer to the RN and RPC in the GE06 plan. In the case of an assignment planning refer to either the RPC or the regulator's own drafted planning conditions⁶⁹.
4. Check assignment or allotment plans with potential network operators or service providers (by consultation). In this way the regulator assures that no licence will be awarded that the licence holder might claim is not executable.
5. As an alternative for conducting a detailed network planning, the regulator could invite potential applicants to determine the maximum service coverage in a public tender procedure (under the condition that the detailed calculations are provided). Successively, the regulator can then select the best planning (either that is highest or closest to a set target) and then attach the predicted network coverage to the licence terms and conditions.
6. Only in the case of an assignment planning by the regulator and where the regulator would like to stipulate the coverage clearly upfront, the calculation of a detailed service coverage prediction seems to be justified.

2.4 National spectrum plan

The National Spectrum Plan reflects the long, medium and short-term planning of the available national spectrum resources for DTTB and MTV services in a particular country. It may also include the stipulated assignment procedures for the various services and a national frequency register, including all the assigned licences and licensees.

With a National Spectrum Plan the regulator strives to ensure effective and efficient spectrum usage and compliance with international standards. As well as informing market parties on the current and future (intended) use of spectrum.

This section focus on the planning process and inclusion of the *commercial* DTTB and MTV services in the National Spectrum Plan. The licensing of the Public Service Broadcasting is included in section 2.2.3.

⁶⁹ The GE06 plan includes three common Reference Planning Configurations. However, the Regulator is free to draft its own planning conditions. Such situations could arise for specific required services not accurately covered by the three included RPCs.

This section includes the following paragraphs:

1. The context of the national spectrum plan;
2. Planning current and future DTTB and MTV spectrum use;
3. General approaches for spectrum usage;
4. Implementation guidelines.

2.4.1 The context of the national spectrum plan

At a national level the radio-frequency spectrum is considered the State's public domain. As such, it is subject to the State authority and must be managed efficiently so as to be of the greatest benefit to the entire population. As the result of the State's right to manage the spectrum, authorized spectrum users derive the benefits of the right and associated obligations to access and use the spectrum.

The National Spectrum Plan is the result of the national (long term) planning process for spectrum usages and basically matches *supply* with future market *demand*. The associated planning process spans across all categories of use. Typical usage categories are:

1. Federal, including spectrum for the following services:
 - a. Military and emergency services;
 - b. Public Service Broadcasting - PSB (see section 2.2.3. on licensing PSB)
2. Non-Federal (or commercial use), including sub-categories such as:
 - a. Mobile (voice and data, including GSM, DCS1800, UMTS, WiMAX, etc.);
 - b. Fixed links (relay services);
 - c. Private Mobile Radio/paging services;
 - d. Broadcasting (including terrestrial radio and television services, such as DTTB and MTV, and Electronic News Gathering services);
 - e. Wireless (including wireless telephony, WiFi, cordless microphones, etc.);
 - f. Satellite services, and;
3. 'Other', including services such as Radio astronomy.

The National Spectrum Plan (or sometimes also referred to as National Frequency Plan) is the key instrument for efficient national spectrum management and comprises in most cases (also for DTTB and MTV services):

1. The current use of the available spectrum for radio communication (including the spectrum for broadcasting), registered in a National Frequency Register⁷⁰. Such a Register includes information (per frequency range) on:
 - a. Radio service (i.e. assignments);
 - b. Prescribed system (e.g. DVB-T for digital television services or T-DMB for mobile television services)⁷¹;
 - c. Licensing regime (licence needed or licence free);

⁷⁰ Update the National Frequency Register in a separate cycle from the National Spectrum Plan. The planning cycle is much longer for the National Spectrum Plan (i.e. spectrum management policies and objectives do not change every one or two years). The National Frequency Register should be updated instantaneously when new frequencies are being used or terminated.

⁷¹ In the case where a system is prescribed. In Europe and elsewhere, technology-free spectrum management approaches are promoted. See ECC report 80, "Enhancing harmonization and introducing flexibility in the spectrum regulatory framework, March 2006

- d. License holder (may not be public information);
 - e. License duration;
 - f. Required/allowed radio interfaces (e.g. maximum power, channel spacing, etc.);
 - g. User rights and obligations (such as exclusive use, sharing with equal rights or with priority, etc.).
2. The planned or intended use of the available spectrum (including the spectrum for DTTB and MTV services), including information (per frequency range) on:
 - a. See above, except for licence holder;
 - b. Planned assignment procedure;
 - c. License fees (i.e. spectrum pricing instruments).

The National Spectrum Plan may also include the State' spectrum management approach by incorporating:

1. The spectrum management objectives, including objectives such as:
 - a. Balanced spectrum usage between the various categories of use (for example between broadcasting and telecommunications)⁷²;
 - b. Efficient spectrum usage;
 - c. (International) Harmonization of spectrum assignment and associated consumer equipment;
2. The preferred assignment procedure (per type of service or frequency range)⁷³;
3. The preferred licensing regime (e.g. technology independent licences).

For more background on general spectrum management approaches (like 'command and control' versus flexible approaches or 'technical driven' versus market based approaches), please refer to the appendices of this part of the Guidelines.

2.4.2 Planning current and future DTTB and MTV spectrum use

The national (long term) planning process for spectrum management is basically matching *supply* with future market *demand*. Typically the associated planning process spans across all categories of use. For example, the planning can run across the categories Governmental⁷⁴, non-Governmental and 'Other'. This planning process is no different than any other strategic planning process with the following steps in an iterative process⁷⁵:

1. Determine spectrum requirements for the future use (e.g. by consultation of the market or extensive market analysis);
2. Assess spectrum availability (e.g. by analysing the National Frequency Register and/or ITU International Frequency List);
3. Draft planning options (e.g. by apply scenario analysis) and public hearing;
4. Finalize spectrum plan;

⁷² See also section 2.10 'Digital Dividend'

⁷³ In the case of indicating a preferred assignment procedure per type of service, the spectrum manager can consider the maturity of the service and the likelihood of the 'Winner's Curse'. Preferred assignment procedures per frequency range are often based on an assessment of 'technical' scarcity. First-Come-First-Served assignment procedures are not uncommon (see also section 2.5 'Assignment Procedures').

⁷⁴ For example, falling into this category is the spectrum for the police forces or military services.

⁷⁵ For a more detailed description of the planning process see Report ITU-R SM.2015.

5. Implement spectrum plan (i.e. apply spectrum management instruments to re-allocate spectrum use).

This planning process can also be applied per category of use or frequency band. The planning steps remain the same. For planning the DTTB and MTV spectrum the same planning steps can be followed.

With an accurate National Frequency Register the current frequency use will be easily identified (see the above step 'Assessing spectrum availability'). In such a case the planning process will focus on assessing future *demand*. Two basic options exist for assessing this future demand:

1. Market consultation, and/or;
2. Market analysis (including for example international studies on DTTB and MTV services and analysing TV viewing reports).

A powerful instrument in any strategic planning process is scenario analysis (applicable for both steps of determining spectrum requirements and drafting planning options). In a scenario analysis external and internal factors are being identified and analysed so as to arrive to the key factors determining future scenarios (ideally having two or three base scenarios by varying a limited set of key factors). ITU-R report SM2015 includes a comprehensive list of factors to be considered. Scenario analysis will help to improve the national frequency planning process by providing insight into:

1. Key external factors (e.g. number of television households, television advertising spend, deployment of other television platforms such as IPTV/WiMAX, etc);
2. Risk factors (which factors can vary the most, or are most unpredictable and have potentially the largest impact – such as early DTTB/MTV licence termination, the licence holder returns licence or goes bankrupt, or the introduction of an unforeseen disruptive technology);
3. Planning re-tuning opportunities (under which conditions is the planning out-dated results of international frequency planning conference not adopted yet in the national planning, clarity on the 'digital dividend' discussion);
4. Mitigation strategies (how can undesired effects/developments be counterbalanced – such as re-farming of current DTTB spectrum usage due to 'Digital Dividend' results⁷⁶, ASO);

2.4.3 National spectrum plan publication and DTTB/MTV introduction

Nowadays, most regulators publish their National Spectrum Plan (including the spectrum management approach and objectives) and the associated National Frequency Register on the internet and the general public and market players have free access.

As described in the previous section, the Plan basically describes the current and future use of the national spectrum⁷⁷. As said, it is important that the provided information is accurate and up-to-date as potential investors will base their first market assessments on this information.

⁷⁶ For example, a DTTB service provider uses frequencies above channel 60 and those channels have been allocated to a different category/Mobile services.

⁷⁷ In federal States spectrum management tasks and duties can be split and assigned to different (language) regions. This is not unusual for managing broadcast spectrum. For example, in Belgium the broadcast spectrum is managed at a regional level and telecommunication spectrum at a national level. However, as broadcast and telecommunication industries converge, such an approach can be more and more challenging (for example when assigning MTV licences which tend to be more useful when they have nationwide coverage).

For the transition to DTTB it should be noted that the information should be aligned with any publications on the ASO (see sections 2.14 till 2.18).

2.4.4 General approaches for pricing spectrum usage

Before going into any details of pricing spectrum usage it is important to note that the regulator can charge money for spectrum usage at different moments in time. The figure below schematically illustrates this point.

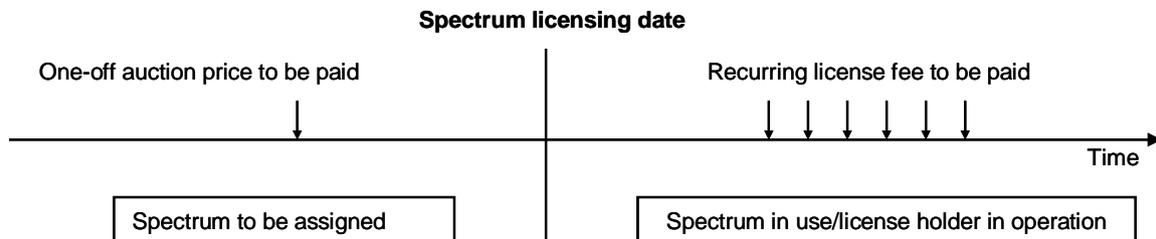


Figure 2.4.1: Timing of charging spectrum usage

The most common form of paying for spectrum licences (i.e. spectrum usage, on the right side of the above figure) is a cost based system. Spectrum management costs money and these costs are charged to spectrum users or, to be more precise, to spectrum licence holders (as opposed to licence free spectrum usage). By aggregating all spectrum management costs (including overhead costs) and subsequently dividing it between all licence holders, the licence fee is determined.

Following the passage of the European Union Regulatory Framework for Electronic Communications in 2002, new ways of charging for spectrum usage/licences were introduced. In countries such as the UK, Australia and New Zealand, so called ‘administrative incentive pricing’ regimes have been introduced.

These pricing regimes are not based on costs but on economic value so as to make spectrum allocation more flexible and return this economic value to society at large. For determining the economic value of licences (i.e. the licence fee to be paid each period) complex models are used based on principles of ‘next-best-alternative’ or opportunity pricing. As these pricing considerations go beyond the scope of these guidelines, more details may be obtained from the websites of Ofcom in the UK (www.ofcom.org.uk), Commerce Commission of New Zealand (www.comcom.govt.nz) or ACMA of Australia (www.acma.gov.au).

Next to ‘administrative incentive pricing’ regimes, which are based on economic value, regulators also introduced the assignment instrument of auctions (left hand side of the above figure). Especially for licensing/assigning mobile telephone licences, auctions were introduced. In an auction, the bidder assigning the highest economic value to the licence and consequently offering the highest price, will acquire the licence.

Auctions are used primarily as an instrument to allocate scarce resources (i.e. spectrum) in a transparent manner and are different from the above mentioned ‘administrative incentive pricing’ regimes. However, licensees having acquired their licence through an auction and hence having paid the economic value of the licence already, should not be charged twice by applying also an administrative pricing regime for that licence. For more details on auctions please refer to section 2.5 of these guidelines.

License fees based on cost recovery have the following advantages and disadvantages:

1. Advantages:
 - a. Transparent and accountable;
 - b. Relatively easy to determine price levels (as opposed to value based pricing);
 - c. In line with 'command and control' spectrum management approach;
2. Disadvantages:
 - a. Does not reflect economic value of spectrum and can result in allocating spectrum to users/applications not generating most value for society;
 - b. Pricing can vary from year to year as the number of licence holders and/or users change of the years (given a certain cost level), generating market resistance/court cases;
 - c. Needs regular updating as cost levels can change over time;
 - d. Ignores earning capacity of licence holders. Especially the spectrum levies for broadcasters can be relatively high and this can be perceived as unfair.

2.4.5 Implementation guidelines

References to DAB-T/T-DMB, and DBV in this section do not change the task or issues involved in spectrum planning, where other systems are in use within the Asia Pacific, the relevant standard and protection criteria should be used for those systems and the pertinent system reference substituted for DAB,T-DMB, DVB-T etc..

The following guidance on *spectrum planning* can be provided:

1. Execute the DTTB and MTV planning process like a strategic planning exercise;
2. The DTTB and MTV planning process should address at least the following key decisions:
 - a. The number of multiplexes to assign and in what order: e.g. the regulator can decide to issue the multiplexes in two batches; a first set of multiplexes to test the market and a second set of multiplex to further grow the market⁷⁸;
 - b. Application of the multiplex: in case the regulator would like to set aside multiplexes earmarked for MTV and/or DTTB⁷⁹. Also for the frequencies in Band III, the regulator has to decide whether these frequencies are going to be assigned to DAB/T-DMB and/or DVB-T;
 - c. Aggregation of multiplexes: the regulator has to decide either how many multiplexes can be aggregated by any single licence holder or issue a fixed set of multiplexes⁸⁰;
3. In addition to the listed factors in Report ITU-R SM.2015, consider also the following factors in the DTTB and MTV planning process:
 - a. International frequency allocation: ITU-R and more specifically the GE06 and the associated bi-/multi-lateral agreements;

⁷⁸ Alternatively, the Regulator can decide to leave the launching schedule of multiplexes to the licence holder (of a set of multiplexes). In cases where market demand is yet unclear, the licence holder can regulate the demand and supply accordingly to the market developments. For example, in the UK this type of licence was issued to the commercial DAB operator Digital One (see www.ukdigitalradio.com).

⁷⁹ For example, the Regulator can decide to have a minimum number of multiplexes to be operated for MTV (out of a set of multiplexes and the licence holder is free to decide which multiplex). Alternatively, the Regulator can leave it to the licence holder to decide what application will be taken into operation.

⁸⁰ For more details on aggregation rules see section 2.5.

- b. Digital Dividend: i.e. frequency channels in band V above channels 60 might not internationally be exclusively allocated to Broadcasting (see also section 2.10) and allocating spectrum above channel 60 to Broadcasting might be risky (i.e. costly and lengthy spectrum re-farming might be necessary)⁸¹;
 - c. For MTV service, the number of mobile telecom providers: with several MTV service providers in the market, channels offered by all providers might be shared or, in other words, transmitted only once. The planning process should therefore address the interest in mutually exclusive channels and common channels⁸²;
 - d. Joint or shared roll-out of DTTB and MTV: a joint or shared roll-out (between licence holders) can contribute to frequency efficiency, site sharing and content efficiency (harmonized content offering across MTV and DTTB platforms)⁸³;
 - e. ASO: switching off analogue television services will free-up spectrum (at a later date) and will determine the available multiplexes in the future and hence the future market conditions⁸⁴;
4. Consult market parties as successful launches of DTTB and MTV service will require active participation of commercial parties and investors, most notably the Public Broadcaster, commercial broadcasters, Content Distributors (especially national broadcast network operators) and mobile operators.

The following guidance can be provided for *including DTTB and MTV service introductions* in the National Spectrum Plan:

1. If possible, provide clarity on the Digital Dividend (channels above 60) allocation, preferably before assigning any new DTTB and/or MTV frequency licences as it will provide bidding entities insight into the future competitive landscape (will there be more providers in the near future?)⁸⁵;
2. Be in line with Legislation, Policy and Regulations and the ASO plan as the National Spectrum Plan is considered to be a key spectrum management instrument, most notably:
 - a. License terms and conditions of assigned spectrum rights for DTTB (and possibly MTV) and future assignments;
 - b. Assignment procedures for assigned spectrum rights for DTTB (and possibly MTV) and future assignments;
 - c. Policy decisions or intended decisions on the Digital Dividend;

⁸¹ The World Radio Conference of 2007 (WRC-07) concluded that in Region 1 the 790-862 MHz sub-band will be allocated on a co-primary basis to mobile services in addition to broadcasting and fixed services as from 2015, subject, where necessary, to technical coordination with other countries. Please note, that this allocation on a co-primary basis was decided before the compatibility studies (between broadcasting and mobile services) have been finalized. Also the individual members have to decide the allocation of this sub-band. For further details see section 2.10.

⁸² Mobile operators offering MTV would like to differentiate their offers and hence require their own capacity. However, common (popular) channels can be shared between them. This will require an independent multiplex operator.

⁸³ For more technical details see section 4.7.

⁸⁴ The ASO process is described in more detail in sections 2.14 and 2.16.

⁸⁵ Assigning the 'Digital Dividend' to applications other than broadcasting could result in significant costs for the incumbent broadcast network operators as the network might have to be retuned and service quality might degrade. For Regulators to avoid picking up the bill for these retuning costs (including costs for extra communication to the public), this specific risk should be included in the licence terms and conditions.

- d. Licensing framework, especially for acquiring authorizations to broadcast content (see section 2.8 Media Permits and Authorizations) and to roll-out infrastructure (see section 2.7 Local Permits);
 - e. Switch over date(s)⁸⁶.
3. Published and/or be updated in the following cases:
- a. Completion of WRCs and most notably the GE06 Agreement;
 - b. Decisions on spectrum re-farming operations, especially in relationship to the Digital Dividend discussion;
 - c. Publication of ASO policies and plans;
 - d. Decisions on assigning DTTB and MTV spectrum, either planned (e.g. auctions or beauty parade) or in case of a 'First-Come-First-Served' application.

The following guidance can be provided on *pricing spectrum*:

1. Its recommended to apply a relatively 'simple' cost recovery model (over a market based approach such as administrative incentive pricing) when introducing DTTB and MTV services because (unless such a system is already in place):
 - a. Of the advantages as mentioned in the previous section;
 - b. Determining upfront the market value of *any* service is very difficult (as experience in the UK, Australia and New Zealand has shown). If such a regime is applied, it really has to be applied to all commercial categories (see also section 2.4.1) because it will be difficult to (legally) separate markets;
 - c. DTTB and MTV services are still in their early phases and determining upfront the market value for this category is perhaps the hardest to do (see also Implementation guidelines in section 2.5.3).
2. Consider the consequences of setting an administrative charge 'per frequency in operation'. Such a pricing regime is very often applied for analogue applications (like FM or TV), but can result in disproportionate charges for a DTTB licence holder⁸⁷;
3. Avoid mixing different pricing regimes. For example, assigning the spectrum licence through an auction and also charging value based licence fees. This combination will be considered as paying twice for the same value (for society).

Appendix 2.4A: Overview of spectrum management approaches

For the DTTB and MTV markets transparency on the applied or intended spectrum management approaches is paramount for developing the DTTB and MTV markets. Especially investors in these capital intensive markets will seek this transparency and guidance.

Nowadays, spectrum management approaches run across two dimensions and spectrum managers have to balance these dimensions:

1. 'Command and control' versus flexible approaches;
2. 'Technical-driven' versus market-based approaches (including both market-based principles between applications⁸⁸ and when assigning licences).

⁸⁶ (Parts of the) assigned spectrum rights in a licence can be conditional, i.e. can be taken into operation when the analogue frequencies are freed up. Especially in the case of assigning DTTB and/or MTV allotments, the timing of available spectrum can become complex.

⁸⁷ For example a single licence holder operating 5 multiplexes will bring 5 frequencies per site on air. A charge per frequency in operation does not reflect the monitoring effort of the Regulator and hence this operator can argue that the fee is disproportionately as compared to for example a FM broadcaster.

'Command and control' versus flexible approaches

The 'command and control' approach is currently applied by most national spectrum managers around the world. This approach is embedded in the ITU-R Radio Regulations in which, for specified frequency ranges, the different radio services and their relative status are allocated⁸⁹.

At a national level the spectrum manager specifies these allocations (i.e. exact frequencies, locations, radio interface, technology, standards, etc.) and assigns them to individual users or service providers ('command'). Subsequently the spectrum manager then monitors appropriate use of the assigned spectrum rights ('control'). In this way, harmonization of frequency bands is promoted and hence equipment can work across borders and can be produced at a large (regional/global) scale.

At a national level this 'command and control' approach is under increasing pressure because:

1. Compartmentalization of spectrum by assigning spectrum to types of services (such as aeronautical radio navigation or broadcasting) and users (federal, non-federal, and shared) is becoming inefficient as frequency scarcity increases;
2. Technologies become available that can improve spectrum utilization (such as 'smart' receivers/transmitters and shared spectrum technologies)⁹⁰;
3. Technology life cycles are becoming shorter (and very often shorter than the licence duration) and individual users or service providers would like to have the flexibility to switch to more efficient/better technologies.

Consequently, flexible approaches to spectrum management are advocated in Europe and the United States. Such alternative approaches comprise elements such as:

1. Allowing licence free spectrum utilization in defined ranges of the available spectrum;
2. Allowing smart technologies to operate across different spectrum categories;
3. Assigning technology and/or standards free licences.

'Technical driven' versus market based approaches

Next to advocating more flexible approaches to spectrum management, also promoting more economic incentives for assigning the available spectrum has been discussed and applied over time. Traditionally, spectrum has been assigned by technological considerations (like application type, spectrum efficiency, number of services, etc.). More and more economic incentives have been incorporated in spectrum management approach and most notably:

1. Pricing and assigning spectrum accordingly to the (perceived) market value. Regular applied instruments in this philosophy are assigning spectrum by auction and levying spectrum licence fees based on earned revenues or profits;
2. Allocating spectrum to applications or services, generating the highest economic value. This is the current debate around the 'Digital Dividend', allocating broadcast spectrum to telecommunication applications as these services would generate more economic value for society.

⁸⁸ Introducing market-based principles in determining which services should be allocated in a specified band, is currently a key topic in the broadcast and telecommunications markets for the UHF band, referred to as the Digital Dividend (see also section 2.10).

⁸⁹ See Report ITU-R SM.2093, 'Guidance on the regulatory framework for national spectrum management'.

⁹⁰ See GAO report on Spectrum Management on www.gao.gov/new.items/d04666.pdf.

2.5 Assignment procedures

This section is primarily focused on assigning spectrum rights for DTTB and MTV services and the common instruments and procedures applied. The different included instruments and procedures can be applied to assigning any right or good. Hence the different instruments and procedures can also be applied for assigning broadcast and operating rights (see section 2.2). Assigning licences will have economic effects and some more detail information on these effects can be found in the appendices of this part of the Guidelines.

This section comprises the following paragraphs:

1. Basic assigned instruments and procedures;
2. Assignment procedures for DTTB and MTV services;
3. Implementation guidelines.

2.5.1 Basic assigned instruments and procedures

In terms of assigning spectrum rights, the following three basic instruments are applied⁹¹:

1. *First Come First Served (FCFS)*: This means that the applications are appraised individually in the order in which they are submitted (no comparison one with the other). A licence is granted depending on the appraisal. The applications are first of all evaluated in terms of admissibility and then minimum requirements, whereby checks are made to ensure that:-
 - a. The application is consistent with allocation and allotment agreements;
 - b. There is sufficient frequency capacity;
 - c. The application cannot be 'inserted' into another application ('sharing');
 - d. The application will not cause (or be affected by) interference;
 - e. The applicant has the required expertise and financial resources to offer/execute the proposed service/usage;
2. *Public Tender or Beauty Parade*: In such cases the regulator makes known in advance which requirements it sets for a service/infrastructure and which aspects will be involved in the appraisal of the tenders. The proposals can be submitted either in writing ('bid book') or verbally (for example, in the United States verbal procedures are also used: 'comparative hearings'). The selection criteria can be divided into three categories:
 - a. The applicant (for example solvency, technical qualifications) and the application (for instance form and layout requirements, fee obligations, timing of submittal);
 - b. The service being offered (for example proposed rates, quality and degree of coverage);
 - c. The technical quality of the system (for instance the frequency usage required and the quality of the proposed infrastructure);
3. *Auctions*: In the case of auctions, frequencies are allocated on the basis of a bid for a licence. The regulator lays down a limited number of admissibility criteria (which work as a threshold), but does not get involved in the actual details of the frequency allocation. The bidder who assigns the highest economic value to the licence will make the highest

⁹¹

Sometimes Lottery is also included as an assignment instrument. Licenses were allocated in the United States through lotteries at the beginning of the nineties. After paying an entry fee, interested organizations could acquire a licence through a lottery. However, the entry fee was far less than the value of the spectrum. This resulted in organizations with speculative objectives taking part in the lotteries. In view of this experience, lotteries are not being considered.

offer⁹². Various forms of auctions are possible and have been applied in spectrum management⁹³:

- a. Dutch auction (with a descending bidding price);
- b. The conventional auction, including:
 - i. Single round, often sealed or closed bid (first price or second price/Vickery auction);
 - ii. Multi-round, open bid (including sequential, standard simultaneous and combination auction)⁹⁴.

In the table below an overview is provided of the strength, weaknesses, risks and general applicability of each assignment instrument.

Table 2.5.1: Overview of assignment instruments

Instrument	Strength	Weakness	Risk	Application
<i>FCFS</i>	Fast Simple	Does not promote spectrum efficiency	A more efficient application does not get licence because it is submitted too late/late	Economic value of the licence is limited Number of licences per year is large and no scarcity is expected in the near future Permits/licences are similar in their application There is no (foreseeable) shortage of spectrum/frequencies
<i>Public tender or beauty parade</i>	Focus on quality Thorough procedure Regulator retains (most) control over the assignment	Time consuming Not transparent	Risk of appeal procedures Can result in excessive profits for licence holder	The number of licences per year is limited There is a new service or system where several different solutions are (still) possible Grip on the assignment process is necessary (for example in the case of distorted markets) Supplementary requirements are needed on the basis of social and cultural factors (and need to be compared)

⁹² Auctions were introduced to include market based instruments into spectrum management, next to so called administrative incentive pricing of licences (see section 2.4.4).

⁹³ For more detail on auction design see Handbook of Telecommunications Economics, Martin Cave, Sumit Majumdar and Ingo Vogelsang, Peter Cramton on Spectrum Auctions, Elsevier Science, 2001 and FCC's, Second/Fifth Report and Order on auction design, 1994.

⁹⁴ For the different auction types an overview is included in Appendix A: Overview of different auction designs.

Instrument	Strength	Weakness	Risk	Application
<i>Auction</i>	Results in allocation efficiency (in economic terms) Simple Transparent Returns economic value to the government/society	Regulator has less control over end result (depending on the set quality requirements) Auction is an upfront investment and may slow down service investments due to capital market constraints	Collusion between bidders could result in lower proceeds Errors in the auction design and execution could result in the wrong assignment Winner's Curse, bid was too high and service has to be terminated	The number of frequencies to be assigned is less than the available spectrum/licences Quality requirements can be formulated upfront No market distortions that could be jeopardized long term interest of end-users

2.5.2 Assignment procedures for DTTB and MTV services

Observing the DTTB licensing assignment procedures across the world we can conclude that in almost all countries the DTTB licence for Public Service Broadcasting (e.g. assigned to a Public Broadcaster) are assigned by priority and that the DTTB spectrum rights are assigned by means of a public tender or by renewal to commercial parties⁹⁵.

In some cases the public tender was accompanied with additional instruments to return (parts of) the economic value to society. In the table below an overview is provided:

Table 2.5.2: Applied assignment instruments for commercial DTTB services

Country	Applied policy for existing analogue television licence holders	Applied assignment instrument for other DTTB spectrum rights	Remarks
Australia	Renewal	Public Tender	In Australia, most of the digital television spectrum licences were renewals of existing analogue licences ⁹⁶
Belgium ⁹⁷	By priority	Public Tender	Only the Public Broadcaster had an analogue television licence Additional digital licence fees to be paid on the basis of a percentage of the gross revenues
Denmark ⁹⁸	By priority	Public Tender	Only the Public Broadcaster had an analogue television licence

⁹⁵ 'By priority' is referring to (Public) Broadcasters getting their digital licence first, without any competition, to carry-out their digital Public Service Broadcast obligation. This might entail that they can offer more services as compared to the analogue situation. The remaining digital spectrum is then assigned to other commercial interested parties/bidders. 'Renewal' is referring to (commercial) analogue television licence holders getting their licence/analogue rights 'converted' to a digital licence enabling them to at least continue broadcasting their current program(s) after ASO. This might result in spectrum efficiencies if the digital licence holder only facilitates a limited number of channels.

⁹⁶ For more details see www.acma.gov.au.

⁹⁷ See State publications in 'Belgisch Staatsblad' no 2008-3603 (Decision of 18th of July 2008) and no. 2008-4155 (Decision of 17th of October 2008), respectively the licensing procedure and licence terms and conditions.

⁹⁸ See country reports on www.digitag.org and www.dvb.org

Country	Applied policy for existing analogue television licence holders	Applied assignment instrument for other DTTB spectrum rights	Remarks
Finland	By priority	By priority ⁹⁹	National network operator was assigned the licence with roll-out obligations. The Public Broadcaster had an analogue television licence and got automatically facilitated on the DTTB platform.
France ⁹⁸	By priority	Public Tender	The Public Broadcaster and other existing analogue broadcasters got facilitated on the DTTB platform. Please note that this right to be facilitated will expire at the time of the ASO. This does not apply to the Public Broadcaster.
Germany	By priority	By priority ¹⁰⁰	National network operator was assigned the licence with roll-out obligations. The Public Broadcaster and other existing analogue broadcasters got facilitated on the DTTB platform. Please note that the Public Broadcasters (ARD/ZDF) got a full multiplex assigned. Others have to share a multiplex.
Netherlands	By priority	Public Tender	Only the Public Broadcaster had an analogue television licence Additional licence fees based on percentage of gross revenues ¹⁰¹
New Zealand ⁹⁸		By priority, FCFS	The Public Broadcaster, in cooperation with commercial broadcasters developed a proposal for DTV
Spain ⁹⁸	By priority	Public Tender	The Public Broadcaster and some other commercial broadcasters had an analogue television licence. They are facilitated on the first multiplexes
Sweden ⁹⁸	By priority	Public Tender	Only the Public Broadcaster had an analogue television licence
United Kingdom	By priority	Public Tender	The Public Broadcaster and three other commercial broadcasters had an analogue television licence. They were facilitated in the first two digital multiplexes
United States	Renewal ¹⁰²	Public Tender	Additional licence fees based on percentage of gross revenues

⁹⁹ The initial licence was assigned by priority to the National Broadcast Network Operator (Digita, fully government owned), before this operator was acquired by the commercial TDF group. In this way, TDF acquired the DTTB frequency licence. To date there is only one DTTB network operator in Finland.

¹⁰⁰ The initial licence was assigned by priority to the National Broadcast Network Operator (T-Systems, part of Deutsche Telecom, fully government owned), before this operator was (partly) privatized and acquired by the commercial TDF group. In this way, TDF acquired the DTTB frequency licence too.

¹⁰¹ Next to paying the monthly licence fee to the spectrum manager, the licence holder has the obligation to pay an additional annual charge of 15% over that part of its annual revenues above EUR 45 m, commencing in the 8th year of operation (licence duration is 15 years).

¹⁰² In the US most of the DTV spectrum licences were renewals of existing analogue licences (as most broadcasters/stations operate their own transmitter network). For more details see www.fcc.gov.

A similar picture can be observed for the applied assignment instruments for the MTV licences. The table below provides an overview¹⁰³:

Table 2.5.3: Applied assignment instruments for MTV services

Country	Applied assignment instrument for MTV spectrum rights	Remarks
Australia	Not assigned or planned yet	
Belgium	Public Tender	Additional licence fees based on profitability
Denmark	Public Tender	
Finland	Public Tender	
France	Public Tender	
Germany	Public Tender	Media licence (broadcast rights to be re-assigned)
Korea	Public Tender	
Netherlands	Public Tender ¹⁰⁴	Additional licence fees based on percentage of gross revenues
New Zealand	Not assigned or planned yet	Digital Dividend is delaying (political) decisions
Spain	Not assigned or planned yet	
Sweden	Not assigned or planned yet	Digital Dividend and HDTV is delaying (political) decisions
United Kingdom	Not assigned or planned yet ¹⁰⁵	Digital Dividend debate is delaying process
United States	Not assigned or planned yet	In Trial phase

The above discussed assignment instruments should be embedded in a carefully prepared assignment procedure. A general overview of the steps in a typical assignment procedure is described in Appendix 2.5.A.

2.5.3 Implementation guidelines

In addition to the above tables, the following guidance can be provided for DTTB and MTV assignment procedures:

1. Although additional requirements (like service roll-out and channel line-up/bouquet, must carry obligations, etc) can be stipulated in an auction procedure (see step 6, but only as a

¹⁰³ For more details see BMCOforum, Best practice regulatory frameworks for mobile TV, June 2008.

¹⁰⁴ In the Netherlands (and Italy) the MTV licensing was related to the DTTB licence by allowing the licence holder to offer MTV service as well. The initial DTTB licence was assigned through public tender.

¹⁰⁵ The UK had a commercial launch based on the radio standard DAB (-IP) but not on television designated bands yet. BT Movio launched its mobile broadcast entertainment service based on DAB-IP technology and a wholesale business model. Virgin Mobile started retailing the service to customers, but discontinued services in July 2007.

threshold), in most cases a public tender should be preferred because of the following considerations:

- a. The regulator strives to achieve media objectives and would like to *compare* service offering as to select the 'best' service (and not just check whether the offer passes the threshold). Comparison of offerings is very often necessary as the regulator is not familiar with what commercially is possible;
 - b. In most cases, the DTTB/MTV market is not a 'proven' market (in the sense that the revenues are still hard to predict with high levels of uncertainty¹⁰⁶) and the risks of a Winner's Curse is relatively high in the case of an auction¹⁰⁷;
2. Avoid combining a 'beauty parade' and an auction instrument to assign DTTB/MTV licences. In such an approach the regulator first selects the 'best' bidders and then assigns the spectrum licence to the highest bidder between the selected bidders. Or alternatively, the regulator request bids with a qualitative offer (e.g. channel bouquet/line-up and service roll-out) *and* a bidding price. Practice has demonstrated that such an assignment procedure results in bizarre outcomes (e.g. bidders compensate a perceived relatively weak qualitative offer with extraordinary high bidding prices or, conversely, bidders believed to have an excellent qualitative offer do not offer a reasonable price). Also such an approach is prone to legal procedures as the balancing between the qualitative offer and price is not clear/transparent and/or not perceived to be fair;
 3. Avoid combining auctioning spectrum licences and forms of administrative incentive pricing (i.e. levying licence fees based on market or economic value)¹⁰⁸. In general the licence holders or market players perceive such a combination as paying twice for the same licence. This should not be confused with paying the auction price in various instalments during the licence duration (so as to lower the need for attracting capital and consequently increasing the financial resources for service roll-out);
 4. If the regulator would like to exclude possible bidders, prepare these exclusions of possible bidders thoroughly as these rules can be legally contested. The regulator might like to exclude parties with significant market power (and a potential risk that they will abuse this power). The regulator publishes these qualification rules upfront (see step 4 in the above table). National or international legislation might limit the possibilities of excluding parties upfront;
 5. Stipulate aggregation rules in cases where more than one DTTB and/or MTV licences/multiplexes can be applied for in the assignment procedure. Without aggregation rules, there is risk of 'deep pockets' acquiring all available licences which can limit the quality and/or diversity of the service offering (especially in the case of auctions without any 'must carry' type of rules);
 6. If possible/known, determine and publish other future DTTB/MTV assignments, when the first DTTB/MTV assignment procedure is announced (in the case of assigning available multiplexes/frequencies in stages). Bidders need to know their competitive environment

¹⁰⁶ In contrast, in a proven market the revenue side is relatively easy to predict, especially through comparing similar business in other markets/countries (i.e. benchmarking) because the service is homogenous and the uptake curves 'look' similar across the various markets.

¹⁰⁷ The Winner's Curse is the problem of assessing the revenue side as in most case the cost side is relatively easy to estimate. In Auction design the problem of the Winner's Curse can be reduced by having multi-round auctions. In competitive markets, auctions do not lead to higher end-consumer prices, they reduce operating margins. Hence this is not a reason not to select auction as an assignment instrument.

¹⁰⁸ See also section 2.4.

during the licence duration. Special caution is required in the case where bidders are allowed to ask for clarification during the bidding procedure (see step 4 in the above table). The regulator's answers might be used in legal appeal procedures;

7. Start preparing the assigning procedure for DTTB licences (see step 1 in the above table) when:
 - a. There is a market initiative requesting a licence. The application and applicant should satisfy admissibility and minimum requirements, before starting any preparations. Such a request does not necessarily result in a FCFS procedure;
 - b. The government would like to take the lead in the introduction of DTTB services as it sees the availability of such services crucial in the further economic, social and human development of the country;
 - c. Analogue television licences (are about to) expire, because assigning DTTB licences will provide an opportunity to terminate analogue television licences (for example, by stipulating 'must carry' rules for analogue channels in the DTTB licence);
 - d. ASO plans have been formulated and decided, because DTTB licences are required to facilitate the continuation of existing (analogue) television services and to free-up spectrum (for ASO planning and timing see section 2.16);
8. If possible, combine the licensing procedure for MTV and DTTB licences as this will allow bidders to reap infrastructure and operating synergies (e.g. combined network roll-out and service provisioning). In cases where the DTTB business case seems to be weak, such a combination could be critical for market parties to be interested. In practice such combined licensing is carried out by either¹⁰⁹:
 - a. Stipulating that at least one of the multiplexes should be used for MTV, or;
 - b. Organizing separate DTTB and MTV assignment procedures closely after each other, or;
 - c. Assigning the national DTTB network operator the MTV licence as well by priority (in combination with strict access and pricing rules for the MTV platform, to avoid anti-competitive behaviour).

Appendix 2.5A: Economic effects of assigning licences

Assigning spectrum rights is about assigning a defined set of rights in the most efficient way. In general the term 'most efficient' could refer to either:

1. 'Technical' efficiency, including:
 - a. Spectrum efficiency: which application or bid uses least frequency spectrum? Technical efficiency is however difficult to define in general terms; the definition can vary from system to system. How, for example, can the efficiency of a DTTB television signal be compared with the efficiency of a GSM system? Efficiency comparisons are probably only possible between related systems;
 - b. Subjective forms of efficiency: which application/bid is closest to fulfilling the set requirements or objective? For example, when assigning DTTB licences the bid with the most balanced channel bouquet and the best service acquires the licence;

¹⁰⁹ See respectively the licensing procedures in Belgium/Denmark, France and Finland.

2. Economic efficiency: which application or bid can generate the highest economic return or value for society? In a spectrum auction, the bidder with the highest bid will acquire the licence.

In recent years various spectrum management instruments, based on economic principles, have been introduced, like auctions, tradable spectrum rights and administrative incentive pricing. It is important to note that these different instruments deal with different types of efficiency. The following three types can be distinguished:

1. *Allocation efficiency* relates to the allocation of a frequency (band) to the organization which will be able to obtain the highest economic return. It is, for example, possible that two operators want to provide an identical service. The expected return can differ significantly between one operator and the other, because one of them can achieve substantial cost savings by using better network planning or can realize higher returns through a more effective marketing strategy. In this category falls the auction instrument;
2. *Production efficiency* can be created when an operator can provide services at a lower cost. In the case of licences, it is possible that an operator can make savings through synergy between related systems. As an example, a DTTB network operator/service provider could operate a DVB-H system significantly cheaper by making common use of a large number of system components such as broadcast sites or billing systems. Into this category fall instruments such as administrative incentive pricing as licence holders could be given an incentive to produce more efficiently by basing the licence fee on this higher value (not included in the scope of this section);
3. *Dynamic efficiency* comes into the picture when the distribution of frequency bands adapts itself very rapidly to trends in supply and demand. In order to obtain dynamic efficiency, it is necessary that the licence holder is given freedom in how the frequency band is used. It is quite conceivable, for example, that an operator acquires the availability of a band for digital television and is entitled to divide it as he sees fit between DTTB and MTV. The operator will adjust the bandwidth continuously according to the return he can achieve on each system. Into this category fall instruments such as application/technology 'free' licensing and tradable spectrum rights (not included in the scope of this section).

Appendix 2.5B: Assignment procedure steps

A general overview of the steps in a typical assignment procedure is described in the table below.

Table 2.5B1: Elementary steps in an assignment procedure

Step	Description	Objective	Activities/Results
1	Formulate detailed assignment policy	Determination of assignment instrument and procedure for DTTB and MTV spectrum licences	Carry out market consultation and survey Determine available frequencies and bandwidth Determine number of licences Determine licence duration Establish general licence terms and conditions Determine primary assignment instrument
2	Setting up assignment planning and schedule	Determining key milestones in DTTB and MTV licensing procedure	Determining completion date for application document Determining opening of licence application Determining duration of appraisal phase Determining final assignment date

Step	Description	Objective	Activities/Results
3	Draw up and publish procedure for granting the licence	'translating' the detailed assignment policy into frequency management items	Define procedure, including possibilities to ask clarification and/or questions, appeal procedures, etc. Define assignment instrument (e.g. type and design of auction) Formulate admissibility requirements (i.e. minimal requirements to qualify) Formulate technical system requirements (e.g. radio interfaces and/or broadcast system) Formulate service requirements (e.g. number of channels, roll-out pace, etc.) Define detailed licence terms and conditions
4	Collect applications	Collecting completed and timely applications (application acceptance)	Check whether all received applications are complete Return incomplete applications Check whether all corrected applications have been received
5	Appraise applications	<i>In case of public tender:</i> selecting the best plan (i.e. plan that most closely matches requirements/objectives) <i>In case of auction:</i> selecting qualified bidders	Evaluate all accepted applications for admissibility/qualification (threshold) Evaluate and score all qualified applications on technical requirements (threshold) Evaluate and score applications on service requirements (threshold) Carry out comparative evaluation (<i>only for public tendering</i>) Announce best bid (<i>only for public tendering</i>) Announce qualified bidders (<i>only for auctions</i>) Handle any objections or complaints
6	Assigning spectrum rights (and obligations)	Assigning the available DTTB or MTV licences	Organize auction (auctioneers, location and bidding facilities – might be computer based) (<i>only for auctions</i>) Register and instruct bidders (including assign anonymity to bidders) (<i>only for auctions</i>) Collect up-front payments (if any) (<i>only for auctions</i>) Stop, pause and close auction (<i>only for auctions</i>) Collect down payment (could be in instalments) (<i>only for auctions</i>) Assigning frequencies by issuing the license (<i>both auction and tender</i>)

Appendix 2.5C: Overview of different auction designs

The table below gives an overview of the advantages and disadvantages of the different types of auction. The table is divided into three parts. The aforementioned types of auction are compared with one another in each part

Table 2.5C1 Advantage and disadvantages of the various auction designs.

Auction type	Advantages	Disadvantages	Risks	Use if
<i>Dutch Auction</i>	<ul style="list-style-type: none"> – does not drive up prices 	<ul style="list-style-type: none"> – starting price is difficult to fix – no information about value of product so danger of winner's curse – little allocation efficiency – practically only possible sequentially so no use of synergy 	<ul style="list-style-type: none"> – incorrect starting price can result in no bid or no realistic price – relatively more prone to collusion 	<ul style="list-style-type: none"> – homogeneous products which are not interdependent – product value is known or can be derived from previous auctions – high speed is required – product value is low
<i>Conventional Auction</i>	<ul style="list-style-type: none"> – Different versions possible (Vickery, multi-round simultaneous, etc.) – easier to set starting price/minimum bid – information about value of product in open auction – more allocation efficiency 	<ul style="list-style-type: none"> – has a greater potential to push up prices (however countermeasures possible such as not bidding on price and limiting the number or rounds) 	<ul style="list-style-type: none"> – pushing up prices 	<ul style="list-style-type: none"> – Flexibility is required in the auction design – little information is known about the value of the asset – assets/products are interdependent
<i>Closed/Single round</i>	<ul style="list-style-type: none"> – more protection against collusion – fast – reduces upward price pressure – simple and hence cheap 	<ul style="list-style-type: none"> – winner's curse – less allocation efficiency – less transparent 	<ul style="list-style-type: none"> – large price differences possible (and with Vickery it can lead to very low prices, embarrassing the regulator) 	<ul style="list-style-type: none"> – product value is low (other types of auctions are too expensive in relationship to the product value) – there is a large number of products and speed is required – relatively little importance is attached to allocation efficiency – there is deemed to be a high risk on collusion – value of the product is more or less known in the market

Auction type	Advantages	Disadvantages	Risks	Use if
<i>Open/multi-round</i>	<ul style="list-style-type: none"> – less risk of the Winner’s curse – higher allocation efficiency – is generally considered as fair (chance to revise bid) 	<ul style="list-style-type: none"> – less protection against collusion – greater risks of pushing up prices – auction can last a long time, depending on the stopping rules – more complex and hence more expensive to organize 	<ul style="list-style-type: none"> – pushing up prices 	<ul style="list-style-type: none"> – allocation efficiency is considered to be important – a fair auction is required, considering the ‘public/market opinion’ – there is uncertainty about the value of the product – product value is deemed to be high
<i>Sequential</i>	<ul style="list-style-type: none"> – simple and hence cheap – results in slight upward pressure on prices 	<ul style="list-style-type: none"> – problem with the sequence when there are several products: which products first and in which combinations? – little utilization of synergy (less allocation efficiency if interdependence) 	<ul style="list-style-type: none"> – sequence not correctly set – not seen as ‘fair’ (no opportunity to revise bid) 	<ul style="list-style-type: none"> – no dependency between one product and another – Low product value
<i>Standard simultaneous/open/multi-round</i>	<ul style="list-style-type: none"> – high degree of allocation efficiency when products are dependent on one another – less danger of winner's curse – no sequencing problems 	<ul style="list-style-type: none"> – complex but manageable (even with greater number of bidders), but more expensive – complex for bidders – many rules and much preparation necessary – auction can last a very long time depending on activity and stopping rules 	<ul style="list-style-type: none"> – can take a long time – greater chance of errors in how auction is set up because of the many rules needed – pushes up prices 	<ul style="list-style-type: none"> – products are interdependent – product value high
<i>Combination/open/ multi-round</i>	<ul style="list-style-type: none"> – highest degree of allocation efficiency for interdependent products – analogous to standard simultaneous auction 	<ul style="list-style-type: none"> – the most complex (probably no longer manageable when there are many bidders) and therefore most expensive type of auction – the ‘free rider’ problem as a result of which there is a good chance that only package bidders win 	<ul style="list-style-type: none"> – free rider problem – analogous to standard simultaneous auction 	<ul style="list-style-type: none"> – analogous to standard simultaneous auction

2.6 License terms and conditions

The regulator has to set licence terms and conditions for any of the three types of licence categories, as mentioned in section 2.2 “Licensing Framework”. This section will focus on the licence terms and conditions of the DTTB and MTV frequency or spectrum licences.

Assigning DTTB/MTV frequency rights is carried out in conjunction with assigning the other two types of rights as well. However, broadcast or operator rights could also be included in the spectrum licence, depending on the existing regulatory and legal framework. In some situations changing the legal framework might take too long (or is not desired) for the planned DTTB/MTV spectrum licensing and the regulator might decide to include broadcast or operator rights in the spectrum licence. But in the framework of these guidelines and in this section, we assume that the frequency licences serve the sole purpose of safeguarding efficient and proper spectrum usage.

This section comprises the following paragraphs:

1. Licensing and fair competition rules: assigning DTTB/MTV spectrum licences will create exclusivity and the regulator has to ensure fair competition;
2. Frequency licence terms and conditions: the standard licence terms and conditions to be included in a DTTB/MTV spectrum licence;
3. Implementation guidelines.

2.6.1 Licensing and fair competition rules

At a national level the radio-frequency spectrum is considered the State’s public domain and is a scarce resource. Moreover, for most radio applications it is the only or unique resource. As the result of the State’s right to manage the spectrum, authorized spectrum users acquire very often the exclusive rights to access and use the spectrum. In this way, by assigning licences, the regulator interferes in markets. Consequently, the regulator should also ensure fair competition at the same time.

Assigning frequency rights is normally carried out on the basis of exclusivity. Frequency sharing does occur for some applications, like wireless telephony (DECT), Internet (WiFi) and wireless microphones. However, for DTTB and MTV applications, assignment of spectrum rights is carried out on the basis of exclusivity for the main reason that no technology is available (yet) to allow frequency sharing. Other reasons for assigning on the basis of exclusivity are:

1. Safeguarding un-interrupted broadcasts;
2. Safeguarding DTTB/MTV investments;
3. Exercising control over media/television platforms (and their content).

The root of the fair competition issue is that assigning exclusive frequency rights to one market player will impose, at the same time, a limit on market access for other parties. The regulator has to avoid creating unfair competition and possibly to guarantee access to the platform. Whether additional regulation is needed to guarantee fair and open competition for the DTTB/MTV markets depends on the local circumstances:

1. The existing legal framework: for example in Europe, the various Directives already safeguard to a great extent fair competition. National governments have to adopt these competition rules in their national legal framework, including aspects such as:
 - A. Transparent and non-discriminatory licensing criteria for spectrum licences: limiting selection criteria either to:
 - i. ‘Essential criteria’ addressing the bidder: bidder should be technically and financially capable of offering the DTTB/MTV services, should be registered in the trade registers, etc.;

- ii. Other criteria addressing the bid: the number, the roll-out speed, the variety, the quality and the pricing of the offered DTTB/MTV services¹¹⁰;
 - b. Limited grounds for excluding bidding parties for the DTTB/MTV licence, either:
 - i. Bidder does not meet the ‘essential criteria’, or;
 - ii. Probable risk of market power abuse: potential bidders owns or has control over competing platforms (with a significant market share, e.g. above 25 per cent of the relevant market) and is likely to acquire the licence just for strategic blocking or limiting competition;
 - c. Access to and fair pricing of ‘essential facilities’: including either:
 - i. Site/antenna sharing rules imposed on parties owning or controlling high towers which cannot be duplicated in an economic feasible way¹¹¹;
 - ii. Access to networks when these cannot be duplicated too (i.e. rules for Open Network Provisioning). When only one DTTB/MTV network operator/provider is licensed this might be the case;
2. The selected DTTB/MTV assignment procedure: when the assignment procedure is open to all interested market parties, the selection criteria are transparent and non-discriminatory and published up-front, most competition issues are resolved. In contrast, assigning by priority frequency rights (without a tender procedure or auction) to commercial parties might raise the need for additional legislation¹¹²;
3. The market structure for television services: the more distribution/platform alternatives that are available for end-consumers, the less likely is that markets are being disturbed by assigning exclusive rights. The licence holder will not be in the position to abuse its ‘power’. However, the regulator might have to consider platform ownership carefully. Cross-ownership might be grounds to limit access to the assignment procedure for DTTB and MTV licences¹¹³.

In principle the regulator has two key regulatory instruments to ensure fair competition when licensing exclusive DTTB/MTV rights:

1. Assigning the DTTB/MTV spectrum licences in open and transparent assignment procedure, including:
 - a. Publishing the ‘essential’ and other criteria upfront, transparent and not favouring one or other specific party (e.g. requiring specific content that only one party can delivery because it holds the exclusive rights to this content);
 - b. Limiting the grounds for the exclusion of potential bidders: either bidders do not meet the ‘essential criteria’ or there is a probable risk of market power abuse;

¹¹⁰ In case of an auction the selection criteria will mostly only include ‘the essential criteria’.

¹¹¹ Although the Essential Facilities theory can provide a theoretical framework, in practice it will come down to listing these high towers and defining economic feasibility (i.e. defining a reasonable return for investments). Alternatively, the Regulator could set site sharing rules on the basis of preventing ‘horizon’ pollution.

¹¹² To distinguish from assigning frequency rights to Public Broadcasters, as these bodies operate already under a special Act or under special provisions in either the Broadcast or Telecoms Act.

¹¹³ For more details on cross-ownership regulation see the FCC 2006 review of the Media Ownership Rules on www.fcc.gov/ownership/.

2. Imposing 'Open Network Provisioning' rules on DTTB/MTV network providers in case these networks have been rolled out exclusively by one party (like in Finland), including¹¹⁴:
 - a. The grounds for refusing capacity;
 - b. The maximum (multiplex) capacity to be allocated to one single broadcaster or service provider;
 - c. The fair pricing of capacity¹¹⁵;
 - d. The rules for capacity reservations¹¹⁶.

2.6.2 Frequency licence terms and conditions

The list below provides an overview of the licence terms and conditions which, in most cases, are included in a DTTB/MTV licence. These terms and conditions apply to DTTB/MTV licences issued to commercial parties and Public Service Broadcasters. However, the latter group acquires its licence under a different legal framework and might include specific rights and obligations (see section 2.2.3):

1. Granting of licence, including:
 - a. The definition of the legal basis of the licence (referring to the Broadcast, Media or Telecom Act);
 - b. The licensing starting and termination dates, either fixed dates or dates related to other events such as the acquisition of an operating or broadcast licence;
 - c. Definitions (of terms used in the text);
2. Spectrum rights: depending on whether the DTTB/MTV licence is based on allotments or assignments (see also 2.3.1), the rights are defined in frequency tables stipulating the maximum allowed transmitting powers (ERPs), transmitter locations/sites and geographical area in which a specified frequency can be used. In addition, the following duties are include too:
 - a. Avoiding interference;
 - b. Applying proper (and possibly certified) transmitter equipment;
 - c. Complying with health and safety measures (for own personnel and the public);
 - d. Reporting transmitter activation and cooperating with inspection;
 - e. Providing information to the regulator;
3. License obligations including:
 - a. The obligation to provide television services within a certain time frame (roll-out obligations);
 - b. The obligation to provide a defined portfolio of television services (could be by including as obligations the services promised in the licence holder's bid);
 - c. Service level obligations, including aspects like broadcast standards, geographical/population coverage, service/network availability, allocated bandwidth/multiplexes per service, etc

¹¹⁴ For more details on Open Network Provisioning rules see also www.ictregulationtoolkit.org/InfoDev/ITU.

¹¹⁵ The Regulator will have to establish a fair return on investments for the investments (Capex) and margin on the operational costs (Opex). This might also entail setting rules for which part of shared and overhead costs may be included in the regulated prices.

¹¹⁶ Any reservation system is prone to strategic blocking and the Regulator might have to set rules for maximum reservation periods and capacity.

- d. The obligation to provide site and antenna sharing (this provision might be incorporated in national legislation and this licence term just confirms its applicability);
4. Exercise of spectrum rights: the licence may include the possibility that entities other than wholly owned affiliates can use (parts of) the defined spectrum rights. This might be relevant in situations where another company, other than the licence holder, will actually roll-out and operate the broadcast network;
5. Spectrum trading and sharing: the regulator may or may not allow trading or sharing of the defined spectrum. Or alternatively, the regulator could include the following: the licensee shall not, except with the prior written approval of the regulator, assign, transfer, trade, sell or otherwise dispose of the whole or any part of the rights, privileges, duties and/or obligations under this frequency licence to any person or persons;
6. Interoperability and technical standards: the licence may stipulate any requirements on interoperability and technical standards to be applied. For details on these stipulations, please refer to section 2.1;
7. License fees (see also section 2.4.4 and 2.5.3): including fees for:
 - a. Covering (a part of) the costs for spectrum management and monitoring;
 - b. Recouping market value, i.e. additional fees based on the market value of the licence, for example a percentage of the revenues realized in the 6-8th year of operations;
8. License duration and renewal: for DTTB and MTV licences the licence duration ranges from 10 to 20 yrs, as the DTTB/MTV business is very capital intensive. Very often, renewal is included in the licence as well. Please note that without stipulating the grounds for renewal or termination (i.e. refusal of renewing the licence), such a clause is in effect just a licence extension;
9. Modification, revocation and termination: including the right for the regulator to either terminate or change the licence (terms and conditions) when deemed necessary (very often based on major spectrum efficiency considerations). In additions, items are included on dispute resolution, sanctions, and “force majeure”;
10. Complaints received from the public, about programming (depends on the framework and bidding procedure). This could also include complaints from the public about interference. The licence terms stipulate that the licence holder should handle these complaints and resolve them in an adequate time frame;
11. Content and Copyrights: to exclude the regulator for being responsible for paying any content or copy rights to be paid. The licence holder remains responsible for paying any of these levies. This might also be incorporated in the broadcast licence. It may also be possible that payment for these rights is arranged between the licence holder (i.e. the service provider) and the individual broadcasters, by having mutual agreements¹¹⁷.

2.6.3 Implementation guidelines

The following guidance can be provided for setting DTTB and MTV licence terms and conditions

¹¹⁷ Content rights arrangements and legislation vary from country to country. However, very often, national collecting societies are present and will collect any duties. Collecting societies tend to collect fees from all parties that generate revenues from using the content (e.g. service providers and content distributors). Studios and Majors will generally only collect fees directly from broadcasters (very often on the basis of the number of ‘runs’ and ‘simulcasts’ on the DTTB platform might be exempt from paying as programs are also broadcast on other platforms at the same time).

1. Include the spectrum rights:
 - a. In the case where the GE06 Plan includes assignments: stipulate frequency assignments (i.e. with the exact transmitter locations and powers) in the licence, or;
 - b. In the case where the GE06 Plan includes allotments: the regulator has two options either include assignments or allotments. Including assignments in this situation will require detailed network planning. However, it is recommended to include allotments in the licence as the licence holder will be in the best position (and will probably have better means) to detail the network planning that best fits its business plan requirements. When including allotments, the regulator should be aware that the licence holder has the possibility of selecting the transmitter location and the individual powers of each station. Consequently, the regulator will have to include the 'Reporting transmitter activation' clause in order to monitor proper spectrum usage;
2. For including technical standards in the licence terms and conditions, please refer to section 2.1.2;
3. When including a roll-out obligation, make sure the licence holder can actually roll-out the services, especially with regards to any required local permits (see also section 2.7). It would be better if some 'checks' by local governments on, for example, EMC matters will be waived or relaxed with granting the national frequency licence. This will speed up the licensing of building permits. Such a policy will not hamper the local council to determine the best location for the DTTB/MTV transmitter sites. Also, monitoring to ensure transmitter emissions are correct (i.e. whether the transmitting station transmits within the set interference limits) will still be required;
4. Include the assignment instrument in the renewal clause. The possibility of renewal can make investing in DTTB/MTV services more attractive. But when, having issued a licence with a fixed duration and after termination, the regulator decides that renewal is possible through an auction (for re-assigning the licence) market parties will claim that this is not a fair policy. The current licence holder made the business a success and now has to pay in the auction for getting the business back. From economic perspective this argument does not hold but, as discussed before, it is advisable to assign DTTB and MTV licences not by auction but by public tender. In this light, any renewal clause should state the (re)assignment instrument which, preferably, should be by public tender;
5. When the licence is assigned through a public tender, include the services (etc) proposed in the licence holder's bid in the licence terms and conditions. For both types of public tender:
 - a. Best bid: the bidder with the best offer acquires the licence;
 - b. Qualifying bid: the bidder who surpasses a set threshold (e.g. certain service level requirements) will get the licence (although not recommended in these guidelines this type of public tender, is very often applied in combination with a monetary bid).
6. Check consistency between the licence terms and conditions of any commercial licence holder and the Public Broadcaster (if applicable), including:
 - a. Service or network roll-out obligations: the Public Broadcaster might have an obligation for near 100 per cent coverage for rooftop antenna, whereas the commercial licence holder would like to roll-out an indoor network or perhaps in a smaller area. A shared network roll-out might become more complex and fragmented;

- b. Sharing of multiplex capacity: sharing multiplex capacity might be desired or necessary and any legal limitation should not stop this collaboration from happening;
 - c. Sharing EPG and programming information: both the Public Broadcasters and the commercial licence holder might have to share/provide EPG data between services (including an agreed format);
 - d. Conditional Access and Free-to-Air broadcasting: a joint network roll-out between the Public Broadcaster and the commercial licence holder might require an agreement for the common use of a Conditional Access System and/or the exemption of applying such a system;
7. Check ASO compliancy: make sure the licence terms and conditions are in line with any ASO plans, including:
- a. The possibility to (temporarily) change defined frequencies for resolving any spectrum incompatibilities (see section 2.17);
 - b. Site sharing obligations and the requirement to remove old analogue antennas in order to resolve any infrastructure incompatibilities (see section 2.17);
 - c. The obligation to carry and provide PSB free-to-air channel(s): i.e. if the licence holder applies a Conditional Access System, this system should be able to offer free-to-air channels. Also, perhaps more importantly, the licence holder has to provide the retail logistics for getting a 'free-to-air-only' smart card.

2.7 Local permits (building and planning)

For rolling out terrestrial communications networks, including DTTB and MTV networks, transmitter sites are required. This section addresses the necessary permits and authorizations from local governments required to establish and operate broadcast transmitter stations. This section includes the following paragraphs:

1. Economics of rolling out transmitter sites;
2. Instruments to facilitate transmitter site erection;
3. Implementation guidelines.

2.7.1 Economics of rolling out transmitter sites

In any DTTB/MTV network the number of sites is the key cost driver. The broadcast network operator aims to reduce the number of sites in its network design, whilst maintaining the required service levels of service coverage, reception quality and network availability (see also section 4.2 and 4.3).

In turn, considering the cost structure of a transmitter site, the second cost driver is having the availability of a mast or other tall construction. Erecting new transmitter masts tend to be expensive. Not only for the purchase of a mast, but also the possibly (long) procedure to acquire permission to erect such a mast (i.e. a building permit). The associated costs do not only include the cost of a site acquisition organization but also any delays in service launch and hence cost of capital.

Consequently, the broadcast network operator's objective is to re-use as many existing sites as possible¹¹⁸. These existing sites can either be own property or third party property. In case of third party property, the network operator will bear operational expenses for site rental fees.

¹¹⁸ Availability of antenna space on a mast is not only determined by the physical meters of free space but also the wind load of the mast, i.e. the mechanical strength of the mast to carry additional wind load.

From a network operator's point of view, having access to and fair pricing of sites is important to keep investment and cost levels down (and ultimately provide a profitable service). However, these third party site owners could be a direct competitor (e.g. the incumbent broadcast network operator or the Public Broadcaster) or a commercial tower company¹¹⁹ and they may abuse their position in not granting access or charging unfair prices.

Hence, the regulator and the local governments do have an important role here to facilitate transmitter site build-up and site sharing arrangements.

2.7.2 Instruments to facilitate transmitter site erection

Regulators tend to intervene in this tower market for the following reasons:

1. Facilitating site sharing and fair pricing;
2. 'Horizon pollution': Regulators may like to control the number of transmitter sites and plan the locations of these transmitter sites;
3. Health hazard control: Regulators have a duty to control health hazards for EMC, noise, dangerous goods and mast construction strength.

In pursuing the above objectives the regulator normally applies the following instruments:

1. Requiring and issuing *building permits* (very often at a local or regional level): granting of rights to erect new sites to the DTTB and/or MTV network operator;
2. Mandating *site sharing rules* (at a national level): imposing obligations for network operators (including telecommunication providers and other broadcast network operators) to provide antenna space on their sites;
3. Providing guidelines for and determining *site sharing pricing* (at a national level): imposing obligations for network operators to charge fair prices for antenna space;

Depending on the relative importance of the regulator's objectives a mix of the above instruments is applied. However, an important interaction does exist between the using the instruments of building permits and site sharing rules. Having very strict rules and long procedures for acquiring building permits can turn sites into 'essential facilities' (see also 2.6.1) and consequently the need for site sharing rules will increase. Also, strict building permit procedures can hamper, or even make it impossible, for the spectrum licence holder to comply with stipulated service/network roll-out obligations.

Building permits

Before allowing the transmitter site to be erected and taken into operation, the (local) regulator can check compliance in the following areas¹²⁰:

1. Field strength and EMC, addressing:
 - a. Field strength calculations: a check on whether the maximum permitted levels of radio emissions are not exceeded by the introduction of (additional) DTTB /MTV

¹¹⁹ Tower companies are either dedicated companies owning transmitter locations (masts or other tall constructions) or a subsidiary of a broadcast network operator, telecom operator or utilities company. They rent-out antenna and transmitter space. They tend not to own any transmitter equipment and are considered real estate owners, although special real estate. Some typical examples are Crown Castle International and American Tower.

¹²⁰ In some countries, the permission to build and to transmit (take the transmitter into operation) are split in two separate licensing procedures: the building permit and the environmental permit. In addition, they might be related. For example, the building permit procedure is not started before the environmental permit is assigned.

- equipment¹²¹. This check is carried for the purpose of protecting the health or safety of persons who operate, work on or use the services supplied by DTTB/MTV transmitters;
- b. Electromagnetic Compatibility (EMC): a check to ensure EMC levels are not exceeded. Most industrialized nations have established agencies or other regulatory bodies responsible for defining and enforcing EMC standards¹²². If EMC regulations exist in a country, equipment manufacturers cannot legally ship their product into that country until compliance with those regulations is met. The purpose of the regulation is to minimize electromagnetic interference between electronic products which may diminish the performance of other electrical products or disrupt essential communications. All products that fall within the scope of the regulation are subject to compliance with the arrangements and must be labelled appropriately with the compliance mark;
 2. Mechanical: check on whether the mechanical construction can carry the additional (wind) load of the (additional) DTTB/MTV equipment (this might also include dishes for fixed wireless links to transport the multiplex streams to the transmitter tower). Local regulators might stipulate an independent and certified engineering bureau to carry out the calculations. Standards for mechanical strength calculations are numerous and vary from country to country (and even between local governments);
 3. Noise: check to ensure the DTTB/MTV transmitters, their cooling equipment and power supply do not exceed set standards for maximum noise levels. Especially in urban areas such standards might be applicable. Standards for noise limits are numerous and are specific for each environment. For example, a DTTB/MTV transmitter installed on the top of an office block might have to comply with different standards than a dedicated transmitter tower in a rural area;
 4. Dangerous goods: check whether or not too many dangerous goods are accumulated in one single location. For example, there may be limits in place on the storage quantities of diesel for the transmitters' power supply or back-up generator. Additionally, some fire prevention measures have to be taken;
 5. Horizon pollution: Local governments check whether the planned DTTB/MTV transmitter sites fits in the local building plans (in the case of erecting a new mast). This might be the hardest requirement to meet, requiring intensive lobbying and additional investments. Because DTTB towers tend to be very tall (over 100 meters) the horizon pollution might be perceived as large. Especially in urban areas this might be a hard nut to crack. Special commissions might be in place to assess the aesthetics of the building request. It is not unusual that specially designed towers are requested, pushing up the DTTB investment levels considerably.

¹²¹ Sites carrying several services (like FM radio or Analogue television) next to the planned DTTB/MTV services might require specialized software and knowledge for calculating the cumulative field strength. Several international bodies exist for setting Radio Frequency or field strength safety standards and guidelines. Globally, the two leading organizations are the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE).

¹²² See for example the Federal Communications Commission (FCC) in the United States and The British Standards Institution (BSI). Institutes providing standards include International Electrotechnical Commission (IEC), Comité Européen de Normalisation (CEN) and European Telecommunications Standards Institute (ETSI).

Normally, most of the above checks are carried out at a local level and very often with different standards and calculation methods applied. However, it could be argued that the test on field strength and EMC could be simplified and carried out at national level. For example, by the national radio agency or communication commission that issue the frequency licence and check spectrum compliancy (see previous section). In addition, the national regulator could also inform the local governments what standards are applicable for these DTTB/MTV building requests. In some countries, centralized approaches have been applied for the roll-out of mobile networks.

Site sharing rules

Generally, site sharing rules are applicable to certain entities such as telecom operators and broadcast network operators as defined in the relevant Telecoms Act. Very often these entities are defined as parties that provide a network/service for electronic communications, including broadcast communications. Real estate property owners (and possibly tower companies) might not fall under the defined entities.

In essence, site sharing rules provide arrangements to acquire access to transmitter sites and (possibly) pricing methods and limits. The ground rule is that parties that fall under the defined entities should provide access to any reasonable request. The site sharing rules might provide grounds for refusing access, including:

1. The site sharing request is not deemed reasonable: for example the requesting party does not provide (enough or relevant) technical data to assess the capacity claim on the tower or claims a reservation without a clear date for actual operations¹²³;
2. The requested capacity is not available: either the maximum wind load is exceeded with the additional antenna system or there are no physical meters left on the mast¹²⁴;
3. The site owner has reserved the capacity for its own services or operations: this ground for refusal will require the adoption of a reservation system in the site sharing rules.

Site access rules might not necessarily come with rules for fair pricing. As mentioned before, site sharing rules might be imposed on the basis of 'essential facilities' and/or 'horizon pollution'. In any case, the applied pricing regimes are very often based on the theory of essential facilities¹²⁵. It is important that the regulator can impose two types of pricing regimes:

1. Price cap: this form of price regulation is the most strict form (and it can be debated whether this should be applied) as price cap regulation will dictate the maximum price the site owner is allowed to charge for site sharing;
2. Cost plus: under this regime site sharing price is based on a defined list of allowed costs plus a maximum margin or yield on top of these costs. Many costing models exist and even after adopted a refined model many debates/conflicts still can occur, more specifically about¹²⁶:

¹²³ As indicated in section 2.6, capacity reservations need special attention as they might be prone to strategic blocking.

¹²⁴ It is not always evident whether maximum load capacity is reached, when the requesting party is proposing mast rearrangement (i.e. moving antenna systems) and problems might occur on the payment of these rearrangement costs.

¹²⁵ For more details and background on the Theory of Essential Facilities please refer to www.ftc.gov/os/comments/intelpropertycomments/pitofskyrobert.pdf.

¹²⁶ Many different cost models exist under this regime, most notably (in the telecoms industries) Long Run Incremental Costs (LRIC) models. Regulators in many countries apply this model, such as New Zealand, Australia, the United Kingdom, the European Community, and the United States. These

- a. What cost to include and for what portion: especially R&D and overhead costs are debatable;
- b. What depreciation scheme: historical or replacement costs;
- c. What percentage for the Weighted Average Cost of Capital (WACC)

2.7.3 Implementation guidelines

The following guidance can be provided in regulating building permits and site sharing:

1. Determine (local) policy objectives first and apply the regulatory instruments accordingly. For example, if the key objective is to avoid horizon pollution do not use essential facility arguments, because this leaves the regulator open for legal attack. ‘Essential facilities’ might be difficult to prove and the objective to prevent horizon pollution might be lost;
2. Check consistency between applied regulatory instruments and the existing legal framework, especially:
 - a. Check applicability of the existing site sharing framework: very often defined for mobile operators, and not for any other operators or tower companies. Consequently the DTTB/MTV introduction might require a re-definition of the Telecoms Act (which is normally a lengthy process);
 - b. Check building permit and site sharing regimes with any included service roll-out obligations in the spectrum licence (and/or broadcast licence);
 - c. Check consistency in applied building and environmental standards across the country and consider centralizing checks and informing local governments about the standards to be applied.
3. Consider addressing access to transmitter equipment space. Site sharing rules are very often limited to providing access for antennas, but transmitter space might be as difficult, or if not more difficult, to get access to. Transmitter space could be the limiting factor rather than the mast capacity and floor space pricing might not be regulated and market parties might charge excessive prices;
4. When site sharing rules are desirable for the purpose of avoiding strategic blocking, also provide rules on pricing. Site sharing rules without pricing rules tend not to work as excessive pricing will, in effect, stop access;
5. Generally for MTV networks many more sites will be required, compared to rolling out a DTTB network for rooftop¹²⁷. These additional MTV sites might be similar in height than mobile network sites. Hence for MTV networks the presence of site sharing rules for mobile operators might be especially relevant.
5. Make information on existing sites available for licence holders. In some countries special agencies exist for administering transmitter sites and their use¹²⁸. Such agencies could help in making information on sites available, harmonize site sharing policies and speed up licensing procedure by provide expert knowledge to local councils or perhaps even evaluate site share applications. The latter can be especially relevant for DTTB roll-out as, most likely, the digital transmitters will be installed on the analogue television sites.

models are also applied for site sharing. For more details see www.ictregulationtoolkit.org, section 3.3.2.

¹²⁷ Depending on required coverage, transmission mode, etc. (see Networks sections).

¹²⁸ For an example of an Antenna bureau and its register see respectively www.antennebureau.nl/voetmenu/english/ and www.antenneregister.nl/www/tpl/frameset.html.

2.8 Media permits and authorizations

As described in section 2.2.2, Licensing DTTB and MTV services will involve three types of rights, including broadcast rights. Broadcast licences, as defined in these guidelines, grant the right or permission to broadcast television content on a defined broadcast DTTB/MTV platform in a designated geographical area and for a specified period.

In regulating access to the DTTB and MTV platforms and/or to determine content composition on the DTTB and MTV platforms, the regulator can avoid unwanted broadcasts, promote defined broadcasts or avoid duplication of content.

In most countries, the regulator granting broadcast rights will differentiate between:

1. Public Service Broadcasting (PSB)¹²⁹: Public Service Broadcasters are normally authorized in a different way. In most cases the broadcast content is specified in a (separate) Media or Broadcast act. For more details on licensing public broadcasters please refer to section 2.2.3;
2. Non-Public Service Broadcasting or commercial broadcasting: this group of broadcasters includes pay-tv operators (i.e. they offer a channel package/television content on the basis of subscription fee or pay-per-event) and free-to-air broadcasters (they offer television content on the basis of advertising income).

In this section we focus on granting media/broadcast permits/authorizations for Non-PSB/commercial broadcasters. This section is organized into the following paragraphs:

1. Broadcast licensing framework: the different levels of granting broadcast rights;
2. Broadcast licensing requirements: the broadcast requirements to be met for granting the licence (may be split in different service/content categories);
3. Implementation guidelines.

2.8.1 Broadcast licensing framework

By nature of the digital broadcast technology, where multiple programmes or services can be carried on one frequency (i.e. multiplex), the broadcast rights for DTTB/MTV services are very often organized at two levels¹³⁰:

1. *Programme level/linear broadcast stream*: the right to broadcast a specific television programme/service (or sequence of programmes/services), either through a general broadcast authorization or for a specified platform only, like the DTTB/MTV platform (referred to as media/broadcast permit/authorization). These rights will come with the obligation to adhere to a defined set of *content* criteria such as:
 - a. A certain level of local news coverage, arts, religious programming;
 - b. A maximum number of repeated programmes;
 - c. A percentage of locally produced content (content production quotas);
 - d. A maximum number of advertising hours, etc;

¹²⁹ Refers to broadcasting intended for the public benefit rather than for purely commercial concerns. PSB requirements can be imposed on the national/regional public broadcasters as well as on commercially funded broadcasters as part of their licence to broadcast.

¹³⁰ See also the difference between the licensing framework for analogue and digital television services in section 2.2.1.

2. *Platform level/multiplex level*: the right to broadcast a bouquet of television channels and services with associated obligations (either laid down in the frequency licence as specific terms or in a separate broadcast licence) such as:
 - a. The obligation to provide a defined portfolio of television services (including ‘must carry’ and pricing regulation rules);
 - b. The obligation to carry Public Service Broadcasting (PSB) channels or programming;
 - c. Service level obligations, including aspects like broadcast standards, geographical/population coverage, service/network availability, allocated bandwidth/multiplexes per service.

2.8.2 Broadcast licensing requirements

When granting DTTB/MTV broadcast permits for commercial broadcasters at the programme level, regulators tend to differentiate three categories of requirements/conditions to be met for granting a broadcast licence:

1. *Applicant*: the applicant has to comply with a set of ‘essential criteria’ to be eligible for granting a licence, including¹³¹:
 - a. Legal status: the regulator might require the applicant to be a legal entity registered in the trade registers or may also allow individuals to apply;
 - b. Ownership restrictions: in many countries cross-ownership rules exist, avoiding concentration of power in the media industry¹³². The applicant may have to fulfil these cross-ownership requirements;
 - c. Jurisdiction: this aspect is especially relevant for broadcasters with multi country broadcast or Headquarters outside the country of the regulator, which is very often the case for DTTB/MTV multi-channel international broadcasts. For example, the European ‘Television without Frontiers Directive’ arranges this aspect¹³³. Dual licensing is not permitted. A service which is licensed (or otherwise appropriately authorized) in one Member State does not need separate licensing in any other Member State. In Africa dual licensing might be permitted in the absence of such international directives;
2. *Television programme services*: this is the core of the broadcast requirements and is very often based on a linear broadcasting model, comprising a stream of programmes. Normally for each programme an authorization has to be granted, although such individual applications might be combined in one overall application. The regulator may apply a set of defined *content* criteria (see previous paragraph) *and/or* can refer to separate entities/organizations: monitoring whether the broadcasted content/advertising complies with the broadcast standards or ‘codes of (proper) conduct’¹³⁴. In order to regulate the number of commercials/advertising, the television programme services may be split into four categories and for each category a maximum number of broadcast hours is applicable:

¹³¹ See also section 2.6.1 on ‘essential criteria’.

¹³² See also section 2.11.2.

¹³³ See 89/552/EEC, as amended by European Directive 97/36/EC.

¹³⁴ For programming and advertising content, separate ‘codes of conduct’ may exist with separate entities monitoring proper conduct. For example in the UK: Ofcom and Advertising Standards Authority. For example codes please refer to www.cbaa.org.au/ in Australia, www.asasa.org.za in South Africa or www.ofcom.org.uk/tv/ifi/codes/ in the UK.

- a. *Editorial content*: is a 'normal' television programme service, conventional programme material. The majority of television content fall within this category;
 - b. *Advertising*: advertising for third party products or services in scheduled advertising breaks or slots;
 - c. *Teleshopping*: teleshopping is a special form of advertising and involves the broadcast of direct offers to the public with a view to the supply of goods or services in return for direct payment;
 - d. *Self-promotional service*: self-promotional material is a particular kind of advertising in which the broadcaster promotes its own programmes, services or channels.
3. *Additional services*: on a DTTB/MTV platform two additional service categories need to be addressed specifically:
- a. *Electronic Programming Guide (EPG)*: because the EPG is the 'window' on all available services on DTTB/MTV platform, regulators may wish EPG providers to comply with a EPG code of conduct, including provisions to ensure:
 - i. That information on the available services are not biased/not unfairly distributed and access to the EPG service is made on fair, reasonable and non-discriminatory terms;
 - ii. The inclusion of information on how to use the EPG or Access services (see below) in order to provide aid to people with disabilities;
 - iii. The inclusion of the PBS channels.
 - b. *Access services*: access services include service like subtitling, sign language and audio description. The regulator can include targets for access services (in either percentage of programming or for specific programmes/events) and require promotion of awareness for these services.

2.8.3 Implementation guidelines

The following guidance can be provided on assigning broadcast rights (i.e. media permits and authorizations):

1. Keep PBS separate from commercial broadcasting and limit the set of defined *content* criteria in terms of the type of programming, including percentages for local news coverage, arts, religious content and the maximum number of repeats. Such content requirements are very difficult to monitor and are best facilitated by the Public Broadcaster as they are the key vehicle for the regulator to arrange and have direct control over the (DTTB) television content. In addition, allowing Public Broadcasters to have advertising income will make setting content requirements more complex. The content requirements should be in line with each other between the PSB and commercial domain, in order to prevent level-playing-field/competition issues;
2. Have a dedicated or additional code of conduct for DTTB and MTV platforms as the existing regime may be based on analogue television services only, by including a code of conduct for the EPG and Access services¹³⁵;
3. Exclude clearing content rights by including a content (and copy) right clause in the broadcast licence/authorization. When granting broadcasting rights the regulator should explicitly mention that these rights do not waive any content fees. The licence holder will

¹³⁵ For example codes see Ofcom's 'Code of Practice on Electronic Programme Guides' and 'Code on Television Access Service', 17 April 2008.

- still have the duty to clear the content rights with the relevant rights holders (e.g. collecting societies, the Majors and studios);
4. Exclude platform access rights by including an additional clause stipulating that issuing the broadcast licence will not grant the right to have access to any DTTB/MTV multiplex. To avoid unnecessary work, it might be even better to first ask whether the applicant has come to an agreement with the multiplex operator, before taking the application into consideration;
 5. Consider inclusion of 'listed events'. Although not specific for the introduction of DTTB and MTV, 'listed events' may be a relevant topic in countries where these platforms will be the first platforms to facilitate Conditional Access. With Conditional Access systems, specific events can be easily 'shielded' from the general public. Regulators may restrict the acquisition by broadcasters of exclusive rights to the whole or any part of live television coverage of listed events such a major sports events;
 6. Arrange a Conditional Access provision (in the relevant Media/Broadcast Act) if not present at the date of the DTTB/MTV introduction. A Conditional Access provision/directive will guarantee:
 - a. Legal protection of encrypted services: such a provision might be required by suppliers of content;
 - b. Access to and interoperability of Conditional Access Systems, to be provided on fair, reasonable and non-discriminatory terms. Especially relevant in situations where multiple pay-tv operators/providers are present on the DTTB/MTV platform and viewers should not be confronted with two Conditional Access Systems and consequently two smart cards.

2.9 Business models and public financing

This section addresses the financing of Public Service Broadcasting (PSB). Financing of non-PSB or commercial broadcasters is by definition a matter for the private market to resolve. For the business planning and financing of commercial DTTB/MTV services please refer to section 3.4 of these guidelines.

This section is split into the following paragraphs:

1. General PSB financing models and sourcing;
2. DTTB specific financing issues;
3. Implementation guidelines.

2.9.1 General PSB financing models and sourcing

As discussed in section 2.2 of these guidelines, Public Service Broadcasting (PSB) refers to broadcasting intended for the public benefit rather than for purely commercial objectives. In most cases the PSB content is specified in a media or broadcast act or separate contract/charter. Prescribing television channel and service to be provided by the Public Broadcaster will also imply making resources available for the specified content.

The funding of a defined PSB services can be organized in three basic forms, which can change or be combined (over time):

1. A PSB entity is established by government, with defined PSB services, fully funded by public sources (either through licensing fees and/or general taxes)¹³⁶. For example the BBC in the UK or the VRT in Belgium operate their service under this model;
2. A PSB entity is established by government, with defined PSB services, funded by public sources and (later) partly by commercial income (mostly advertising based). Examples include France Television and the Publieke Omroep in the Netherlands;
3. A commercial/private broadcaster was established, fully funded by commercial income (either advertising based and/or subscription based) and has a PSB obligation assigned (very often when the broadcast or spectrum rights was granted). Examples include TV2 in Sweden, ITV in the UK and TF1 in France.

A mixed system, whereby the defined PSB service is operated by commercial party or the Public Broadcaster deploys also commercial activities, will require rules for accounting separation. Such a system of having separate accounts for the PSB activities is the same as applied in the telecoms industry (for example for wholesales services provided by dominant market parties or for terminating (mobile) telephony traffic in local access networks).

This issue of accounting separation is closely related to (forbidden) cross subsidization, also frequently quoted in the broadcast industry when commercial broadcasters are competing with public broadcasters in the same advertising market¹³⁷.

The introduction of DTTB will, initially, not lower the required PSB resources as often a simulcast period is required in which two networks are operated in parallel (see also section 2.15.3) and the number of channels to be produced will normally increase. There are different sources for funding the PSB services. The collected resources are either made available to a PBS entity (option 1 and 2) or to a commercial entity (option 3)¹³⁸:

1. General taxes: financial resources for PSB are made available as a certain proportion of the national government's total budget;
2. TV licence fees: financial resources are collected on the basis of ownership of a television set/device. Every citizen in possession/or owning a television set will have to pay a TV licence fee. Variations exist. For example, in some countries (with nearly 100 per cent of the population watching television), it is by default assumed that everybody watches the PSB channels and hence every citizen has to pay TV licence fees;
3. Industry levies: fees as a percentage of annual revenue, on certain classes of licensed operators;
4. Various other regulatory sources such as the proceeds of licence competitions, frequency spectrum auctions and fees;
5. Alternative resources from third parties: including the World bank, IMF, ITU/Broadcaster Unions sponsored project and NGOs;

¹³⁶ Please note that the Public Broadcaster might be allowed to deploy commercial/market activities next to its PBS duties/defined tasks. For example, by selling television programme formats, publications and merchandising. The key point is however, how the defined PSB services are being financed.

¹³⁷ For more detail on accounting separation and cross subsidization, please refer to www.ictregulationtoolkit.org chapter 2.6.1 and www.ofcom.org.uk, review of the wholesale Broadband Access Markets.

¹³⁸ See also www.ictregulationtoolkit.org, chapter 5.2.1.

6. Private Public Partnerships (PPPs): in such partnerships the Public Broadcaster and a commercial DTTB licence holder will jointly roll-out a combined DTTB services. Different forms of PPPs can be applied:
 - a. A commercial party rolls-out the network/service and the PSB is carried in the bouquet. In return for its investment efforts the commercial party is allowed to use the remaining multiplex capacity of the PSB multiplex, does not have to pay any content rights for the PSB content and gets access to EPG data;
 - b. A Public Broadcaster rolls-out the network/services with multiple multiplexes and a conditional access platform allowing pay-tv services to be billed. The Public Broadcaster rents out the remaining capacity to any commercial broadcaster interested in DTTB distribution;
 - c. The Public Broadcaster and a commercial network operator jointly finance the DTTB network, providing a free-to-air DTTB services¹³⁹. Remaining capacity will be rented out to any other commercial broadcasters.

2.9.2 DTTB specific financing issues

The introduction of a DTTB platform will pose some specific financing issues, including:

1. Financing of digital receivers: especially relevant in the case of a mandatory switch-off date set by the national government. Such a date will raise the issue of compensating affected viewers, who have to purchase a digital alternative. An approach for resolving this issue might be through a joint network roll-out with a commercial pay-tv operator (PPP). For more details on financing receivers see also section 2.15;
2. Financing the impact of free-to-air stipulations: national legislation might stipulate free-to-air reception. However a joint or combined roll-out with a commercial pay-tv operator might complicate this issue as this might jeopardize the commercial party's business model: the other broadcasters might request free-to-air reception too. Generally this issue is resolved by providing viewers with a smart card on which the PSB channels are not encrypted.
3. In the case where the PSB service is encrypted (by having a conditional access system), either as a pay or free-to-air service, it might provide the PSB entity with an opportunity to lower content right duties as the number of viewers is controlled¹⁴⁰. On the other hand, cost may increase because of the costs of providing smart cards. But these costs could be shared with a commercial party offering pay DTTB services. However some regulatory monitoring might be required as the provisioning of smart cards should allow a PSB option only (without the commercial services) and smart card provisioning might be misused to lure viewers into more expensive pay-tv options;
4. Financing the simulcast period: see section 2.15.3;
5. TV licensing fee systems might need revision: the existing system might be based on free television reception for every viewer with an analogue television set, assuming a near nationwide coverage of the terrestrial network for PSB. The DTTB service introduction can increase the number of PSB channels and consequently the Public Broadcaster might

¹³⁹ In this model the Public Broadcaster forms the launching client for the commercial broadcast network operator, in the form of long term distribution contract. This will facilitate access to other financial resources to further fund the DTTB investments. In addition, a variation on this model is that the broadcast network operator shares in the advertising income as a form of payment.

¹⁴⁰ The content right duties are based on the number of activated smart cards, rather than on the potential number of viewers. Although generally the case, it might be very dependent on the local legislation and the policy of the collecting society.

request an increase of the existing TV-licence charge. However, this might be deemed to be (legally) unfair because the DTTB service might not be accessible to the entire population (e.g. because there is no (near-) nationwide coverage). For example, in the UK the introduction of DTTB led to a hefty public debate and a revision of the TV licensing system.

2.9.3 Implementation guidelines

The following guidance can be provided for funding PSB:

1. Do not count on cost reductions in the short run due to the introduction of DTTB. Although DTTB platforms are more efficient and can lower the distribution costs per channel (in the long run, with more services utilizing the multiplex capacity), in the short run costs will increase, mainly due to:
 - a. simulcast period;
 - b. possibly (partly) financing of receivers
2. When financial funds are limited, apply a PPP model¹⁴¹. Which exact model to apply depends on the specific local circumstances, like the current legislation, the market structure and the position/financial means of the Public Broadcaster;
3. Check the legal framework on 'DTTB compliancy', especially in the areas of:
 - a. The definition of 'free-to-air' PSB: a strict definition might limit the possibilities of PPPs;
 - b. TV-licence fees: current definitions might limit the possibilities for increasing the PBS budget.

2.10 Digital dividend

The digital dividend is the spectrum in Band III, IV and V that is available after analogue television has been transferred to digital television. Any spectrum available after digital television services have been facilitated should be reallocated. Typically such a spectrum reallocation will involve a political decision. As a first step the digital dividend should be defined (i.e. what is under consideration) and all possible allocations should be identified.

Discussions on digital dividend in the Asia-Pacific have generally not advanced beyond a conceptual stage as at the end of 2010. This section provides a comprehensive overview of the relevant considerations to inform further discussion and decisions on this matter within the Asia-Pacific.

This section includes the following paragraphs:

1. Definition of the digital dividend and its application;
2. Determining the size of the digital dividend;
3. Digital Dividend options;
4. Implementation guidelines.

2.10.1 Definition of the digital dividend and its application

'Digital Dividend' can best be defined as the spectrum made available over and above spectrum that is required to accommodate the existing analogue television services in a digital form in VHF (Band III: 174 – 230 MHz) and UHF (Bands IV and V: 470 – 862 MHz). It is expected to be fully available

¹⁴¹ Do not resort to an auction instrument as an additional source for finance. For further motivation see the Implementation guidelines of section 2.5.

throughout Europe and Africa only after the complete switch off of analogue television (2012 EU objective, 2015 Region 1 objective, 2015 ITU deadline for protection of analogue).

Although the above definition is commonly used, it is important to note the following:

1. Existing analogue television services also make use of Band I (47 - 68 MHz) and, after digital switchover, Band I spectrum could be considered as digital dividend too¹⁴²;
2. Band III is also planned for T-DAB and many existing T-DAB services already make use of Band III, and;
3. Non-broadcasting services make use of Bands III, IV and V, in a number of countries.

Clearly under this definition, after ASO, spectrum will be 'left over' and the key question is how this remaining spectrum should be allocated. Many possible applications of the digital dividend are under discussion. Three categories can be identified¹⁴³:

- 1) *Broadcasting*: spectrum needed for the improvement of terrestrial broadcasting services, including:
 - a. Services with higher technical quality (notably HDTV);
 - b. Increased number of programmes;
 - c. Enhancement of TV experience (e.g. multi-camera angles for sports, individual news streams and other quasi-interactive options), and;
 - d. Digital radio services (i.e. T-DAB);
- 2) *Mobile Multimedia Broadcasting*: Radio resources needed for "converged" broadcasting services which are expected to be primarily "hybrids" of traditional broadcast and mobile communication services (like T-DMB/DVB-H network in combination with a GSM/UMTS/HSDPA network);
- 3) *Fixed/Mobile Services*: Frequencies to be allocated to new "uses" which do not belong to the broadcasting family of applications. Some of these potential new "uses" of the spectrum dividend are future services and applications which are not yet marketed and others are existing ones which do not operate yet in these frequencies (e.g. extensions of 3G services, short-range radio applications). The following example applications can be listed:
 - a. Mobile telephony/broadband;
 - b. Broadband access to scarcely populated areas;
 - c. Services Ancillary to broadcasting, which already coexist with broadcasting;
 - d. Low power devices (licence exempt or not);
 - e. Private mobile radio;
 - f. Military communications;
 - g. Public Protection and Disaster Relief (PPDR).

¹⁴² Band I was not planned for digital broadcasting at RRC-06 and is regulated by the revised Stockholm Agreement. Band I is less attractive than Bands III, IV or V for many services due to (a) its long wavelength, and therefore large antenna dimensions, (b) its susceptibility to ionospheric interference and (c) the high levels of man-made noise at these frequencies. In general, not much interest has been expressed for Band I.

¹⁴³ Already identified by the EU in its Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions; "EU spectrum policy priorities for the digital switchover in the context of the upcoming ITU Regional Radiocommunication Conference 2006 (RRC-06)", COM(2005) 461, Brussels 29.9.2005.

2.10.2 Determining the size of the digital dividend

As indicated in the previous paragraph the size of the digital dividend is a matter of definition and is basically determined by:

1. The base spectrum under consideration: VHF (Band III: 174 - 230 MHz) and UHF (Bands IV and V: 470 - 862 MHz)¹⁴⁴, often expressed in number of 'layers'¹⁴⁵;
2. Minus the applications or services reserved for broadcasting (categories *Broadcasting* and *Mobile Multimedia broadcasting*).

Hence the actual size of digital dividend can vary from country to country and depends on the regulator's objectives. However, in the current debate on the digital dividend there seems to be consensus on the scope of the digital dividend as indicated above. In other words, first the broadcasting applications or services should be facilitated. Consequently, in Band III, IV and V, regulators first have to allocate spectrum to facilitate broadcasting applications¹⁴⁶:

1. *Existing analogue television services* (and possibly in some country some other non-broadcasting services in Band III, IV and V);
2. *Additional DTT* for the improvement of terrestrial broadcasting services;
3. *MTV services* (in the case of T-DMB in Band III);
4. *Digital radio services* (i.e. T-DAB) in Band III.

Quantifying the above four categories the following indication can be provided:

1. *Existing analogue television services*: In most countries there are four analogue TV services and these can in general be accommodated into one DVB-T multiplex for which one DVB-T layer is needed. However, countries with five or more analogue TV services and using DVB-T with a robust modulation, may need two DVB-T multiplexes and thus two layers for broadcasting their existing analogue TV services in digital format;
2. *Additional DTTB/MTV services*: The general consensus is that for a successful introduction of DTTB, more multiplexes are needed than the number of channels containing the current analogue TV programmes. In most European countries, four to five multiplexes (and thus layers) are assigned in addition to facilitating the current analogue television service;
3. *Digital radio services*: During the RRC-06 it was recommended that each administration would limit the number of layers for digital radio/T-DAB to 3.

¹⁴⁴ With possibly Band I, see also footnote 142.

¹⁴⁵ A layer is not defined in the GE06 Agreement, nor was it defined at RRC-06, but for most European countries it may be described as a set of channels which can be used to provide full or partial nationwide coverage. The number of layers depends, among others, on the geographical situation, the level of accepted interference, transmission and reception characteristics.

¹⁴⁶ The supporting arguments to allocate the digital dividend for broadcasting applications can be found in EBU view "How should the digital dividend be used?", February 2008 and a common view published by Association of Commercial Broadcasters and Audiovisual Services in Germany and the EBU "European broadcaster's view on spectrum policy", February 2008.

The table below provides an overview of the number of layers for each category.

Table 2.10.1: Number of layers per broadcast category

Band III		Band IV/V
T-DAB	DTTB/MTV	DTTB/MTV
3	1 or 3 ¹⁴⁷	7-8

How much spectrum is precisely used for these broadcast categories depends on many local factors but most notably:

1. The use of Single or Multi Frequency Networks (SFN or MFN);
2. The applied modulation/required robustness of the signal;
3. The required bit rate per service (e.g. HDTV is required) and the applied compression technology (e.g. MPEG 2 or 4).

Consequently the remaining spectrum (if any), is generally considered to be that part of the digital dividend that can be allocated to services other than broadcasting (category *Fixed/Mobile Services*).

In Europe we have seen that many countries license five or six multiplexes for DVB-T or DVB-H in Band IV and V. This means that in those countries a considerable part of the digital dividend will be used for the categories *Broadcasting* and *Mobile Multimedia Broadcasting*. After having licensed five or six multiplexes for DVB-T or DVB-H, in general one or two layers remain.

2.10.3 Digital dividend options

From a technical point of view there are only two options for digital dividend applications, either:

1. Applications making use of the GE06 Plan entries: applications in this category will require no or limited modifications to the GE06 Agreement (such as DVB-T, HDTV, DVB-H, T-DAB and T-DMB);
2. Applications making use of a dedicated sub-band: applications in sub-bands will require considerable and lengthy modifications of the GE06 plan¹⁴⁸.

From a technical point of view it does not matter what applications the Plan entry represents, either *Broadcasting* or *Fixed/Mobile Services* as long as the frequency ‘contour’ of the applications is the same (i.e. the same interference levels)¹⁴⁹.

As mentioned in the previous paragraph, consensus exists over allocating a large part of Band III, IV and V for *Broadcasting* and *Mobile Multimedia Broadcasting*. Consequently these broadcasting applications fall into the category of applications that makes use of the GE06 Plan entries.

¹⁴⁷ In the case of applying T-DMB three layers could be realized as result of the smaller bandwidth per multiplex.

¹⁴⁸ A dedicated sub-band is to be understood as a set of contiguous channels with a total bandwidth narrower than or equal to the band 470 - 862 MHz, with the intent to enable administrations to use it for fixed/mobile services including uplinks if they so wish, or to continue to use it for broadcasting services, if they so wish.

¹⁴⁹ For more technical details on the technical constraints of applications based on Plan entries and sub-band allocations, see “Implementation of the Digital Dividend – technical constraints to be taken into account, Jan Doeven, EBU Technical Review, January 2007.

As most *Fixed/Mobile Services* use a system based on a different bandwidth (mostly 5 MHz) and have a return path, these applications will fall automatically in the second group of applications that will make use of dedicated sub-bands. The World Radio Conference of 2007 (WRC-07) concluded that in Region 1 the 790-862 MHz sub-band will be allocated on a *co-primary* basis to *Mobile services* in addition to broadcasting and fixed services as from 2015, subject, where necessary, to technical coordination with other countries¹⁵⁰.

It is important to note that it is up to the individual countries to decide the allocation of the digital dividend, more specifically about the allocation of services in the 790-862 MHz band. Industry pressure from telecom operators is great to allocate the 790-862 MHz sub-band uniquely to *Fixed/Mobile Services*. This is illustrated by the many CEPT efforts to investigate many different technology options for applying different services in the broadcasting bands¹⁵¹.

This illustration of industry pressure is cumulated in CEPT 's latest report on 'White Spaces'¹⁵². These white spaces have limited geographical extension and time duration, and any utilization must take into account the protection of nearby Primary Services (i.e. *Broadcasting services*). This white space operation can only be on a non-interference and non-protection basis and applying special technology that will 'search dynamically' for these white spaces (like ultra wide spectrum systems operating in a limited geographical range). Such systems would theoretically only require a general or type approval (i.e. no frequency licence assignment).

The table below provides an overview of the different options and the consequences for the national regulators.

Table 2.10.2: Digital dividend options and their timing (from CEPT report 25, adapted)

Option		Additional activities/ Timing at national level
<i>Broadcasting: Additional broadcast applications (portable reception, high definition TV, additional programmes, DVB-T2...)</i>		
Implementation within GE06 digital plan entries	It could be implemented prior to analogue switch-off (2012 resp. 2015)	None

¹⁵⁰ Most African countries are still determining their position on the allocation of Mobile services in the 790-862 MHz band as part of their preparations for the WRC-12. However, the 15 member states of the Southern African Development Community (SADC) have already committed to the allocation of Mobile services in the 790-862 MHz band. The current SADC member states are Angola, Botswana, the Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, United Republic of Tanzania, Zambia and Zimbabwe. For more detail see www.sadc.int.

¹⁵¹ See the CEPT reports to the European Commission on "Technical considerations regarding harmonisation options for the Digital Dividend", numbers 21, 22, 23, 24 and 25, published 1st of July 2008.

¹⁵² The wording of "White Spots" or "White Spaces" or "Interleaved Spectrum" has been used to introduce a concept of frequency spectrum which is potentially available at a given time for further utilisation within frequency spectrum originally planned for broadcasting in GE06. See for more details CEPT report 24.

Option		Additional activities/ Timing at national level
<i>Mobile Multimedia Broadcasting</i>		
Implementation within GE06 digital plan entries	It could be implemented prior to analogue switch-off. There may be a need for rearrangement or limited local re-planning allowing for the restrictions imposed by DVB-T, analogue TV and other services. There may also be a need for some local cross border coordination to create layers below 750 MHz.	Limited re-planning and cross-border coordination taking into account analogue switch-off (2012 in EU countries /2015 in Region 1). Modifications of GE06 Plan through its Articles 4 and 5 may be required.
A harmonized sub-band implemented within GE06 Agreement	It could be implemented at national level prior to analogue switch-off but will require significant re-planning and cross border coordination. The European wide harmonization and implementation of a sub-band for mobile multimedia broadcasting services is not realistic before at least 2020 and in the near and medium term, it may only be considered on a non-mandatory basis. There will be restrictions imposed by DVB-T, analogue TV and other services.	National re-planning and cross-border coordination taking into account analogue switch-off (2012 in EU countries /2015 in Region 1). Modification of GE06 Plan through its Articles 4 and 5.
<i>Fixed/Mobile Services</i>		
Implementation within GE06 digital plan entries	Under this approach, an administration would implement fixed/mobile service only in areas and in channels where it has GE06 plan entries (i.e. using the envelop concept see Article 5.1.3 in GE06 Agreement), taking into account the possibility to apply the procedures for the modifications of the Plan. Co-allocation in Region 1 to mobile service for the band 790 - 862 MHz was made at WRC-07. This band or part of this band could be used to implement mobile uplink. It is recommended not to pursue this approach for harmonization further.	None or there may be a need to apply the procedures of GE06 to modify some of the GE06 Plan entries.
Implementation in a dedicated sub-band in 470 – 862 MHz for downlink + uplink outside 470 – 862 MHz	This approach consists in introducing a sub-band for only the downlinks of the fixed/mobile services, and introducing their uplinks in a band, outside the 470 - 862 MHz range, in order to avoid co-channel Interference from Broadcasting stations in neighbouring countries. The main difficulty with such an approach remains that there is currently no available spectrum for uplink and that the consideration of bands already used would require thorough regulatory and technical investigation. Therefore, this approach cannot be pursued without such information. This approach does not formally fulfil the question asked by the EC since the uplink path is not within the 470 - 862 MHz band. It is recommended not to pursue this approach for harmonization further.	There may be a need to modify GE06 Plan through Articles 4 and 5 in the sub-band dedicated to downlink.
Implementation within a dedicated sub-band	WRC-07 co-allocated the band 790 - 862 MHz to the mobile service (except aeronautical mobile), on a primary basis from 17 June 2015 with an identification of the band for International Mobile Telecommunications.	There may be a need to modify GE06 Plan through Articles 4 and 5 in the harmonized sub-band.

Option		Additional activities/ Timing at national level
	<p>The band 790 - 862 MHz was already co-allocated to the mobile service in a number of countries in Region 1 (RR 5.316) before WRC-07.</p> <p>The implementation of an assignment to the fixed/mobile services using a frequency in this sub-band requires the use of the GE06 provisions applicable to other primary services (see Res. 224). Administrations will have to apply the coordination procedure in the GE06 Agreement using the trigger field strength in Annex 4 of the Agreement corresponding to digital land mobile systems (e.g. CDMA).</p> <p>This approach would require specific band plan within the sub band to ensure operation of fixed/mobile services in the band 470 - 862 MHz.</p> <p>There will be restrictions imposed by DVB-T, analogue TV and other services.</p>	
<i>White Spaces</i>		
Cognitive techniques for new white space applications	<p>The current CEPT view is that any new white space applications should be used on a non-protected, non-interfering basis.</p> <p>The feasibility of cognitive sharing schemes has not yet been conclusively demonstrated. It is too early in the development cycle to judge the final capabilities of cognitive radio technology for white space devices.</p>	Type approval of such systems
Programme Making and Special Events (PMSE)	<p>The controlled access of PMSE services on a secondary and temporary basis to white space spectrum is expected to continue in the foreseeable future, taking into account the development of digital broadcasting in the frequency band 470 - 862 MHz.</p> <p>Noting that the majority of PMSE are located in the band 790 - 862 MHz, administrations may need to identify alternative band for PMSE usage.</p>	National consideration of migration of frequency use

In summary, one can conclude that consensus exists over earmarking channels 60-69 (i.e. 790-862 MHz in Band V) for non-broadcasting services. The table below provides an overview of countries that already have allocated these channels to non-broadcasting services and countries that are very likely to allocate this spectrum in the same way. Hence regulators should be careful in assigning these channels for DTTB and MTV services.

Table 2.10.3: Digital dividend allocations for channels 60-69
(from Policy Tracker, March-June 2009, adapted)

Country	Allocation
<i>Allocated already</i>	
Finland	Allocated to mobile broadband. Will also be used for wireless audio devices (790-822 MHz and 854-862 MHz) until new frequency bands can be allocated. Military use will also continue. The government said that the band's technological features make it "particularly suitable for high-speed wireless broadband services, particularly outside built-up areas".

Country	Allocation
France	Government has allocated band to the provision of broadband Internet services for 100 per cent of the population. It plans to invite candidates to tender to provide these services during 2009.
Germany	The Federal Ministry of Economics has proposed opening the band, currently used for broadcasting, for mobile services and/or radio systems for providing Internet access. The initial proposal unveiled last summer has been disputed by broadcasters. However, in June The Federal Council (Bundesrat) which consists of all the country's regional governments approved the national government's proposal to use the 800MHz band for mobile broadband.
Sweden	Government has allocated band to non-broadcast services and plans to auction spectrum. Non-broadcast services not yet specified but announcement of plans did note that the move created space "for competing additional broadband services as a complement to the existing 3G networks".
Switzerland	Band to be used for mobile broadband after 2012. Government said the band would enable excellent mobile broadband coverage of rural areas while offering good penetration into buildings.
Spain	Ministry of Industry announced in June the allocation of the 800 MHz spectrum to Mobile Broadband services. Spectrum will be available in 2015.
<i>Very likely to allocate</i>	
Slovenia	Expected to allocate band to mobile services
UK	UK has announced it may rethink its digital dividend plans to fall in with the harmonized sub-band proposal. Recommendations to the government have been made in the "Digital Britain" report, published in June 2009 ¹⁵³ . The government also asked an Independent Spectrum Broker to facilitate discussions between mobile operators and recommend a way forward. Decision still pending but pressure mounting to allocate spectrum to non-broadcasting.

2.10.4 Implementation guidelines

The following guidance can be provided on managing the Digital Dividend choices in relationship with assigning DTTB and MTV licences:

1. Determine the size of the digital dividend for non-broadcast applications in a step-by-step approach by:
 - a. Determining the spectrum base (Band III, IV and V) and checking if also Band I should be included too. Including Band I seems only to be relevant in countries where there is already (analogue) television service in operation. If there is no television service in operation in Band I, and hence no associated installed receiver base in place, this band should not be included in the spectrum base;
 - b. Investigate and determine the number of Analogue/existing television services in operation. Careful consideration should be given to the exact broadcast locations and areas as many services are only made available in limited geographical areas;

¹⁵³

For full report see [www.culture.gov.uk/what we do/broadcasting/6216.aspx](http://www.culture.gov.uk/what_we_do/broadcasting/6216.aspx).

- c. Determine the required digital bandwidth for each analogue service and determine the number of layers (see paragraph 2.10.2 in this section and also sections 4.1 and 4.2);
 - d. Determine the number of Digital radio services in Band III in terms of number of layers (see paragraph 2.10.2 in this section);
 - e. Determine the number of additional DTTB multiplexes/layers for the next 10-15 years and avoid allocating services in the channels 60-69 (see paragraph 2.10.2 and 2.10.3 in this section and also sections 4.1 and 4.2);
 - f. 'Calculate' (i.e. the base minus the spectrum for broadcast applications) and determine the 'left over' (if any) for non-broadcast applications. Report to the government.
2. Be aware that it is not necessary to assign all DTTB/MTV licences in one round (i.e. one single assignment procedure). However, assigning DTTB/MTV in multiple rounds will require sound arguments as spectrum will be temporarily left 'on the shelf'. Industry pressure will be great to allocate this spectrum for other services. Special care should be given to the argument for both the total number of layers and for the phased approach. The latter could include arguments such as the first round is to test the market and the licences should be assigned in a controlled manner so that the policies can be fine-tuned to market developments.

2.11 National telecom, broadcast and media act

In the previous sections 2.1 – 2.10 all the policy and regulatory choices/decisions directly related to the introduction of DTTB/MTV services have been addressed in detail. This section addresses the compliancy of the intended policy decisions with the existing and relevant regulatory framework. Very often this regulatory framework comprises national Telecommunications, Broadcast and Media Acts. The relevant regulatory framework varies from country to country and other Acts may have to be considered as well in the compliancy review, especially in the area of cross and foreign ownership and state aid.

This section is structured as follows:

1. Checking compliancy with existing national, Telecommunications, Broadcast and Media Acts;
2. Checking compliancy with other legislation, especially related to cross and foreign ownership and State aid.

2.11.1 Check compliancy with telecom, broadcast and media acts

For all the DTTB and MTV policy decisions the regulator will have to check compliancy with the existing (national) legislation laid down in the various Acts. Very often three Acts are directly related to policy and regulatory choices as addressed in Part 2 of these guidelines:

1. Telecommunications Act: Especially those parts concerning the management and the assignment of spectrum are relevant;
2. Broadcast and/or Media Act: especially those parts concerning acquiring the right or permission to broadcast television and radio (and associated) content.

From country to country, the exact content and titles of the various Acts can vary. In some countries there is no specific Broadcast Act as those regulatory aspects are integrated into the Telecommunications Act or alternatively into the Media Act.

DTTB/MTV introduction practice has shown that there are some areas that are likely to have some discrepancy with existing legislation. The table below provides an overview.

Table 2.11.1: Typical areas of attention for intended DTTB/MTV policy decisions

Intended policy decision	Area of attention for compliancy
Exclude market parties up-front in a licence bidding procedure	Telecoms/Broadcast Act might not allow this as it stipulates only 'essential criteria' for excluding market parties. Also the Competition Act might stop such policy intentions.
Increase TV licence fee for digital viewers to finance the introduction of DTTB/MTV	Broadcast Act might not allow this as the TV licence fee is levied on every citizen in the country. Also Competition law might resist such intention (see next paragraph in this section).
Have Public Broadcast Services behind Conditional Access	Media Act might not allow this, even when the Public Broadcast Services are free of charge. The notion of Free-to-Air might not be defined accurately enough.
Applying 'must carry rules' for the DTTB platform	In the absence of such rules for other competing television platforms, such an intended policy might raise the issue of not creating a level-playing-field. Conversely, not applying similar rules for DTTB, whilst applying them to other platforms, might also cause conflict.
Allowing the "State-assigned" or single DTTB/MTV operator (wholesale model) to offer DTTB services on his own platform	Competition law might limit such possibilities. Alternatively, such intended policy decision might ask for special measures such as having the State assigned operator to publish its wholesale tariffs and to have accounting separation.

Whilst checking regulatory compliancy, the regulator might need to change the legislation in order to be able to execute its DTTB and MTV objectives. This might delay the introduction of DTTB/MTV services. Hence the regulator should check compliancy as a continuous process when compiling the DTTB/MTV policies. Also the Roadmap should cater for any necessary legislation changes. Alternatively, if introduction speed is critical in the DTTB/MTV policies, the regulator might consider altering the conflicting policy decision so as to make it fit into the existing regulatory framework

2.11.2 Checking compliancy with other legislation

In some countries, licensing DTTB and MTV services might raise some specific issues, that are not directly related to DTTB and MTV, including:

1. *Cross-ownership*: possibly in separate legislation, the ownership of media related activities might be limited. For example, publishers of papers/magazines/books (with a certain market share) are not allowed to own or control any other activities/companies in, for example, the television or radio industry. Such restrictions are often referred to as cross-ownership or media concentration rules. This may provide grounds to exclude or reduce the participation of media companies in DTTB/MTV assignment procedures;
2. *Foreign ownership*: possibly in separate legislation, existing legislation might limit the ownership of foreign shareholders in any company or bidding entity. Perhaps confined to more specifically media companies. This may provide grounds to exclude or reduce the participation of any foreign bidders for DTTB/MTV licences;
3. *State aid*: possibly in separate legislation or in the Broadcast act, the commercial activities of the Public Service Broadcaster (PSB) might be limited as they may be considered as forbidden state aid in commercial DTTB/MTV markets. PSB commercial activities are in

principle defined by what is not stipulated as their public broadcasting task. However, the introduction of DTTB/MTV might blur that definition. For example, the PSB operating a shared multiplex together with commercial broadcasters;

4. *Digital rights management (DRM)*: possibly in separate legislation, copy and privacy rights legislation might restrict or lay down requirements for the introduction of DTTB/MTV services. DRM is a generic term that refers to access control technologies (such as Conditional Access Systems) that can be used by hardware manufacturers, publishers, copyright holders and individuals to try to impose limitations on the usage of digital content and devices.

Cross-ownership rules

Cross-ownership rules may not only limit the ownership across media platforms (like publishing and television) but also within a single platform. For example, the ownership of multiple radio/television entities (e.g. broadcasters) in a single local market may be restricted. In the table below an example overview is provided of ownership or concentration limits in the different countries.

Table 2.11.2: Concentration limits in four countries

Country	Concentration limits (simplified)
US ¹⁵⁴	No entity can hold more than 39 per cent (reach) of the national TV market No combinations among the four major national TV networks Newspaper-broadcasting cross ownership not permitted. An entity may hold a TV station and a radio station in a single market (and more radio stations in larger markets)
UK ¹⁵⁵	A person may not acquire a TV licence if he/she holds a 20 per cent market share in the newspaper market.
France ¹⁵⁶	No person may hold a television licence and 20 per cent of the newspaper market in a local area.
Sweden ¹⁵⁶	No ownership restrictions beyond normal competition law

In the following paragraphs an example set of cross-ownership rules is provided (taken and adopted from the FCC Media Ownership Rules¹⁵⁷).

1. *Newspaper/Broadcast Cross-Ownership Rule* – to limit the ownership between newspaper and broadcast entities. Next to specific prohibitions and limits (e.g. the shareholder stake limits), the following aspects are also included:
 - a. A set of factors to evaluate a proposed combination, including (1) the extent to which cross-ownership will serve to increase the amount of local news disseminated through the affected media outlets in the combination; (2) whether each affected media outlet in the combination will exercise its own independent

¹⁵⁴ See www.fcc.gov/cgb/consumerfacts/reviewrules.html.

¹⁵⁵ See www.ofcom.org.uk/static/archive/rau/publications-archive/adobe-pdf/regulation/codes_guidelines/crossmed.pdf.

¹⁵⁶ See p8 on www.nordicity.com/presentation/2007_may_Insight_Ownership_and_Concentration.pdf.

¹⁵⁷ See the FCC 2006 review of the Media Ownership Rules on www.fcc.gov/ownership/.

- news judgment; (3) the level of concentration in the designated market area (DMA¹⁵⁸); and (4) the financial condition of the newspaper or broadcast station, and if the newspaper or broadcast station is in financial distress, the owner's commitment to invest significantly in newsroom operations;
- b. Waivers and when waivers are unlikely. For example for smaller markets (smaller than the top 20 DMAs), the Commission adopted a presumption that it is inconsistent with the public interest for an entity to own newspaper/broadcast combinations and emphasized that it therefore is unlikely to approve such transactions. The Commission will reverse the negative presumption in two limited circumstances: when the proposed combination involves a failed or failing station or newspaper, or when the combination results in a new source of a significant amount of local news in a market;
2. *Local Television Ownership Limit* – under this rule, a single entity may own two television stations in the same local market if (1) the so-called 'Grade B' contours of the stations¹⁵⁹ do not overlap; or (2) at least one of the stations in the combination is not ranked among the top four stations in terms of audience share and at least eight independently owned and operating commercial or non-commercial full-power broadcast television stations would remain in the market after the combination.
 3. *Local Radio Ownership Limit* - as a general rule, one entity may own (a) up to five commercial radio stations, not more than three of which are in the same service (i.e., AM or FM), in a market with 14 or fewer radio stations; (b) up to six commercial radio stations, not more than four of which are in the same service, in a market with between 15 and 29 radio stations; (c) up to seven commercial radio stations, not more than four of which are in the same service, in a radio market with between 30 and 44 radio stations; and (d) up to eight commercial radio stations, not more than five of which are in the same service, in a radio market with 45 or more radio stations;
 4. *The National Television Ownership Limit* – this type of rules permits a single entity to own any number of television stations on a nationwide basis as long as the station group collectively reaches no more than 39 per cent of the national TV audience;
 5. *Radio/Television Cross-Ownership Limit* – this limit cross-ownership between radio and television companies. Under that rule, one company may own in a single market: one TV station (two TV stations if permitted by the local TV ownership rule) and one radio station regardless of total market size; or if at least 10 independent media voices (i.e., broadcast facilities owned by different entities) would remain after the merger, up to two TV stations and up to four radio stations; or if at least 20 independently owned media voices would remain post-merger, up to two TV stations and up to six radio stations or one TV station and up to seven radio stations. Parties must also comply with the local radio ownership rule and the local TV ownership rule.

¹⁵⁸ Designated Market Area is a term used by Nielsen Media Research to identify an exclusive geographic area of counties in which the home market television stations hold a dominance of total hours viewed. There are 210 DMA in the U.S.

¹⁵⁹ A contour may be visualized by imagining a rough circle surrounding a transmitter site at some distance, where the circle represents a certain field strength value, with greater radio field strengths inside, and lesser radio field strengths outside. The distances to the contours herein were derived using the maximum effective radiated power (ERP) and antenna height above average terrain (HAAT) combination permitted for each station class. For grade B the parameters are 50.0 kW ERP at 150 meters.

As the above example demonstrates, (cross-)ownership rules tend to be complex, especially in the area of broadcasting as it serves additional objectives of independent news judgment and diversification of news resources.

Foreign ownership rules

Foreign ownership rules are intended to maintain a balance between encouraging investment in the broadcasting industry and meeting the government's sovereignty and security objectives. However, any foreign ownership restriction always comes together with concerns about whether these restrictions limit the ability of broadcast companies to gain access to capital. They may act as a barrier to innovation and growth in the sector.

Historically, governments have been concerned that foreign control of mass media facilities would confer control over the content of widely available broadcast material, which could lead to the possibility of foreign propaganda and misinformation. These fears are not unreasonable in situations where there are relatively few sources of information available to the public.

However, nowadays these risks seem to be lower, especially when considering that sources of information have multiplied tremendously¹⁶⁰. Moreover the introduction of DTTB/MTV will further open up the channels of information.

A global trend can be observed that governments tend to lift foreign investment restriction in the telecommunication industry first, followed by lifting or relaxing the limits in the broadcasting industry. Especially, the introduction of DTTB/MTV will heat up this debate. Industry parties argue that the high cost of DTTB/MTV networks and the adoption of HDTV will increase the costs for broadcasters tremendously. Hence there might be pressure to relax foreign investment rules.

The follow paragraphs outline the foreign ownership limits in Australia (taken and adapted from the independent Communications Law Centre in Australia¹⁶¹):

1. The Treasurer has the power to stop substantial acquisitions of Australian assets which are contrary to the national interest;
2. It is allowed for single foreign shareholders to only hold up to 25 per cent of the shares in a mass circulation newspaper, with a maximum of 30 per cent for all foreign interests;
3. Foreign proposals to establish ethnic newspapers in Australia will not generally be approved without substantial local ethnic community involvement and local control of editorial policy;
4. Under the Broadcasting Services Act, a foreign person cannot exercise control over commercial TV licences. Foreign owners cannot have company interests in more than 25 per cent of a subscription TV licence (and overall foreign interests cannot be more than 35 per cent);
5. There are no specific limits on foreign ownership or control of commercial radio in the Broadcasting Services Act and acquisitions in this market fall under the Foreign Takeovers Act and are considered on a case by case basis.

State aid

State aid can come in different forms and may lead to conflict with the competition regulations. To support and facilitate the uptake and development of DTTB/MTV services the government/State

¹⁶⁰ In contrast, the number of information sources may be limited in some African countries, especially the penetration of Internet access is an important parameter to consider.

¹⁶¹ See the website www.comslaw.org.au/LeftMenu/MediaOwnership/tabid/61/Default.aspx.

might decide to make some financial means available. Practice has shown that governments tend to provide financial support in the following DTTB/MTV areas, which may lead to competition law conflicts:

1. Providing aid for purchasing digital receiver equipment. Especially in the case of ASO (see sections 2.14 – 2.18 on the ASO) governments have provided support. For example in the United States, viewers could acquire up to two vouchers (of USD 40 subsidy each) for the purchase of a digital receiver. Also in other countries State aid was provided, for example Italy where viewers received a tax reduction if they purchased an integrated digital television set (IDTV) or in the UK where eligible viewers (e.g. over 75 years old or have lived in care home for 6 months or longer) can be provided with a digital receiver and/or installation aid under a special help scheme;
2. Imposing an additional television licence fee to fund the digital broadcasting activities of the Public Service Broadcaster. For example in the UK and Sweden the government intended¹⁶² to increase the television licence fee to finance respectively the production of digital television content and the roll-out of the DTTB network;
3. Financial compensation to analogue television Broadcasters which are required to discontinue analogue transmission before the expiry of their spectrum licences. Most notably this took place in countries like United States and some European countries;
4. Assigning one or more DTTB multiplexes by priority (i.e. without having to participate in a competitive bidding procedure) to Public Service Broadcasters (see also section 2.2.3). Especially in markets where the PSB also has advertising income and where there are several other competing television platforms (e.g. satellite or IPTV) in the market, such an assignment may lead to a legal conflict.

All four above examples of State aid have led to competition law conflicts. Especially commercial Broadcasters and other commercial television Service Providers may take such (intended) State aid decisions to court.

Some important European Commission/Court rulings have provided some guidance on when State aid is acceptable, including:

1. In the case of “Berlin-Brandenburg”¹⁶³ the Commission gave specific indications of acceptable forms of public support for the digital switchover:
 - a. Funding for the roll-out of a transmission network in areas where otherwise there would be insufficient TV coverage;
 - b. Financial compensation to Public Service Broadcasters for the cost of broadcasting via all transmission platforms in order to reach the entire population, provided this forms part of the public service mandate;
 - c. Subsidies to consumers for the purchase of digital decoders as long as they are technologically neutral, especially if they encourage the use of open standards for interactivity;

¹⁶² In both cases the European Commission ruled that increasing the television licences fee for the intended purposes was in conflict with competition legislation. For the UK “Altmark” case ruling see <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/05/73&for>

¹⁶³ See <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/05/1394&format=HTML&aged=1&language=EN&guiLanguage=en>.

- d. Financial compensation to broadcasters which are required to discontinue analogue transmission before the expiry of their licences. Provided this takes account of granted digital transmission capacity;
 - e. All measures must also respect the principles of transparency, necessity, proportionality and technological neutrality.
2. Also in the “Altmark” case, the European Court provided the following guidance on compensation for the costs incurred in the discharge of a Public Service obligation do *not* qualify as state aid if a number of conditions are cumulatively met:
- a. Clear public service obligations;
 - b. Pre-established parameters for determining the compensation;
 - c. No overcompensation and;
 - d. Either selection of (network) operator through tender procedure or determination of compensation with reference to costs of a typical, well-run undertaking.

In many cases of directly compensating the Public Service Broadcaster for digitalization costs the Commission concluded that the “Altmark” conditions were not fulfilled. In those cases, there were no objective pre-established parameters for determining the compensation. Furthermore, PSB network operators have not been selected by way of a tender procedure, and the compensation was not determined on the basis of an analysis of the costs of a typical well-run undertaking.

Finally granting one or more multiplexes by priority to Public Service Broadcaster has shown fewer difficulties. In most countries it is common practice that the duties of the Public Broadcaster are defined in a separate Broadcast or Media Act. Provided that the regulator will extend the defined duties to include digital broadcasting, little problems can be expected. It is a commonly accepted practice to assign one or two multiplexes by priority to the Public Service Broadcaster.

Digital Rights Management (DRM)

Digital rights management has received international legal backing by the implementation of the 1996 WIPO Copyright Treaty (WCT). Article 11 of the Treaty requires participating nations to enact laws against DRM circumvention¹⁶⁴.

The WCT has been implemented in most member states of the World Intellectual Property Organization¹⁶⁵. The American implementation is the Digital Millennium Copyright Act (DMCA), while in Europe the treaty has been implemented by the 2001 European directive on copyright, requiring member states of the European Union to implement legal protections for technological prevention measures¹⁶⁶.

Basically, a national implementation will require that the legal framework (possibly in a dedicated Act) will criminalize the production and dissemination of technology that allows users to circumvent technical copy-restriction methods. For example, under the national legislation, circumvention of a technological measure that effectively controls access to a work (including television broadcasts or films) is illegal if done with the primary intent of violating the rights of copyright holders.

DRM legislation is, as such, directed at the general public and not specifically addressed to DTTB/MTV licence holders, network operators, service providers or viewers.

¹⁶⁴ For the text of the Treaty see www.wipo.int/treaties/en/ip/wct/trtdocs_wo033.html .

¹⁶⁵ For participating members, including African countries, see www.wipo.int/treaties/en/ShowResults.jsp?lang=en&treaty_id=16.

¹⁶⁶ For the text of the European Copyright Directive, see <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0029:EN:HTML>.

However, in the DTTB/MTV licensing practice such national DRM legislation may require the regulator to:

1. Include a reference to the DRM Act in the broadcast/spectrum licence terms and conditions (see also section 2.6.2 of these guidelines);
2. Check compliancy of any mandated Conditional Access System for either a DTTB or MTV platform (see section 2.1 of these guidelines).

2.11.3 Implementation guidelines

The following guidance can be provided:

3. Check intended policy decisions continuously with existing legislations and allow time for changing existing legislation, if necessary. The Roadmap planning should include time for this. In addition, carrying out market consultations (see Roadmaps in sections 6.1-6.3), covering the key policy decisions, during the policy making process will help to increase political acceptance;
4. When introducing and licensing DTTB/MTV services the following should be checked in relationship to existing *cross-ownership* rules, whether:
 - a. DTTB/MTV multiplex control or ownership falls under the definition of media and/or broadcast entities as intended in the (cross-)ownership legislation;
 - b. A broadcast over the DTTB/MTV will add another television or radio entity in the local market;
 - c. Broadcasting both radio and television channels over a DTTB/MTV platform will affect any radio/television cross-ownership limits;
 - d. Any indented permission for DTTB/MTV licence trading¹⁶⁷ will obey the cross-ownership rules as well.
5. When introducing and licensing DTTB/MTV services the following should be checked in relationship to any existing *foreign ownership* rules, whether:
 - a. DTTB/MTV multiplex control or ownership falls under the definition of media and/or broadcast entities as intended in any foreign ownership legislation;
 - b. Bidders for the DTTB/MTV licences (either for spectrum or broadcasting rights) will have to adhere to foreign ownership limits in:
 - i. Either the radio markets, or;
 - ii. Television markets, and/or;
 - iii. Both markets;
 - c. Any indented permission for DTTB/MTV licence trading will obey the foreign ownership rules as well;
 - d. Any asymmetry in foreign ownership rules for the Telecommunication and Broadcasting industries exists. Such rules may be laid down in separate Acts. The further convergence between both industries may not contribute to clarity for foreign investors and hence limit the development of both industries;
 - e. The alignment between foreign ownership ruling and production quotas. Also consider rebalancing any lift of ownership rules with setting production quotas.

¹⁶⁷ Trading refers to the possibility to transfer and/or sell a spectrum licence to another company or entity. Very often the rules to grant such a permission are focused on whether the new entity is qualified (i.e. essential criteria) to operate the licence.

With setting production quotas governments can limit risks of unwanted broadcasts (see section 2.8.2 of these guidelines);

6. When introducing and licensing DTTB/MTV services the following should be checked in relationship to *State aid* law, whether:
 - a. The intended measures to support the introduction of DTTB/MTV is compliant with the criteria as provided by the (or similar criteria):
 - i. “Berlin-Brandenburg” case;
 - ii. “Altmark” case;
7. When introducing and licensing DTTB/MTV check compliancy with any national Digital Rights Management (DRM) legislation. Although primarily focused on criminalizing unauthorized copying or re-use of content and hence addressed to general public, DRM references could be included in the broadcast/spectrum licence terms and conditions. Also for the purpose of excluding any liability.

2.12 Law enforcement and execution

Any defined DTTB/MTV policy embedded in the relevant regulatory framework (see previous section 2.11) should have a form of law enforcement to have the set policy executed. For the introduction of DTTB/MTV services, and similarly for any service requiring spectrum, law enforcement focuses on the following policy aspects:

1. Defining the National Spectrum Plan (see section 2.4);
2. Assigning spectrum and broadcast licences (see sections 2.2, 2.5, 2.6 and 2.8);
3. Assigning local/building permits (see sections 2.2 and 2.7).

For maintaining the proper execution of the National Spectrum Plan and the assigned spectrum/broadcast licences, often specific law enforcement entities exist. Varying from country to country, these entities are to include entities like the ‘Radio Agency’, the ‘Communications/Broadcast Commission’, the ‘Electronic Media Regulatory Authority’ or the ‘independent Competition Authority for the communications industries’.

For maintaining the proper execution of assigned local/building permits, usually a non-DTTB/MTV specific regulatory framework exists. In this section we will not address this type of law enforcement because this falls outside the scope of these guidelines. However, as discussed in section 2.7 it is important though that local councils/administrations are well informed about the specifics of DTTB/MTV broadcasting and are aligned with national spectrum policies (see section 2.7.3).

In this section the law enforcement organizational structure for the above first two policy aspects are discussed. This section is structured as follows:

1. Centralized and segmented models;
2. Impact of convergence;
3. Implementation guidelines.

2.12.1 Centralized and segmented models

Regulators enforce DTTB/MTV policies by carrying out certain market interventions (like spectrum and broadcast licensing). In general regulators will intervene only where there is evidence that regulation is necessary, but then will do so firmly, effectively and decisively. However, using the least intrusive regulatory methods possible to achieve the public policy ends of which the regulators are the guardians. When regulation is necessary, regulators tend to promote and to facilitate effective co-regulation and self-regulation, placing greater reliance upon licensees and the industries to police their own affairs.

As said before, the organizational structure in which law enforcement is embedded, varies from country to country. Basically two basic models can be distinguished; a segmented model in which the various regulatory duties are split between Ministries and different specialized entities (very often organized per industry) or a centralized model in which all regulatory duties for one or more industries (e.g. the communications industries, including broadcasting and telecommunications) are centralized in one single entity. Good examples of the latter model are the Federal Communications Commission (FCC) in the US and Ofcom in the UK¹⁶⁸.

The figure below illustrates the two different models and has included the key regulatory activities directly related to DTTB/MTV (and as addressed in the previous sections 2.1-2.10).

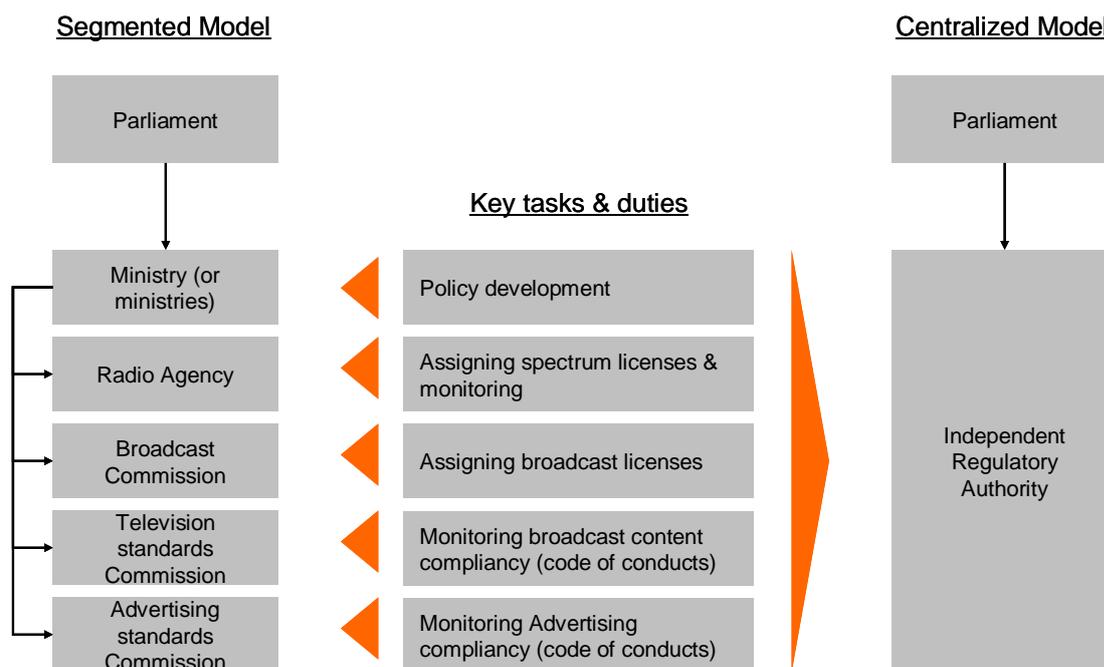


Figure 2.12.1: Segmented and centralized regulatory models

Both models can have their own country specific implementations. For example in the segmented model it is possible that for example the Radio Agency does not directly report to any ministry but is directly governed by Parliament. Also, a centralized model can still operate in a non-coordinated way where different departments are working in their separate compartments. Both models do exist and little can be said about their relative effectiveness and efficiency. However, some countries are moving towards a more centralized or coordinated model.

Before assigning any DTTB/MTV licence one should check whether the above key tasks and duties are clearly assigned and coordinated between the existing regulatory entities. The trend towards a more centralized model is not directly related to the introduction of DTTB/MTV. However, the introduction of MTV is very often quoted as the example of the wider industry trend of convergence as it brings

¹⁶⁸ For example Ofcom was formed by bringing together five existing Regulators – Oftel (telecoms), Radiocommunications Agency (spectrum), ITC (television), the Radio Authority (radio) and the Broadcasting Standards Commission (standards, fairness and privacy in relation to all broadcasters including the BBC).

together the telecommunications and broadcasting industry¹⁶⁹. In other words, the introduction of DTTB/MTV may prompt a review of the organizational structure of the regulatory entities.

It is the wider industry trend of the converging industries of broadcast and telecommunications that makes a more coordinated model necessary. As indicated in previous sections (see 2.2.2 and 2.11.2) asymmetry in legislation between the industries can occur and should be avoided. For example, asymmetry can occur when setting 'must carry', cross- and foreign ownership rules or selecting assignment procedures (auction or public tender). In a segmented model with entities organized by industry and without close coordination between them, such asymmetry is more likely to happen.

2.12.2 Impact of convergence

Apart from any efficiency considerations, regulatory convergence (i.e. towards a more centralized or coordinated model) is mainly driven by the widely observed market convergence trend. As illustrated in the figure below, this market or industry convergence trend will result in a restructured value chain (see also part I and section 2.2.1 of these guidelines).

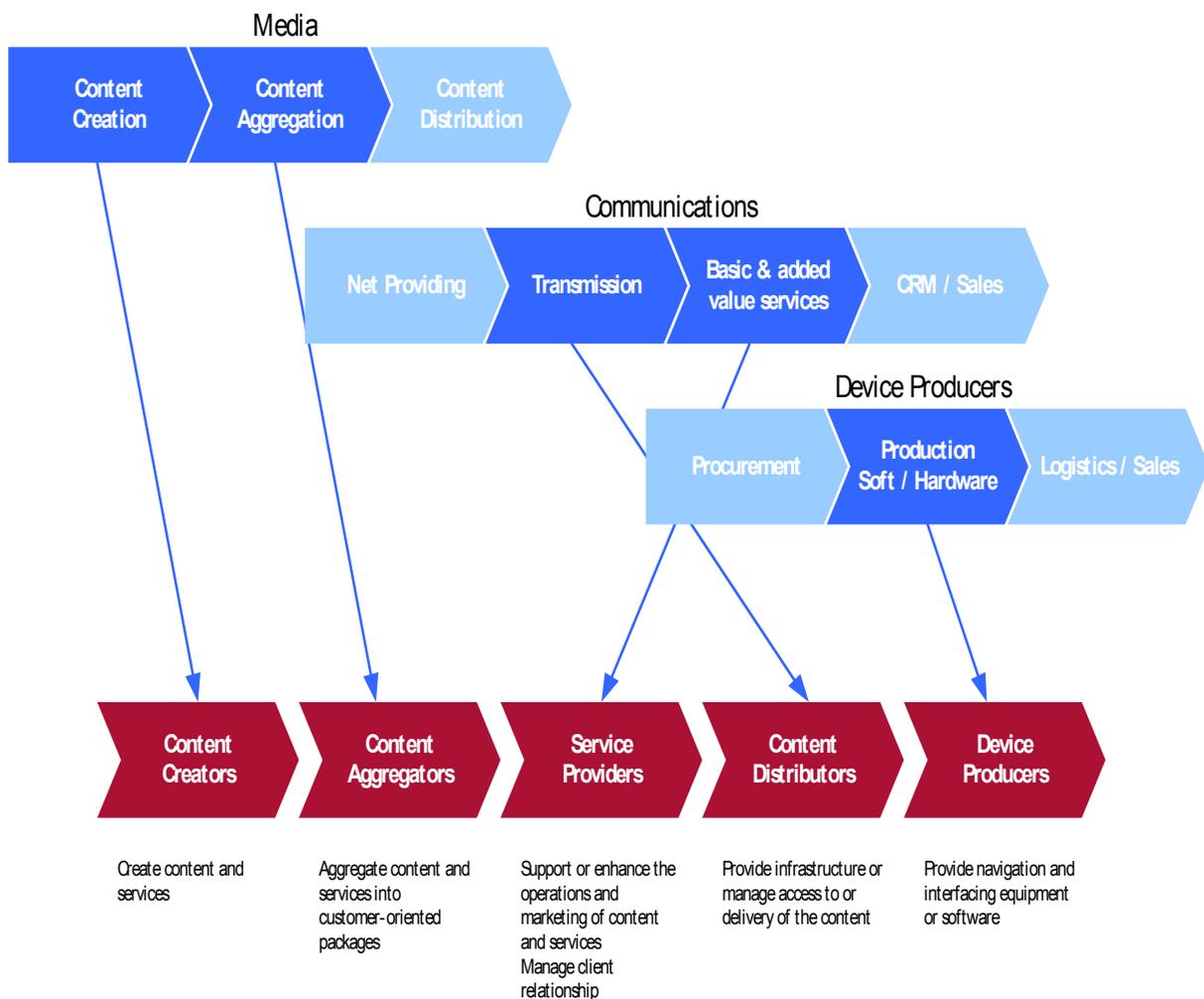


Figure 2.12.2: Industry convergence

¹⁶⁹ Not only because of device convergence, integrating two receivers onto one device, but also that shared business models between broadcasters and telecom operators are necessary. For more details on business models see section 3.4 of these guidelines.

Convergence takes place at basically three different levels, all having their specific impact on the regulatory framework:

1. Network convergence;
2. Device convergence;
3. Industry/corporate convergence.

Network convergence

By the definition of network convergence, convergence will have taken place when all the different electronic communications networks (broadcasting, cable, satellite, telephony fixed and mobile) are each capable of providing all the different services (radio, television, voice, data) and with reasonable shares of consumer usage by each network¹⁷⁰. From a consumer perspective, the various networks are interchangeable and service roaming could be seamless.

An important development in this network convergence trend is the adoption of the Internet Protocol (IP) for transporting any data, regardless whether this data represents information, voice, video or audio. Many telecom and broadcast companies follow a so-called “all IP” strategy facilitating efficient network operations, data exchange and seamless service roaming between networks.

Telecom networks are now able to deliver typical television services (e.g. by means of IPTV networks) and, conversely, broadcast networks are delivering typical telecom services like telephony and internet. More specifically, DTTB/MTV networks have become interactive by delivering, for example, services such as video-on-demand, gambling, shopping and voting.

With this *network* convergence an increased need for coordination arises between the telecommunications and broadcast regulations, especially for:

1. Setting *content* requirements (see section 2.8). Traditionally the telecom regulator concentrates on regulating carriage but not content whereas the broadcast regulator very often has statutory content regulation powers;
2. Setting *platform access* requirements (see section 2.1.1, 2.2.2 and 2.6.1). Also here the telecom regulator has to liaise with the broadcast regulator as in the telecommunications industry platform access is not regulated in the same way. In the telecommunication industry a regulated ‘wholesale’ model is common, whereas in the broadcast industry access was regulated mainly at the level of site/antenna sharing. However, as previously discussed in these guidelines the introduction of DTTB/MTV may argue for the application of an wholesale model (see section 2.1.1).

Device convergence

Device convergence, however, is happening and at seemingly a faster rate than network convergence. The mobile handset in the 3/4G world receives voice, data, still and (real-time) moving pictures – one-to-one and one-to-many communication. The PC screen routinely accesses movies, music, radio and television stations. The MP4 players or Personal Media Players (PMP) have become a combined Internet access device, DVD player and television set.

¹⁷⁰ The ultimate form of network convergence would be one single unified network. However due to the specific characteristics of specific networks this is not even desirable. For example, broadcasting networks are very cost efficient in delivering large amounts of data to many. In fact the incremental costs are zero. The costs to transmit to one television set within the transmitter coverage area are exactly the same as to transmit to ten million television sets. This is in sharp contrast with, for example, an IPTV network delivering television services.

Although device convergence may not lead to one single device accessing any platform or service, a small number of devices, the PC, the PDA, the TV set, the games machine, the mobile phone will be accessing, seamlessly, a much broader range of what were once separate, device-dependent services.

In a segmented regulatory model, this development will pose the question of why, for example, the (broadcast) regulator can regulate the content of one service (e.g. television programming displayed on a television set) but not of the other (e.g. the moving picture sequence downloaded from the Internet but also displayed on the same television set). From a consumer point of view, both services look pretty much the same on their television set.

With this *device* convergence an increased need for coordination arises between the telecommunications and broadcast regulations, especially for:

1. Setting *technology and standardization* requirements (see section 2.1). As discussed access to a telecom *service* is differently organized than in the broadcasting industry. For example in the broadcasting industry it is common practice to lay down conditional access requirements (having a Common Interface) for the Integrated Digital Television sets (IDTV), this is unknown in the telecoms industry. With the ever increasing number of different devices, a device specific regulation may well not be sustainable in the long run;
2. Setting limits for *subsidizing and bundling services*. In the telecoms industry some regulators restrict the possibilities of handset subsidizing whereas in the broadcast industry subsidizing receiver equipment is very often an accepted practice. Also dissimilarities may exist between the broadcast and telecom industry in the area of bundling services (e.g. only offering a single television, internet and telephony package may be prohibited in the telecoms industry)

Corporate convergence

Corporate convergence might have been at its height during the dotcom boom but corporate convergence is still taking place. Perhaps not at the same scale as the examples of Telefonica, the Spanish telecoms company, buying Endemol, the TV production company or Time Warner and AOL merging or Vivendi in France adding Hollywood movie studios to its telecoms business.

Nevertheless, telecoms companies today, fixed and mobile, have started to offer television services and have built up know-how of the content business, whether or not they choose to acquire content properties. Conversely, content or broadcast companies have started to deliver telephony and Internet services and their programming over a widening range of networks and to different audiences.

With this *corporate* convergence, especially, arises the regulatory issue of defining the legal entities/players like telecommunications, broadcast network operator and mobile network operator. For the different legal entities, different regulatory regimes might be applicable. For example, mobile operators might have obligations to share transmitter sites whereas broadcast network operators might not have. Review and revision of defined entities might be necessary. Again this will require coordination between the relevant regulatory entities.

2.12.3 Implementation guidelines

The following guidance can be provided:

1. Before assigning any DTTB/MTV licences, the involved ministries and regulators should check if the following tasks are clearly defined and no jurisdiction problems could occur:
 - a. Policy formulation, including aspects such as defining the National Spectrum Plan, setting standards, setting licence terms and conditions etc.;
 - b. Assigning spectrum licences and monitoring proper use of the assigned spectrum;

- c. Assigning broadcast licences or permission to broadcast television and radio content;
 - d. Monitoring broadcast and advertising compliancy (e.g. by applying codes of conduct for editorial content, EPG, access services and advertising);
2. Continuously align and coordinate the DTTB/MTV efforts between the involved regulatory entities, which seems especially relevant for licensing MTV services and for the areas as indicated in section 2.12.2 (including setting requirements for content, platform access, technology and standardization, subsidizing and bundling services);
3. Although not strictly related to the introduction of DTTB/MTV services, the government might consider a (phased) restructuring of the regulatory entities towards a more converged or centralized model. However, this should never hamper the realization of any set targets for the Analogue Switch-Off - ASO - (e.g. as communicated to the public by official publication)¹⁷¹ or the planned assignments of DTTB/MTV licences (e.g. as indicated in the National Spectrum Plan).

2.13 Communication to end-consumers and industry

Informing the public at large¹⁷² and the television industry about the changes in the areas of legislation, policies and regulations (related to the introduction of DTTB and MTV) is a government led task.

Informing the end-consumers and the industry is an important element of policy execution. Providing adequate and timely information will ensure and support a rapid service take-up, a profound market development (i.e. content development and receiver supply/availability) and a smooth service transition.

This section is structured as follows:

1. Scope of government led communications: in what cases does a need arise for government led DTTB/MTV communications;
2. DTTB/MTV specific communications moments and topics;
3. Implementation guidelines.

2.13.1 Scope of government led communications

To limit the risks of distorting the market or confusing the market, regulators or legislators should only communicate about services and activities that directly fall within their responsibilities. A regulator should scope clearly where his communications duties lie. Related to DTTB/MTV licensing a need for public communication can arise in the case of:

1. Government intervention restricting or changing free market competition (see section 2.6.1);
2. Defined Universal Services and Access to these Services (see sections 2.1 and 2.2.3);
3. Health and safety hazards (see sections 2.6.3 and 2.7.2).

¹⁷¹ For more details on the ASO see sections 2.14-2.18 of these guidelines.

¹⁷² Please note that marketing and communication to specific user groups, such as carried out by commercial parties (e.g. network operators and Service Providers) and/or Public Broadcasters are separate and covered in section 3.5 of these guidelines.

Government intervention restricting free market competition

The first case is valid for both DTTB and MTV as spectrum is a valuable and restricted resource which is assigned to a limited number of licence holders. As such the free market is restricted and hence the government has to explain and communicate his intentions and actions. Allocating parts of the spectrum for specific user categories, which is very often part of the National Spectrum Plan, is also a form of restricting free competition. In addition, issuing broadcast licences and building permits could also potentially limited market competition. In fact, any form of licensing can be considered as market intervention¹⁷³.

Defined Universal Services and Access to these Services

The second case can be different for DTTB and MTV licensing.

A need arises for public communications when the legislator has defined for end-consumers a Universal Services (US) and Access to these Services (UAS). As a general guideline for determining these US and the UAS, a service has to satisfy two tests¹⁷⁴:

1. In the light of social, economic and technological developments, has the ability to use the service become essential for social inclusion; and
2. Are normal commercial forces unable to make the service available for all to use?

The outcomes of these two tests can be different from country to country, especially for developing countries. The main driver for inclusion may be economic before social factors. Special consideration might be given to the educational aspects of the widespread availability of (digital)¹⁷⁵ television content.

The services to be included in the scope of universal and service access (UAS) will change as technology and society change. Especially convergence developments, where various delivery platforms (e.g. Wireless/WiMAX, IPTV/Internet networks) can deliver television content in an efficient manner, the inclusion of Universal Services and UAS might change. Market consultation and evaluation might be necessary every three years.

With regard to DTTB services, most countries have defined US and UAS in various Acts (either Telecommunications or Broadcast/Media Acts) for these services and generally include:

1. Free-to-air reception of the Public Broadcaster's radio and television content against acceptable costs for national viewers¹⁷⁶ (see section 2.2.3);
2. (Near) 100 per cent population or geographical coverage of Public Broadcaster's radio and television content (see section 2.2.3);
3. 'Must carry' rules for specified content and delivery networks (see sections 2.2.1, 2.5.3 and 2.8.1).

¹⁷³ It should be noted that in most countries spectrum licensing and management are allowed under the competition laws. For example, in the European competition laws, assigning spectrum licences are explicitly mentioned as lawful interventions. From a legal competition point of view, assigning broadcast licences might be reviewed more thoroughly. See also section 2.6.1 of these guidelines.

¹⁷⁴ For more details on US/UAS and these tests and example test see www.ictregulationtoolkit.org, respectively module 4 and section 1.1.4, *infoDev/ITU*.

¹⁷⁵ Especially digital television, because digital television can more easily facilitate thematic channels due to more distribution capacity and the possibility of interactive applications.

¹⁷⁶ Very often only defined for the analogue terrestrial platform and it is unclear if such a provision also applies to the other/digital platforms. Also, acceptable costs are very often not defined. Especially when ASO is considered, these questions might arise and need to be resolved.

For MTV services, as addressed in section 2.1, such US and UAS stipulations are rare. However, under certain market situations (e.g. the MTV platform is the only network to deliver television content in rural areas) the above tests can result in a different outcome.

Not only should the legislator earmark the DTTB/MTV service as a US, but should also define what capacity is reasonably and proportionally required for this US. Sections 2.2.3, 2.3.2 and 2.10.2 have provided guidance on assigning capacity to DTTB/MTV services.

Health and safety hazards

As discussed previously in these guidelines, before allowing the DTTB/MTV transmitter site to be erected and taken into operation, the (local) regulator checks for compliance with health and safety regulations, including field strength and EMC. The general public and industry should be informed about which standards and norms are applicable and should be adhered to. Very often governments will refer to and base their field strength and EMC regulations on standards of international bodies:

1. Field strength: the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE)
2. Electromagnetic Compatibility (EMC): International Electrotechnical Commission (IEC), Comité Européen de Normalisation (CEN) and European Telecommunications Standards Institute (ETSI).

For both DTTB/MTV such field strength and EMC standards should be known and published. Especially for the equipment producers (transmitter and receiver equipment) an alignment with international norms is advisable so as to reap the benefits of a global economy of scale.

2.13.2 DTTB/MTV communication moments and topics

The previous paragraph already provides general guidance when government led communications should take place. In this paragraph the specific communication moments and topics will be further specified.

It should be noted that communications around the Analogue switch-off (ASO), i.e. switching off of the analogue television signal and replacing it with a digital signal is addressed in section 2.18. The ASO is addressed separately in these guidelines (in sections 2.14 -2.18) because of its high social impact (both the analogue and digital service are considered a US) and unique occurrence (since the introduction of television). A large part of the government led communications is directly related to this ASO.

The table below provides an overview of the DTTB/MTV related communications moments, topics and intended audiences. The table also refers to the relevant sections where detailed information and the policy considerations can be found.

Table 2.13.1: Communications moments and topics

When	Category	Topics	Primary Audience (Public/ Industry)	Sections
Continuously	Regulatory framework and organization	Legal framework and relevant Acts	P/I	2.11
		Regulatory entities and their duties and tasks	P/I	2.12
		Public Service Broadcasting (role, tasks and duties)	P/I	2.2.3, 2.5.2
		Regulatory decisions on legal framework	P/I	2.11, 2.2

When	Category	Topics	Primary Audience (Public/ Industry)	Sections	
		Market consultations (general and industry wide) ¹⁷⁷	I	-	
	Inquiry, complaint and appeal procedures	Assignment procedures	I	2.5	
		EMC and Safety (standards)	P/I	2.6.3, 2.7.2	
		Spectrum interference (amongst users)	I	2.3	
		Home equipment interference ¹⁷⁸	P	-	
Recurring	National spectrum planning	Preparatory market consultations	I	2.4	
		National Spectrum Plan	P/I	2.4	
		International planning conferences (GE06)	I	2.3, 2.4	
		Re-farming and revoking spectrum under existing users	I	2.4	
		Appeal procedures for spectrum management decisions ¹⁷⁹	I	-	
Case by case	Assigning DTTB/MTV licences	Preparatory market consultations on DTTB/MTV	I	2.4, 2.5	
		Applicable licensing framework	I	2.2	
		Applicable technology standards	I	2.1	
		Applicable assignment procedure	I	2.5	
		Spectrum licence terms and conditions	I	2.6	
		Broadcast licence terms and conditions	I	2.8	
		Required local/building permits	P/I	2.7	
		DTTB/MTV regulatory decisions (including revoking) and appeal procedures	P/I	2.5 Appendix	
	Digital Dividend	Market consultations on Digital Dividend	I	2.10	
		International Digital Dividend decisions ¹⁸⁰	P/I	2.10	
		Digital Dividend regulatory decisions (including revoking) and appeal procedures	I	2.10	
	ASO		See sections 2.18	P/I	2.18

¹⁷⁷ Regulators might carry out market consultations on a review of complaint procedures or topics which may require additional regulation. For example asking for proposals on how to regulate access services (subtitling), video on demand services, etc.

¹⁷⁸ In some countries it might be possible that the DTTB frequencies are in use by cable companies. The introduction of the DTTB service might cause interference and viewers need to be helped to resolve these problems (by sending the affected viewers other cable connectors). For example in the Netherlands a dedicated website has been published to help viewers, see www.stai.nl/index.html.

¹⁷⁹ Regulators might have on their website complaint procedures. See for example www.ofcom.org.uk/about/accoun/complaints/.

¹⁸⁰ A good source for information is the subscription based website service called Policy Tracker, see www.policytracker.com.

2.13.3 Implementation guidelines

The following guidance can be provided on government led communications to end-consumers and the industry:

1. Limit the risks of distorting or confusing the market by communications based on the principles of:
 - a. Impartiality and accountability: making sure that certain market parties or end-consumer groups are not favoured, that policy decisions are evidence supported and are based on a legal constitution;
 - b. Responsibility: only communicate about topics where there is direct responsibility as indicated in section 2.13.1. For example, informing the market about available transmitter or receiver equipment might be best left to the market;
 - c. Transparency: keep the audiences continuously up-to-date on the regulatory process and decisions (even when there is no progress). Provide information in time and complete so that end-consumers and industry can have a reasonable preparation time;
2. Select appropriate communication tools for the target audiences. Communication tools should be tailored and a one-fits-all approach should be avoided. The following tools are generally applied for the two main audiences:
 - a. End-consumers/general public:
 - i. Consumer associations and interest groups (and they inform their members);
 - ii. Website (depends on the internet access and availability);
 - iii. Printed media (official Gazette, newspapers and magazines);
 - iv. Radio and television channels (for specific events like the ASO, see for more details section 2.18);
 - b. Industry:
 - i. Market consultation and information sessions;
 - ii. (International) conferences and fairs;
 - iii. Direct mail (using the Regulators' licence holder registers);
 - iv. Website (perhaps with a special login for licence holders);
 - v. Printed media (official Gazette, newspapers and professional magazines).

2.14 Transition models

The process of transitioning from analogue to digital terrestrial television broadcasting can be carried out in different ways depending on the local situation (e.g. the number of terrestrial viewers and channels, spectrum availability), international obligations and the government's policies and objectives.

This section and the following sections 2.15 to 2.18 all deal with the situation that analogue television broadcasts *have* to be stopped and the existing analogue services are migrated to a DTTB platform in *one coordinated effort, led by the national government*. The key element for the Analogue switch-off (ASO) process to be initiated is that the government sets a *mandatory* date for analogue switch-off.

This situation is fundamentally different from the situation where the national government decides to introduce a DTTB platform next to any existing analogue services; both the analogue and DTTB services can coexist next to each other and there is no (clear) objective to switch-off the analogue service in the near future.

This section comprises the following paragraphs:

1. *ASO objectives and hurdles*: the key ASO objectives and what hurdles the regulator encounters when initiating an ASO process;
2. *ASO factors*: the key factors determining the ASO transition model;
3. *ASO transition models*: the basic transition models for realizing an ASO;
4. *Implementation guidelines*: what model to apply in which situation.

2.14.1 ASO objectives and hurdles

Analogue switch-off is the *process* of turning off the analogue *terrestrial* television signal and replacing it with a digital signal.¹⁸¹ It will basically require changing existing television broadcast networks and changing end-consumer television receiver equipment (either connecting a digital converter to the existing television set/recorder or replacing the existing television set with an integrated digital television set and/or digital recorder). Very often with an ASO, not only the existing analogue channels will be converted into digital channels, but also additional DTTB channels will be introduced at the same time (as more than one/two multiplexes will be assigned)

ASO objectives

The ASO is a government initiated policy, aiming at gaining *spectrum efficiency*¹⁸² which will bring *consumer benefits* (more choice in television channels and services) and *industry benefits* (new revenue streams and business models). For more details on these consumer and industry benefits please refer to Part I of these guidelines.

These above objectives are very valid reasons for governments to introduce DTTB services, however these objectives do not make it *necessary* to switch-off analogue and hence to carry out an ASO operation. The main reason for analogue switch-off is in the government's objectives:

1. To have a universal television service on the DTTB platform, and/or;
2. To securing the future of the terrestrial platform.

For countries, possibly for various countries in Africa, where there is no frequency shortage that would prevent near-universal DTTB coverage, another reason to switch-off analogue transmissions exists. With the global objective to switch-off analogue transmissions, it is inevitable that analogue transmitter and receiver equipment will become obsolete. Consequently, network maintenance costs will go up and ultimately service levels will degrade as spare (analogue) components are no longer readily available.

ASO hurdles

With such clear benefits of having DTTB services, one could ask why ASO does not take place 'automatically' (i.e. without any government intervention). Any ASO, in the shorter run, involves significant costs and difficulties associated with the need to:

1. Introduce technical upgrades in all segments of the value chain: requiring a (government led) coordinated effort across industries, otherwise the typical 'prisoner's dilemma' will

¹⁸¹ This implies a transition from analogue terrestrial television to DTTB. Consequently in the functional framework the sections 4.1 – 4.9 on the technical implementation of DTTB networks are relevant too. Please note that an implementation of DTTB network can also be carried out independently from any ASO, if there are enough frequencies available. The same applies to any implementation of a MTV network.

¹⁸² ASO spectrum efficiency may result in freeing up spectrum, the so-called Digital Dividend (see section 2.10).

occur: Studios or content creators will not produce digital content if no digital networks and viewers are available;

2. Review spectrum mechanisms and approaches: DTTB services will require the allocation of spectrum and assignment of licences, and possibly re-farming spectrum (moving current users to different parts of the spectrum). Both typical government tasks;
3. Financing the cost of ‘simulcasting’: to provide viewers a period of time to switch to another/digital platform, most ASOs will require a period of simulcasting, where both the existing analogue services and the new digital services are broadcast. Such a simulcast period will imply additional network costs with hardly any or limited added value for the individual broadcaster involved. In most cases, these individual broadcasters are either Public or commercial broadcasters. Consequently, governments must provide funds or compensation for these additional network costs. In addition, without a simulcast period, spectrum can sometimes not be freed-up and the ASO is, in effect, not possible.

2.14.2 ASO factors

A set of key interdependent factors will determine the approach chosen for the ASO process, i.e. the ASO transition model. As these factors are related and very often controlled/influenced by different parties/entities, a collaborative and interactive approach for designing and managing the ASO process should be adopted (see section 2.15). These factors include¹⁸³:

1. Required PSB services;
2. The number of analogue terrestrial television viewers;
3. Availability of spectrum;
4. DTTB service uptake.

Required PSB services

First of all the government should determine which services are considered to be a Universal Service on the DTTB platform. These services then have to be facilitated on the DTTB platform after switching them off on the analogue platform. In most cases, these services are limited to the Public Service Broadcasting (PSB) services. Next to the national PSB services, also regional and local PSB services should be taken into account. These regional and local PSB services should not necessarily (all) be facilitated on the DTTB platform (see also below).

Whether the DTTB platform can facilitate all PSB services depends heavily on:

1. Spectrum availability (see below and also section 2.3);
2. Network design and planning (see sections 4.2. and 4.3), and;
3. If a simulcast period is required: the government and/or Public Service Broadcaster might require a ‘simulcast’ period, allowing analogue viewers to switch to an alternative television platform. A simulcast period is however not necessarily required in each geographical area or for all PSB services¹⁸⁴, but if so, also;
4. Duration of the simulcast period: the minimum duration of the simulcast period will determine the possibilities of re-using frequencies and hence the available DTTB capacity (and total duration of the nationwide ASO).

¹⁸³ See also Digitag report “Analogue switch-off: Learning from experience in Europe”, 2008.

¹⁸⁴ For example in the Netherlands the analogue transmitters were switched-off nationwide, in one go, whilst only in half the country the PSB services were simulcast on the DTTB platform. Also regional PSB services did not have a simulcast period on the DTTB platform as they were facilitated on the satellite platform.

The number of analogue terrestrial television viewers

As an ASO process is a government led process, this risk of disenfranchising viewers is politically a sensitive topic and should be prepared carefully. Especially determining the various viewer groups¹⁸⁵ and the number of affected viewers is critical¹⁸⁶.

“Countries with very few television households relying on the terrestrial analogue television platform will be able to switch-off their analogue platform quickly and with little risk of large groups of viewers to lose television services. This has been demonstrated in highly cabled countries, such as Luxembourg, the Netherlands and Switzerland which completed analogue switch-off quickly.”

In determining the number of viewers of the different television platforms in a given country, very often the reception mode used for the primary television set is the determinant. However, in most television households more than one ‘receiver’ is present: multiple television-sets with different reception modes (e.g. the first set is cable connected and the second set relies on the terrestrial platform) and video recorders. In Europe most television households own an average of 2.2 television sets and most secondary television sets rely upon the terrestrial platform.

The following aspects should be taken into account when determining the various affected viewers (i.e. those relying on the analogue terrestrial platform):

1. Second (and third) television-sets and their reception mode;
2. Video recorders: video recorders have an in-built analogue receiver enabling the recording of a different television programme than that being watched simultaneously on the connected television set. The standard set-top-box has only one tuner therefore to facilitate this ‘split’ functionality an advanced set-top-box will be equipped with a twin tuner¹⁸⁷;
3. Viewers in ‘multi-dwelling units’: viewers in this group share a common analogue receiver infrastructure, for example residential houses with several tenants (all watching television through a single analogue cable system), hotels, public building and places, prisons¹⁸⁸, etc;
4. Affected Public Service Broadcasting (PSB) services and alternative reception modes: not only the national PSB services should be considered but also the regional and local PSB should be taken into account. Especially as these regional/local services might not be facilitated on the DTTB platform¹⁸⁹ or on the satellite platform (or any other alternative platform).

¹⁸⁵ Television Household (TVHH) and Household (HH) are commonly used terms. However the term implies a ‘family, ranging from single households to multi person households, watching television’. With this term very often other television usage is overlooked. For example, small groups of people watching television in clubs, bars and other public places.

¹⁸⁶ Some text passages in this chapter are taken from Digitag report “Analogue switch-off: Learning from experience in Europe”, 2008, see quotation marks.

¹⁸⁷ This problem with second television sets and recorders is not DTTB specific but applies to all digital platforms. In most cases it is for the digital television service provider to manage this problem, i.e. to offer a twin tuner or a second tuner. A twin tuner is a set-top-box device incorporating two tuning units. Hence two different channels can be watched and recorded at the same time.

¹⁸⁸ In Germany, when switching off analogue television in Berlin, analogue television viewers in prisons were an unexpected group of viewers complaining of not be able to receive television anymore.

¹⁸⁹ Facilitating regional services on a DTTB is very spectrum in-efficient and relatively expensive. For more details see section 4.2 and 4.3.

Subsequently, per identified viewer group the actual numbers should be estimated and per group the number of affected PSB services. The government should then determine its responsibility in resolving the identified problems, ranging from just informing affected viewers to financially compensating viewers.

Availability of spectrum

"The availability of spectrum will determine whether a given market can simultaneously offer analogue and digital terrestrial services in a given area or region. In some countries, the launch of DTT services is contingent upon switching off analogue services first.

For example, in Switzerland, partial analogue switch-off took place before DTTB services could be launched. In Germany, the simulcast period in various regions (for example the metropolitan area Berlin) has been short, ranging from a period of 3-9 months.

As mentioned in the previous paragraph, in most countries, near-universal DTT coverage is generally not possible without first completing analogue switch-off in a certain area"

By re-using the freed-up analogue frequencies for the launch of DTTB service elsewhere, in a phased approach it is possible to complete the ASO nationwide¹⁹⁰. Such a phased approach could imply a complex 'frequency puzzle' which has to be carefully designed and planned.

DTTB service uptake

In any ASO process, the actual attractiveness of the DTTB platform will for a large part determine the success of the ASO operation and the government should take this aspect into account. The attractiveness of the DTTB platform is directly related to:

1. "The availability of the services (coverage): national coverage will make it easier for end-consumers to understand the DTTB offering and a nationwide service is also easier to market";
2. The appeal of the service offering (content): the DTTB offering should have added value as compared to the analogue services (or any other competing platform). For example, in a typical terrestrial-TV country (i.e. where a large proportion of the population relies on the terrestrial platform) and without any cheap multi-channel offering on alternative platforms, DTTB's added value could be in the (limited) extra channels for a lower subscription fee (in the case of a pay-tv offering) or even free-to-air (in the case of an advertising-based offering);
3. The cost of the service: i.e. the price of receiver. High costs for the receiver will increase barriers either of the DTTB service operator (in the form of subsidies) or for the viewer (in the form of high purchase prices). However, DTTB receivers are continuously decreasing in price and basic receivers (USB-based, without Conditional Access) are approaching the USD 10 ex-factory price.

Next to the other available digital alternatives, the assessed attractiveness of the DTTB platform will for a large part determine the speed of DTTB penetration and hence the required simulcast period.

¹⁹⁰ For determining the available DTTB spectrum, see section 2.3. For the technical utilization of the available spectrum and network planning see section 4.2 and 4.3.

2.14.3 ASO transition models

Several different models to digital switch-over have been adopted, depending on the local circumstances (see previous paragraph on ASO factors). However, two basic models can be identified (with combinations and in-between variants):

1. ASO *with* simulcast period, with two sub-categories:
 - a. *Phased approach* to analogue switch-off: region by region the analogue transmitters are switched-off. In principle, such a switch-off approach can be combined with a two basic roll-out scenarios for the DTTB network:
 - i. The DTTB network is also rolled out in a phased approach, region by region, or;
 - ii. The DTTB network is already available with (near) nationwide coverage before the first transmitters are switched-off;
 - b. *National approach* to analogue switch-off: on a nationwide scale, the analogue transmitters are switched-off at one moment in time whilst a (near) nationwide DTTB network is available;
2. ASO *without* simulcast period (in limited geographical areas or specific regions): the analogue transmitters are switched-off and at the same moment (i.e. one or several hours later) the digital transmitters are switched-on at the same transmitter site(s).

ASO with simulcast and a phased approach to analogue switch-off

"In a phased approach, analogue switch-off takes place in a given country region by region 'DTTB network planners' (i.e. a special task force with industry and government participation) prepare a timetable detailing when analogue transmitters will be shut off throughout the country.

A phased approach provides several benefits:

1. DTTB planners can apply the lessons learned in one region to improve the process in another region. Should something go wrong after analogue switch-off, the 'damage' is limited to a single region;
2. The released frequencies can be re-used in a neighbouring region in order to increase its DTTB coverage and expand the DTTB service offering;
3. DTTB planners are able to spread the cost and resource the effort of digitalization in a more manageable manner.

The phased approach has been used in Austria, Germany, Norway and Sweden. Other countries likely to use this approach include Spain, France and Italy.

In countries, such as the UK, that have opted to launch national DTT services before beginning analogue switch-off, it has been possible to observe how the DTT market develops before finally deciding how and when to end analogue services. This has generally been the case in countries with many households depending on the analogue terrestrial television platform"

ASO with simulcast and a national approach to analogue switch-off

"In a national approach to analogue switch-off, analogue services are ended simultaneously across the whole country. All viewers benefit from the advantages of digital switchover, as viewers are treated equally and given the same access to services but equally all suffer from the need to equip for digital (either for the DTTB platform or any other competing platform such as satellite or cable).

However, this approach can in most cases only be adopted after DTTB services have been launched and made available to all viewers. In Finland, where DTTB services reached nearly 100 per cent of the population, it was possible to switch-off the analogue platform on one set date. This approach was adopted in Finland, Andorra, the Netherlands and Luxembourg and is planned for use in Denmark.

In a unique variation to this strategy, the Swiss public service broadcaster SRG-SSR switched-off two out of its four analogue channels across the country as early as March 2002. It was only after this partial analogue switch-off that it launched the DTT platform. However, such action seemed only to be acceptable to viewers because of the low viewing rates of the switch-off channels (due to multi language channels)".

A nationwide approach will concentrate the efforts at one moment in time and might be difficult to manage (depending on the scale of the involved networks). However, a nationwide switch-off has the following benefits:

1. Simple and concise communication possible to the affected viewers: no need for viewers to check when their region is going to be switched-off and no confusion possible for 'border cases';
2. All viewers benefit from the advantages of digital switchover, as viewers are treated equally and given the same access to services but equally all suffer from the need to equip for digital (although depending on the roll-out of the DTTB network some viewers might have a longer simulcast period);
3. Depending on the spectrum availability, a nationwide approach could free-up spectrum more rapidly and make those frequencies available to DTTB network (for example, to increase the number of television channels/multiplexes).

ASO without simulcast

Although not applied very frequently, it is possible to switch-off the analogue transmitters without facilitating a simulcast period. In such an approach, where in a very short timeframe the analogue service is replaced by a digital service, the high simulcast costs are not incurred.

The key ASO factor determining such an approach is the political willingness to adopt this model (see above "required PSB services). The key (political) risks associated with this model are:

1. Viewers cannot *switch back* to their analogue platform. Please note that in *both* models, with and without simulcast, viewers have to purchase a digital receiver for the DTTB platform (or any other alternative). In this aspect there is no difference;
2. If something goes wrong after analogue switch-off, the damage is not confined to one region but is suffered on a nationwide scale (however, the number of affected viewers can still be limited).

Clearly the above risks will call for political willingness to adopt this model. But when available budgets for simulcasting are low and the number of potentially affected viewers are low too, this model is certainly feasible (in at least limited geographical areas) as the Dutch case has proven.

2.14.4 Implementation guidelines

The following guidance can be given in determining which ASO transition model to apply:

1. The figure below illustrates the three basic decisions:

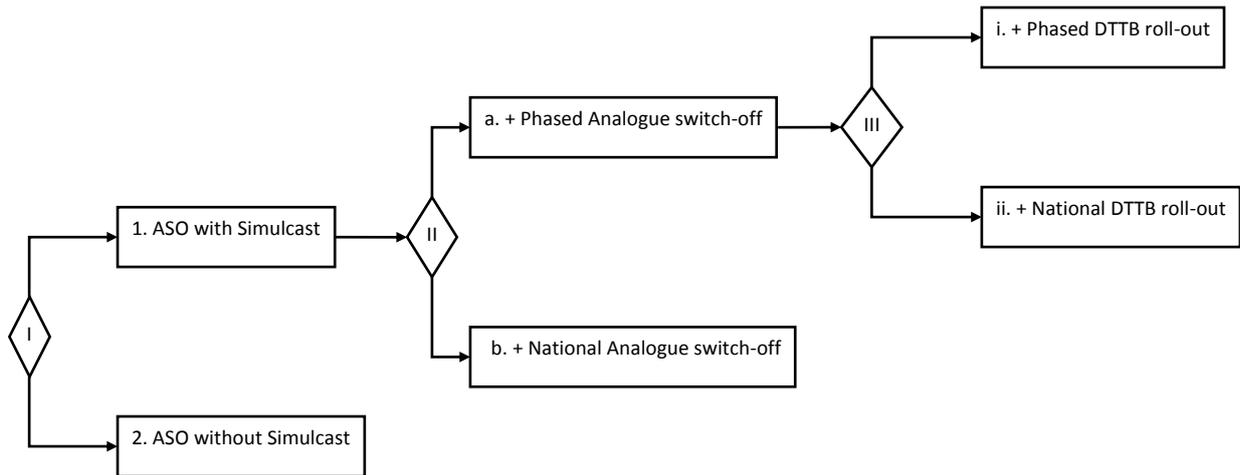


Figure 2.14.1: Decision tree for ASO transition models

For each decision the relevant ASO factors are mentioned between brackets:

- a. Decision I:
 - i. Model 1: when the politicians stipulate a simulcast period [required PSB services]. This is when the (political) risks of failure are assessed high. This is likely when the analogue terrestrial television platform is relatively large, as compared to the other available platforms for PSB services [The number of analogue terrestrial television viewers] *and/or* added value of the DTTB platform is deemed to be low [DTTB service uptake];
 - ii. Model 2: when the politicians don't stipulate a simulcast period and the down side risks are deemed to be low (possibly only in certain regions) [required PSB services]. This is likely when the analogue platform is relatively very small [The number of analogue terrestrial television viewers]. This type of model was applied in the Netherlands (in half of the country).
- b. Decision II:
 - i. Model 1(a): when the [The number of analogue terrestrial television viewers] is relatively big and the sheer size of the switch over operations are relatively big (not enough resources to manage the ASO in one go);
 - ii. Model 1(b): when the [The number of analogue terrestrial television viewers] is relatively small. This model was applied in countries such as Finland, Andorra, the Netherlands and Luxembourg.
- c. Decision III:
 - i. Model 1(a)(i): when the [The number of analogue terrestrial television viewers] is relatively big and available spectrum is limited [Availability of spectrum] and frequencies have to be re-used. This ASO transmission model was applied in Germany;
 - ii. Model 1(a)(ii): when [The number of analogue terrestrial television viewers] is relatively big and available spectrum is not limited too much for a nationwide DTTB network with enough multiplex to have an attractive alternative [Availability of spectrum] + [DTTB service uptake]. This transmission model was applied in the UK.
2. A joint ASO process with a close cooperation with commercial parties is recommended as they have an interest to provide the viewers with a set-top-box. Commercial parties can generate revenue streams which can (partly) finance set-top-box subsidies. This obligation can be included in the DTTB frequency licence terms and conditions. Such an approach

should be specifically considered in case the PSB funds are limited. It is likely that the existing funding model will not be adequate to cover the investment needed to migrate to digital broadcasting transmitting network/s, let alone to (partly) finance set-top-box subsidies and the simulcast period (double network costs);

3. In case governments would like to compensate viewers for the costs of switching to digital (i.e. purchasing a set-top-box or IDTV) a voucher system such as that applied in the US could be considered. In such a system responsibility of the government should be limited to the primary television set and inform the viewer about the other receivers (e.g. second sets and video recorders) in order to limited fraud.

2.15 Organizational structures and entities

The ASO process is a complex and time consuming operation and a special purpose entity (e.g. Task Force, Committee or separate company) may coordinate the overall process and planning. The ASO process is a joint effort between the legislator, regulator(s), content aggregators (i.e. public and commercial broadcasters), distributors (i.e. broadcast network operators for all platforms), device creators (i.e. receiver equipment producers and retailers) and end-consumer associations.

This section is split into:

1. Key success factors for ASO: a successful ASO has its fundamentals in its organization; four organizational success factors to be taken into account;
2. Organizational ASO structures and entities: example ASO organizations;
3. ASO costs and support: main categories of ASO associated costs and how government can provide (financial) support;
4. Implementation guidelines.

2.15.1 Key success factors for ASO

No single recipe exists for a successful ASO as the local circumstances are different in each country. However, some common key success factors have been identified in countries where the ASO have been completed or in those markets that have begun the process. The following success factors have been incorporated into the ASO organizations and plans of many countries¹⁹¹:

1. Cooperation and coordination across the value chain;
2. Strong leadership;
3. Effective communication strategy (see also section 2.18);
4. Sufficient financial resources for the ASO organization.

Cooperation and coordination across the value chain

A successful ASO will require the active participation of, and coordination between the government and the television industry. Only by working together, the broadcast industry can ensure a minimum amount of disruption for viewers. With reference to the value chain as presented in section 1.2, the following functions/entities will need to support and participate in the ASO initiative:

1. Government/the regulator: key tasks and duties include:
 - a. Administrations need to decide and politically agree the basic ASO transition model (see previous section 2.14)

¹⁹¹ See also DigiTAG report “Analogue switch-off: Learning from experience in Europe”, 2008.

- b. Administrations need to take political decisions, setting a firm analogue switch-off timetable (in line with the selected ASO model, either phased or national);
 - c. The regulator should manage and execute any additional frequency coordination efforts to free-up (temporarily) spectrum (very often with neighbouring countries)¹⁹²;
 - d. The regulator needs to assign the required DTTB media and frequency licences (to the PSB and commercial parties, either a service provider or individual broadcasters);
 - e. The regulator might need to take away any obstacles in the acquisition of building permits (in case new sites or temporarily transmitter sites have to be erected quickly) or any other permits
2. Content creators: although not heavily involved they should:
 - a. Be informed about the ASO timetable and the impact on the production chain;
 - b. Come to agreement about the content rights for PSB services (or any other service transitioned from the analogue platform) to the DTTB platform;
 3. Content aggregators (PSB) and commercial broadcasters): key tasks and duties include:
 - a. Broadcasters need to ensure that viewers are informed (by incorporating ASO items in their programming);
 - b. Broadcasters need to ensure the continuation of receiving their television services (by delivering their television feeds to the DTTB head-end and, in case distribution is outsourced, agree distribution with the broadcast network operator);
 4. Other (DTTB) Multiplex operator/Service providers: analogue terrestrial viewers do not necessarily have to migrate to the new DTTB platform, they can also switch to other platforms that also provide the affected programming (such as satellite, cable or IPTV). Also, it is possible that a commercial DTTB service provider is already operating a service in the market. Hence all service providers who offer an alternative for the affected viewer need to:
 - a. Make sure that the marketing around analogue switch-off does not favour the terrestrial platform but instead informs viewers about opportunities for television reception across all platforms. They can supply useful information to viewers while also showcasing their support for analogue switch-off;
 - b. In case of a DTTB service provider already in operation, this provider should also cooperate in the coordination of the additional DTTB network(s) roll-out as site and other facilities might have to be shared. Possibly also some frequencies have to be exchanged or re-farmed;
 5. Content distributors (DTTB network operator): key task and duties include:
 - a. Network operators need to make necessary upgrades to their equipment to allow for digital broadcasting (including also erecting new sites or changing masts);
 - b. Network operators may need to help in detailing the network planning and the associated roll-out planning (as the regulator very often has only got very rudimentary network planning), serving as input for the government/regulator to set the switch-off timetable¹⁹³.

¹⁹² See also section 2.3 "ITU-R Regulations" for the GE06 Plan procedures for taking frequencies in use (as bi-lateral coordination may be required) or altering entries in the Plan.

¹⁹³ This might also include providing various ASO scenarios and timetables, for the government/regulator to select from or to decide their decision upon.

6. Device creators (equipment manufacturers): key task and duties include:
 - a. Manufacturers need to supply sufficient quantities of DTTB receivers in regions (either set-top-boxes, IDTVs and any other DTTB receivers);
 - b. In case of pay-tv services (either in collaboration with the PSB or not), the manufacturers might need to embed the right/required Conditional Access System in the set-top-box¹⁹⁴;
 - c. Manufacturers may be required to certify compliancy with any set standard (see section 2.1) and to provide proper or specific labelling on receiver devices to better inform the viewers;
7. Viewers: last but not least, the affected viewers should be involved in the planning and execution of the ASO process. An early commitment from consumer associations could help facilitating the ASO process and avoid unwanted negative publicity during or after the ASO. For most they need to:
 - a. Be informed about the impact on viewers of the ASO changes;
 - b. Help setting an acceptable ASO timetable;
 - c. Help informing their members (i.e. the viewers) about those ASO changes and help them selecting the best digital alternative for them (in impartial way).

Strong leadership

"The decision to stop analogue television services needs strong leadership to affirm when and how analogue switch-off will proceed and define a clear roadmap. This can provide the necessary credibility to the process and help avoid unnecessary delays. While the government can provide such leadership, it is best to establish a switchover commission or separate organizational entity to do so.

Most countries have set-up an organization to steer the analogue switch-off process. Such an organization should bring together the above mentioned functions/entities of the broadcast industry.

To succeed, the organization must be given a clear mandate by government¹⁹⁵ and sufficient funding to carry out its work"

Effective communications strategy

As identified by the European Commission's report "on accelerating the transition from analogue to digital broadcasting"¹⁹⁶ next to the success factor of broadcaster cooperation (see previous section), an information strategy to inform the consumer was identified.

As discussed in section 2.14.2, the ASO duration is mainly driven by the uptake of the new DTTB service and the viewers need to know, first of all:

1. Why an ASO process is planned and what the benefits will be;
2. The planning of the ASO: the date when analogue terrestrial television will end (in which area) and the availability of the DTTB platform/services;
3. Alternative platforms and programme availability on these other (digital) platform(s);
4. Equipment needed, and associated costs, to receive digital television programmes.

¹⁹⁴ Please note that embedding Conditional Access Systems in IDTVs is very often not allowed. In this way pay-tv operators would be in the position to abuse their position by locking-in the viewer.

¹⁹⁵ For example on the website of the Norwegian ASO commission, the Ministerial mandate is published. See www.ntv.no/.

¹⁹⁶ Commission of The European Communities' report no. SEC (2005)661, Brussels, 24 May 2005, p5.

In order to prepare for analogue switch-off, viewers will need to have access to this information in a timely fashion¹⁹⁷.

Sufficient financial resources for the ASO organization

"Depending on the size of the operation and the selected transition model, the cost of digital switchover will vary among countries. However as a minimum, sufficient resources must be available to support communication and marketing activities of the ASO organization in order to help prepare the (vulnerable segments of the) population.

Next to making funds available for the ASO organization the government's responsibility may be defined to cover other associated costs as well. Resources can also be used to provide incentives to accelerate the digital switchover process. Subsidies can be distributed to viewers to help offset the cost of DTTB receivers, or to help develop appealing content for the DTTB platform"

2.15.2 Organizational ASO structures and entities

In most countries a special organizational entity is established to manage the ASO process¹⁹⁸. The entities can range from an 'ASO Task Force' or 'ASO Commission' (led by government and/or regulator representatives) to a separate organization with daily management (and supervised by the government and/or the regulator).

Key in all these organizational entities is that all involved parties in the value chain are represented in this organization (see above paragraph) and are mandated. Also, they are all organized as a project, with clearly defined objectives, planning and fixed termination date.

In the figure below an example organizational structure is provided. The scope of the organization is mainly driven by the government's scope of assumed responsibilities. For example whether the government compensates viewers in their digital receiver equipment purchase costs or provides separate communication websites and channels, next to the broadcasters channels (see also section 2.15.3)¹⁹⁹.

The number of involved staff per included function is mainly driven by the size of the ASO operations and the selected ASO transmission model (see previous paragraph).

In the table below a European overview is provided of the ASO organizations in each country. For more details on these organizations please refer to their website²⁰⁰.

¹⁹⁷ For more detailed information on ASO communication, see section 2.18.

¹⁹⁸ For more detailed information on ASO associated costs, see section 2.15.3.

¹⁹⁹ For a full scope ASO organization see "The Digital Switchover Programme: Programme Structure, Ofcom and Digital UK, March 2009. Available on www.digitaluk.co.uk.

²⁰⁰ From DigiTAG report: "Analogue switch-off: Learning from experience in Europe", 2008.

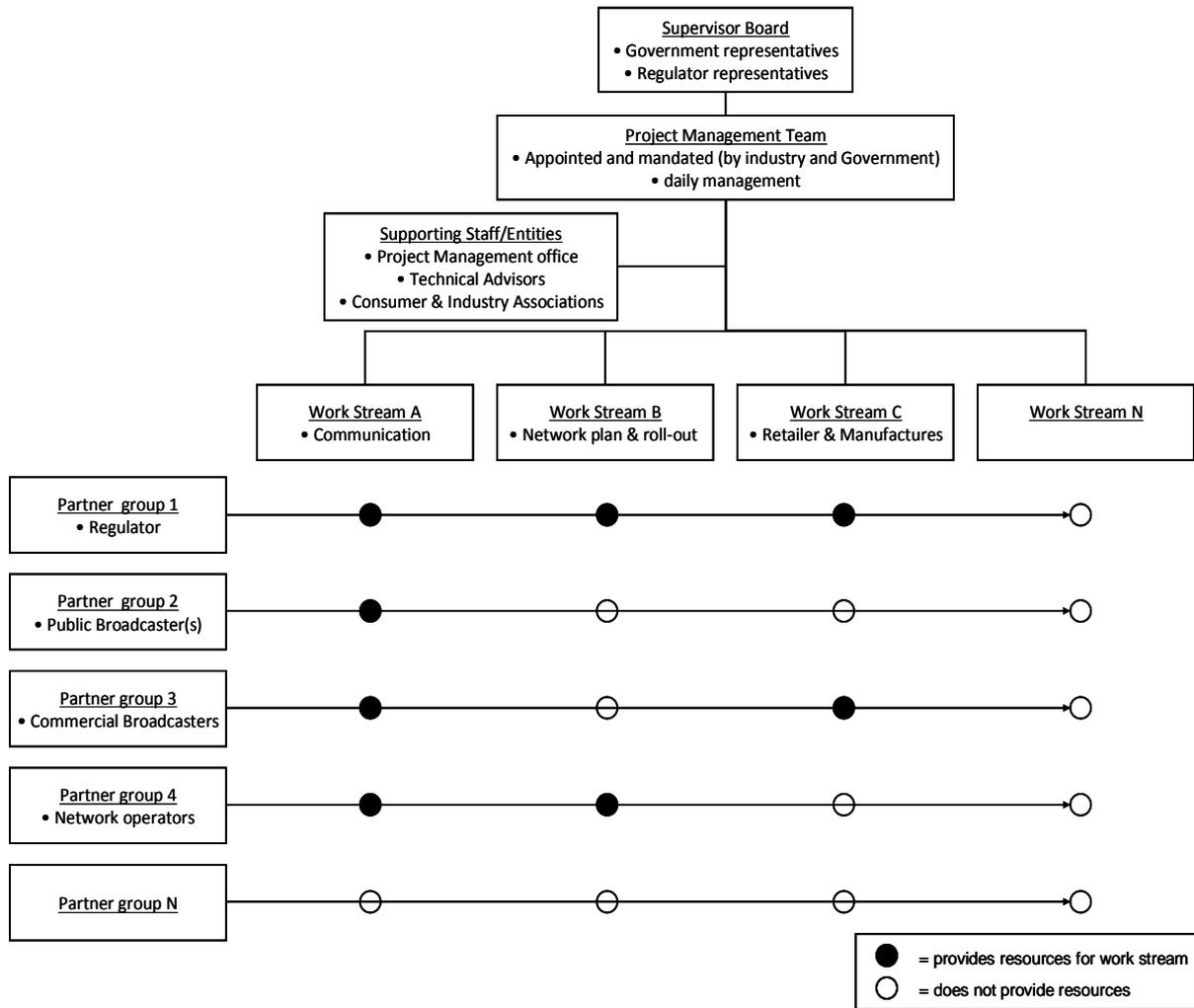


Figure 2.15.1: An example ASO organizational model

Table 2.15.1: National ASO organizations

Country	ASO organization	Website
Estonia	Committee for DTV Transition	n/a
France	France Télé Numérique	n/a
Germany	Ueberallfernsehen	www.ueberallfernsehen.de
Italy	Italia Digitale	n/a
Netherlands	Signaalopdigitaal	n/a
Norway	NTV	www.ntv.no/
Sweden	Digital Switchover Commission	www.digitaltvoergangen.se
United Kingdom	Digital UK	www.digitaluk.co.uk
United States	NTIA	www.dtv.gov

2.15.3 ASO costs and support

As mentioned before, the ASO process is a government led process because it sets a mandatory switch-off date. Consequently, the next question is what the government considers to be its responsibility in steering the process and resolving any (financial) hurdles. The following main categories of ASO associated costs/activities are listed (in decreasing magnitude):

1. Costs for migrating viewers to digital, including (in increasing cost levels):
 - a. (Only financially) Compensating consumer costs for purchasing a digital receiver;
 - b. Helping to install new digital receiver equipment (possibly limited to a selected group of people with special needs, like elderly or disabled people);
2. Transmitter network migration efforts (for changing the transmitter networks)²⁰¹;
3. Re-farming of spectrum efforts and compensations²⁰²;
4. Simulcast period for PSB services (the costs of running two networks in parallel during the simulcast period)²⁰³;
5. Managing the ASO process and informing all relevant parties, including:
 - a. Consumers/viewers;
 - b. Regional/local governments/councils;
 - c. Equipment manufacturers and retailers;
 - d. Property managers (of multi dwelling units and shared aerials)
6. Setting mandatory certification and labelling of receiver equipment (to safeguard proper functioning and avoid scams/frauds)²⁰⁴;
7. Cost for resolving any DTTB interference: in some countries it might be possible that the DTTB frequencies are in use by cable companies. The introduction of the DTTB service might cause interference and viewers need to be helped to resolve these problems (by sending the affected viewers other cable connectors).

The table below provides an overview of the relative impact on the size of the ASO organization and budget (necessary financial resources) when the government takes on the responsibility of the above mentioned ASO associated costs/activities.

²⁰¹ Migration costs are separate from simulcast costs as these are defined as running two (or more) networks in parallel (during the simulcast period). These migration costs are typically incurred by the broadcast network operator and include cost such as design and engineering costs and temporary facilities and sites.

²⁰² The ASO may require existing spectrum users to change their frequencies. Very often retuning and migration costs are involved and these users will request compensation.

²⁰³ Explicitly excluding the costs of the running the DTTB network after the ASO. Depending on the ambitions of the Public Broadcaster (running many additional channels or only the analogue channels) this might be more (in the case where several multiplexes will be put into operations) or less (in the case where part of a multiplex will be utilized).

²⁰⁴ The increased proliferation of television sets with an integrated digital tuner (IDTVs) can ease the digital conversion task. However, consumer aid might be required to limit confusion. France and Italy have mandated digital tuners in television sets. The United States has made digital tuner mandating a cornerstone of its digital transition policy. Since March 2007, manufacturers have been obliged to include a digital tuner in all television sets.

Table 2.15.2: ASO activities and impact on ASO organization and budget

No.	ASO Activity	ASO organization function (functions can mentioned multiple times)	Relative cost/ budget indication
1	Migrating viewers to digital	Logistic function for administrating and handing-out vouchers Logistic function for aerial retuning and installation Contact centre function for (technical) assistance Consumer communication function Media and Public Affairs function	++++
2	Transmitter network migration efforts	Network planning function	+
3	Re-farming of spectrum efforts and compensations	Network planning function	++
4	Simulcast period for PSB services	Broadcast network roll-out monitoring function	+++
5	Managing the ASO process	Broadcast network roll-out monitoring function Market monitoring and research function Consumer communication function Industry communication functions	+
6	Setting mandatory certification and labelling	Industry liaisons function	+
7	Cost for resolving any DTTB interference	Logistic function for handing-out connectors Contact centre function	+

The table above shows that the largest cost will be the compensation of the viewers (depending on the number of television viewers). For example, in the US, the government has set aside nearly USD 1 billion²⁰⁵, and in the UK, the budget was estimated to be GBP 603 million for providing set-top-boxes

²⁰⁵

Under the 2005 Digital Transition and Public Safety Act, an initial budget was set aside of USD 890 million for set-top-boxes/converters (22 250 000 coupons of USD 40 each) and USD 100 million for administrative set-up. To assist consumers through the conversion, the National Telecommunications and Information Administration (NTIA) handled requests from households for up to two USD 40 coupons for digital-to-analogue converter boxes. By January 2009, the maximum budget of 33 500 000 coupons (i.e. USD 1.34 billion) was exceeded and the NTIA placed coupon requests on a waiting list. With the February 2009 “DTV Delay Act” the initial ASO date of February 2009 was postponed to the 16th of June 2009 allowing more households to apply for coupons. Under the American Recovery and Reinvestment Act of February 2009, an additional USD 650 million was inserted in the DTV transition assistance.

and installation aid²⁰⁶. However, as the cost of DTTB set-top boxes continues to drop, they become more affordable and financial aid might not be necessary.

In the paragraphs below some key considerations on this financial support to viewers are included.

How many households will need help with the digital transition should be assessed country by country. For some, financial assistance will be necessary to enable the purchase of equipment allowing for the reception of digital services. For others, physical assistance will be necessary to help set-up new digital equipment²⁰⁷. In general two models have been applied:

1. Help and assistance for selected groups;
2. Universal help and assistance.

Selected groups

"Deciding who should benefit from this help has been addressed by some national governments. This can be a delicate and political sensitive process. In the United Kingdom, the Digital Switchover Help Scheme has been set-up to provide an estimated 7 million households with support. Such support includes equipment to convert one television set, help with installation and an aerial replacement if deemed necessary. Households with at least one member that is aged 75 years or over or has a significant disability are also eligible for the programme.

In France, the government has set aside funding for digital switchover projects. This ensures that all households that are exonerated from paying the television licence fee, based on age or income levels, will receive financial support. Furthermore, support is also available to those households that can only access television services using the analogue terrestrial platform. Aid may also be granted to households located in border regions should it be necessary to speed the analogue switch-off process"

In some countries, financial aid has been handled through social services (e.g. Sweden and Germany). In Berlin, approximately 6000 set-top boxes were distributed to low-income families who relied on the terrestrial platform for television access but could not afford a DTTB receiver.

Universal help

"In some countries, financial support has been made available to households regardless of income levels or need, like in the United States. Households, regardless of their television reception or

²⁰⁶ Under the Digital Switchover Help Scheme, the government ring fenced 3.5% of the UK's television licence fee income, totalling to GBP 603 million. The Scheme has clear stipulations on the people eligible for aid. The Scheme estimated in its central case that 4.7 million households would receive a set-top-box (with varying degrees of assistance) in the period 2007-2013. In the June 2009 "Digital Britain" report, it was expected however that the Scheme will under spend by GBP 200 million. For more detailed information on the Digital Switchover Help Scheme budget, see Appendix B and C of the summary published under www.digitaltelevision.gov.uk/pdf_documents/publications/2006/Summary_DSHS.pdf.

For the "Digital Britain" report of June 2009 see www.culture.gov.uk/what_we_do/broadcasting/6216.aspx.

²⁰⁷ This may be dependent on the state of the existing rooftop antenna (eroded/tilted or not) and the type of network. For example, an in-door network might not be dependent on existing roof-top antennas. Also, nowadays set-top-boxes are more and more 'plug and play' devices.

income, can apply for up to two coupons worth USD 40 each to use towards the purchase of a digital set-top box. In Europe, very few countries have granted similar subsidies to households²⁰⁸.

2.15.4 Implementation guidelines

The following guidance can be given in setting up the ASO organization:

1. Include the identified ASO success factors in your organization design, by:
 - a. Cooperation and coordination across the value chain: Involving all parties of the broadcast industry and organized in a project management structure
 - b. Strong leadership: Providing the project management leadership with a clear and strong mandate (the latter, by providing sufficient funds for the set tasks);
 - c. Effective communication strategy: Having a communication function, as a bare minimum, in the project management organization;
 - d. Sufficient financial resources: Having sufficient resources available to support the communication and marketing activities of the ASO organization and any other set tasks for the ASO organization.
2. Apply project management principles for the ASO organization, including:
 - a. Appointing project management leadership;
 - b. Defining the scope (set tasks, out-of-scope activities/tasks and project end-date) and project plan;
 - c. Establishing a project management office (for managing the day-to-day planning)
 - d. Defining clear Work Streams with defined milestones and deliverables;
 - e. Defining task and responsibilities for all the involved organizations.
3. Apply a modest organization model (i.e. a temporarily 'ASO Commission' or 'ASO Task Force' who convene regularly under the supervision of government representatives) in countries where:
 - a. The terrestrial television platform is small²⁰⁹ and/or the number of PSB services is limited (e.g. one or two national channels and no regional programming), and;
 - b. The selected ASO transition model is a nationwide switch off approach or an ASO without a simulcast period;
 - c. The assumed ASO tasks (i.e. the government's responsibilities) are limited and do not include financial or physical assistance for viewers migrating to digital.
4. In the case where financial resources are limited, limit the scope of the governments responsibilities to managing the ASO process, as a bare minimum (see activity 5 in Table 2.12.1). However, make sure this approach is legally backed-up (e.g. not compensating viewers or spectrum re-farming costs for existing broadcasters)
5. However a limited scope of ASO activities might hamper the DTTB uptake seriously as people might not be able to afford digital receivers. Alternatively, the government can make use of any commercial parties interested in rolling out DTTB services. Preferably

²⁰⁸ The European Commission has been vigilant in ensuring that its rules governing competition and platform neutrality have been observed. Only subsidies that can be used across all television platforms are permitted.

²⁰⁹ However, the impact of the ASO should not be underestimated. The number of terrestrial viewers may be limited in absolute numbers but the relative proportion might be very high. This might be the case for several African countries. In addition, the alternative providers may be limited too. For example in most African countries only one alternative is available: a pay-tv satellite service (provided by two key players DSTV in East / Anglophone Africa and Canal+ in West / Francophone).

such a party would roll-out the DTTB service in close collaboration with the Public Broadcaster so that infrastructure and other facilities can be shared. In this way, the government costs for ASO can be limited. Such a market driven approach should include as a minimum:

- a. Issuing a DTTB licence to a commercial party with defined obligations to roll-out a DTTB network;
- b. Prescribing collaboration with the PSB for a joint network roll-out (this could include also sharing multiplex capacity across all available multiplexes)²¹⁰;
- c. Setting 'must carry' rules for the DTTB licence holder for carrying existing analogue television PSB channels;
- d. Stipulating the provision of relatively cheap DTTB receivers (to be best assessed in a public tender procedure);
- e. Providing assistance to the DTTB licence holder for rolling out the DTTB network, including help for getting access to sites and acquiring building permits (or any other permits).

2.16 ASO planning and milestones

In this section the national ASO planning is detailed and it includes the following paragraphs:

1. Outlining the ASO planning: when and where to begin the process and how long the entire operation should last;
2. Overall ASO planning set-up: including the overall programme structure and the key result paths in a an ASO plan;
3. ASO planning phases (in a phased approach, see section 2.14.3): the three phases and their key milestones;
4. Implementation guidelines on planning the ASO.

2.16.1 Outlining the ASO planning

When outlining the ASO planning three questions should be addressed:

1. When should we start the ASO process?, and;
2. Where should we start²¹¹?, and;
3. What duration should the ASO operation have?

When to begin the process

There is no clear marker that will indicate to governments when to start planning the ASO process as there are no mandatory deadlines. However, there are the following time constraints or pressure factors, forcing governments to act:

1. Market parties are interested in providing DTTB services and need to have clarity about the number of multiplexes available and the licensing regime. Hence, the government needs to provide or update the National Spectrum Plan to include the licensing of DTTB services and ASO plan. The latter will be necessary as the DTTB licence duration is likely to

²¹⁰ Preferably in a statistical multiplex mode as this would be most spectrum/capacity efficient.

²¹¹ Please note that this is only a relevant question in case the ASO transmission model has a phased approach to analogue switch-off (see section 2.14.3).

- cover the analogue switch-off date (of 2015 as the general date and 2020 for some countries Band III, see GE06 Plan)²¹²;
2. DTTB platform has only been partly launched (e.g. only to carry the PSB services) and market parties are interested in providing DTTB services and the introduction of such services are only possible when analogue spectrum is freed-up;
 3. The 'digital dividend' discussion is putting increasing pressure on the government to act. Early planning will help to safeguard the future of terrestrial television and to prepare a profound plan to facilitate as many users as possible;
 4. Neighbouring countries may launch DTTB already and might ask for spectrum changes (see also section 2.3). In such a situation the neighbouring countries will be the 'asking' parties and not being prepared may lead to inefficient spectrum usage in the own territory;
 5. Analogue terrestrial equipment (transmitters and receivers), inevitably, will become obsolete and costs for maintaining the terrestrial networks will become unacceptably high. In addition, viewers/consumers will be deprived from the digital opportunities DTTB platforms provide;
 6. The Public Broadcaster would either like to introduce more services or would like to see its transmission costs lowered (especially in the case of one or two SDTV channels and when calculated per programme channel).

Where to begin the process

Determining where to begin the analogue switch-off process in a phased ASO approach varies between countries. Several considerations come into play when selecting the best area to start, including:

1. Assessed risk profile: Governments might adopt a risk-averse ASO approach that limits the impact of any failures in the ASO process;
2. Required speed of the ASO process: Governments like to see the introduction of the DTTB platform in high profile areas so as to provide an example for the rest of the country;
3. Technical considerations or spectrum availability: In some areas infrastructure might not be available to facilitate new DTTB equipment or in some areas of the DTTB spectrum is not available (e.g. because it will require bi-lateral negotiations with neighbouring countries or is in use by other national users)

However, based on the various considerations, three basic options can be identified:

1. *Starting in highly populated areas:* Some countries, such as Germany, have begun the process in large urban areas with high population densities but few transmitters. This option does not necessitate extensive planning to simultaneously switch off several transmitters and corresponding gap-fillers in a coordinated way. However, it can be fraught with risk given that many people, often numbered in millions, are affected by a process that has not been tested elsewhere;
2. *Starting in rural areas:* Other countries, especially those with a high reliance on the terrestrial television platform, have opted to begin the process in areas with low population densities. By doing so, the process can be trialled several times and experience built up before affecting large population centres. This has been the case in Sweden and is part of the planning approach taken for the United Kingdom.

²¹² Please note that the GE06 Plan does not include switch-off dates but rather dates when the analogue is no longer protected.

3. *Starting in simulcast or test areas:* In France, analogue switch-off is likely to begin in the areas where DTTB services were first launched and thus have had the longest experience with the service. Although exceptions may arise in border regions due to international frequency coordination issues. In some countries, analogue switch-off has been tested in pilot areas. Spain has trialed analogue switch-off in Soria (Castile and León). In Italy, pilots have taken place in Sardinia and Val d'Aoste.

How long should the process last?

In a phase approach the key question is really how much time is the viewer allowed to benefit from the simulcast period (i.e. can have the opportunity to try the DTTB service and have the opportunity to fall back to the analogue platform). This period can range from a couple of months to several years²¹³. Although this is deemed to be a political decision (see section 2.14), the frequency availability (i.e. the network planning) will determine the range of possibilities. In practice the government will set minimum criteria and the network planning will provide the exact details.

2.16.2 Overall ASO planning set-up

The scope (i.e. the number of Work Streams or Result Paths) of the ASO planning is dependent on the assumed responsibilities by the government. Also the Work Streams of the planning are reflected in the ASO organization (see section 2.15.3).

The ASO planning is focused on the delivery of a series of regional switchover projects, in the case of a phased approach. However, there may be planning matters that cut across multiple Work Streams or multiple regional projects (for example, international co-ordination of frequencies). Work Streams may also have national projects (for example, a national communications campaign and contact centre management). In other words, activities and milestones from each Work Stream will be interdependent on the work carried out in other Work Streams, increasing the complexity of the overall planning.

In a full scale project planning the following Work Streams or Result Paths can be identified:

1. *Communications:* To ensure that analogue television viewers are smoothly converted to digital TV by creating awareness, providing support and cultivating the right climate for switchover. Including sub-result paths for:
 - a. Contact centre management: To provide timely, relevant and platform neutral advice about switchover to consumers and trade audiences, including technical advice, via websites and contact centre;
 - b. Multi dwelling units and shared aerials: To ensure that owners, managers, tenants and residents of all properties, where there is a communal TV aerial system or those receiving television services outside of the home are able to continue to receive services after switchover;
 - c. Media and Public Affairs: To manage relationships with key political and media stakeholders, nationally and regionally. To work with the voluntary sector and local government to reach out to the hard to reach and potentially vulnerable. To secure a common approach to consumer protection across all relevant agencies.
2. *Device producers and delivery :* To supply the information and resources to the supply chain to enable them to supply the right product or service, in the right quantity at the right time, in the right place, to meet 100 per cent of the required consumer demand and

²¹³ For some country examples see Digitag report "Analogue switch-off: Learning from experience in Europe", 2008.

satisfy the demand for related services as a result of digital switchover. This Work Stream may also include certification and labelling;

3. *Network plan and roll-out*: To plan and co-ordinate the conversion of the terrestrial transmitter network to digital within the timeframe agreed with the government. Including network planning and network roll-out monitoring activities. In a phase ASO approach this Work Stream might include several sub-Work Streams for each separate switch-off region;
4. *Consumer and Market monitoring*: To support the ASO programme by providing consumer and market information which can be used to monitor the progress of the ASO process, inform communications strategies, and assist the equipment supply chain's logistics planning;
5. *Regulations and Licensing*: To ensure that the programme is informed and engaged where appropriate in regulatory activities including licensing; spectrum management; international co-ordination, research and policy development in local areas relating to digital switchover (such as granting building and environmental permits).
6. *Financial and aerial installation support*: To manage the financial administration and the logistic chain for either providing compensation vouchers or physical assistance for installing or retuning receiver equipment.

2.16.3 ASO planning phases

The overall ASO planning in a phased approach might be a complex 'puzzle', but at the level of a regional switch-off project (in the Work Stream 'Network plan and roll-out'). Three phases can be identified:

1. Phase 1: The introduction of DTTB services
2. Phase 2: The simulcast period and the preparation of the Analogue switch-off;
3. Phase 3: The analogue switch-off.

Phase 1: The introduction of DTTB services

In this phase of the planning the DTTB network will be rolled-out (in the region) and digital transmitters will be installed in either existing or new sites (for resolving any compatibility issues see section 2.17). For the actual network planning, please refer to section 4.3.

It is important that in this phase of the planning:

1. The National Spectrum Plan should be updated and the DTTB licensing should be completed;
2. No further analogue terrestrial television frequency licences should be issued and possibly existing analogue television licences should be revised (to make it possible to terminate the licence);
3. Existing regulations have been reviewed to ensure that they reflect the implications of digital transmissions;
4. Current analogue broadcasters are being informed that they will be allowed to continue with analogue transmissions up to analogue broadcasting switch-off date;
5. The start-up phase of digital broadcasting will be closely monitored in terms of coverage, reception quality and interference in general and in particular in the cable reception.

Phase 2: The simulcast period and the preparation of the analogue switch-off

In this phase of the planning the viewers in the affected region, are being actively informed about the switch-off date. It is important to note that Phase 2 might overlap with Phase 1, i.e. already before the DTTB network is being rolled-out or completed, the general public is being informed about the switch-off date.

It is important that in this phase of the planning:

1. Receivers are available and distributed in the right amounts and locations;
2. Postcode or address 'checker' (for affected viewers to check if they are affected and possible what type of receiver is best – rooftop aerial or perhaps an indoor aerial might be sufficient) and websites are tested and operational;
3. Contact centres are tested and ready to be operational;
4. In case of financial compensation and installation aid, the logistics chains for these services are tested and operational;
5. Broadcasters will include in their programming ASO information and actively promote switch-over to digital.

Phase 3: Analogue switch-off

This stage will involve the switching off of all analogue terrestrial broadcasts in the region. Ideally before analogue switch-off all affected viewers have upgraded their TV sets to digital by using a set-top-box or IDTV. All current analogue terrestrial broadcasters will need to have migrated to a digital platform.

It is important that in this phase of the planning:

1. The affected viewers are being monitored (by having call centres on stand-by) and research is carried out to identify any problems and learning points for the next switch-off region. Especially after the first region some time should be allowed before switch-off starts in the next region in order to incorporate the lessons learned;
2. Analogue equipment is dismantled, allowing re-use of transmitter infrastructure;
3. Re-engineering of digital transmitters sites to remove any analogue restriction that might have existed in order to protect analogue TV.

2.16.4 Implementation guidelines

The following guidance can be provided when planning the ASO process:

1. Although there are no clear markers for commencing any ASO process, it is best to begin ASO planning early because:
 - a. The benefits of analogue switch-off will be reaped early (see section 2.14.1)²¹⁴;
 - b. Early planning will put any country in the requesting (leading) role when bi-lateral coordination with neighbouring countries becomes necessary;
 - c. The longer the preparation time, the better the plan and the more spectrum will be available for broadcasting services (and any other services);
 - d. Early planning will allow time for testing migration scenarios, DTTB services and any other new broadcast service (e.g. mobile television);
2. Plan the ASO duration to be as short as possible: the shorter the process the less costs will be involved for the simulcast period and running the ASO organization. The minimum set simulcast duration will determine to a great extent the ASO duration;
3. "It is best to avoid analogue switch-off during the winter and summer months (applicable to countries with such a seasonal pattern). Technically, it can be very difficult to work on transmission equipment in the winter, thus making it difficult to roll-out DTTB services. For viewers, switch-off should be avoided during the summer when many go on holidays

²¹⁴ See section 2.14.2 and Commission of The European Communities' report no. SEC (2005)661, Brussels, 24 May 2005, p5-7.

and are less likely to receive publicity information and may not prepare properly. Choosing the correct day of the week is also important. Weekends, when viewers are more likely to watch television during the day, should be avoided. In addition, as many viewers will wait until the last minute to buy a DTTB receiver, they will not have much time to make their purchase should shops be closed on Sundays"

4. The calendar for political and sporting events will also need to be taken into consideration too. Switch-off during nightly hours is normally the best hour;
5. Plan the ASO phases on the basis of the network planning (which is very often based on the spectrum availability) and technical possibilities, taken into account the specific weather conditions. In most European countries, the technical possibilities to change antennas in the winter period is limited. However, for some African countries this might be less of a problem;
6. As a next step, plan the communication 'around' the technical network roll-out planning. Communication can start as early as 2.5 to 3 years ahead of switch-off to provide the public with general information on the ASO process. Normally 6 months to one year before the analogue switch-off date the affected viewers are informed about the actual switch-off date in (a specific region);
7. Plan the communication process on the basis of the time necessary to ensure that viewers no longer depend on the analogue terrestrial platform.
8. Preferably, decide the allocation of the 'digital dividend' (see section 2.10) before any ASO plan is drafted because:
 - a. Spectrum re-farming, due to alternative allocation of the 'digital dividend' might either interfere in the ASO planning or require re-planning after the ASO process and broadcasters might be very reluctant to cooperate (again);
 - b. For a solid network planning the frequency availability should be determined, otherwise this might increase the number of scenarios when planning the ASO (during the planning phase of the ASO);
 - c. A carefully drafted ASO plan may create some leverage for negotiating spectrum for broadcast services, rather than non-broadcasting applications.

2.17 Infrastructure and spectrum compatibility

Infrastructure and spectrum compatibility or, more likely, incompatibility, happens in the case of having:

1. A simulcast period, having both a digital and analogue service in the same geographical areas (as mention in section 2.14.3 it is possible to have no simulcast period and to switch-over from one hour to the other), *and*;
2. The analogue and digital plan are not compatible (see GE06), i.e. there is a lack of digital spectrum in a certain area, not necessarily the entire country. In some countries there might only be analogue terrestrial television service in Band I/III and non in Band IV/V²¹⁵.

This situation of infrastructure and spectrum incompatibility is likely to occur in the ASO process and should be addressed in the network planning prior to actual execution of the ASO process.

This section is organized in the following parts:

1. Scoping incompatibility: where can incompatibility occur;

²¹⁵

Please note that in some countries non-broadcasting services might be operational in Band IV/V.

2. Implementation guidelines for resolving incompatibility issues.

2.17.1 Scoping incompatibility

Incompatibility can happen in both the transmitter infrastructure as well as in the available spectrum. The main incompatibility issues have been listed below:

1. Infrastructure or network facilities, including:
 - a. Lack of antenna capacity, either:
 - i. In the case of antenna sharing (two or more service or frequencies on one antenna²¹⁶): the antenna has reached its maximum electrical load (especially occurring at the antenna connectors);
 - ii. In the case of a new antenna: the new antenna exceeds the maximum wind load capacity or there is a lack of physical space to place the new antenna²¹⁷;
 - b. Lack of floor space for placing extra transmitters: the additional floor space is technically limited by the maximum length of the feeder cables to the antennas. Longer cables may allow for the placing of the transmitters in containers outside the mast premises (depending also on local building regulations);
 - c. Lack of power/back-up/no-break facilities: the existing power supply facilities might have reached its maximum load. In addition, in rural areas, installing extra power units might be limited by fuel supply logistics;
 - d. Lack of cooling capacity: see above.
2. Spectrum, i.e. in (a limited) geographical area the digital and analogue frequencies cannot coexist. In such a case the network planner has to trade off two key aspects in its network design:
 - a. Continuation of the existing analogue services so as to avoid complaints due to degrading service and that, consequently, viewers will migrate to other available (competing) platforms;
 - b. The largest/best possible coverage for the digital service, ideally as close as possible to the analogue coverage (however 100 per cent is not possible otherwise there would not be an incompatibility problem). Without a good digital signal people cannot switch to the new DTTB service.

2.17.2 Implementation guidelines

For resolving the problems of infrastructure and spectrum incompatibility the following guidance can be provided:

1. For infrastructure incompatibility:
 - a. If there is a lack of antenna space: reduce the number of antenna layers and at the same time increase the transmitter power so as to compensate for the

²¹⁶ Even frequencies/services with different antenna diagrams can technically be facilitated on one single antenna system, a so called 'multi-pattern' antenna, however those antennas are relatively complex and expensive and sharing prices will be more complicated (as it has to be combined with mast sharing and there is little experience in the world about antenna sharing).

²¹⁷ In some cases the physical mast space might be technically available but the location has been reserved for future services. However, the Regulator should provide a site sharing regulatory framework and monitor any strategic blocking that may occur.

- reduced antenna gain²¹⁸. This option is becoming more and more (economically) feasible as transmitter prices continue to drop and the price differences between various power ranges are diminishing too. Conversely, a lack of floor space can be compensated by increasing antenna gain;
- b. If there is a lack of transmitter space: place transmitters in prefabricated containers adjacent to the existing premises of the transmitter tower. However, this may be limited by the maximum length of the feeder cable. Prefabricated container production has got the added benefit and convenience of enabling construction off-site (e.g. at the manufacturers premises) and therefore increasing production output;
 - c. If there is a lack of both floor space and antenna space: reduce both the transmitter power and the antenna gain and consequently lower the ERP. In order to compensate for this reduced ERP, the planner can either:
 - i. Increase the robustness of the signal. At the cost of having less services but having the same reception mode/system variant (in-door or roof-top reception) and associated coverage, or;
 - ii. Change the reception mode/system variant. At the cost of requiring a more sensitive receiver installation, possibly only achievable with a roof-top antenna, but having the same coverage and number of services;
 - iii. Reduce coverage. At the cost of having less viewers, but having the same number of channels and reception mode.
 - d. Lack of antenna space and capacity: split analogue antenna in two for respectively the analogue and digital services at the cost of accepting a reduced analogue service and having a larger digital transmitter²¹⁹. In this way the analogue service can be gradually degraded (by further reducing power), providing an incentive to viewers to switch to digital. In the ultimate case, a temporary site should be considered. The cost of having a temporary site can be minimized by reusing these temporary sites by moving them from region to region after each regional switch-off, which will need careful planning.
2. For spectrum incompatibility:
- a. Make a service trade-off between the number of affected analogue viewers and new digital viewers. This rationale could help the network planner in balancing service levels of both television services. This may be a complicated and delicate exercise when both services are not operated by the same service provider/operator. In some cases, this might be even a cross-border exercise when analogue services abroad are affected;
 - b. Assess the incompatibility problems first in the group of gap-fillers or small relay transmitters because:
 - i. The problems will be the largest in this group of transmitters (because there are so many of them), and;
 - ii. In this group of transmitters, the largest degree of 'engineering'/planning freedom as they are small and very often in shielded areas. Also these frequencies can be moved around the country to free-up spectrum elsewhere;

²¹⁸ The gain of the antenna is directly related to number of layers of the antenna, hence the physical length of the antenna and perhaps more importantly the wind load.

²¹⁹ Assuming the analogue antenna is made redundant by having a 'switch-able' top- and bottom-half.

- c. Assess site by site the possibilities for balancing the service levels of the digital and analogue service. The network planner can:
 - i. Improve the digital service by lowering the ERP of the analogue transmitter, increasing the robustness of the digital signal or reducing coverage of digital services;
 - ii. Allow more digital interference on analogue services. Check the level of interference which can be tolerated by the viewers. Planners should consider reducing analogue service levels, in order to provide an incentive for viewers to switch to digital.

2.18 ASO communication plan

This section focuses on communication to the *viewers* (identified as one the key success factors for ASO) and will address:

1. Communication strategy: including communication *messages* (related to the communication stage) and *target groups*;
2. Communication *tools*: the various communication means to reach the listed target groups;
3. Implementation guidelines.

2.18.1 Communication strategy and messages

Any communication strategy, informing the public at large, is based on several successive stages (i.e. creating awareness, understanding, etc.) The figure below presents the communication strategy for ASO transition and is based on these general communication stages, that span from creating ASO awareness through to measuring satisfaction after ASO completion²²⁰. The presented model can be used:

1. For designing communication messages in each stage of the ASO transition process;
2. For determining key performance indicators (and formulating survey questions) to monitoring ASO progress.

For some example communication messages that inform viewers on ASO (i.e. creating awareness and understanding of the ASO transition), please refer to the websites as included in Table 2.12.1.

As said in section 2.16, the speed of the ASO process is determined largely by the duration of the simulcast period which, in turn, is driven by the time viewers need to be informed and purchase a digital alternative. Also, setting a firm switch-off date is necessary as viewers tend to purchase a digital receiver just weeks prior to the deadline.

Hence, in a phased ASO approach, measuring 'readiness to convert' should be carefully planned, especially for the first region. The lessons learned from this first region could be used to set ASO dates for successive regions. However, it is not recommended to take a flexible approach and to convert to digital when viewers are 'ready'.

²²⁰ From the "Ofcom and Digital UK Switchover Tracker": Survey Switchover Progress Report – Q1 2008, available on the Digital UK website.

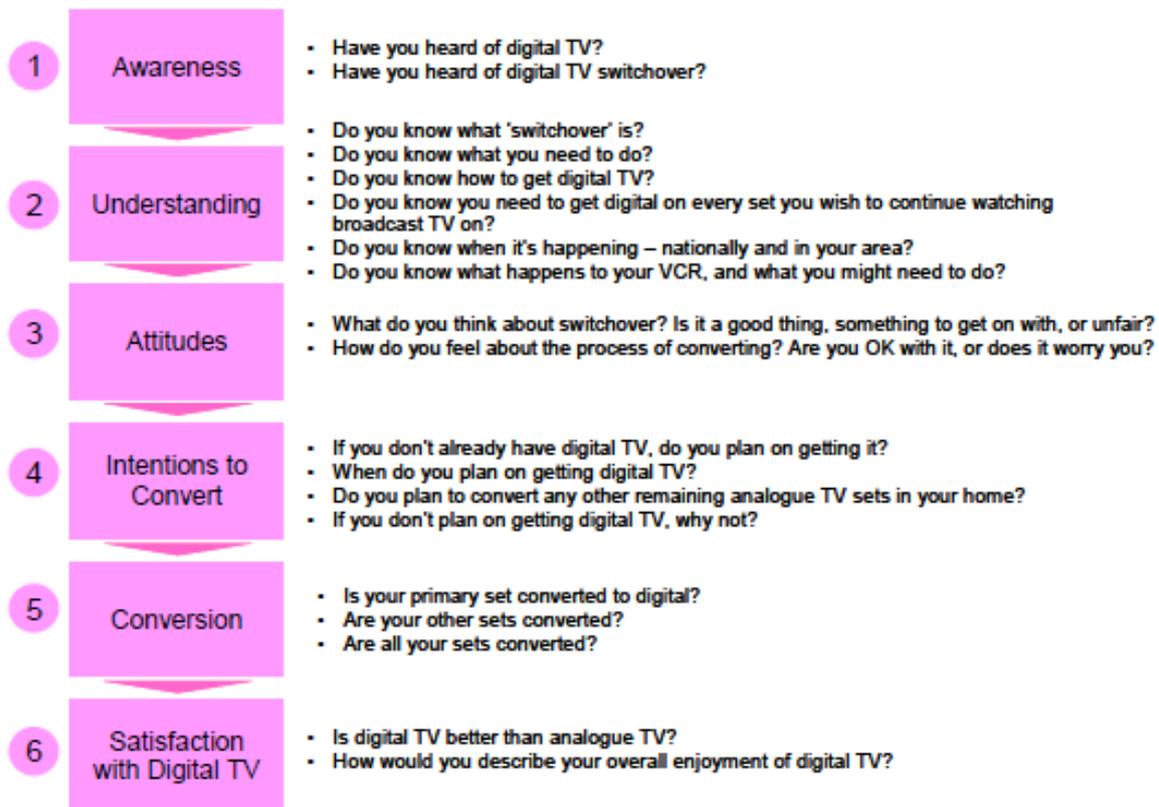


Figure 2.18.1: ASO communications model

In the ASO communication strategy, the various target groups have to be identified. Depending on the scope set for the ASO organization (see section 2.15), the following target groups can be listed:

1. Viewers, including various sub-groups and cross sections:
 - a. National or by-region (especially for a phased approach);
 - b. Rural/Urban (might have an impact on the communication tools available)
 - c. Social class, sex and age;
 - d. Disabled, elderly people and people with special needs;
 - e. Community centres and facilities (including town halls, libraries, prisons, hospitals, etc.);
 - f. Landlords of multi dwelling units/shared aerials (including flats, student halls, hotels, etc.)
2. Industry, including:
 - a. Manufacturers of digital receivers (and any related industry associations);
 - b. Retailers of digital receivers and/or digital television subscriptions (might include next to DTTB, satellite, cable or IPTV pay-tv subscriptions);
 - c. Certification/labelling institutions (for providing uniform/trustworthy certificates and labels);
 - d. Local governments (after informing them about ASO and its timetable, they should also be informed about providing necessary local permits);
 - e. Consumer associations.

Because a digital television set-top-box/converter only outputs one analogue television channel at the time, the introduction of DTTB poses a special problem for premises using a shared/central

antenna system. In the case of analogue reception, multi television sets could easily be connected to the central antenna system and be tuned to different programme channels independently from each other (because each television set already has got an in-built analogue tuner). With the introduction of DTTB, each analogue television set/screen will require a digital tuner and therefore a simple solution of connecting only one set-top-box to a central antenna system will not work.

Reaching out to property managers (for multi dwelling units or shared antenna systems) needs therefore special attention²²¹.

2.18.2 Communication tools

The most critical communication tool is the television channel(s) of the Public Service Broadcaster (PSB). As mentioned in section 2.15, the Public Broadcaster is a key member of the ASO team. The best way to reach the relevant viewers is through the television channels that will be affected: i.e. the analogue terrestrial PSB channels. Intensive communication on the PSB channels will be crucial for informing the viewers.

Although the Public Broadcaster' cooperation might be critical, it is not evident that the broadcaster will cooperate on its own accord. The Public Broadcaster might be reluctant to inform its viewers that the programming will be discontinued on the current platform because this could be perceived as a negative or unpleasant message, let alone the additional costs for the Public Broadcaster to free-up television capacity for these ASO messages²²². Hence, an ASO planner might have to incorporate adequate time to get the Public Broadcaster on board the ASO team.

National communication tools

"At a national level, general information on what will happen when and how to prepare must be made available to viewers. In some countries, a mascot has been used to serve as a guide for viewers in the analogue switch-off process such as the robot Digit Al seen in many of the advertisements in the United Kingdom.

Sweden initiated the use of the eye-catching pink colour in its branding of analogue switch-off. The colour was omnipresent in each region prior to analogue switch-off and used in all communications by the government, broadcasters and network operator. Pink was also the colour of the bus that travelled around the country providing viewers with information on digital switchover. Advertising in this colour was also used, including on a Stockholm underground train.

Other tools used in national communication campaigns have included:

1. Websites;
2. Advertisements in national (printed) media;
3. Direct mail²²³, and;
4. Call or contact centres.

Websites with information on digital switchover have been set up in virtual all 'ASO' countries such as Germany, United Kingdom, Norway, Finland and Sweden. Generally these website have been set

²²¹ See www.digitaluk.co.uk, "Business & Organisations".

²²² In the case that the Public Broadcaster is partly funded by advertising, this might even be a bigger hurdle as the ASO communication would eat-up valuable advertising space. Consequently, the Public Broadcaster might ask for additional funding.

²²³ Please note that direct mail is very often not addressed as the individual viewer's address is not known. In countries with high levels of analogue terrestrial television penetration this might not pose a large 'overshot'. In other countries, some extra effort might be required to locate viewers.

up by the group responsible for leading the process and in close cooperation with providers of information such as the broadcasters and network operators/planners. It is important that information between the websites of the ASO organization, network operators and broadcasters are synchronized.

Traffic can be large at these ASO websites and sufficient internet access capacity should be allocated. Also, depending on the 'media profile' of a specific country, reaching viewers through the (printed) media might prove to be important.

"For example in Sweden, the Digital Switchover Commission spent much time in interviews with journalists from newspapers, radio and television. Organized media activities included press conferences, accompanied visits to transmission towers, and breakfast sessions.

Generally, the ASO process generated positive media coverage. In the United Kingdom, Digital UK continually ensures that the media is informed of the analogue switch-off process by sending out press releases on a regular basis, generally based on research and studies on the status of the process.

Direct mail sent to households is a further means to inform viewers about the impending switch-off. Letters and brochures were sent to all television households in Sweden by the government and the network broadcast operator Teracom. Similarly, information was sent to television households in Whitehaven, in the United Kingdom and to all homes in Switzerland. In Germany, television viewers in Berlin received information prior to their switch-off".

Viewers have also sought out information from contact centres set up in Germany, Finland, Sweden, Switzerland and the United Kingdom. In Finland, the call centre responded to over 4000 calls, especially in the weekend following switch-off. The government in Finland also set up an information desk in Helsinki which helped 3000 visitors in the 3 day period that it was available. The call centres used in Andorra and the Netherlands did not report any increase in the number of calls received on the day or the days after switch-off.

Regional communication tools

In a phased ASO approach and in the case of Regional information can also include details on the type of services available after regional PSB channels information might differ per region and not be (all/only) available on the DTTB platform. Hence tailored information might be needed.

For example in the Netherlands, in certain regions, viewers were used to receiving more than one analogue regional PSB channel. However, on the DTTB platform the number of regional services was limited to one or two. In addition, viewers had to be informed that all regional PSB services were also available on satellite.

It is important to note that, should changes be made to the frequency channels used, following analogue switch-off (for example to free-up spectrum elsewhere, see also section 2.14.2), viewers will need to know how to re-scan their DTTB receivers. Most set-top-box receivers scan automatically, however this is either carried out when instructed manually or by rebooting the set-top-box. So it might be necessary to inform viewers to re-scan their digital receivers during the ASO process.

The same type of tools used for national communication can also be used for regional communication, including websites, advertising, direct mail and contact centres. However, using retailers to inform the public should typically be addressed regionally.

"Sales personnel in consumer electronic shops should be trained to provide consumers with information on how to prepare for digital switchover. Retail shops have often made available brochures and other information sheets on digital switch-off and, at times, they have dedicated store

space to digital switchover logos and other marketing material. The Digital Tick logo used in the United Kingdom provides viewers with the guarantee that the product purchased will work in an all-digital broadcast environment. A further logo indicates equipment that is judged easy to install based on independent testing."

Training of shop personnel costs money and retailers should have an incentive to do so. One should realize that this incentive stems from the fact of being able to sell new receiver equipment. Margins are really only high enough on IDTVs (or a set-top-box with a new television set). Margins on set-top-boxes tend to be very low. When actively using the retail channel to inform viewers, it is important to consider whether the introduction of DTTB services will lead to additional sales in television sets²²⁴.

2.18.3 Implementation guidelines

The following guidance can be provided for developing an ASO communication strategy:

1. Taking into account the local circumstance, draft the ASO communication strategy on the basis of (as detailed in the previous paragraphs):
 - a. A staged model, in which per stage the provided information or message varies;
 - b. Targeted at different groups of the population, and;
 - c. Applying a mix of communication tools, differentiating the tools per target group and stage/message.
2. Special communication care should be given to landlords, managing multiple dwelling units or shared aerials as they can be responsible for a large share of the affected viewers. In some African countries this also might prove to be the case;
3. Although not on the top of the communication tool mix in Europe, radio might be more important in some countries in Africa. This might especially be relevant in those countries where television penetration is still relatively low. ASO messages on the radio, could help to get people interested in DTTB television (with its additional services), which might boost the 'Information Society' objectives some governments might have;
4. From a communication's point of view, don't start the ASO process without the collaboration of the Public Broadcaster if there is a low penetration of other communication tools like the Internet and printed media. In such a situation the PBS channels might be the only way to reach the affected viewers. This situation might apply for some countries in Africa.

²²⁴ In addition, in case of a pay-tv offer on the DTTB platform, the sales commission for the subscription might provide incentive for retailers to invest in proper information.

Glossary of abbreviations

3/4-G	Third/Fourth Generation
API	Application Programming Interface
ASO	Analogue switch-off
ATSC	Advanced Television Systems Committee
CA	Conditional Access
CAS	Conditional Access System
CAPEX	Capital Expenditure
CDMA	Code Division Multiple Access
CEN	Comité Européen de Normalisation
CEPT	European Conference of Postal and Telecommunications Administrations
CI	Common Interface
CIM	Common Interface Module
DCS1800	Digital Cellular System 1800MHz
DECT	Digital Enhanced Cordless Telecommunications
DMA	Designated Market Area
DMCA	Digital Millennium Copyright Act
DRM	Digital Rights Management
DSO	Digital Switch Over
DTTB	Digital Terrestrial Television Broadcasting
DVB-H	Digital Video Broadcasting-Handheld
DVB-T	Digital Video Broadcasting-Terrestrial
DVD	Digital Versatile Disc/Digital Video Disk
EMC	Electromagnetic compatibility
EPG	Electronic Programme Guide
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FCFS	First Come First Served
GE06	Geneva Agreement 2006
GSM	Global System for Mobile Communications
HDSPA	High-Speed Downlink Packet Access
HDTV	High Definition Television
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IDTV	Integrated Digital Television set
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IPTV	Internet Protocol Television
ITU	International Telecommunication Union
MFN	Multi Frequency Network
MHP	Multimedia Home Platform
MHz	Mega Hertz
MPEG-4-AVC	Moving Picture Expert Group – Advanced Video Coding
MTV	Mobile Television
NGO	Non-Governmental Organization
OPEX	Operational Expenditure
PDA	Personal Digital Assistant
PMSE	Programme Making and Special Events

PPP	Public Private Partnership
PSB	Public Service Broadcasting
R&D	Research and Development
RN	Reference Network
RPC	Reference Planning Configuration
RR	Radio Regulations
SDTV	Standard Definition Television
SFN	Single Frequency Network
T-DAB	Terrestrial-Digital Audio Broadcasting
T-DMB	Terrestrial-Digital Multimedia Broadcasting
UA	Universal Access
UAS	Universal Access Service
UMTS	Universal Mobile Telecommunications System
US	Universal Service
WACC	Weighted Average Cost of Capital
WCT	WIPO Copyright Treaty
WIPO	World Intellectual Property Organization
WRC-07	World Radiocommunication Conference 2007

Part 3

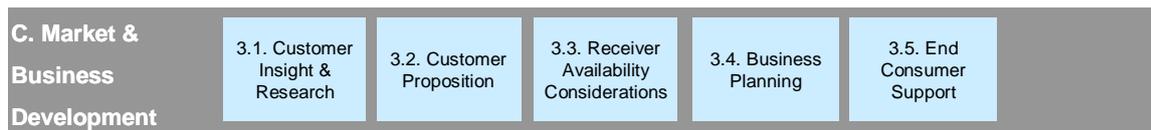
Market and Business Development

Introduction

This part of the guidelines will provide an overview of the key business issues and choices Digital Terrestrial Television Broadcasting (DTTB) and Mobile Television (MTV) Service Providers/Broadcast network operators face when planning the commercial launch of these services. It includes a set of business activities and tools for defining the DTTB/MTV service proposition and associated business case and plan, taking into account identified demand drivers, service barriers, financial feasibility and more specifically receiver availability and customer support issues.

This part is not only intended for *commercial* market parties seeking an acceptable return on their investments, such as DTTB/MTV Service Providers and Broadcast network operators. Also regulators should acquire an understanding of the key business issues and choices at hand so as to define realistic DTTB/MTV policies and licence conditions.

Commercial parties will seek a DTTB or MTV Service Proposition which fulfils a consumer demand, generating sufficient revenues (either advertising or subscription based). In contrast, Public Service Broadcasters (PSB) normally fulfil objectives of public interest in the field of information and culture. That is why they are interested in viewing ratings, high population coverage and mainly prefer unencrypted broadcasting. Market and business development works differently as they have to fulfil primarily these 'information and culture' objectives. However, PSBs can also have advertising-based income and some of the topics addressed in this section might also be relevant for PSBs.



3.1 Customer insight and research

Launching a commercial DTTB and/or MTV services, will require the identification of demand drivers (i.e. customer needs), competitive advantages, service uptake projections and possibly market entry barriers in the local market(s). Service Providers and Network Operators will carry out some form of market research to identify these demand drivers, competitive advantages and service uptake projections.

This section is structured as follows:

1. Overview of the DTTB and MTV markets: market definition, key service and market characteristics;
2. Market research methods: basic market research approaches and embedding market research in the DTTB/MTV business planning process;
3. Implementation guidelines.

3.1.1 Overview of the DTTB and MTV markets

Both DTTB and MTV based services deliver linear broadcasts (i.e. live broadcast streams) to end-consumers equipped with a digital receiver, whereby:

1. MTV services deliver the linear broadcasts onto a *mobile* device with, in most cases, return channel capacity (allowing interactive services), including any mobile phone or PDA-like device, and;
2. DTTB services deliver the linear broadcasts onto a *stationary or portable* device with, in most cases, no return channel, including Set-Top-Boxes (STB), digital recorders/personal video recorders (e.g. PVRs) or Integrated Digital Television sets (IDTV).

With the difference between mobile and stationary/portable reception of linear broadcast content two different end-consumer needs are addressed. Consequently, today most regulators, Service Providers and Network Operators consider both services to operate in two distinct markets.

The table below provides an overview of the key differences between the DTTB and MTV markets.

Table 3.1.1: Key difference between the DTTB and MTV markets

Market element	DTTB	MTV
<i>Content</i>	<ul style="list-style-type: none"> • High resolution (possibly HDTV) • Long form (e.g. films and live sport coverage) • Semi interactive (e.g. EPG and programme associated data and information) 	<ul style="list-style-type: none"> • Low resolution (possibly 'tailor' made ¹) • Short form (e.g. news bulletins, soap highlights, music video clips) • Fully interactive (e.g. programme associated Internet pages, video-on-demand services and direct service ordering)

¹ MTV content might be produced in a different format and screen lay-out. For example ticker information or screen overlays may need different letter size and fonts.

Market element	DTTB	MTV
<i>Viewing time</i>	<ul style="list-style-type: none"> • Prime time focused: between 19:00 and 23:00 hrs. • Average viewing duration: > 1 hr. 	<ul style="list-style-type: none"> • Prime time scattered: around office hours (travelling to and from work and at lunch break)² • Average viewing duration: < 1 hr.
<i>Target groups</i>	<ul style="list-style-type: none"> • Television households (preferably without a multi-channel offering) • Households³ • Leisure sites (e.g. campsites, sport clubs, boats, etc) • Public places (e.g. bars, stations, libraries, etc) 	<ul style="list-style-type: none"> • Mobile phone users and users of other mobile devices (like navigation systems, PDA and MP4 players)
<i>Receivers and Service life cycle</i>	<ul style="list-style-type: none"> • Long (4-8 yrs or more) • Service provider switching (churn) low (5-10 per cent) 	<ul style="list-style-type: none"> • Short (1-3 yrs) • Service provider switching (churn) high (>10 per cent-30 per cent)
<i>Window of opportunity</i>	<ul style="list-style-type: none"> • ASO • Roll-out speed of other digital platforms⁴ 	<ul style="list-style-type: none"> • Availability of alternative technologies (like LTE)
<i>Type of service offering</i>	<ul style="list-style-type: none"> • 'stand-alone' multi-channel offering 	<ul style="list-style-type: none"> • 'Piggy Back' offering (i.e. service is offered as an add-on to another existing service)
<i>Revenue models</i>	<ul style="list-style-type: none"> • Advertising based • Subscription based 	<ul style="list-style-type: none"> • Advertising based • Subscription based • Revenue sharing
<i>Competing platforms</i>	<ul style="list-style-type: none"> • Satellite multi-channel (e.g. Canal+, Multichoice/DSTV, HiTV) • Cable multi-channel (e.g. UPC in Europe) • IPTV multi-channel (e.g. France Telecom and Free in France) • Internet multi-channel and VoD (e.g. Youtube, Joost, etc.) • Other DTTB licence holders 	<ul style="list-style-type: none"> • Mobile operators offering mobile television on the basis of G3/4 • Other MTV licence holders • DTTB licence holders offering free-to-air channels (e.g. in Germany)⁵
<i>Market maturity</i>	<ul style="list-style-type: none"> • Mature • Established value chain • Elaborate channel offering • Interactive services available 	<ul style="list-style-type: none"> • Early stages • Value chain/business model not established yet • Limited dedicated channel offering • Limited number of interactive service

² Based on user trials in Europe, see for example www.dvb-h.org/PDF/060626.Oxford-Final-Results.pdf page 8-10.

³ In some African countries television service uptake is limited by the roll-out and extension of the electricity network. A growing electricity network may imply an increasing potential market for DTTB services.

⁴ Once a set-top-box or any other digital receiver is delivered to the customer, a second set-top-box from a different service provider will not get in to the same household, at least for a long period (depending on the receiver and service life cycle).

⁵ For more details on the possibility of using the DTTB standard DVB-T for mobile television services see EBU Technical Review – 2008 Q4, "Mobile TV standards: DVB-T vs. DVB-H".

Market element	DTTB	MTV
<i>Universal Service</i>	<ul style="list-style-type: none"> • “Must carry” rules may apply • “Price cap” rules may apply • ASO related stipulations 	<ul style="list-style-type: none"> • No or limited “must carry” rules • No or limited “price cap” rules • No ASO stipulations

Although the above table suggests two distinct markets, over time the boundaries between the two markets will blur, because of:

1. Converged service concepts⁶: digital television Service Providers will introduce service offerings across several delivery platforms. Current examples, indicating this trend, are:
 - a. Broadcasters delivering popular linear programming over the DTTB platform (or Cable/Satellite/IPTV) and having “catch-up” or “high light” streams available on the mobile platform;
 - b. Service providers offering “telly any/everywhere” concepts enabling viewers to watch their favourite programmes anytime and anywhere they like. Most notably telecom operators are exploring these possibilities;
2. Receiver and network developments: improved receiver technology will make digital television streams available on an ever growing number of devices, due to:
 - a. Integrated chip-set: several receivers (e.g. UMTS, T-DMB, DVB-H and DVB-T) are integrated onto one chipset/receiver, limiting the risk of standard/technology lock-in;
 - b. Miniaturization: receivers are miniaturized onto smaller devices like USB/PCMCIA sticks and cards, increasing the number and type of ‘screens’ television content will be accessible;
3. Regulation and licensing: regulators follow more and more the international spectrum management trend of *technology neutrality*; enabling licence holders to offer a wider range of services (see also section 2.1 of these guidelines).

With blurring boundaries between digital television markets, new opportunities will arise but also new competition will be introduced. In researching the market and consumer needs these developments should be considered. The next paragraph will address incorporating these aspects into a market research design.

3.1.2 Market research methods

In the DTTB and MTV business development/planning process, market research and the resulting customer insights are used for the following key elements:

1. Service Proposition: determining the demand drivers (i.e. customer needs) for the various customer target groups will help determining the willingness-to-pay and which attributes of the Service Proposition have to be included;

⁶ A future service scenario could look like this: in the train on your way home from work, you watch the live Music awards on your MTV-enabled mobile phone. You like the nominated songs, and so you order four MP3 music clips from your mobile, asking for them to be delivered both to your mobile and to your media centre at home. When you arrive at the railway station, you have to stop watching, even though they are about to announce the winner. When you get home, you switch on your television, and you continue to watch the Music awards from the point where you stopped watching in the train.

2. Business Case: determining the relative value of the included Service Proposition attributes (as compared to the attributes of the competing Service Propositions) will help assessing the DTTB/MTV market share and up-take curve;
3. Network Planning: determining the customer target groups (e.g. where they are located, when and under what conditions they would like to receive the television content) will help planning the initial DTTB and MTV network (type of required network and roll-out order)

In the DTTB and MTV business development process, the above elements are interrelated. The simple example of network coverage (as part of the Service Proposition) illustrates the interrelationship between these elements. The network coverage determines the number of sites (through Network Planning) and this number will in turn drive one of the key costs in the Business Case. Ultimately, the balance between financial means and a marketable Service Proposition has to be found. The figure below depicts the interrelationship between the three elements.

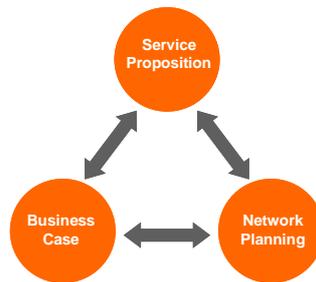


Figure 3.1.1: Service proposition interactive model

Market research should therefore be embedded in an iterative business planning process. Preferably, in order to reduce costs and time-to-market lead times, field market research (i.e. interviewing or testing under end-consumers) should only be conducted once and at the beginning of the planning process. This will require the market research to be set-up thoroughly and with enough scope (i.e. investigating several alternative Service Propositions and their attributes). The figure below depicts an example of such an iterative business planning process.

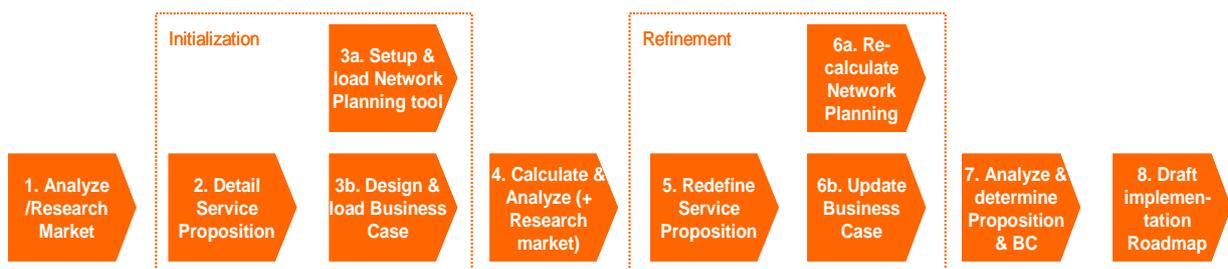


Figure 3.1.2: Market Research embedded in business planning process

It should be noted that after initial calculation of the network planning and associated business case (see step 4 in the above figure) a fundamental different approach might be required and additional market research will be necessary. In addition, as the business planning process is normally carried out over a longer period (1/2 yr to 1 yr as a minimum) changes in the market and regulatory environment might occur, having a significant impact on the business planning process. The latter also arguing that the process should be set up as an iterative process.

For carrying out market research, elaborate literature and specialized firms can be found. The different market research methodologies will not be individually addressed in these guidelines. However, a general three-step approach will be presented for:

- Step 1. Determining the Service Proposition attributes and willingness-to-pay;
- Step 2. Estimating the DTTB/MTV market share;
- Step 3. Selecting the DTTB/MTV uptake-curve.

For each step, several research methodologies are suggested. The methodologies can be combined and are not necessary limited to one single step but can also cover all steps in one single market research effort.

Step 1. Determining the Service Proposition attributes and willingness-to-pay

For any service launch the Service provider has to determine which service attributes to include in its Service Proposition. These attributes can be categorized as:

1. ‘Must haves’/bare minimum: these attributes are necessary for the service to be accepted by the end-consumers/viewers, regardless of price;
2. ‘Competitive advantage’ or ‘unique selling point’: these attributes will set aside the DTTB/MTV service from other Service Propositions in the (future) market and preferably they are unique, that is to say that competitors cannot copy these attributes in the near future.

Table 3.1.2: Example Service Proposition attributes for DTTB and MTV

	‘Must haves’	Competitive advantage
DTTB	<ul style="list-style-type: none"> • Number of channels above threshold level (dependent on the competing television offerings) • Top-10 most viewed channels • ‘Must-carry’ channels • Pre-paid facilities⁷ 	<ul style="list-style-type: none"> • Exclusive content (for example English Premier League football rights) or local/regional content⁸ • Portability • Receiver price/one off price⁹
MTV	<ul style="list-style-type: none"> • Integrated package with telephony subscription (implying one billing and content protection system) • MTV receiver integrated in one handset (no separate receiver)¹⁰ • Top-10 most viewed channels • Pre-paid facilities 	<ul style="list-style-type: none"> • Exclusively produced content (for the MTV platform) • Picture quality • Service availability

⁷ As opposed to subscription/post-paid paying schemes, in Africa most post-paid schemes are commonly available as well.

⁸ Regional content is difficult to facilitate on Satellite platforms as the potential revenues are too low compared to the distribution/transponder costs. In a DTTB platform, with local insertion, these distribution costs are significantly lower.

⁹ In markets with only a multi-channel offering on the satellite platform, a DTTB offering could lower the barrier-to-entry for consumer by having a significant lower receiver installation cost (i.e. decoder and antenna/dish). Compare: ex-factory cost DTTB receiver + antenna ~ \$55 and satellite receiver + dish ~180.

¹⁰ For example Nokia’s SU-33W receiver which can be connected to the mobile handset through a Bluetooth interface. Such a solution might work in predominately pre-paid markets.

In the above table some examples are provided for DTTB and MTV services. The attributes included in the table do not necessarily apply to all DTTB/MTV markets and are dependent on the specific customer demands and competitive landscape. For a more elaborate overview of Service Proposition attributes see the next section of these guidelines.

To determine the DTTB/MTV Service Proposition attributes, four research methodologies can be applied:

1. *Consumer trial*: in a closed user group the DTTB or MTV services are tested, by providing potential customers a sample service. Such an approach, depending on the number of participants and number of DTTB/MTV sites, can be relatively expensive¹¹. Consumer trials are very often combined with a survey (see below) to collect additional information. Consumer trials can provide reliable information on:
 - a. Service attribute values: for example which channels are appreciated most or what EPG features are best appreciated;
 - b. Viewing/use patterns: for example when are the channels/services used, how often and for what duration?¹²
2. *Market survey*: by interviewing a representative group of potential customers detailed information can be collected on the composition of the target groups and how attribute values change between the various groups. This information can be collected on:
 - a. media behaviour: information can be collected on media consumption patterns (e.g. use and appreciation of current television and radio services) of the potential target groups (e.g. differentiated between the standard demographics like income, social class, household size and composition);
 - b. Switching factors: what attributes would make consumers switch to an alternative services (e.g. 25 per cent lower price, possibility to subscribe to a limited number of channels, better picture quality, portability, etc);
 - c. Price perception: an indication of the 'willingness-to-pay' can be obtained. However, the reliability could be low depending on the set-up of the questionnaire and the service references (i.e. are there alternative price markers for the interviewee like other digital television offers);
 - d. Relative value of the presented Service Proposition attributes;
3. *Benchmarking/market comparables*: studying commercial DTTB and MTV launches in other markets/countries, could provide information on what attributes add value. However, careful consideration should be given to translating this information to the local DTTB/MTV market, especially for:
 - a. Type and number of channels: television content preferences vary greatly between countries due language and cultural differences. Only a very few channels have global appeal (like Discovery channel, National Geographic, BBC World and CNN);
 - b. Willingness-to-pay: the willingness-to-pay can vary greatly between countries due to market structure like free-to-air offers, exclusive content deals and government

¹¹ For more details on the technical set up and associated costs of a MTV trial, please see section 5.9 of these guidelines.

¹² Because MTV handsets have an in-built return channel, very accurate real-time information can be collected about individual viewing patterns and use of other/interactive service. Please note that for respecting privacy regulations, the participants should be asked their explicit permission to collect this data.

intervention (e.g. television licence fees, provision of cable distribution and price regulation);

4. *Expert panel*: bringing together a selected group of key customers and/or industry thought leaders in a structured but unhurried forum, so that a Service Provider can learn their opinions on various Service Proposition attributes and other marketing issues. Expert panels should be selected carefully, as the expert preferences might not represent the DTTB and MTV target groups. However, expert panels can provide information quickly and can be combined with additional market research for determining potential market share (see next paragraph).

The figure below provides an example of market research results on the relative value of the various Service Proposition attributes (including competition offerings).

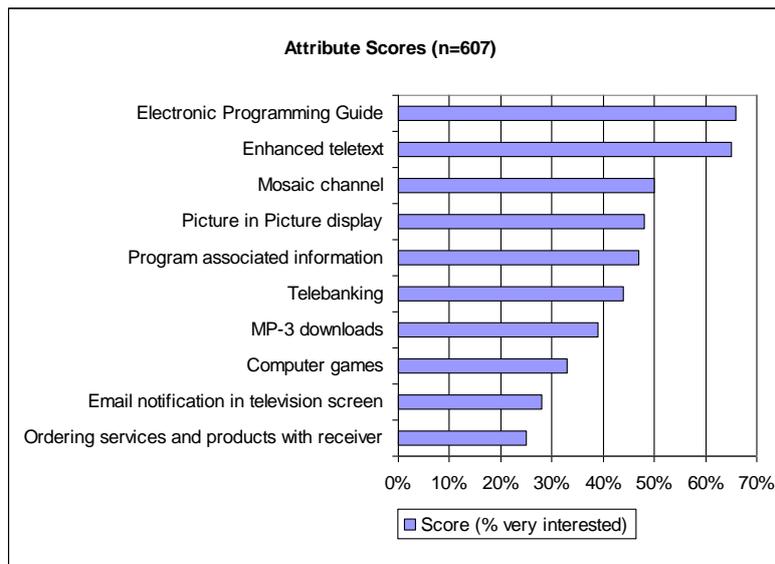


Figure 3.1.3: Example market research results on attribute values.

Step 2. Estimating the DTTB/MTV market share

At this stage the DTTB/MTV service provider will have to consider the consumer’s alternatives. Hence the provider will need to know the competition’s current and possibly future offerings. By lining up the available (and future) service offerings and evaluating the value of the included attributes, the potential market share can be estimated. The market research results from Step 1, forms the input for this step.

For estimating the DTTB/MTV market share the following research methodologies are available:

1. *Conjoint or Rank Order and Acceptance (ROA) analysis*: Conjoint analysis requires research participants to make a series of trade-offs, for example by presenting them a series of cards with possible DTTB/MTV service propositions (including the competition’s attributes) and asking the participants to rank them in order of preference¹³. The mathematical analysis of these trade-offs will reveal the relative importance of the

¹³ The design of these cards should be done carefully to include all possible attributes and to make them distinguishable for the research participants. The cards do not necessarily include real Service Propositions.

various attributes. To improve the predictive ability of this analysis, research participants should be grouped into similar target groups or client segments. Further improvement can be obtained by applying a Rank Order and Acceptance analysis, in this method the participants are also asked to indicate which card propositions are not acceptable. In this way, information is also collected on 'must have' attributes. The figure below illustrates a simplified example of a series of cards.

<p>Card 1</p> <ol style="list-style-type: none"> 1. A single television package 2. of 20 channels 3. No Video-on-Demand 4. Information channels 5. Simultaneous viewing & recording 6. Internet and email on screen 7. Price: € 45 per month 	<p>Card 2</p> <ol style="list-style-type: none"> 1. a-la-cart selection of channels 2. of 10 channels 3. Video-on-Demand 4. Information channels 5. Simultaneous viewing & recording 6. Internet and email on screen 7. Price: € 20 per month
<p>Card 3</p> <ol style="list-style-type: none"> 1. A single television package 2. of 50 channels 3. Video-on-Demand 4. Information channels 5. Simultaneous viewing & recording 6. No Internet and email on screen 7. Price: € 10 per month 	<p>Card 4</p> <ol style="list-style-type: none"> 1. A single television package 2. of 10 channels 3. Video-on-Demand 4. No Information channels 5. No simultaneous viewing & recording 6. Internet and email on screen 7. Price: € 40 per month

Figure 3.1.4: Example ROA cards for digital television offerings

2. *Market breakdown and market comparables:* in this approach the potential market for DTTB and MTV services is broken down into smaller market segments and for each market segments the potential market share should be estimated. An expert panel could assess the relative strength of DTTB/MTV service attributes, as compared to the competition's service attributes, in each segment. Subsequently all the estimations are summed to a grand market total. Such a bottom-up approach could be further improved by checking the grand total with market comparables for the total market (see above). A common model to segment the market is Roger's diffusion of innovation or Product Life Cycle model with the categories of adopters: innovators, early adopters, early majority, late majority, and laggards.

The figure below provides an example of market research results on market shares of the various Service Propositions.

	DTT basic rental	DTT basic purchase	Analoge C basic	Analoge C standard	Satellite
Age					
<30	25,7%		7,8%		
30-40	15,8%		12,3%		
40-50	0,2%		16,6%		
>50	0,3%		24,0%		
Gender					
Male	3,4%		21,3%		
Female	1,3%		23,2%		
Household size					
1	0,2%		21,4%		
2	3,0%		24,9%		
3	16,3%		1,5%		
4	4,4%		24,7%		
5+	10,5%		5,7%		
Education					
bo, lbo	0,9%		27,1%		
ha, vw	6,5%		12,4%		
un	2,6%		21,6%		
Income					
<2250	0,6%		19,6%		
2250-3500	13,2%		18,9%		
3500-5500	1,1%		22,0%		
>5500	5,9%		16,3%		
Overall	5,5%		18,6%		

Figure 3.1.5: Example ROA results

Step 3. Selecting the DTTB/MTV uptake curve

In the previous step, the results show an estimate of the potential DTTB/MTV market share. This is the market share at market saturation level. But little information is known about how quickly this potential market share can be obtained and neither is the curve known at this stage.

Assessing the uptake curve is important because DTTB and MTV services are capital intensive, requiring relatively large up-front investments. Most uptake curves, especially for innovative products and services, are based on Roger's Product Life Cycle model. When plotted over a length of time the adoption of an innovation follows an S curve. Extensive academic literature can be found on estimating this S curve.

A pragmatic approach is in essence based on market comparables. What services are similar to the planned DTTB and MTV services and what adoption curve can be observed? In the case where good market comparisons are lacking, the remaining uncertainties (speed of adoption and exact curve) can be incorporated in the business case sensitivity analysis.

3.1.3 Implementation guidelines

The following guidance can be provided for customer insight and research:

1. Carry out profound market research, especially in the case where the required funding is largely to be provided by third parties (e.g. banks or private equity funds). In any business case for DTTB/MTV services the key value driver is the penetration level of the service. External financiers will seek evidence for the presented penetration levels. Strategic investors might adopt a different stance (e.g. they might also consider the synergies with their current business lines);
2. Consider market research as part of the business planning process and for planning DTTB/MTV services this process will be a highly iterative process. Service Proposition

- design, Network Planning and Business Case development are strongly interrelated and need to be set-up in a flexible way so that changes can be executed easily;
3. Consider DTTB and MTV as different markets, having different demand drivers and competitive environment. Hence the Service Proposition is different. Just 'copying' the DTTB offering (e.g. 20 linear channels) onto a MTV platform will in many cases not be enough. Especially (FTA) broadcasters will see little added value in doing so as they will question whether new target groups will be reached or additional viewing hours will be obtained¹⁴;
 4. Include competition in any market research. In the long run, competition will be present (even when markets are limited by the number of issued spectrum licences). Also consider regulatory limitations for example:
 - a. Limitations to provide hand-set subsidies (e.g. like in the Belgium mobile market);
 - b. Limitation to freely assemble the channel line up (e.g. due to 'must-carry' obligations);
 - c. Limitation to strike exclusive content deals (e.g. in Europe the European Commission issued a list of sport and national events not to be included in pay-tv packages).

3.2 Customer proposition

In the previous section an outline of the applied market research methods are provided for determining the DTTB/MTV Service Proposition attributes. This section focuses on determining the competitive advantage and what the related service attributes could look like, based on previous DTTB/MTV service launches around the world.

This section is structured as follows:

1. DTTB competitive advantage and related Service Proposition attributes;
2. MTV competitive advantage and related Service Proposition attributes;
3. Implementation guidelines.

3.2.1 DTTB competitive advantage and related Service Proposition attributes

From a commercial perspective, the competitive advantage of a DTTB offering is solely dependent on the competitive landscape of the television market. Hence DTTB launches differ from country to country and are marketed in different ways, emphasizing different competitive advantages.

However, from observations of the various DTTB launches, six competitive advantage categories (or marketed reasons for DTTB launch) can be identified:

1. *Interactivity/enhanced television services*: in markets with only analogue television platforms, DTTB could offer interactive service as a competitive edge (however for a limited duration as all platforms will migrate to digital in the long run). Without any return path, these interactive services are limited to services like the Electronic Programme Guide (EPG), additional programme information and enhanced teletext. Recent market developments show that (mass produced) receivers come available with return path capabilities, such integrated IPTV/DTTB set-top-boxes. Also television set producers, like Philips and Sony, launch Internet enabled television sets for browsing and accessing

¹⁴ In markets with little television platforms available and/or with platforms with only a limited reach, the consideration of broadcasters might be different.

- Internet content on the television screen with a normal remote control. This development comes under the phrase Hybrid Broadband Broadcast (HBB)¹⁵;
2. *Additional Pay-TV platform/conditional access and billing facilities*: as DTTB platforms can easily be equipped with conditional access and billing facilities, it could provide Service Providers a platform to launch pay-tv services, such as tiered television packages, pay-per-view offerings and pre-paid facilities. Pay-tv services are often launched on the basis of a multi-channel offering and hence this competitive edge comes very often in combination with a 'additional channels' augment (see below);
 3. *Addition channels/multi-channel offering*: in markets with the analogue terrestrial television platform being the main platform and offering only a limited set of channels (e.g. 2-5 channels), the introduction of a multi-channel DTTB offering could be a key demand driver. It should be noted however that in most countries a multi-channel (pay-tv) satellite offer is available too and the DTTB platform is faced with limited capacity. A long(er) lasting competitive advantage should really be added to the DTTB platform;
 4. *Lower costs (one-off and recurring)*: A DTTB platform could have the advantage of having lower network costs¹⁶ and receiver costs. For example, if the competing platform is digital satellite, the receiver costs are approximately USD 180 (ex-factory, including receiver dish and installation). A DTTB receiver costs around USD 50 (ex-factory, including antenna and excluding installation). Especially these one-off costs could form a major barrier for consumers to adopt digital television. However, following a low cost strategy should be carefully considered as the competitor could have 'deeper pockets';
 5. *Picture and reception quality*: the introduction of DTTB could entail for viewers a significantly better reception and/or picture quality. A DTTB offer could include HDTV channels. As addressed in section 4.4 of these guidelines, trade-offs have to be considered between picture quality and reception quality (i.e. robustness of the signal). Notably, the recent publication of the DVB-T2 standard could entail a significant improvement for facilitating HDTV channels¹⁷;
 6. *Usability/Portability*: DTTB services are wireless and can be received on very compact receivers. Hence DTTB services have the competitive advantage of portability, especially when the receiver comes with a small antenna or an integrated antenna. The latter even allows mobile reception as shown in the German market with the launch of mobile phones with integrated DVB-T receivers. None of the regular competing television platforms can offer such functionality¹⁸. Whether portability forms a demand driver,

¹⁵ HBB defines the convergence between broadcast and Internet content for a coherent experience, it makes possible accessing Internet content on a television display. Manufacturers have demonstrated confidence in the emergence of this new market that allows viewers to watch Internet video content directly on their television sets by making many products available. For more details see www.digitag.org/WebLetters/2009/External-Aug2009.html.

¹⁶ Benchmark studies have shown that terrestrial networks are in most cases inherently cheaper than cable or satellite networks (except in cases where coverage approaches 100% of the population). A DTTB roll-out can be rolled out quicker and be localized to where the target population is situated. In addition, in the case of re-use of the analogue terrestrial infrastructure (sites and antennas) the cost difference could be even larger.

¹⁷ Technical trials have demonstrated that one DVB-T2 multiplex can facilitate up-to four HDTV channel (in combination with the MPEG 4 compression technology). Commercially available set-top-boxes are expected in 2010 and the additional costs are expected to be around 30% (unconfirmed).

¹⁸ It should be noted that recent developments of DVB-SH and Wi-MAX technologies could change the competitive landscape and should be considered as well.

depends on the local market and should be investigated (like all the other above mentioned categories).

These six main competitive advantages (or marketed reasons for adopting DTTB) can be depicted in a diagram. The figure below depicts the DTTB launches in four different countries, illustrating the wide range in market 'profiles'.

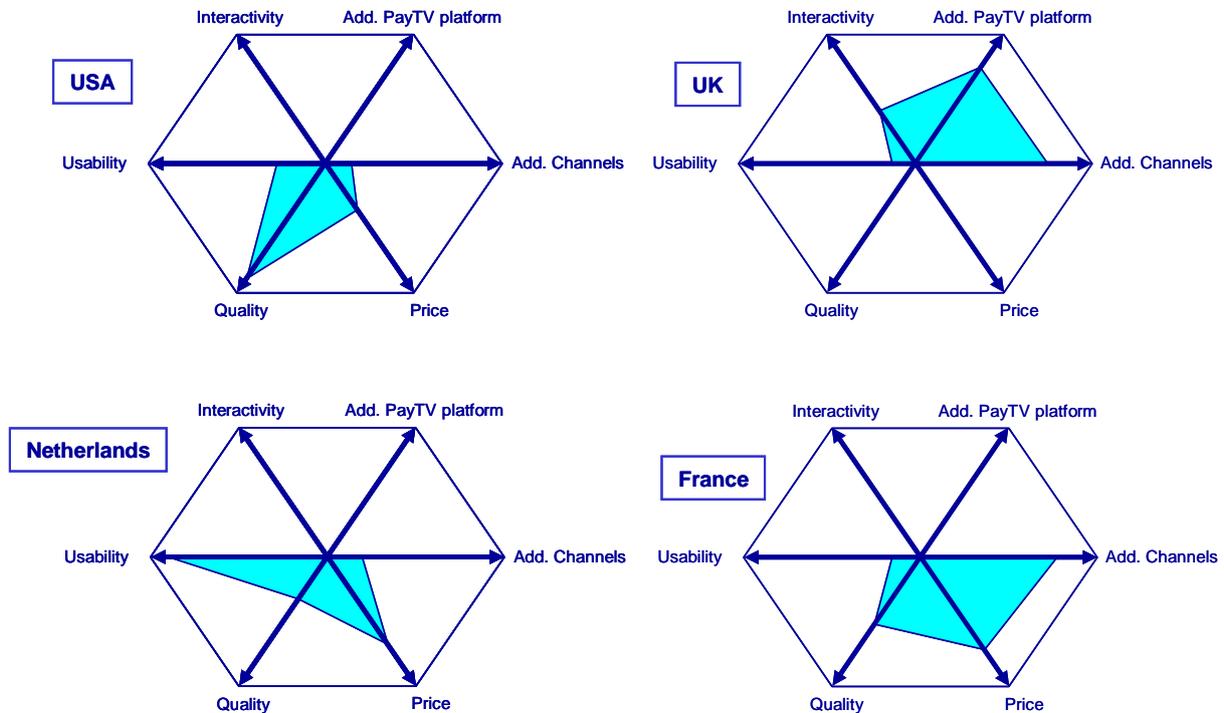


Figure 3.2.1: Competitive advantage categories for DTTB at time of launch

In the above figure it should be noted that the initial launch in the UK was followed by a market failure as the Service Provider ONdigital/ITV Digital went bankrupt. The platform was re-launched on the basis of an advertising model (rather than a pay-tv offering), building on an ITV Digital customer base of 1.25 m subscribers with a set-top-box. The service was re-named FreeView. Clearly this appeals on the competitive advantage of price.

It seems that the recent DTTB launch in France incorporated these 'lessons learned' into their service offering, as the DTTB platforms offer a free-to-air multi-channel television package with HDTV channels included. Whether a DTTB free-to-air model can work, depends largely on whether (existing) broadcasters on the DTTB platform can reach additional viewers (or increase viewing hours).

In addition to the above mentioned six categories, any DTTB Service Proposition should always be complemented with the attributes for:

1. Installation and service activation: how viewers can get access to the services and how (individual) services can be activated, including the following aspects to consider:
 - a. Retail logistics and channel management: which outlets (shops/Internet) provide receivers and smart cards and what are the commission schemes;
 - b. Smart card handling: provision of pre-activated smart cards, pre-paid cards, 2nd smart cards (for second screen in the home) and try-out periods;

- c. Installation aid: coverage and reception check (on the internet or via SMS, could include advise on best receiver installation), antenna direction guidance, ‘plug and play’ instructions and at-home installation aid ;
2. Billing and customer care: how to bill the customer and handle service change requests and, in the case of a free-to-air DTTB offering, how to promote the platform. The following aspects should be considered, including:
 - a. Television package tiers, service change requests (e.g. service up-grade notices over the phone or via SMS) and discount schemes;
 - b. Moving house and address changes (might require coverage check/other receiver);
 - c. Sending invoices (e.g. only over the Internet or broadcasting billing information), and invoice intervals
 - d. Collection and bad debt handling;
3. Service deactivation/subscription cancellation and receiver returns: only in the case of subscription based DTTB services. How viewers can cancel their service and how to return the rental receiver (the latter not applicable for a purchased receiver).

In the table below an overview is provided of example DTTB attributes, grouped in the six competitive advantage categories.

Table 3.2.1: Overview of example DTTB attributes

Category	Attribute	Example (country)
<i>Interactivity/ enhanced television services</i>	• Programme information/ information channel	• Red button service of the BBC, see www.bbc.co.uk/digital/fla/interact_demo.shtml
	• Enhanced teletext, with full colour graphics	• For demo see www.teletextextra.co.uk/
	• Enhanced EPG	• For example and implementation guidelines see www.im-reports.com/DM/EPG/samples.html#chap_2
	• Interactive service (DTTB platform only), including push VOD ¹⁹	• For example offering see www.topuptv.com on the basis of the DTTB free-to-air service Freeview in the UK • For example services see www.mirada.tv/digital-tv-platforms/
	• Hybrid Broadband Broadcast, requiring return path/Internet connection, including push and full VoD.	• For an example of Internet/DTTB set-top-boxes see www.adbglobal.com/files/ADB_datasheet_5810TX.pdf • For Internet enabled Integrated Digital Television sets see www.nettv.philips.com/

¹⁹ Push video on demand is a technique used on systems that lack the interactivity to provide real-time streaming video on demand. A push VOD system uses a personal video recorder (PVR) to automatically record a selection of programming, transmitted over DTTB platform (or the Internet connection). Users can then watch the downloaded programming at times of their choosing.

Category	Attribute	Example (country)
<i>Additional Pay-TV platform/ conditional access and billing facilities</i>	• Tiered service packages	• DTTB pay-tv services in Sweden: Boxer, see www.boxer.se/ • DTTB pay-tv service in Italy, DGTv, see www.dgtvi.it
	• Pay-per-view/event	• DTTB pay-per-view services in Italy: DGTv, see www.dgtvi.it
	• Pre-paid services	• Multichoice scratch card payment service for example in Ghana and Kenya see www.dstvafrica.com
<i>Addition channels/multi-channel offering:</i>	• Multi/premium channel offering	• DTTB pay-tv services in Sweden: Boxer, see www.boxer.se/ • DTTB pay-tv service in the Netherlands: Digitenne, see www.digitenne.nl/kpntv/
	• Multi-channel free-to-air offerings	• Free-to-air DTTB service in the UK, Freeview, see www.freeview.co.uk/freeview • Free-to-air DTTB service in France, TNT, see www.tnt-gratuite.fr/
<i>Lower costs/one-off and recurring</i>	• low cost offering	• compare DTTB set-top-box prices, especially free-to-air boxes/receivers come as cheap as USD 30-40 retail price
<i>Picture and reception quality</i>	• HDTV offering	• Free-to-air DTTB service in France, TNT, see www.tnt-gratuite.fr/
<i>Usability/Portability</i>	• Portable offering	• Digitenne service from KPN in the Netherlands, see www.digitenne.nl/kpntv/
	• Mobile offering (in-car and mobile)	• Free-to-air DTTB in Germany, see www.ueberall-tv.de/3content/3eqip/eqip.htm

3.2.2 MTV competitive advantage and related Service Proposition attributes

As for DTTB, the competitive advantage of a MTV offering is solely dependent on the competitive landscape of the television market. Compared to DTTB markets, MTV markets are however relatively new and basically still two market situations can be distinguished²⁰:

1. No mobile television services are commercially available in the market yet. Within this market situation two sub-situations can be distinguished:
 - a. No mobile television services in the market yet and no/limited nationwide or near nationwide television platforms available;
 - b. No mobile television services in the market yet and nationwide or near nationwide television platforms available;
2. Mobile television services are present in the market, delivered over a switched mobile network (e.g. UMTS). For example in Korea, Japan and most European countries.

The competitive advantage for both market situations differ fundamentally. Using the competitive advantage framework, as discussed in the previous paragraph, the two situations are depicted in the figure below.

²⁰ For any DTTB service introduction, the DTTB Service Provider is facing competition from one or more television offerings already present in the market.

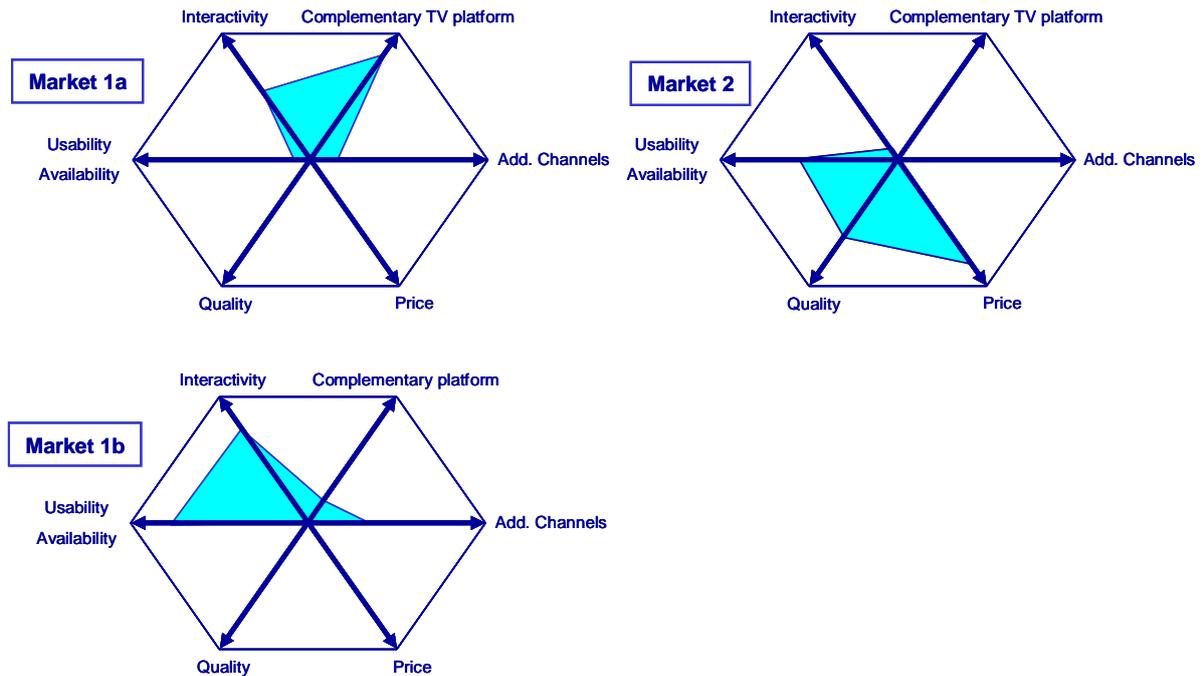


Figure 3.2.2: Competitive advantage categories for MTV at time of launch

Addressing the different market situations in the above figure, the following can be observed:

1. *Interactivity/enhanced television services*: Only in markets without a mobile television service in the market (market 1a en 1b), MTV could add interactivity in the television market as a competitive advantage²¹. In markets with already a mobile television offering on switched mobile networks, interactivity is (technically) already well developed. However, the launch of MTV services could help the development of truly interactive and broadcast related content, as broadcasters tend to get involved closer²². Specially developed interactive content could create a competitive edge. But this is not necessarily uniquely related to the introduction of a MTV platform;
2. *Complementary TV platform*: in some markets (market 1a) the introduction of an MTV services could be driven by the lack of any other primary television platform. Provided that the mobile network is extended beyond the television network coverage, MTV could form a complementary TV platform. In some markets with already a mobile television offering (market 2), some mobile operators have considered launching a MTV service for extending the UMTS based mobile offering in under-served areas (sometimes referred to as mobile television roaming)²³;

²¹ For MTV service categories and examples of interactivity see p 41-43 of the Implementation Guidelines for DVB-H Services, DVB Document A092r3, April 2009. Available on www.dvb-h.org

²² See for example the National Football League (NFL) television service, especially developed for mobile reception. For more details see www.nfl.com/mobile.

²³ Such a combined service scenario will require a considerable amount of work in the areas of network/handset integration for seamless service roaming and marketing communication and support when both offerings (on UMTS and MTV platform) are not the same.

3. *Addition channels*: In none of the markets a competitive advantage is expected from offering real time scheduled multi-channel offerings. These offerings are suitable for big(ger) screens. Only MTV exclusive or dedicated channels could create a competitive advantage. To date, more and more content becomes available for the mobile platform. However, this content is not necessarily restricted to the MTV platform. In markets already with a mobile television offering (market 2), the competitive advantage of MTV could be in a combined service scenario of delivering popular channels over MTV and VoD/less viewed channels over UMTS/HSDPA. Such a service strategy is depicted in the figure below;
4. *Price/lower costs*: Especially in market 2 lower costs is a strong point for introducing MTV based services. Compared to UMTS based solutions (not considering any sunk costs for mobile operators²⁴) MTV platforms can deliver broadcast content much cheaper. In any transmitter network the key costs driver is the number of sites. Due to the better propagation and the larger transmitter heights of MTV platforms, the number of sites in a MTV network is significant lower;
5. *Picture and reception quality*: In markets with already a mobile television offering (market 2), MTV platforms could add value by offering a better picture quality (by locating a higher *constant* , non-shared, bit rate) and possibly better reception quality (by having a more robust signal). This competitive advantage will become more evident when traffic levels (more viewing hours and more concentrated) become higher. In some markets, traffic congestion problems with UMTS/HSDPA solutions have been reported when *active* subscriber numbers exceed 10,000;
6. *Usability/Availability*: In markets without a mobile television offering (market 1), usability is a key competitive advantage. In addition, in countries with a limited electricity network roll-out, the MTV platform might prove to be the only platform to provide television services in rural areas. In markets with mobile television (market 2), MTV's competitive advantage could be network availability. The network availability with HSDPA solutions has been reported to be problematic (access blocking and interrupted broadcast streams). In addition, Broadcasters have reported that MTV solutions (T-DMB or DVB-H) are handset independent and 'porting' the television application to various handset devices is not necessary. It should be noted that this competitive edge might not be enough reason to launch MTV and should be supported by other competitive advantages.

²⁴

Mobile operators could have already invested heavily in UMTS/HSDPA networks and these costs might be considered as sunk costs, reducing the competitive advantage of lower costs.

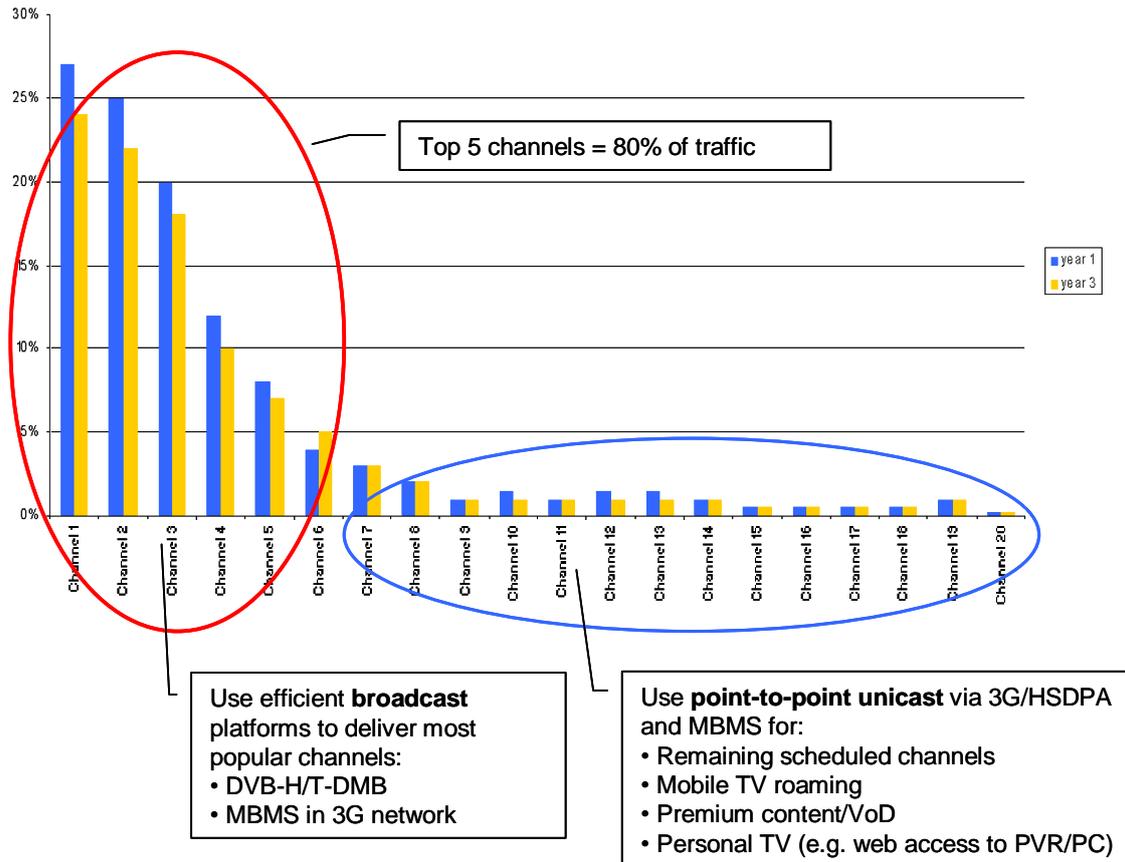


Figure 3.2.3: A typical mobile operators’ MTV service strategy

In addition to the above mentioned six categories, any MTV Service Proposition should always be complemented with the attributes for service activation, billing and customer care and service deactivation. In contrast with the DTTB Service Proposition, MTV Service Providers should specifically consider:

1. In markets where the mobile operator is the Service Provider, the MTV introduction should be integrated with existing service provisioning systems and organization. Special care and attention is needed for integrating the broadcast and mobile Operating Support Systems (OSS) for billing and customer care. For example, MTV services might be billed from the mobile operators billing system, requiring an interface from the MTV platform to the existing mobile platform. Also, MTV packages and services might be ordered with handhelds, requiring an interface from the mobile platform to the MTV platform. A ‘mediation’ platform might be required for resolving these interface requirements. In the picture below a schematic overview of such a mediation platform is provided;
2. In markets where the MTV service is offered as a free-to-air offering, service activation, billing and service deactivation, is relatively simple²⁵. Focus will be on the promotion of

²⁵ Not only restricted to free-to-air MTV broadcasts, mobile operators offering a single MTV package, activated once, will not necessarily require and automated interface between the mobile and broadcast OSS.

the MTV platform and informing the public about the availability of MTV equipped handsets;

3. MTV users will expect the same service coverage for both the mobile and broadcast services. In the case of non-parallel service coverage, special attention is needed to inform the MTV users about service coverage. This information might change over time when network roll-outs are extended.

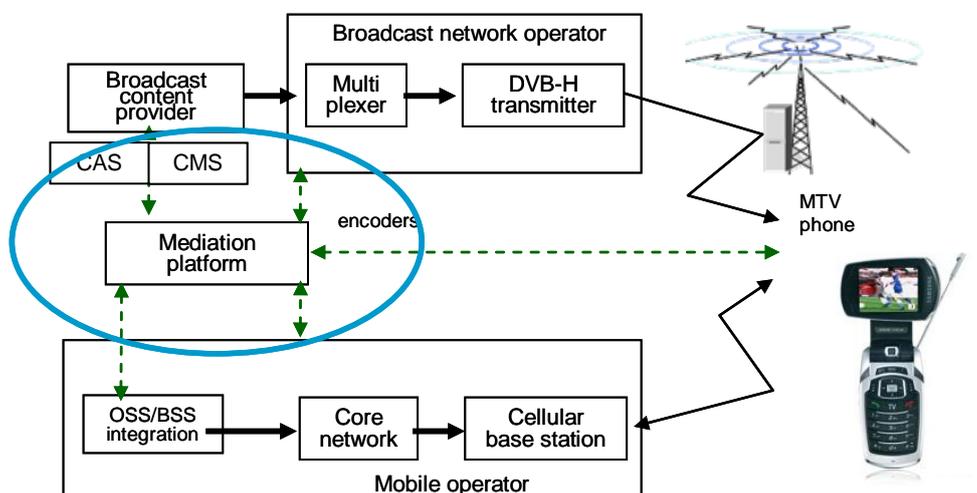


Figure 3.2.4: Schematic overview of the integration between the mobile and broadcast platforms

For some reference MTV Service Propositions, please refer to the following websites:

1. 3 Italia, offering free-to-air and various pay-tv MTV offerings, based on the DVB-H transmission standard, see www.la3tv.it/;
2. Orange Austria, offering pay-tv MTV offerings, based on the DVB-H standard, see www.orange.at/Content.Node/mehr_als_telefonieren/;
3. MTV free-to-air service based on the T-DMB standard in South Korea, see www.worlddab.org/country_information/south_korea;
4. TU Media, pay-tv MTV offering, although based on the S-DMB standard, see www.tu4u.com/index.jsp.

3.2.3 Implementation guidelines

The following guidance can be provided for shaping the customer or Service Proposition:

1. When designing a DTTB or MTV Service Proposition, the Service Provider should seek those attributes that will create a sustainable competitive edge. The provided categories (see figure 3.2.1 and 3.2.2) form a start for designing the DTTB or MTV Service Proposition. The DTTB/MTV Service Provider should have at least one service attribute, and preferably two attributes, along the axis of these diagrams. Focusing on these attributes will be key in having a clear marketing message;
2. In addition to the key service attributes, any DTTB or MTV Service Provider should include in its Service Proposition, the service fulfilment process (e.g., service activation, billing and customer care and service deactivation).

3. DTTB providers, planning service launch in the near future (> 1-2 yrs) could incorporate the most recent developments in their offering:
 - a. Including HDTV channels (Quality axis): the recent introduction of MPEG-4 set-top-boxes and the launch of the DVB-T2 standard make such an offering more (technically) feasible. However it might be necessary (depending on the business case and model) to postpone service launch until the moment that receivers will be 'affordable'. DVB-T2 receivers with a price level around the current DVB-T set-top-boxes are not expected before 2012.
 - b. Including the wide availability of low cost receivers, possibly in combination with a free-to-air proposition (Price axis). The number of DTTB receivers has exploded, including USB sticks, PC-cards, small portable television screens and small/simple set-top-boxes. Also the retail/ex-factory prices have dropped significantly. These recent developments will facilitate the widespread adoption of DTTB receivers and consequently making advertising based (free-to-air) offerings economically more feasible.
 - c. Including Hybrid Broadband Broadcast (HBB) services (Interactivity axis): manufactures have started producing various commercial products, enabling interactive services and reducing the disadvantage of terrestrial-broadcast-only offerings. Such services will require a wide broadband penetration, still lacking in many African territories. However, a phased introduction could be considered (e.g. focusing on the capital or key cities);
4. MTV providers, considering a service launch in the near future, could consider the following:
 - a. Including dedicated/interactive television content and services (Interactivity and Additional Channels axis)²⁶. In this context it is important to note that Broadcasters view MTV services as auxiliary to their real-time scheduled broadcasts (e.g. offering catch-up services or highlights). Popular broadcast/channels are important consumer brands that carry the MTV service. Having the traditional broadcasters on board is key and hence interactivity services should be developed and included in the service proposition;
 - b. MTV services fall often under a lighter regulatory regime as often they will not be considered by the regulator as part of the Universal Service. Consequently, MTV service introduction could take place before ASO. This might create a window of opportunity for MTV services and the time-to-market could be shorter than any other competing platform;
 - c. Depending on the market situation (see above text) and value chain organization, a MTV service proposition should be considered as part of a wider mobile proposition and services should be integrated as one unified and transparent service for the end-consumers (see figure 3.2.3). This will require early cooperation between marketing departments/units which have very often a separated responsibility for the mobile telephony/data and television markets.

²⁶ This point of having specially developed MTV content has been raised by many industry observers. See also the Communication from the Commission to the European Parliament, "Strengthening the Internal Market for Mobile TV, Brussels, 18.7.2007, COM(2007) 409 final.

3.3 Receiver availability considerations

Today many different DTTB and MTV receiver types are commercially available. Also more and more integrated devices, supporting different transmission standards and platforms, are becoming available due to further chipset integration. For example it is not uncommon for MTV receivers to support DVB-T, DVB-H and T-DMB or set-top-boxes having IPTV and DTTB receiver capabilities.

For a Service Provider it is important to draft the receiver’s functional requirements based on the defined Service Proposition(s). Only those requirements supporting the Service Proposition should be incorporated. These ‘must have’ requirements might prove to be too expensive for the business case and therefore receiver considerations might result in a revised Service Proposition. At all times ‘nice to have’ requirements should be avoided as these will come with a price²⁷ and may negatively affect the business case.

As illustrated in the figure below, the process of determining the receiver functional requirements is very often an iterative process.

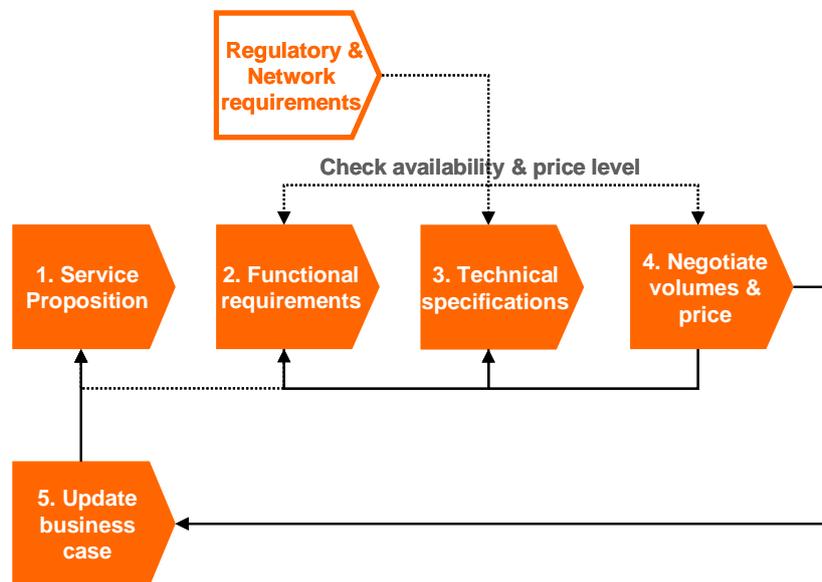


Figure 3.3.1: Receiver function requirements design process.

When drafting the function requirements a Service Provider should ‘check’ receiver availability and price levels. Very often the functional requirements will have to be ‘translated’ into detailed technical specifications²⁸. For example the functional requirement of having a defined EPG (providing a 7 day-ahead programme overview with programme title, start date, duration, parental rating, etc) will have to be translated to EPG compliance with ETSI EN 300 468 v1.9.1 and Character set ISO/IEC 8859-7. It is important to note that the technical specifications might not necessarily only be driven by the functional requirements. For example regulatory requirements might stipulate the

²⁷ Not only in higher receiver costs, but possibly also in more complicated business processes like receiver management, software updates, subscriber management and billing.

²⁸ Alternatively the receiver supplier could be asked to provide a complete technical solution. It should be noted that, in such cases, comparing the various offerings might be more difficult.

compression or transmission standard. In addition, the Broadcast Network Operator may stipulate technical network requirements to the Service Providers on his platform.

In the above figure volumes and receiver prices are negotiated with potential suppliers and vendors. However, in case of free-to-air DTTB/MTV services and/or the DTTB/MTV Service Providers are not purchasing receivers, the functional/technical requirements may also be drafted for the purpose of certifying receivers. With certified receivers the viewers know that the purchased receiver is compatible with the DTTB/MTV network

In this chapter we will focus on the functional requirements from a commercial perspective, i.e. those requirements that are driven by the defined Service Proposition.

This chapter is structured as follows:

1. DTTB functional receiver requirements and availability;
2. MTV functional receiver requirements and availability;
3. Implementation guidelines.

3.3.1 DTTB functional receiver requirements and availability

DTTB Receivers can be divided in the following categories:

1. A STB (Set Top Box) is an receiver which is a separate unit (external) from the TV Set (Display);
2. An IDTV (integrated digital television set) is a receiver which is integrated into the TV set/display;
3. A PVR (personal video recorder or digital video recorder) is a separate unit (external) from the TV set (display) with capabilities to store and playback broadcast services/programmes;
4. Other receivers, such as a PC Cards (e.g. PCI), personal media players (PMPs or MP4 players), navigation devices or USB/Firewire external receivers, these products together with the PC can be treated as an IDTV excluding the CA requirements.

For each included receiver type the Service Provider will have to determine the functional requirements, given the defined Service Proposition. The figure below provides a generic functional model, with some example requirements, for the first three receiver types (derived and adapted from the UK D-book v4²⁹).

²⁹ See www.dtg.org.uk/publications/books/dbook_ch22.pdf .

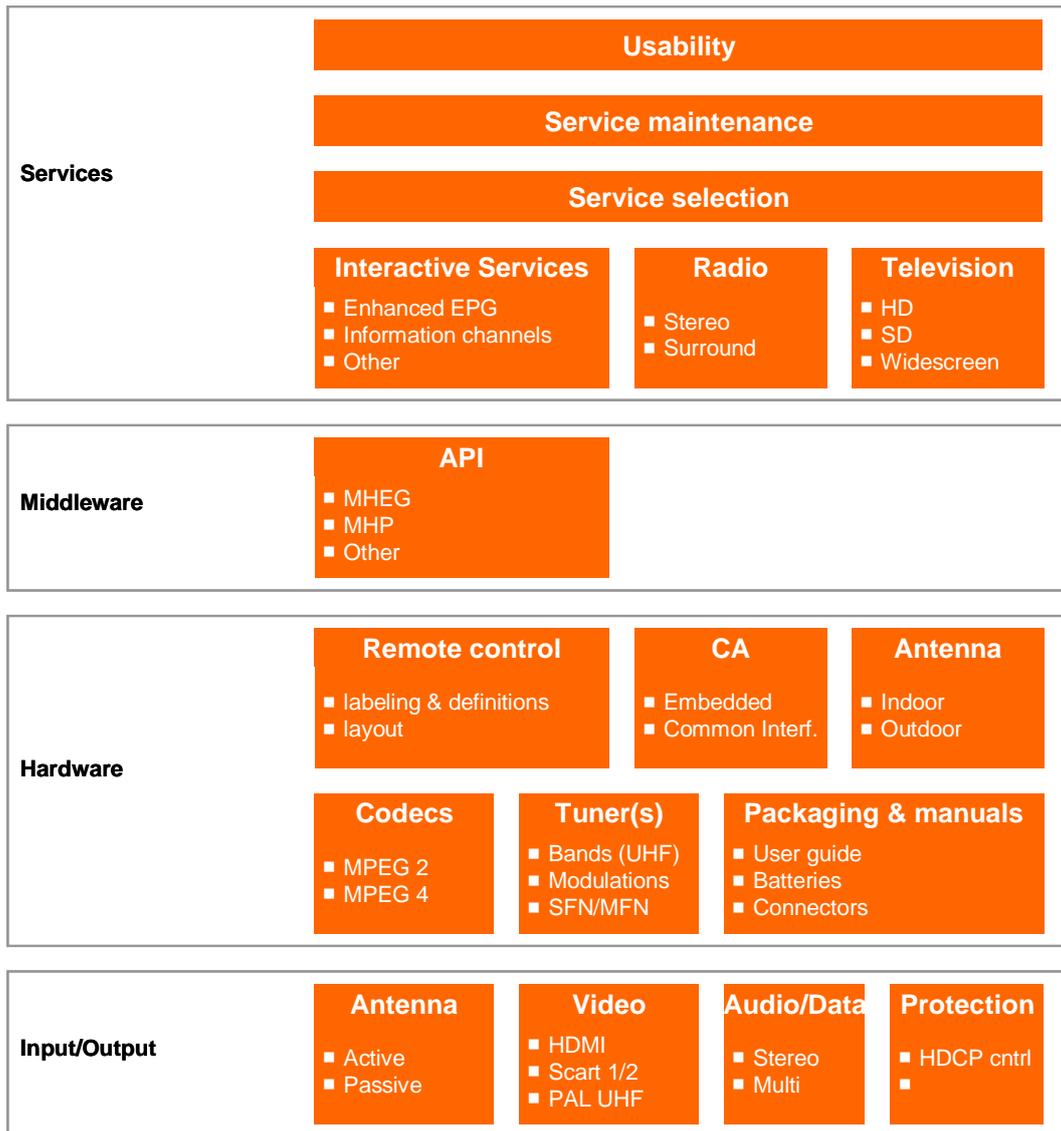


Figure 3.3.2: Receiver requirements model

For example, a Service Provider focusing on the competitive advantage of a cheaper television service and offering a single free-to-air bouquet of television and radio channels will not need all functional elements, such as conditional access, middleware and indoor antenna.

As the above figure demonstrates, many combinations are possible and in principle all receiver configurations are available on the market. However, uncommon configurations will have an additional price. DTTB Service Providers with a limited number of forecasted receivers will have to seek existing receiver production lines in order to keep receiver costs down. This might especially be relevant for CA requirements. Receivers with embedded CA are cheaper than receivers with a Common Interface (CI), but can only work with the specified CA (which is ordered by individual Service Providers).

For example receiver specifications please refer to:

1. Receivers with CA for HD services): Teracom’s minimum receiver requirements for the DTTB networks in Sweden, Denmark and Ireland³⁰;
2. Receivers without CA for HD services: Freeview New Zealand set-top-box requirements for the DTTB network in New Zealand³¹.

The following table provides an overview of either ex-factory or retail price ranges³² for different DTTB receivers³³. As receiver prices keep dropping, the table’s purpose is to provide an impression of the price differences rather than absolute figures.

Table 3.3.1: DTTB receiver price ranges

Receiver type	Minimum ex factory price range	Minimum retail price range
Set-top-box, no CA, MPEG4, DVB-T		\$ 70 - \$ 80
Set-top-box, no CA, MPEG2, DVB-T		\$ 30 - \$ 40
Set-top-box, CA, MPEG2, DVB-T	\$ 25 - \$ 30	
PVR, CA embedded, MPEG2, DVB-T		\$ 130 – \$ 150
USB stick, no CA, MPEG2, DVB-T		\$ 30 - \$ 45

3.3.2 MTV function receiver requirements and availability

Mostly MTV receivers are compact digital television receivers integrated into a mobile phone/handset³⁴. However, market developments show that compact MTV receivers are also built into other devices like navigation, Portable Media Players (PMP or MP4) and game devices. Taking the same approach as that for DTTB, the MTV Service Providers should define the functional requirements for each included terminal type.

Mobile phone terminal producers consider the digital television functionality as an add-on functionality (like photo camera and navigation functionality). Consequently, a major part of the MTV terminal’s functionality is given and is actually driven by other consumer demands and very often by a separately defined Service Proposition. As indicated in the Implementation guidelines in the previous section, Service Providers should consider an integrated approach to defining the Service Proposition. The necessity for such an approach will become apparent when defining the functional requirements of the MTV receiver.

In addition to the DTTB functional model (see figure 3.3.2)³⁵, MTV services have some specific handset functionality and requirements for the Service provider to consider:

³⁰ See www.teracom.se/pub/8626/Teracom%20DTT%20receiver%20spec%20v2.0%20Aug%202008b.pdf

³¹ See www.freeviewnz.tv/images/uploads/file/FreeView%20DTT%20Receiver%20Spec%20v1_3.pdf

³² Ex-factory costs cannot be easily derived from (unsubsidized) retail prices. As a rough estimate one can say that the retail prices are approximately double the ex-factory prices.

³³ Not including antenna or smart card.

³⁴ Including separate MTV receivers which can be connected to the mobile phone using a wireless connection like Bluetooth.

³⁵ Please note: without functional requirements for the remote control. For middleware, hardware and in/output different technical specifications apply.

1. Interactive television services. Interactive services using a return channel will require specific functional requirements. For example, when viewing a live sports event, functional specifications need to be drafted for when/how additional or interactive information can be retrieved or sent (like match statistics, on-line betting, chat with other fans, etc.);
2. Prioritization between television and other phone services. For example, should an incoming call or text message override/stop the viewing;
3. Service ordering and billing. The MTV enabled phone can also be used to order television services (e.g. pay-per-view services). Such functionality on a handheld is relatively new as it will have to interact with the broadcast network. Also the billing of all phone related services should preferably be integrated to one billing platform;
4. Battery consumption. MTV devices are battery operated devices and functional requirements should be drafted for minimum stand-by time and viewing hours. Also some requirements are needed for battery consumption notification and saving energy for critical services (for example, the television services should not exhaust all battery power, so that viewers can still make a call);
5. Channel selection and zapping speed. Although also included in the DTTB functional model, MTV services require special attention for this functionality. MTV zapping time might be (too) long. A dynamic zapping service could help out. The main purpose of a dynamic zapping service is to give the user quickly an impression about the current content of the associated MTV service. The dynamic zapping service can carry different types of content such as a current snap shot, video or sound with reduced quality and data rate;
6. Conditional Access (only relevant for pay-services). From a commercial perspective the key question is whether the MTV service is going to be a terminal locked-in service or not. In other words can the MTV enabled device be used between different Service Providers? As addressed in section 2.1 of these guidelines, two basis options are available:
 - a. SIM card based and handset independent solutions;
 - b. CAS based and handset embedded solutions.

MTV receivers are commercially available for the different transmission standards. In the table below an overview is provided of manufacturers of MTV enabled devices and the standards they support.

Table 3.3.2: Manufacturers of MTV enabled devices

Manufacturer	Example models	Transmission standard(s)
Carmin	Nuvi900T (navigation)	DVB-H
E-Ten	Glofiish V900	DVB-T
Gigabyte	GSmart t600	DVB-T, DVB-H and T-DMB
HTC	Whitestone (n.a.)	Either DVB-H or Mediaflow
LG	Invision, LU1400, HB620T, U900	Mediaflow, T-DMB, DVB-T, DVB-H
Motorola	Krave, ZN4, A680i	Mediaflow, DVB-H
Nokia	N92, N77, N96, SU-33W	DVB-H
Philips	SA065 (MP4 player)	CMMB
Samsung	SGH-P960, Access A827, SGH-F510	DVB-H, Media flow, T-DMB
Sagem	My Mobile TV	DVB-H
ZTE	N7100, PM4 players	DVB-H, CMMB

The current MTV devices (and chipsets) have reached satisfactory performance levels and are commercially available for any market in the world. However, the range of MTV enabled mobile phones is still limited (< 1 per cent of the available mobile phones is MTV enabled). Regionalization of technology standards for broadcast mobile television seems to divide the current MTV terminal market. The following MTV standards exist:

1. DVB-H and T;
2. MediaFlo;
3. T-DMB;
4. ISDB-T
5. CMMB³⁶;

As mobile operators subsidize handsets between the various services no reliable public data is available on the additional ex-factory prices for equipping mobile phones with a MTV receiver. However industry analysts estimate that, with large quantities, the additional costs of a MTV receiver (tuner plus demodulator) will likely be priced in the range of USD 10-15 in mass production.

The Korean market seems to prove these low additional costs. In this market there are a total of 125 different T-DMB devices manufactured by more than 60 vendors. The device types range from mobile phones and car satellite navigation units to PMPs, laptops, USB sticks, portable TVs and even fixed phones and cameras. Prices of T-DMB devices range from USD 150- 300 for portable TVs and sophisticated PMP devices to less than USD 60 for the lowest cost mobile phone and under USD 30 for the cheapest USB stick.

Also in the Chinese market MTV receivers are sold for similar price levels. For example, in Shanghai, shops sell CMMB-equipped PMPs and GPS devices, priced between USD 115 to 400 and manufactured by Philips, Shinco, Wanlida Group and Aigo, among others.

3.3.3 Implementation guidelines

The following guidance can be provided:

1. Consider receiver purchasing as an iterative process between the Service Proposition design and the Business Case development (see figure 3.3.1). As an alternative to the Service Proposition driven approach, Service Providers could consider reviewing receiver availability first and adjusting the Service Proposition accordingly. This might be an apt approach for markets with low levels forecasted for receivers or for MTV markets;
2. Service Providers having their competitive advantage in low costs should consider checking existing receiver production lines, especially when conditional access (CA) will have to be embedded in the receiver. In addition, only include CA requirements when the business model includes pay-services and the additional revenues of these services outweigh the extra CA costs.
3. In the case where receiver manufacturers are invited to give production proposals (see step 4 in figure 3.3.1), draft detailed functional requirements and technical specifications so as to make comparison possible and to avoid unexpected functionality;
4. Check legal requirements for embedding CA. Although embedding CA is, in most cases, far cheaper than applying a Common Interface (CI)³⁷, legal requirements might stipulate the

³⁶ Three other competing standards exist in the Chinese market: DMB-TH, T-MMB and T-DMB.

³⁷ Service Providers offering CA on the basis of CI will have to supply the CI module (CIM), next to smartcard. The CIM costs are extra as compared with an embedded solution. A CIM costs around USD 50-80, depending on ordered volumes.

adoption of CI. For example in Europe, Integrated Digital Television sets (IDTVs) with a screen size above 30 cm should be equipped with a CI slot.

5. Service Providers should determine which receivers will be supported (certified) or purchased. For pay-tv Service Propositions the number of receivers is normally limited to set-top-boxes (STBs) and personal video recorders (PVRs). For free-to-air Service Propositions the range of receiver types can be very wide and normally covers all four different receiver types. It should be noted that certification of receivers by Service Providers could be an expensive operation and should be carefully considered. In addition the legal framework for certification should be checked.

3.4 Business planning

Any DTTB and MTV business planning process will result in a plan for launching or introducing DTTB and MTV services in a defined market, including a set of business goals, the way they can be achieved and the required (financial) means. This DTTB/MTV launch plan is very often a business plan in the case of external funding.

In the DTTB/MTV business planning process three key deliverables or milestones can be identified:

1. Agreement on the *business model* between the involved parties in the value chain. Basically this entails what each involved party will deliver and what the source of income (and the associated costs) will be;
2. Finalized *business case* for each (set of) Service Proposition(s), detailing the associated revenue streams and costs. A business case is very often a spreadsheet model including the profit and loss statement, cash flow statement and balance sheet. In most cases, this spreadsheet model is also used to carry out a financial scenario and sensitivity analysis;
3. Agreement on a final *business plan* between the business plan investors (and possibly management). For a business plan there is no standard format, but normally such a plan includes:
 - a. Mission, strategy and objectives statement;
 - b. Market and competition analysis;
 - c. Service Proposition definitions and market projections;
 - d. Service Proposition delivery, means and organizational set-up;
 - e. Management structure and team;
 - f. Financial projections, analysis and funding.

This section will focus on the first two steps for the introduction of DTTB and MTV services. This section is structured as follows:

1. Business models for DTTB services;
2. Business models for MTV services;
3. Example business cases;
4. Implementation guidelines

3.4.1 Business models for DTTB services

Considering the DTTB business model the key question for DTTB Service Providers is really whether to launch a multi-channel offering on the basis of a free-to-air (i.e. a business model on the basis of

advertising income) or a pay-tv model (i.e. a business model on the basis of subscriptions)³⁸.

In countries with the analogue terrestrial platform as the main delivery platform (i.e. delivering one to four/five television channels) and with a limited pay-tv offering in the market (i.e. a low penetration level) the preferred position might be a free-to-air (FTA) offering. However, whether a FTA or a pay-tv offering can be success depends on various factors, including:

1. For FTA models:
 - a. Additional viewers or viewing hours. Any FTA proposition will have to add additional viewers (or viewing hours) not previously addressed by existing platforms. In most cases, in such a FTA model the network transmission costs of the DTTB network have to be financed by the (commercial) Broadcasters on the platform. Adding viewers or viewing hours is not necessarily restricted to unserved viewers (e.g. because the channels are not broadcast on widely distributed networks), but can also be driven by additional (viewing) value for the end-consumers. In France for example, new viewers were attracted by offering a multi-channel HDTV offering;
 - b. Absolute volume of the advertising market and market share for television advertising. Some markets may have limited advertising budgets, which may not cover the additional cost of setting up and running a DTTB services. Please note that also the advertising budget distribution should be considered. In some markets the advertising spend might be proportionally larger than for other media (e.g. such as radio or newspapers). As advertisers are known to be conservative, changing these spend patterns might be a lengthy process;
2. For pay-tv models:
 - a. Other existing pay-tv offerings in the market and their bouquet composition. Existing pay-tv Service Providers might address only the top segment of the market with relatively expensive packages (very often based on exclusive sport rights). There might be room in the market for offering lower-tier packages without exclusive/expensive content. In addition, existing Service Providers might provide a (perceived) bad service, providing a driver for viewers to switch to an alternative television offering;
 - b. Existing free-to-air offerings. The potential market share for pay-tv service might be limited by the existence of widely adopted free-to-air offerings (e.g. satellite channels);
 - c. Existing television content contracts in the market. Especially exclusive content deals might limit the possibility of creating attractive pay-tv packages. conversely, the absence of exclusive contracts might create an opportunity;
 - d. Willingness to pay³⁹ for television content. The willingness to pay is very often historically and culturally determined. Pay-tv Service Providers should carefully investigate paying patterns for television services. Many examples exist of viewers refusing to pay for content (e.g. for live sport coverage).

³⁸ Combined offerings are possible too. For example see the 'topuptv' offering on the Freeview platform (i.e. FTA DTT platform) in the UK. Please notice that his service was launched after the Freeview platform was well established. For more details see www.topuptv.com.

³⁹ Please note that this is different from the ability to pay. In some countries the ability to pay might be relatively low but the willingness to pay disproportional higher. The ratio between willingness and ability can vary significantly from country to country.

In Figure 3.4.1 below a common business model for FTA DTTB is depicted. In this model, the multiplex operation (i.e. the assignment of the available capacity to the different broadcasters) is carried out by a separate entity from the broadcaster. In the model this functionality is part of the network operator’s activities (see also section 2.2.1 of these guidelines on the value chain and the extra function of the multiplex operator). It should be noted that the function of service provisioning is not included in the figure. Strictly speaking, this function does exist and comprises of platform promotion and providing information on the DTTB service and service activation. Such an entity is very often funded by the broadcasters and network operator. However, there is no service flow through this entity and it is left out for clarity’ sake.

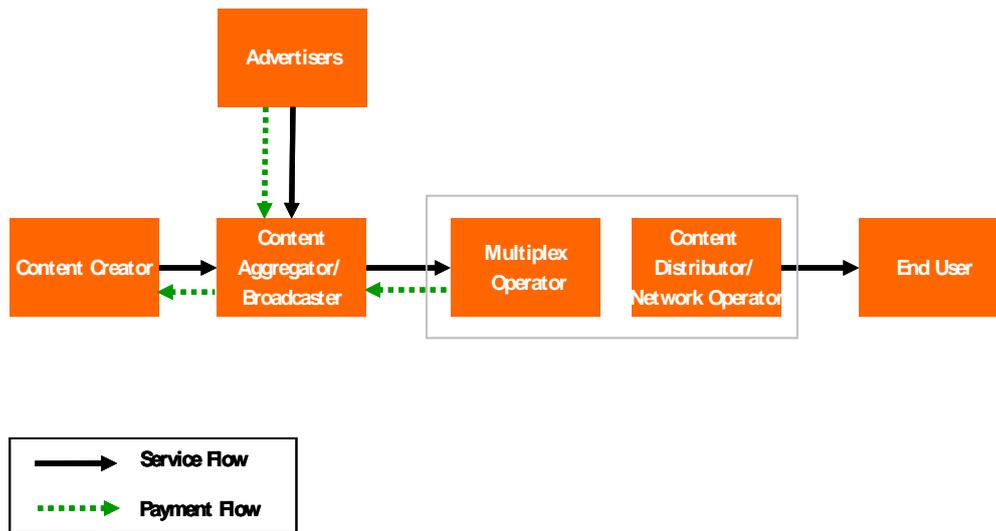


Figure 3.4.1: DTTB FTA business model with separated multiplex operations

An alternative business model for FTA DTTB is that the multiplex operation is assigned (by the regulator) to the Broadcaster. This model resembles the analogue FTA broadcast model and broadcasters tend to adopt such a model quickly. However, such a model may be inefficient from a frequency efficiency point of view and the regulator may not assign in this way. This model is depicted in the figure below.

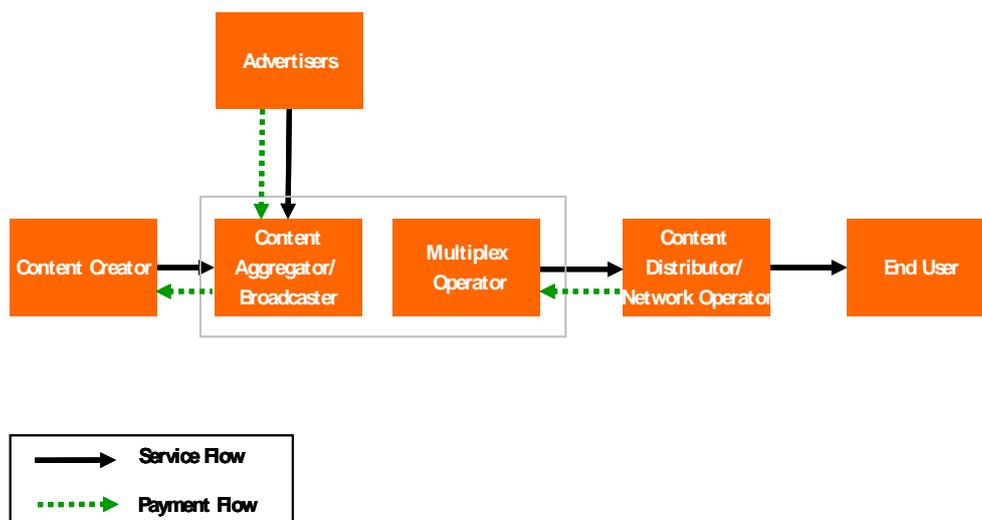


Figure 3.4.2: DTTB FTA business model with multiplex operations with broadcaster

For pay-tv DTTB business models the most common model is depicted in the figure below. In most cases the Service Provider also manages the bandwidth/allocates the available capacity to various services (i.e. the multiplex operations). In this way the Service Provider can optimize the revenues.

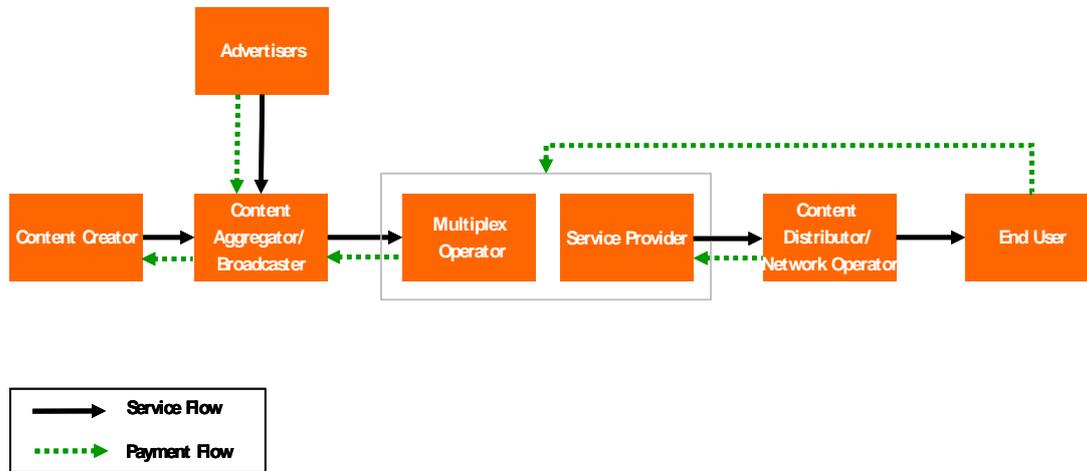


Figure 3.4.3: DTTB pay-tv business model

3.4.2 Business models for MTV services

Also for MTV services the first major consideration is whether the service is going to be launched as FTA or pay-tv service. The considerations for selecting either model, as mentioned in the previous section, are no different. The business models of free-to-air MTV services do not differ from those applicable to any other DTTB service. However, a model where the multiplex operations is carried out by a separate entity (i.e. the Broadcast Network Operator) is more likely to occur (see figure 3.4.1 as opposed to figure 3.4.2).

In a MTV FTA business model the broadcaster provides one or more channels to everybody who owns a device able to receive them. The user can purchase MTV devices in retail shops or any other outlet. Mobile operators may provide/subsidize corresponding mobile devices for up-selling their 3G mobile TV services and also free-to-air broadcast services. The Korean T-DMB offering and the German mobile operators providing their customers with DVB-T enabled devices for the FTA DTTB channels may serve as an example here.

In the case of offering MTV pay-tv services the business models become more complex, especially when a single end-user device delivers two or more pay/subscription services. Most notable the case of delivering mobile and MTV services on handhelds⁴⁰ and having two separate licence holders for respectively the mobile and MTV licence. In such a case the two entities have to share the customer relationship with the end-user and consequently the revenues.

The issue of managing consumer relationships is fundamental. Both broadcasters and telecom operators have long and successful relationships with their respective viewers and customers, but may have initial difficulties in finding a business model where they must cooperate. There are several players in the value chain of both the broadcast and mobile industry that can take on the role of managing the customer relationship (i.e. sell the MTV services). Through (intense) negotiations the allocation of MTV customer management (and hence the resulting business model) is settled, very often prior to assigning the MTV licence.

⁴⁰ This might also be the case for navigation systems or MP4/PMP players.

The assignment procedure determines to a great extent what business model will arise. Basically by stipulating:

1. Who is allowed to acquire the MTV spectrum: are there any parties excluded from bidding (either in a public tender or auction)?
2. What part of the spectrum is a single bidder allowed to acquire: how many MTV multiplexes or parts/slots of a multiplex?

If spectrum is open to any qualified bidder (i.e. the essential criteria, see section 2.6.1 of these guidelines) the following entities could manage the customer:

1. Mobile network operator (including the service provisioning for mobile services);
2. Pay-tv Service Providers;
3. Broadcast network operators.

In principle each of these entities can provide MTV services exclusively to its customers. Under such a vertical approach competition is only possible if several multiplexes are available to be used in different value chains. This may lead to an inefficient use of spectrum as the same channel might be broadcast several times (see also section 2.6 of these guidelines).

Today in most of the markets only one multiplex is available, at least before ASO. Hence regulators tend to prefer a shared network model, where an independent MTV network provider facilitates several MTV service providers on the MTV platform. Such a situation will result in a different business model too.

In the following paragraphs four possible business models are briefly outlined⁴¹:

1. Mobile network operator led model;
2. Pay-tv Service Provider led model;
3. Broadcast network operator led model;
4. MTV broadcaster led model;
5. Shared MTV network model.

Mobile network operator led model

The mobile network operator handles the role of the MTV Service Provider. The mobile network operator manages the end-relationship with customers on service provision, marketing and customer care. For the MTV service, the mobile network operator will need to purchase some content from broadcasters and possibly other content providers. Based on an own MTV spectrum licence the mobile operator may also play the role of broadcast network operation using its existing mobile network infrastructure. Alternative the mobile operator is using the services of a third party broadcast network operator who either owns a frequency licence or uses the licence of the mobile operator.

Customers will have access to an integrated service proposition (i.e. mobile phone and MTV services). The mobile network operator will receive service fee payments for the use of the MTV service from the end-user (e.g. subscription fees, pre-paid or pay per view). The figure below depicts this business model.

⁴¹ Partly taken (and adjusted) from BMCOForum, 'Mobile Broadcast Business Models', September 2008.

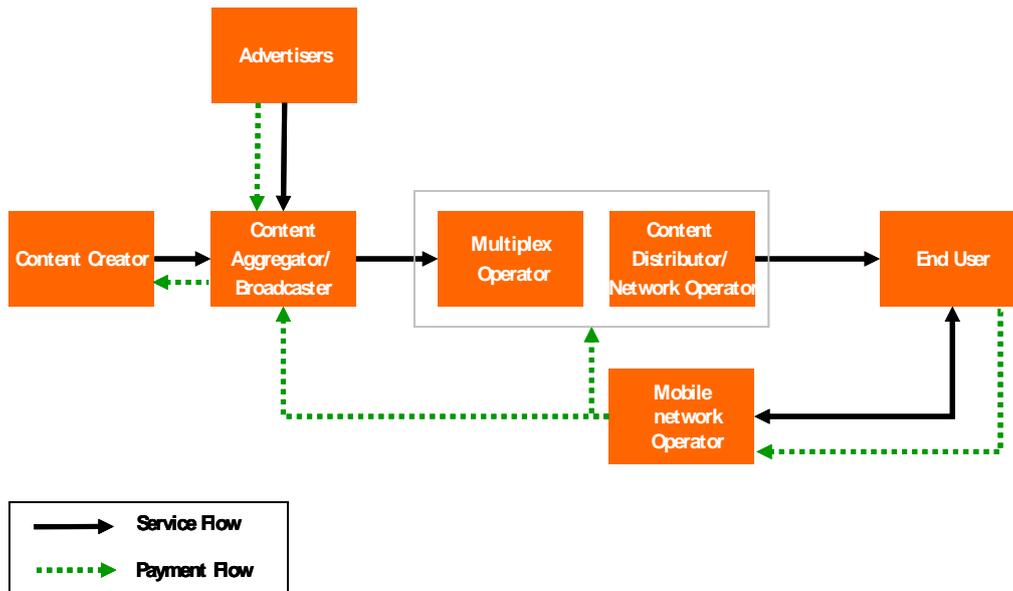


Figure 3.4.4: MTV Mobile network operator led business model

While the mobile network operator would be responsible for general marketing, it could be possible for broadcasters to market individual pay-tv television channels. However the mobile network operator would remain responsible for the billing of those services. Revenues would be shared.

The mobile broadcast services of Hutchison 3 Italy and SK Telecom (branded TU Media, however based on S-DMB) may serve as examples for the mobile operator led model.

Pay-tv Service Provider led model

Pay-tv service providers may be interested in providing mobile broadcast services as an extension of their stationary pay-tv services. In this model the pay-tv service provider handles the role of MTV Service Provider by managing the end-relationship with customers on service provision, marketing and customer care.

Normally a pay-tv Service Provider will use the services of a third party broadcast network operator who either owns a frequency licence or uses the licence of the pay-tv Service Provider.

Being in the role of MTV Service Provider, the pay-tv Service Provider will define the specifics of broadcasting and service purchase and protection. This is likely in markets without subsidizing of mobile phones (e.g. in Belgium). The figure below depicts this business model.

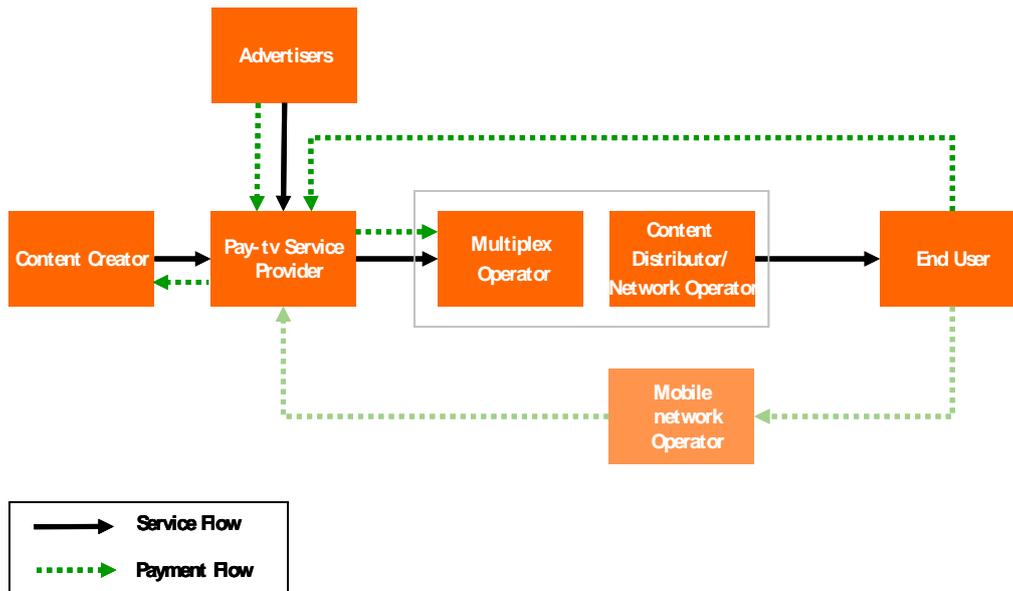


Figure 3.4.5: MTV pay-tv Service Provider led business model

Given the expected initial high cost of MTV enabled receivers, subsidizing the handset is likely to be necessary. It remains to be seen whether such handset subsidies are financially viable in the case of one single revenue (pay-tv) stream. Also, for interactive services, the Pay TV service provider will need to enter into an agreement with the mobile network operator regarding the device technology.

So far, no commercial Pay TV provider led model has been implemented.

Broadcast network operator led model

Broadcast network operator may be interested in providing mobile broadcast services to their stationary access network customers. Two examples here are the attempts of the US cable networks and the Belgium cable networks to respectively win back young customers by providing them MTV services or to extent the distribution of their service over all available platforms.

The model is similar to the pay-tv Service Provider led model. The Broadcast network operator handles the customer relationship and all associated activities of marketing and customer care. Cable and satellite network operators providers may use the services of a third party broadcast network operator who either owns a frequency licence or uses the licence of the cable/satellite network operator. Figure 3.4.6 depicts such a business model.

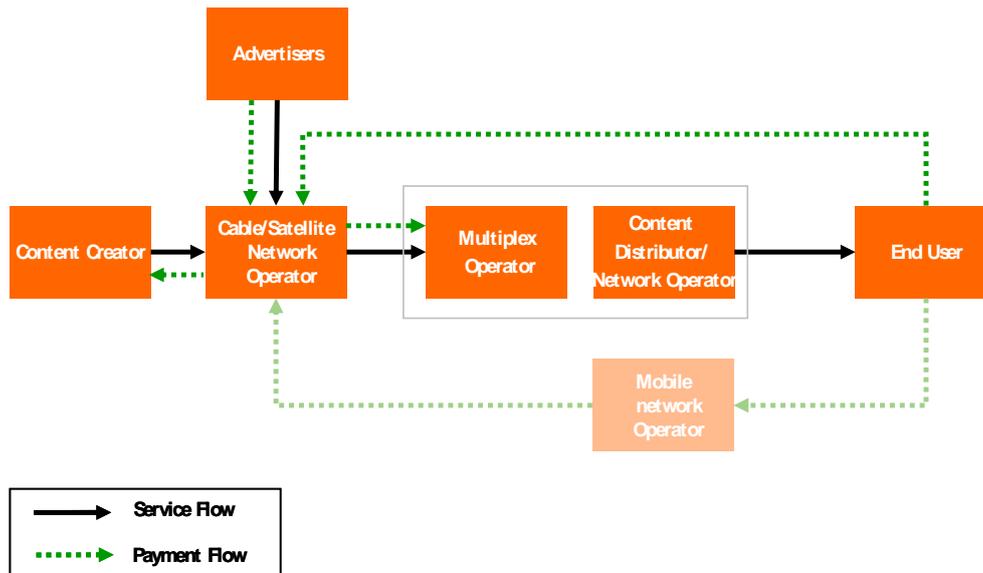


Figure 3.4.6: MTV Broadcast network operator led business model

For interactive services the Broadcast network operator will need to enter into an agreement with the mobile network operator regarding the device technology. As an alternative, the Broadcast network operator could obtain the status of a mobile virtual network operator (MVNO) or use premium SMS.

No commercial Broadcast network operator led business model has been implemented yet. Please note that competition law may stop such a model as no single entity might be allowed to control more than one broadcast platform. Hence cable/satellite network operators may be excluded from the MTV public tender or auction.

MTV broadcaster led model

In Korea and Japan, a FTA business model for MTV services is applied. Basically this model is not different from the FTA models as applied for DTTB services (see previous paragraph). In the MTV markets of T-DMB in Korea and One-Segment in Japan, the MTV services are offered for free to the end-users. The MTV broadcasters own the (MTV) content and also directly operate their own MTV network. They directly distribute audio, video, and data (TPEG, EPG, News, Weather, etc) to the MTV viewers through their networks.

In addition, the MTV broadcaster also provides interactive services (e.g. participation in programmes, quizzes, polls, etc.) by using the mobile telecommunication network (return path). They invoice these interactive services/data through the mobile network operator.

Mostly the MTV broadcasters are existing broadcasters that re-transmit their content in prime time over their MTV network. Also some newly produced MTV programmes (news, weather, traffic information, etc.) are broadcast too. In this FTA model, advertising income and fees for interactive/data services are the main sources of income. The figure below depicts this model.

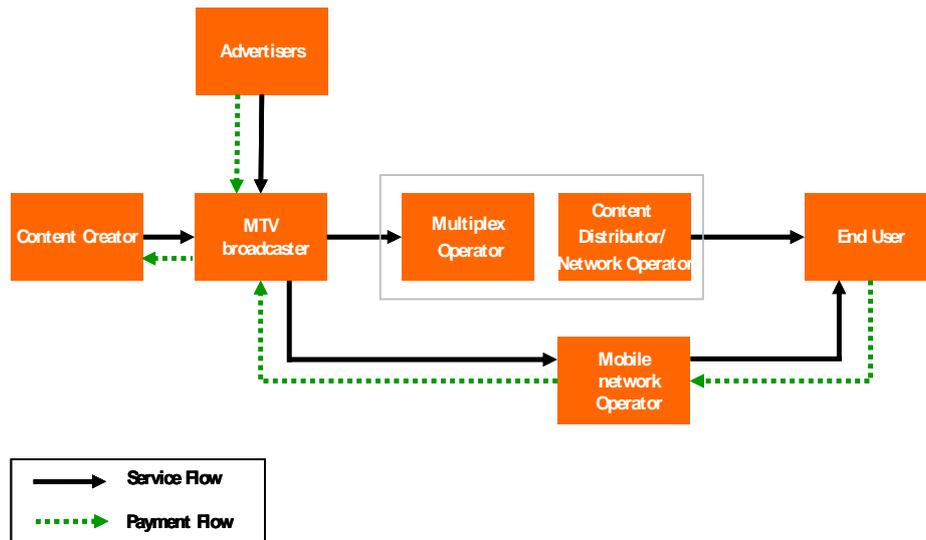


Figure 3.4.7: MTV broadcaster led model

Shared MTV network model

The shared network model is a horizontal business model approach. A dedicated MTV network provider (i.e. the MTV multiplex operator and content distributor/network operator) facilitates broadcasting to mobile devices and so provides shared network offers to various MTV Service Providers (including for example Mobile network operators or pay-tv Service Providers).

Customers of each of the MTV Service Providers will have access to a package contracted by the Service Provider. The packages and the service offer of the various MTV Service Providers may differ in some parts, e.g. in bundling them with other services in different manners. The service packages might be branded differently, allowing for individualized and segment specific marketing.

The MTV Service Providers manage the end-relationship with customers and are responsible for service provision, marketing and customer care.

The dedicated MTV network provider will define the specifics of broadcasting and protection technologies, likely in cooperation with the MTV Service Providers. Hereby the MTV network provider has to take into account the special technical requirements of the MTV Service Providers (e.g. provision of service for connected and unconnected devices).

Figure 3.4.8 depicts this shared MTV network model.

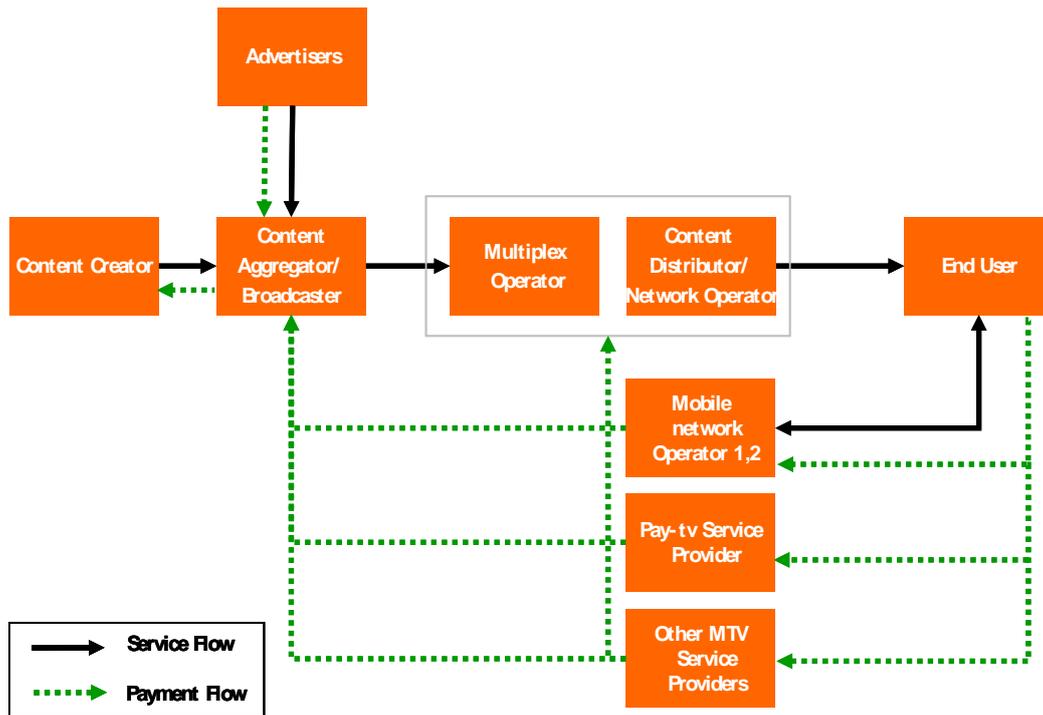


Figure 3.4.8: Shared MTV network business model

While the MTV Service Providers would be responsible for general marketing of their competitive services, it could be possible for broadcasters to market individual television channels. The billing could be carried out by one of the Mobile network operator. Revenues would be shared.

Variants to the shared network model are:

1. The MTV network provider also purchases channels and sell this MTV services to the end-user;
2. The MTV network provider establishes his own channels, acquiring a broadcast licence if necessary.

In countries like Finland and Austria this share MTV network model is implemented.

3.4.3 Example business cases

Each entity in the DTTB or MTV value chain will have to draft a business case, providing financial projections (like a multiyear cash flow and profit and loss overview), key parameters (like break-even year and return on investment) and sensitivities (like the impact of the top-3 cost and revenue drivers).

The business case results will form an important basis for negotiating the role in the value chain and the mutual service contracts. It is important to note that most involved parties already have a running business. For example a Mobile network operator already has the customer care and billing processes/systems in place or a Broadcaster might already has the content rights and production lines in place. Also terrestrial Broadcast network operators have very often the site infrastructure (partly in) already in place (e.g. towers and antennas).

Consequently, business cases for the introduction of MTV and DTTB are very often on the basis of marginal costs (what extra costs and revenues will be generating from the DTTB/MTV service introduction). Hence, the business case for the same service might vary from entity to entity.

In this paragraph we have included some example (simplified) business cases for a terrestrial Broadcast network operator providing DTTB and MTV network coverage.

A terrestrial Broadcaster network operator planning the roll-out of a DTTB or MTV network will have the following key cost categories:

1. *Head-end*: in the head-end the various programme feeds are collected (from the television studios or from satellite feeds), assembled, encoded and multiplexed onto one or more transport streams (please note that the feeds themselves are not included in the costs);
2. *Distribution*: the multiplexed transport streams are distributed (and monitored) to the transmitter sites in the DTTB and MTV network either through fixed wireless links, fibre or satellite links (either rented, purchase or a combination⁴²). At each site the transport stream has to be delivered (decomposed) in the individual multiplexes;
3. *Sites*: at each site the multiplexes are fed into the transmitters. The transmitter amplifies, modulates and converts the signal the right frequency and the combiner section combines the transmitter outputs to one antenna feed. The antenna on top of mast (or other tall construction) will emit the DTTB/MTV signal (onto various frequencies).

For either a DTTB or MTV service these cost categories exist. The key difference between both network types is really the number of sites and the transmitter sizes (i.e. ERPs). For more details see the Network sections of these guidelines.

For each cost category the DTTB/MTV network provider can either incur Capital Expenditure (Capex) or Operational Expenditure (Opex). These two are interchangeable. For example rather than building a distribution network the network provider can choose to rent such distribution capacity. The same applies to building transmitter sites.

Figure 3.4.9 provides example Capex (excluding replacement investments) and Opex for a DTTB (DVB-T) network with 19 sites (no newly built sites), with 4 multiplexes and with transmitter powers varying between 5 and 20 kW ERP.

DTTB network (4 multiplexes)	Capex		Opex	
	Category	Value	Category	Value
Head-end	€ 2,6 m	Site & housing rental	€ 5,0 m/yr	
Adjustments existing network	€ 1,0 m	Energy	€ 0,2 m	
Head-end	€ 1,6 m	Distribution	€ 1,6 m	
Distribution	€ 1,3 m	Maintenance	€ 1,0 m	
Delivery (and decompose)	€ 1,0 m		€ 2,1 m	
Monitoring	€ 0,3 m			
Sites	€ 12,8 m			
Transmitters and combiners	€ 11,6 m			
Antenna system	€ 1,2 m			
Masts	€ 0,0 m			
Equipment housing	€ 0,0 m			
Total	€ 16,7 m		€ 5,0 m/yr	

⁴² A combined scenario might be the rental of dark fibre (just the fibre connection) and the management layer (switching and monitoring the traffic/transport streams) is carried out by the Broadcaster network operator by means of owned equipment.

Figure 3.4.9: Example Capex and Opex for a small DTTB network

Figure 3.4.10 shows the Capex and Opex for a MTV (DVB-H) network for one multiplex and covering the same population as for the DTTB service in the previous figure. However 39 transmitter sites were required and also some newly built sites were necessary to complete the coverage (40 per cent). Transmitter powers are mostly around the 5 kW ERP.

MTV network (1 multiplex)	Capex		Opex	
		€ m	€ m/yr	
Head-end	€ 0,4 m	€ 3,1 m/yr		
Adjustments existing network	€ 0,0 m	€ 0,4 m	€ 0,4 m	Site & housing rental
Head-end	€ 0,4 m	€ 0,5 m	€ 0,5 m	Energy
Distribution	€ 1,3 m	€ 0,5 m	€ 0,5 m	Distribution
Delivery (and decompose)	€ 1,0 m	€ 1,7 m	€ 1,7 m	Maintenance
Monitoring	€ 0,3 m			
Stes	€ 8,8 m			
Transmitters and combiners	€ 5,0 m			
Antenna system	€ 2,8 m			
Masts	€ 0,6 m			
Equipment housing	€ 0,4 m			
Total	€ 10,5 m	€ 3,1 m/yr		

Figure 3.4.10: Example Capex and Opex for a small MTV (DVB-H) network

Figure 3.4.11 shows the Capex and Opex for a MTV (T-DMB) network for four multiplexes and three transmitter sites. Two sites are high power transmitter sites (respectively 30 kW ERP and 20 kW ERP) and one smaller site of 500 W ERP. This network was used to cover a large city (244 km²). Please note that this network should not be compared with the MTV (DVB-H) network in the previous figure as the number of multiplexes, the covered area and the signal strength are different.

MTV network (4 multiplex)	Capex		Opex	
		€ m	€ m/yr	
Head-end	€ 2,8 m	€ 0,523m/yr		
Adjustments existing network (including building adjustments)	€ 1,7 m	€ 0,013 m	€ 0,013 m	Site & housing rental
Head-end	€ 1,1 m	€ 0,05 m	€ 0,05 m	Energy
Distribution	€ 0,2 m	€ 0,36 m	€ 0,36 m	Distribution
Delivery (and decompose)	€ 0,0 m	€ 0,1 m	€ 0,1 m	Maintenance
Monitoring	€ 0,2 m			
Stes	€ 1,19 m			
Transmitters and combiners	€ 0,75 m			
Antenna system	€ 0,15 m			
Masts	€ 01,6 m			
Equipment housing	€ 0,13 m			
Total	€ 4,19 m	€ 0,523 m/yr		

Figure 3.4.11: Example Capex and Opex for a city MTV (T-DMB) network

Very often the DTTB/MTV network provider will charge a monthly charge for the DTTB/MTV network services⁴³. Hereto the DTTB/MTV network provider has to calculate a monthly fee on the basis of:

1. Weighted Average Cost of Capital (WACC) or required return on investments (very often in the range of 12 – 18 per cent);
2. Contract duration and hence the depreciation time (for each network element ranging from 3/5 years for multiplexers and 25/30 years for towers);
3. Margin on the Opex;
4. Percentage of overhead costs.

The DTTB/MTV network operator actually sells population coverage for a fixed amount per year or month. As a result of its unique position in the French market, TDF is the main source of estimates on transmission fees for MTV (DVB-H) deployment. The estimates in Table 3.4.1 were supplied in October 2007⁴⁴.

Table 3.4.1: TDF transmission fee estimates for MTV network services

Outdoor coverage	Indoor coverage	Cost/channel/year
30 per cent of the Population (France)	Good	EUR 4 m
	Deep	EUR 6 m
50 per cent of the Population (France)	Good	EUR 6 m
	Deep	EUR 8 m
Good indoor is reception at up to six meters from the window and includes the ground floor. Deep indoor is reception in all rooms, including those without a window and the ground floor.		

3.4.4 Implementation guidelines

The following guidance on business planning can be provided:

1. Study and understand the implications of the regulatory framework before any business model negotiations are started. The possible DTTB/MTV business models are largely determined by the regulatory framework (see section 2.2 of these guidelines) and the assignment procedure (see section 2.5);
2. Consider and evaluate the provided factors (see paragraph 2.4.1) for adopting a FTA business model. Although for DTTB services the FTA model seems to be the 'default' model, in some markets the FTA model might not work;

⁴³ Revenue sharing models are also possible. Under such an agreement the DTTB/MTV network provider is paid on the basis of the number of MTV/DTTB subscribers (for example a fixed amount per subscriber). As a variant on this variable model, the DTTB/MTV Service Provider and the DTTB/MTV network provider can agree a fixed monthly fee which is topped-up with a fee per subscriber. In such models the DTTB/MTV network provider should really have a say in the DTTB/MTV service provisioning.

⁴⁴ See EBU Strategic Information Service, 'Mobile broadcast television in Europe', January 2008, p41.

3. Keep all options open for selecting a business model for MTV services. Although the pay-tv model seems to be adopted in many countries⁴⁵, the challenge for MTV services is to find a viable or sustainable business model. Many industry analysts have commented on the lack of a viable MTV business model and no ready-made answers are available. In any model, MTV services will require a long planning horizon and possibly synergies with other revenue streams/business lines. At the moment only strategic investors seems to comply with these requirements;
4. Reserve enough time for business model negotiations (or prepare in advance). Given the available regulatory room for negotiations, business model negotiations can be very lengthy. Especially for MTV markets, where many different players can be involved, the negotiations can be complex. In some countries negotiations have lasted over one year (or more). In contrast with enough regulatory pressure (i.e. very short time between MTV licensing publication and the deadline for handing in the bid), business models and contracts can be agreed in a short time. For example in Austria pre-bid contracts were negotiated in three months.
5. Settle the content rights before launching any service. Also in a FTA model (subscription based) interactive services (like interactive overlays or push VOD) content rights should be carefully settled. It may be that content/rights owners might claim a share of these additional revenues. The same applies to having additional advertising space on the EPG. The commercial broadcasters on the DTTB/MTV platform may stop this or claim a revenue share.
6. Not only calculate your own business case (depending on your value chain position), but check whether the additional DTTB/MTV costs in the whole value chain can be covered by additional income. In the most favourable situation, where all involved parties can deliver their services against very low or null marginal costs, the DTTB and MTV network investments remain the major investment hurdle (for more detail see paragraph 3.4.3).

3.5 End-consumer support

End-consumer support is part of the DTTB/MTV Service Provider's customer relationship management (CRM) process comprising normally the following interrelated sub-processes:

1. Subscription management: the process of handling and administrating subscribers' service requests, service change requests and service cancellations/subscription terminations;
2. Order management and fulfilment: the process of collecting, scheduling and executing service and change requests generated by the subscription management process;
3. Catalogue management: the process of administrating, introducing and changing the various DTTB/MTV service offerings, packages and tiers and pricing and discount schemes;
4. Marketing campaign management: the process of managing periodical or one-off campaign/promotion events;
5. Customer Service and support: the process of handling customer questions and support requests (e.g. technical problem resolving, organizing installation services, etc.);

⁴⁵ See for example Austria, Italy, France, Switzerland and the Netherlands. Please note that Mobile operators offering the MTV service for free in combination with a (more expensive or longer) mobile phone contract actually represents an implied price for the MTV service. In contrast, in Korea, Japan and China, MTV services on terrestrial networks are offered for free (i.e. advertising based model).

6. Service provisioning: the process of the actual service activation in the conditional access system (CAS) and inserting the encryption keys in the broadcast signal. In addition, service provisioning includes the smart card and receiver logistics.

In good business practice, any customer support process should be embedded in an overall designed and detailed CRM business process. In the digital television industry these CRM processes can be (partly) supported in the so-called subscriber management system (SMS)⁴⁶.

This section focuses on the key choices to be made when designing the customer/end-consumer service and support processes for mainly DTTB services and more specifically:

1. Customer call centre operations (as part of the CRM sub-processes of subscription management and customer service and support);
2. Retail shops and other channels (as part of the CRM sub-process of subscription management);
3. Service availability checks and tools (as part of the CRM sub-process of subscription management);
4. Smart card and service activation (as part of the CRM sub-processes of service provisioning).

It should be noted that for MTV services with a mobile network operator led business model (see previous section) the CRM processes are largely already in place and the functionality does not change in essence. In these situations the MTV service has to be integrated into the existing CRM processes. As indicated before a 'mediation' platform can take care of this system integration.

This section of the Guidelines is structured according to the above four key choices. This section is completed with Implementation guidelines for end-consumer support.

3.5.1 Customer call centre operations

Customer call or contact centres are vital to the acquisition, retention and growth of the customers base. A badly run customer call centre can hamper the take-up of even the best quality DTTB/MTV services.

In most cases, the customer call centres carry-out the following functions in the CRM process:

1. Handling and administrating subscribers' service requests, service change requests and service cancellations/subscription terminations, including also activities such as:
 - a. Placing outbound calls to check client satisfaction just after services activation;
 - b. Generating and changing client profiles (e.g. address changes, service changes and service usage statistics);
 - c. Placing outbound calls for selling additional services or for carrying out periodical customer satisfaction surveys;
2. Handling customer questions and support requests, including activities such as:
 - a. Resolving billing issues and refunds;
 - b. Service activation, picture quality and reception problems/complaints;
 - c. Handling customer receiver installation requests.

When starting a new DTTB /MTV service the Service Provider will very often face the dilemma of outsourcing the customer call centre activities or keeping the activities in-house. The required

⁴⁶ Example SMS suppliers are Convergys, Nagravision, CSG Systems, Multichoice, but also the main stream CRM providers like Oracle, Siebel and SAP.

number of staff for this function can be relatively large and hence many DTTB/MTV Service Providers have outsourced (partly) this function to an external outsource partner. There is no standard receipt for deciding whether this function should be outsourced or not.

When considering call centre outsourcing the following factors may play a role in the decision making process:

1. *Financial factors*: the DTTB/MTV business plan investors might require a flexible approach with low levels of financial commitment, either by having limited investments in supporting equipment/systems or (long term) personnel contracts;
2. *Scalability factors*: the forecast subscriber numbers may vary considerably and can pose a risk of not being able to handle peak customer care traffic. A scalable solution might have to be sought in a (larger) outsourcing partner. Also, the lack of qualified people or ability to quickly train (large numbers of) people might be a serious consideration;
3. *Current assets and migration risks*: the DTTB/MTV provider might already have a customer call centre in place (for other lines of business) or might have subsidiaries carrying out these activities. Integration of the DTTB/MTV call centre activities into the existing business might be an attractive option in terms of speed and investments needed. However, migration risks have to be evaluated too (especially for running the call centre business);
4. *Service and customer insight considerations*: a host of considerations fall under this category including:
 - a. DTTB/MTV network and service deployment: the network roll-out may not be completed yet and the exact timing and transmitter locations might be unknown. Also the Service Provider would like to test various Service Propositions to find out the best offering. Under such conditions the Service Provider might be inclined to keep the call centre activities in-house. In this way the Service Provider can build up customer insight quicker (at a later stage outsourcing might be easier);
 - b. Complexity of the DTTB/MTV service: complex service offerings (many service tiers, varying discount schemes, many receiver types and different service outlets) might stop the Service Provider from outsourcing the call centre activities at the time of launching the DTTB/MTV service. However, with the availability of current SMS/CRM solutions in the market, the associated business processes can be well supported and the risk of customer dissatisfaction or churn can be minimized;
 - c. Service ease of use: Service Providers supplying just digital converters or zapping boxes (i.e. set-top-boxes with the basic functionality) which are basically 'plug and play' receivers might tend to outsource quicker. However, the call volumes should not be under-estimated even with the simplest service. For example, it is not unusual that the most logged customer problem is the 'upside-down' insertion of the smart card in the set-top-box.

An intermediate position in this outsourcing predicament is to split the call centre functions in a first-line and a second-line call centre. The first-line call centre is then outsourced and handles the repetitive and automated tasks (like handling and administrating subscribers' service requests, service change requests and service cancellations/subscription terminations). The more complicated tasks and those activities closely related to building up customer insight can be kept in-house in the second-line call centre (for example dealing with customer questions and support requests).

3.5.2 Retail shops and other channels

In many cases the retail shops (like consumer electronics, super markets, mobile phone shops or DTTB/MTV branded shops) form the first outlet for DTTB/MTV customers to acquire the services (initial sales).

Next to the retail shops the following customer channels are also commonly applied:

1. Customer contact centre (see above);
2. Internet/website.

Retail shops (and other channels) selling DTTB/MTV services can carry out the following functions (depending on the overall CRM process design):

1. Service demonstration and explanation;
2. Receiver (including antenna) and smart card logistics and supply (possibly including a second smart card for a second television set);
3. Customer and subscription registration, including identification and credit check (registration can either take place by an automated interface with CRM/SMS system or by fax).

When designing the service channels for the DTTB/MTV services, the Service Provider should consider the following specific aspects:

1. *Commissioning structure*: what are the fees for the retailer to sell a receiver, subscription and/or deliver a smart card? Often the retailers already sell other (digital television) offerings and the commissioning structure should be competitive. Consequently, the commissioning structure is an important cost item in the business case. When a commission structure is agreed with the retailers, launching Internet sales or sales by outbound calling of the customer contact centre might raise conflicts with the contracted retailers;
2. *Product training of retailers*: in 'road shows' the various retailers should be trained on the product, even when they are already familiar with selling other digital television offerings. DTTB/MTV services have some specific product characteristics (like the reception mode and in most case the lack of interactivity). Outlets could be numerous and a 'train the trainer' approach is often needed. However the needed resources and the time to run the road show shouldn't be under-estimated;
3. *Receiver and smart card logistics*: this logistic process is no different from other digital television offers and is nowadays a standardized process often supported by SMS/CRM systems. However pre-paid cards systems are not that common in the television industry. Also second (and third) smart card provisioning (for example for the 2nd television set) could increase the complexity of the logistics considerably. The retailer should be made familiar with these DTTB/MTV specific processes. Alternatively the receiver and smart card processes could be outsourced to a logistic partner;
4. *Systems support*: the contracted retailers are likely to sell other products too. Consequently the sales processes should be simple and the selected CRM/SMS system should support this. Alternatively, a fax procedure could be implemented but is receptive to errors and fraud.

3.5.3 Service availability checks and tools

As mentioned before in this section, DTTB and MTV services have some product specific characteristics unknown with other digital television platforms, most notably the network coverage and reception quality.

Most DTTB/MTV networks do not have a (near) 100 per cent population and/or geographical coverage. Before the DTTB/MTV service is sold to a potential customer the coverage and quality of service should be verified. Moreover, DTTB/MTV networks are often rolled out in stages and frequency changes might occur, changing the network coverage profile.

The two most commonly applied methods for offering a service availability check to consumers are:

1. SMS-messaging over the mobile phone network, and/or
2. Internet/website.

In Figure 3.5.1 such a service availability check is depicted (Boxer in Sweden)⁴⁷.

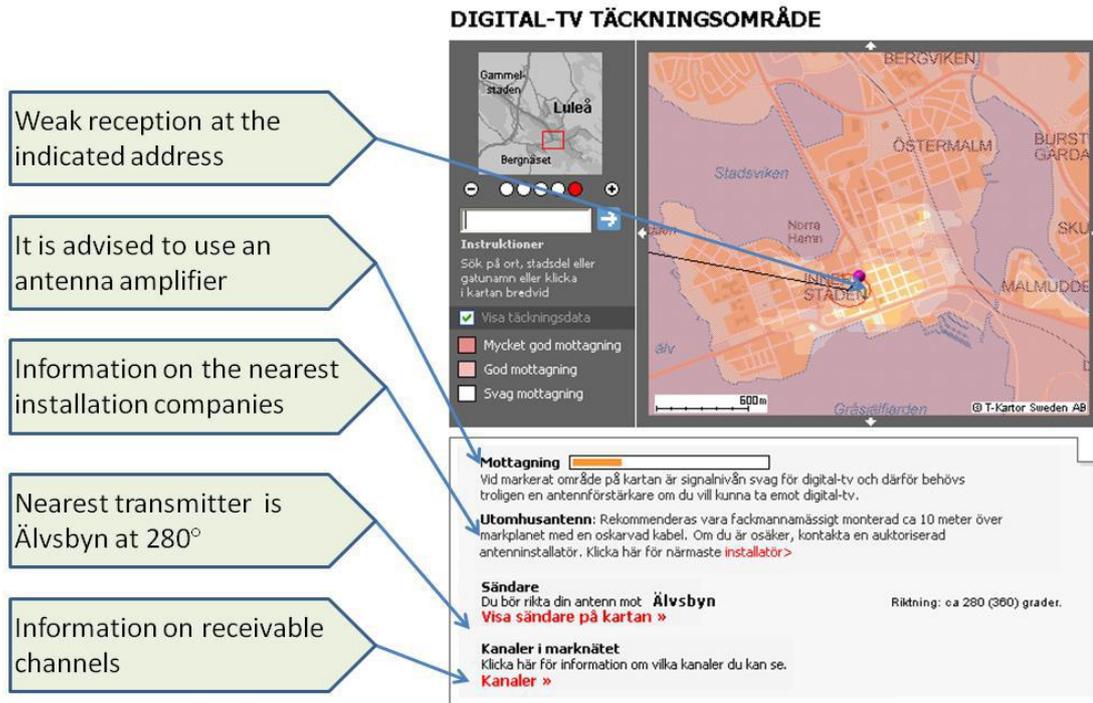


Figure 3.5.1: DTTB service availability check on the website of Boxer (Sweden)

The above figure shows that after entering an address on the Service Provider’s website, the website returns the reception quality plotted on a map. In this example, reception at the entered address is weak and the viewer is advised to use an antenna amplifier. The nearest transmitter (in this case Älvsbyn at 280 degrees) is also indicated. Furthermore, information about the nearest installation companies and the channels that be can be received is available by clicking on the appropriate link.

Ideally the CRM system should support this service availability check. However often this is not the case and a custom built interface is needed. It is critical that this information on service availability is kept up-to-date as it directly impacts sales (it provides a sales advice) and churn (when the sales advice is wrong, selling yes when it is no). At a minimum there should be a procedure in place between the Broadcast network operator (especially the network planning and maintenance department) for exchanging service availability information (including any remedies).

⁴⁷ From the DigiTAG report ‘Networks in Evolution, making changes to the digital terrestrial television platform’, April 2008, available on the website www.digitag.org.

3.5.4 Smart card and service activation

The process of smart card handling and service activation is only applicable for pay-tv DTTB/MTV services. Normally four ways are available to activate the smart card (activation either by the end-consumer or the retailer):

1. Online at the Service Providers website, will allow automatic request handling by the CRM system (standard functionality);
2. Phone, possibly through a Interactive Voice Response system for automatic request handling (standard CRM functionality);
3. Fax, possibly used by retailers without a CRM interface (receptive to error and fraud);
4. Email, a preformatted email will allow automatic handling by the CRM systems (standard functionality).

It is important to keep the requested information to a bare minimum to lower any service acceptance barriers. For basic subscriptions (single smart) the following minimum information should be supplied to the Service Provider's CRM process/system:

1. Name (or other unique identifier) of the retailer the smart card was purchased from;
2. Smart card number;
3. Ordered services or package;
4. Customer's name and address details, including postcode and phone number;
5. Type of decoder/receiver box the client has purchased or is using.

The retailer might ask for identification and the DTTB/MTV Service Provider may carry out a credit check (e.g. with Dun & Bradstreet). When the customer is accepted in the CRM system, the provided information will be 'translated' to the various service activation requests and ultimately the conditional access system (CAS) will make the service technically available to the end-consumer.

To lower the risk of credit default and to reduce smart card handling/activation time (and hence customer waiting/queuing time), pay-tv Service Providers have started to offer pre-paid cards, similar to the pre-paid cards offered by mobile operators. It is important to note that the business case takes such an offer into account by applying higher churn rates and lower Average Revenue per User (ARPU) at an annual basis.

Prepaid systems can be implemented by enabling customers to pay their monthly subscription fees with scratch cards⁴⁸. Scratch cards can be made available from dealers, eliminating the need for customers to wait in queues to pay for their subscriptions (in countries with limited banking facilities). In order to make payments, customers will send the recharge number located on their scratch cards to a designated number of the Service Provider via SMS (Short Message Service). Various cards can be made available for different service packages.

A typical DTTB offering or other digital television offering is to make a second smart card available (for the 2nd television set) to a single subscriber for a reduced price or even without an extra charge. It is expected that the relevance of such a service will become more evident when the analogue terrestrial television service will be switched off (ASO). Viewers can no longer rely on the analogue platform to supply the second or third television set with a television signal. When offering second smart cards there is a higher fraud risk.

⁴⁸ In Kenya the G-UP scratch card was available to all GTV subscribers. Nowadays, GTV is no longer available but the main competitor in Kenya; DSTv has adopted the scratch card approach too.

There is a possibility that the subscriber may try to purchase many cards, and sell most of them to other people at a price which is lower than the regular price, but higher than the price that the subscriber has paid for them. This may cause substantial losses to the DTTB/MTV Service Provider.

The measures to limit the risk of fraud on a DTTB network are limited⁴⁹, they may include:

1. Limiting the number of additional smart cards (to 2 or 3);
2. Differentiating the service offerings between the first and the second smart card. For example the second card does not include the premium channels. However, customer acceptance should be checked (because the second smart card is issued really to resolve the second-set-in-the-home problem);
3. Charging a slightly lower fee for the second smart card (also check customer acceptance);
4. Linking the smart card to the set-top-box identification number (i.e. implementing a sort of 'SIM lock' to the set-top-box⁵⁰). When there is no match the DTTB service will not work. However this might be a problematic solution when the Service Provider also has to broadcast free-to-air channels (the public broadcaster or regulator might not accept such a solution).

Finally, smart card hacking is a widely discussed issue in the pay-tv industry. CAS providers have the primary task to resolve and prevent hacking. Track records are crucial for these CAS providers and when purchasing a CAS these track records should be thoroughly reviewed. It should be noted that in many reported cases the hacking was only of a temporary nature. Changing the encryption keys will normally resolve many of the hacking problems. More serious are those reports of incidents where the Service Provider had to swap the installed smart cards. This is a critical and expensive operation and may result in high churn rates.

3.5.5 Implementation guidelines

The following guidance can be provided for end-consumer support:

1. Design the overall CRM process first and embed the end-consumer support as a sub-process in it. Many process design methods/tools are available for carrying out such a task (often the CRM/CAS suppliers have tools available). A none integrated CRM process can lead to many customer care problems like:
 - a. Selling services that do not exist or are not supported;
 - b. Pricing services wrongly (e.g. not applying tariffs or discounts incorrectly);
 - c. Losing customer sales records and loss of revenue.
2. Design a coherent set of critical performance indicators, when outsourcing customer care activities to an outsourcing partner. Not only indicators for call handling costs and volumes but also indicators to monitor the quality of customer care services (e.g. registration of the subscription duration/churn, levels of customer complaints, etc.). Especially for outbound call activities (for example when acquiring new clients or up-sales) the Service Providers should take special care. Practice has shown that aggressive sales techniques may be applied. Sales figures might go up (temporarily) but churn levels too. Please note that with subsidized/rented set-top-boxes, churn costs per customer can be very high (including the cost of returning boxes, loss of boxes and checking/cleaning of boxes);

⁴⁹ Please note that with digital cable networks (in which each individual subscriber is served by an addressable delivery path), fraud can be limited by linking the smartcard numbers to the delivery address of the subscriber.

⁵⁰ 'SIM locks' are common practice in the mobile industry. SIM-locked handset will stop subscribers taking their subsidized handset to another provider (before a defined period).

3. Only issue a second smart card in those cases where customer/market research has found such a provision to be crucial for the further take-up of the DTTB service. As mentioned in this section, the provision of a second or third smart card is to resolve the 'second-set-in-the-home' problem. In African countries this might be less of an issue as television set penetration is relatively low.

Glossary of abbreviations

3/4-G	Third/Fourth Generation
ASO	Analogue switch-off
BSS	Business Support Systems
CA	Conditional Access
CAPEX	Capital Expenditure
CAS	Conditional Access System
CEPT	European Conference of Postal and Telecommunications Administrations
CI	Common Interface
CIM	Common Interface Module
CMMB	China Multimedia Mobile Broadcasting
CRM	Customer Relationship Management
DMB-TH	Digital Multimedia Broadcast -Terrestrial Handheld
DTTB	Digital Terrestrial Television Broadcasting
DVB-H	Digital Video Broadcasting-Handheld
DVB-SH	Digital Video Broadcasting-Satellite Handheld
DVB-T	Digital Video Broadcasting-Terrestrial
DVB-T2	Digital Video Broadcasting-Terrestrial 2 nd Generation
EBU	European Broadcast Union
EPG	Electronic Programme Guide
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
FTA	Free To Air
GPS	Global Positioning System
HBB	Hybrid Broadcast Broadband
HDCP	High-Bandwidth Digital Content Protection
HDMI	High-Definition Multimedia Interface
HDSPA	High-Speed Downlink Packet Access
HDTV	High Definition Television
IDTV	Integrated Digital Television set
IEC	International Electrotechnical Commission
IPTV	Internet Protocol Television
ISDB-T	Integrated Services Digital Broadcasting-Terrestrial
ISO	International Organization for Standardization
ITU	International Telecommunication Union
LTE	Long Term Evolution
MBMS	Multimedia Broadcast and Multicast Services
MPEG-4-AVC	Moving Picture Expert Group – Advanced Video Coding
MTV	Mobile Television
OPEX	Operational Expenditure
OSS	Operational Support System
PCMCIA	Personal Computer Memory Card International Association
PDA	Personal Digital Assistant
PMP	Portable Multimedia Player
PSB	Public Service Broadcasting
PVR	Personal Video Recorder
ROA	Rank Order and Acceptance
SMS	Subscriber Management System

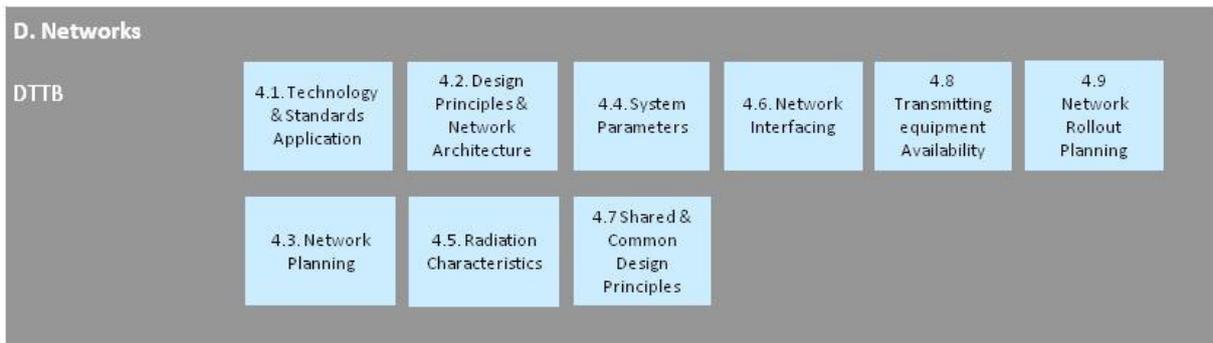
STB	Set-Top-Box
T-DMB	Terrestrial-Digital Multimedia Broadcasting
T-MMB	Terrestrial Mobile Multimedia Broadcasting
TPEG	Transport Protocol Experts Group
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
VOD	Video On Demand
WACC	Weighted Average Cost of Capital

Part 4

DTTB networks

Introduction

Part 4 (DTTB networks) covers functional building blocks 4.1 to 4.9 of layer D of the functional framework described in chapter 1.2. These functional building blocks are depicted below.



The guidelines on key topics and choices of each of the functional building blocks 4.1 to 4.9 are addressed in the subsequent chapters of Part 4.

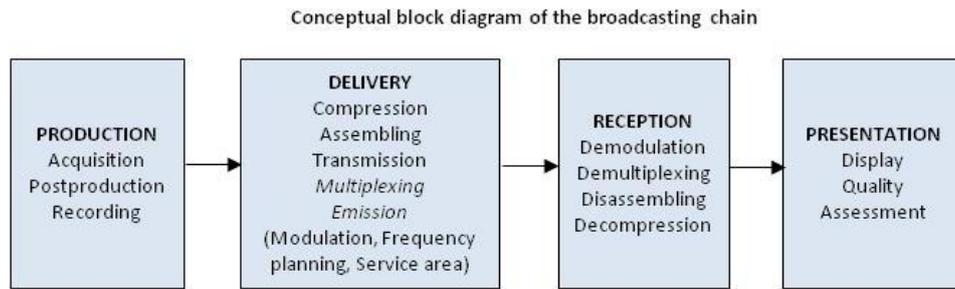
Choices regarding the above mentioned functional building blocks should be made in such a way that the licence conditions are fulfilled and that the business objectives are met. In doing so, optimum solutions should be found between often conflicting requirements regarding picture and sound quality, coverage quality and transmission costs.

Some of the issues regarding technology choices, frequency planning and network planning may also be relevant to regulators, depending on the roles and responsibilities of regulator and network operator in a country.

MTV networks are covered in Part 5. However, because of the similarity of the issues, guidelines regarding functional building blocks 5.3 (Network planning), 5.5 (Radiation characteristics) and 5.7 (Shared and common design principles), are described in the corresponding chapters in Part 4.

For assistance in understanding the scope of this chapter, a conceptual block diagram of the broadcasting chain¹ is illustrated below. The figure includes four main conceptual blocks, namely the production block, the delivery block, the reception block and the presentation block.

¹ See Report ITU-R BT.2140 Transition from analogue to digital terrestrial broadcasting; Part 1, section 1.8, The digital broadcasting chain.



Part 4 of these Guidelines is mainly related to the Delivery block, but the impact on the other conceptual blocks of the broadcast chain is indicated.

4.1 Technology and standards

Chapter 4.1 provides background information and guidelines on key topics and choices regarding the selection of DTTB transmission standards and associated systems. The chapter consists of six sections each containing a subsection with implementation guidelines and an appendix:

- 4.1.1 Technical tests to evaluate system performance;
- 4.1.2 SDTV and HDTV specifications;
- 4.1.3 Selection of DTTB transmission standard;
- 4.1.4 Compression system;
- 4.1.5 Encryption system;
- 4.1.6 Additional services;
- Appendix 4.1A HDTV considerations.

Determining the TV presentation formats, is a step that proceeds the actual selection of a transmission standard and system. TV presentation formats, Standard Definition TV (SDTV) and High Definition TV (HDTV) are independent of the transmission standard and are established as part of the programme production process. However, the choices on the presentation format have an impact on the broadcast delivery process. But also choices in the delivery process are of great importance for the presentation of the picture to the viewer.

HDTV services provide viewers with a significantly enhanced television experience. HDTV services are attracting considerable attention worldwide and are expected soon to become the norm for television viewing². Because of the importance of the issue, Appendix 4.1A gives some more information on HDTV transmission via DTTB networks.

Worldwide, four DTTB standards are in use, all having similar compression systems. The systems related to compression and encryption are, in principle, independent of the transmission standard. However, a number of systems for additional services are standard dependent.

The choice of the TV presentation format (SDTV, HDTV), transmission standard, compression system, conditional access system and systems for additional services should be made within the framework of relevant legislation and regulations and market and business development decisions. In addition, policies and regulations regarding the Analogue Switch-Off (ASO) process can affect the actual choice.

² An overview of the issues surrounding the delivery of HD services on the digital terrestrial television platform is given in DigiTAG report, HD on DTT, key issues for broadcasters, regulators and viewers (2007).

The considerations in Part 4 of these Guidelines are based on the DVB-T standard because:

- The Geneva 2006 Agreement (Article 3.1) is based on the DVB-T standard with regard to DTTB;
- DVB-T has been implemented in a great number of countries in Region 1 (including a number of African countries) and elsewhere³. It is assumed that most of the African countries will adopt the DVB-T standard⁴.

Where relevant, the main differences or attention points in relation to other standards are indicated.

4.1.1 Technical tests to evaluate system performance

Before making a choice between different DTTB standards or to investigate various system parameters of a particular standard, technical tests could be performed⁵ in order to e.g.:

- Compare performance of standards, such as power needed to cover an area with a certain bit rate;
- To test particular national requirements (e.g. indoor or mobile reception, reception in areas with many extreme high buildings, Single Frequency Network (SFN) operation);
- To educate technical staff.

It should be noted that technical tests are costly and time consuming with regard to preparations, performing test and analysing results.

Implementation guideline

Before introducing operational DTTB services, pilot transmission are often performed for:

- Education of technical staff;
- Familiarize key persons in government and market parties with DTTB;
- Testing acceptance of DTTB services by consumers;
- Demonstrating DTTB services;
- Prelaunch of DTTB services.

To date DTTB has been implemented in many countries in all Regions. It is probably no longer necessary to perform technical tests for selecting or investigating a transmission standard. All transmission standards have proven their performance in practice. However, there are distinct differences between transmission standards in technical behaviour and in frequency management (see section 4.1.3).

4.1.2 SDTV and HDTV specifications

Currently most TV transmissions are in Standard Definition (SDTV), 625 lines and 4:3 or 16:9 picture format. High Definition television services (HDTV), either with 1080 lines interlaced scanning (1080i) or 720 lines progressive scanning (720p), have started in some countries.

Television screens able to present HDTV are already present in many living rooms in many countries. More and more HDTV digital terrestrial transmissions take place in the USA, Australia and Europe. Many European broadcasters are preparing themselves for HDTV broadcasts. The European

³ See www.dvb.org/about_dvb/dvb_worldwide/index.xml.

⁴ In reply to a questionnaire in the first phase of the ITU project on the digital broadcasting transition roadmap in Africa, nine African countries confirmed the assumption that DVB-T will be used for provision of digital broadcasting services and two countries did not confirm this.

⁵ Report ITU-R BT.2035 provides detailed guidelines and techniques for the evaluation of digital terrestrial television broadcasting systems.

Broadcasting Union (EBU) expects that, in the future, all TV programmes will be in HD quality and that a minimum of 20 to 25 HDTV programmes will need to be provided on the terrestrial platform in order to make it attractive for the viewers.

The choice of the video bit rate for SDTV and HDTV services is a trade-off between picture quality and multiplex capacity. In order to obtain a good picture quality the following aspects are of importance:

- Flat screens are more sensitive to artefacts and require about two times higher bit rate for a high quality picture than Cathode Ray Tubes (CRT);
- Compression system and encoder quality (see section 4.1.4);
- Use of statistical multiplexing (see section 4.2.5);
- Viewers demands are likely to be higher if comparisons are made with digital satellite or cable transmission (which have higher multiplex capacity than DTTB transmissions) or Blue ray disks, rather than to a noisy analogue picture.

The multiplex capacity should be sufficient to carry the required number of services with the required bit rate and depends on:

- The transmission system (see section 4.1.3);
- Modulation, code rate and guard interval (see chapter 4.4);
- Number of services (including sound and data) that need to be transmitted in the multiplex.

Implementation guideline

The choice of the video bit rate for SDTV and HDTV services is a trade-off between picture quality and multiplex capacity. The trade-off can only be made after multiplex composition (see section 4.2.5) and network planning (see chapter 4.3) have been considered. But in order to achieve an acceptable picture quality the guidance in Table 4.1.1 can be given:

Table 4.1.1: Video bit rate requirements

Format	Screen	Compression	Average bit rate	Remark
SDTV	CRT	MPEG2	≥ 3 Mbit/s	
SDTV	Flat screen	MPEG2	≥ 6 Mbit/s	
SDTV	Flat screen	MPEG4	≥ 4 Mbit/s	
HDTV 720p	Flat screen	MPEG4	≥ 10 Mbit/s	When MPEG4 technology is mature ≥ 8 Mbit/s is expected to be sufficient
HDTV 1080i	Flat screen	MPEG4	≥ 12 Mbit/s	Depending on content and application of horizontal sub sampling

Regarding the sound quality the following guidance can be given:

- A stereo audio signal: 192 kbit/s
- A multi channel sound signal: about 0.5 to 1 Mbit/s.

Furthermore it should be taken into account that:

- Once the multiplex composition has been decided and the services are on air, picture quality can only be improved by:

- ✘ Increasing bit rate at the cost of deleting other services in the multiplex or use of a higher order modulation, higher code rate or smaller guard interval at the cost of reduced coverage (see chapter 4.4);
- ✘ Adopting a more efficient compression system or transmission standard requiring replacement of all set-top boxes and integrated digital TV receivers;
- ✘ Replacement of encoders by more efficient ones, provided that technology is not mature (see also section 4.1.4)
- Consumers tend to purchase large flat screens, resulting in a relative small viewing distance through which artefacts in the picture become more visible. Consequently picture quality requirements will increase.

4.1.3 Selection of DTTB transmission standard

Worldwide, four DTTB standards are in use:

Table 4.1.2: Transmission standards overview

Standard	Modulation	Description in Report ITU-R BT.2140 ⁶	Recommendation ITU-R BT.1306 ⁷	Applicable standards
ATSC	Single carrier 8-VSB	Brief: part 1 section 2.6.2.1 Detailed: part 2, section 1.5	System A; annex 1 table 1a	A/52,A/53, A/65, A/153
DTMB (also referred to as ChinaDTV)	Multi carrier OFDM	Brief: part 1, section 2.6.2.2 Detailed: -	-	GB 20600-2006
DVB-T	Multi carrier OFDM	Brief: part 1, section 2.6.2.4 Detailed: part 2, section 1.6	System B; annex 1 table 1b	EN 300 744
ISDB-T	Multi carrier Segmented OFDM	Brief: part 1, section 2.6.2.5 Detailed: part 2, section 1.8	System C; annex 1 table 1c	ARIB STD-B31 ABNT NBR 15601

A new standard, DVB-T2⁸, has been specified. DVB-T2 will give efficiencies of 30 per cent to 50 per cent in its use of spectrum compared to DVB-T and also a better performance with Single Frequency Networks (SFN). The first DVB-T2 products are expected on the market by the end of 2009. Mass market quantities of DVB-T2 receivers may be reached as from 2012.

Selection guidelines for ATSC (systems A), DVB-T (system B) and ISDB-T (system C) are described in Recommendation ITU-R BT.1306⁹. The guideline for initial selection from this Recommendation has been reproduced in Table 4.1.3. DTMB is not included in the initial standards selection in Recommendation ITU-R BT.1306; as DTMB is a multi-carrier standard it is likely to behave similarly to DVB-T (system B).

⁶ Report ITU-R BT.2140 Transition from analogue to digital terrestrial broadcasting.

⁷ Recommendation ITU-R BT.1306 Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting.

⁸ The DVB-T2 specifications are contained in: DVB Document A122, Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2); June 2008.

⁹ Recommendation ITU-R BT.1306 Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting; Appendix 4 to Annex 1.

Table 4.1.3: Guideline for initial selection of transmission standard, reproduced from Recommendation ITU-R BT.1306

Requirements		Suitable systems
Maximum data rate in a Gaussian channel for a given C/N threshold	Required	A
	Not required	A, B or C
Maximum ruggedness against multipath interference ⁽¹⁾	Required	B or C
	Not required	A, B or C
Single frequency networks (SFNs)	Required	B or C
	Not required	A, B or C
Mobile reception ^{(1), (2)}	Required	B or C
	Not required	A, B or C
Simultaneous transmission of different quality levels (hierarchical transmission)	Of primary importance	C
	Required	B or C
	Not required	A, B or C
Independent decoding of data sub-blocks (for example, to facilitate sound broadcasting)	Required	C
	Not required	A, B or C
Maximum coverage from central transmitter at a given power in a Gaussian environment ⁽³⁾	Required	A
	Not required	A, B or C
Maximum ruggedness against impulse interference	Required ⁽⁴⁾	A
	Not required ⁽⁵⁾	A, B, or C
<p>⁽¹⁾ Tradable against bandwidth efficiency and other system parameters.</p> <p>⁽²⁾ It may not be possible to provide HDTV reception in this mode.</p> <p>⁽³⁾ For all systems in situations with coverage holes, gap filler transmitters will be required.</p> <p>⁽⁴⁾ This comparison applies to B and C in the 2K mode.</p> <p>⁽⁵⁾ First results from Australia, testing the 8K mode, show significant improvements over the 2K mode and suggest the performance of System B and C in the 8K mode may be comparable to that of System A. However, further comparative tests of Systems A, B and C are required to verify relative performance.</p>		

In addition to the selection criteria indicated above, the following frequency management aspects should also be considered when selecting a transmission standard:

- Compliance with the Geneva 2006 Agreement (GE06)¹⁰ (see also section 4.3.4),
 - ✘ Article 3.1 indicates that with regard to DTTB, GE06 is based on DVB-T;
 - ✘ Article 5.3.2 states that other standards than DVB-T may be used, provided that the peak power density in any 4 kHz shall not exceed the spectral power density in the same 4 kHz of the digital entry in the Plan;
 - ✘ Article 5.3.2 states also that such use shall not claim more protection than afforded to the above mentioned digital entry.

¹⁰ The planning area of GE06 Agreement covers Region 1 (parts of Region 1 situated to the west of meridian 170° E and to the north of parallel 40° S, except the territory of Mongolia) and in the Islamic Republic of Iran.

- Availability of planning and compatibility criteria
 - ✘ GE06 contains a wide range of planning¹¹ and compatibility¹² criteria in relation to DVB-T and all broadcasting and non-broadcasting systems in use in Region 1.
 - ✘ If another standard is considered, such criteria should be made available and implemented in the network planning software.

Table 4.1.4 shows for which transmission standard planning and compatibility criteria are currently available in ITU recommendations.

Table 4.1.4: Overview of available planning and compatibility criteria

Standard & channels	Planning and compatibility criteria			
	Service planning	Protection of 625 lines PAL/Secam TV	Protection DVB-T	Other services
ATSC ¹³ 6 MHz	Full set of criteria	B/PAL in 6 MHz channels only	Not in ITU recommendations	Not in ITU recommendations
DTMB 8 MHz	Not in ITU recommendations	Not in ITU recommendations, likely to be similar as for DVB-T	Not in ITU recommendations, likely to be similar as for DVB-T	Not in ITU recommendations
DVB-T ^{14 15} 6, 7 and 8 MHz	Full set of criteria	Full set of criteria	Full set of criteria	Full set of criteria
DVB-T2 6, 7 and 8 MHz	Not (yet) in ITU recommendations	Not (yet) in ITU recommendations, likely to be similar as for DVB-T	Not in ITU recommendations, likely to be similar as for DVB-T	Not (yet) in ITU recommendations
ISDB-T 6, 7 and 8 MHz	6 MHz channels only	Not in ITU recommendations, likely to be similar as for DVB-T	Not in ITU recommendations, likely to be similar as for DVB-T	Not in ITU recommendations

¹¹ Final Acts of the Regional Radiocommunicaton Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06); Chapter 3 to Annex 2, Appendix 3.3.

¹² Final Acts of the Regional Radiocommunicaton Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06); Chapter 4 to Annex 2, Appendix 4.2 and 4.4.

¹³ Recommendation ITU-R BT.1368 Planning criteria for digital terrestrial television services in the VHF/UHF bands; Annex 1.

¹⁴ Recommendation ITU-R BT.1368 Planning criteria for digital terrestrial television services in the VHF/UHF bands; Annex 2.

¹⁵ Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06); Chapter 3 to Annex 2, Appendix 3.3.

The regulatory situation in Region 1 is such that application of the ATSC standard leads to inefficient spectrum usage, because:

- Channel rasters of 7 MHz (Band III) and 8 MHz (Band III, IV/V) are in use, whereas the ATSC standard is made for 6 MHz channel bandwidth;
- Fitting a single carrier transmission into a multi carrier peak power density envelope will lead to considerable power restrictions.

Implementation guideline

For selecting a DTTB transmission standard the following guidance can be given on the basis of technical and frequency management considerations and taking into account receiver availability and receiver prices:

Table 4.1.5 DTTB standard selection guidance

Situation	Standard choice and conditions	
	Green field	Existing DVB-T services
Start before end of 2012 *)	<ul style="list-style-type: none"> • DVB-T • DTMB, but not in case of 7 MHz channels in Band III • ISDB-T, provided that all missing planning and compatibility criteria are made available 	<ul style="list-style-type: none"> • DVB-T
Start after 2012 *)	<ul style="list-style-type: none"> • DVB-T2, depending on receiver price development and considerations given in Appendix 4.1A 	<ul style="list-style-type: none"> • DVB-T, if multiplex capacity is expected to be sufficient • DVB-T2 for new services and (long) transition period for existing services, if limitations in multiplex capacity are expected
*) assuming that through mass volume production and implementation in a number of big European markets DVB-T2 receivers prices are comparable to DVB-T receivers		

The South African Sadiba recommendation¹⁶ is an example of a national standard selection.

4.1.4 Compression system

Currently the key choice for a compression system is the choice between MPEG2 and MPEG4. It is expected that in the future even more efficient compression systems will be standardized. New compression systems are not backwards compatible with existing systems, but receivers with the improved system can normally receive the old system as well.

Replacing a compression system requires replacement of all set-top-boxes and integrated digital TV receivers with the former compression system. Normally a transition period of at least several years will be needed to avoid service interruptions. During this transition a number of attractive services

¹⁶ Recommendations on a South African standard for Digital Terrestrial Television (DTT), minimum receiver functionality and acceptable quality of service.

should use the improved compression system, thus stimulating consumers to buy receivers with the improved compression system.

Practice has shown that MPEG2 encoder generations were more efficient when technology becomes more mature. MPEG2 technology is considered mature now. A similar improvement may be expected with MPEG4 in the coming years.

MPEG4 is also referred to as MPEG-AVC, MPEG-4 part 10 and ITU-T H.264. The main differences with MPEG2 are indicated in the Table 4.1.6.

Table 4.1.6: MPEG2/MPEG4 comparison

MPEG4-MPEG 2 comparison	Comment
MPEG4 coding efficiency at least 1,5 time MPEG2; when the MPEG4 technology is mature an improvement with a factor 2 may be reached	<ul style="list-style-type: none"> When used for an increased number of services, an additional advantage is obtained with statistical multiplexing
Early 2008 MPEG4 receivers were four to five times more expensive than MPEG2 receivers	<ul style="list-style-type: none"> Prices are expected to decrease when mass market volumes are reached
License costs required for use of MPEG4 technology (no licence costs are required for MPEG2)	<ul style="list-style-type: none"> One payment of USD 2 500 per encoder Payment of USD 10 000 each year for any number of encoders per legal entity The less expensive option depends on the way the individual broadcaster operates

Implementation guideline

Selecting a compression system is basically a trade-off between:

- Multiplex capacity;
- Receiver availability and costs;
- Transition problems if MPEG2 receivers are already in the market.

The following guidance can be given for the selection of a compression system:

Table 4.1.7: Compression system selection guidance

Situation	Compression system choice and conditions	
	Green field	Existing MPEG2 services
Non-expensive receivers important	<ul style="list-style-type: none"> MPEG2 	<ul style="list-style-type: none"> MPEG2
Many services or HDTV expected	<ul style="list-style-type: none"> MPEG4 	<ul style="list-style-type: none"> MPEG4 for new services and transition period for existing services

4.1.5 Encryption system

Encryption is, in general, applied to provide a conditional access for viewers that are entitled to receive the service and to prevent unauthorized use. The condition for access could be payment or citizenship of a country in the case where programme rights are geographically limited. In most cases, access is obtained by a smart card. When a viewer fulfils the access conditions (i.e. possesses the

right smartcard and has paid for the services) an authorization signal is transmitted and accepted by the card and the viewer has access to the services.

Encryption of TV signals is a normal practice with many satellite broadcasting services. Also in a number of countries, part of the DTTB package is encrypted and access is provided if a subscription has been paid. It should be noted that as a consequence of encrypting a DTTB signal, also a Subscriber Management System (SMS) should be operated. This SMS manages the billing process and provides authorizations.

There are a number of Conditional Access Systems (CAS) on the market, mainly developed for satellite broadcasting but also applicable to DTTB.

The choice for a conditional access system is a trade-off between costs of the system and security (the expected or reported chances of hacking the system).

Implementation guideline

When selecting a Conditional Access Systems (CAS) it is important to ensure that:

- More than one system can be incorporated (multicript) in case different CAS systems are in use or expected in a country;
- Receiver manufacturers implement the CAS in the receiver or set-top box,
 - ✕ either embedded, the cheaper but less flexible option;
 - ✕ or, by means of a Common Interface (CI)¹⁷, a more expensive solution which makes the receiver independent of the service provider¹⁸ and more flexible¹⁹.

4.1.6 Additional services

In addition to the television signal (consisting of a video and one or more audio channels), a variety of other services may be implemented either in connection with the television service or independent of it. Such services could include:

- Radio services;
- Service Information (SI), the SI is generated in the head end and contains information on current and future programmes;
- Electronic Programme Guide (EPG), receiver generated EPGs based on the SI are the simple solution requiring only limited bit rate;
- Dedicated EPG produced by a service provider, giving the EPG the look and feel of the service provider, but requiring a considerable bit stream and an adequate Application Programme Interface (API) in the receiver;
- Teletext, two lines in the vertical blanking interval (VBI) per picture in analogue TV require a minimum of 37.6 kbits/s of DVB Teletext, often a capacity of about 0,3 Mbit/s per service is allocated , depending on the number of pages;

¹⁷ An enhanced common interface “CI Plus” has been developed by a number of manufactures in order to provide improved copy protection functionality. CI Plus is expected to become the de facto norm in all television receivers by 2011 (source: DigiTAG).

¹⁸ In order to promote interoperability, a government could mandate CI functionality in receivers, e.g., in the EU CI in Integrated Digital TV (IDTV) set is obligatory. However it is in the interest of service providers that consumers do not easily switch from one provider to another.

¹⁹ A Common Interface can have other functions using other types of modules such as web browser or interactive TV.

- System Software Update (SSU), providing over-the-air software downloads for upgrading and fixing receivers²⁰;
- Access services for vision or hearing impaired viewers, Table 4.1.8 summarizes a number of options^{21 22}.

Table 4.1.8: Access services

Access service	Delivery	Bitrate examples
Subtitles	DVB teletext DVB subtitling *)	>38 kbit/s ≤ 10 kbit/s
Spoken subtitles	DVB premixed extra audio channel DVB receiver mixed audio *)	>64 kbit/s 64 kbit/s
Audio description	Premixed Receiver mixed *) Other means (e.g. AM radio, Internet radio)	192 kbit/s 64 kbit/s -
Signing	Incorporated in programme	-
*) recommended by EBU		

Implementation guideline

Capacity needed for additional services can in practice range from 4 per cent to 20 per cent of the multiplex capacity. DTTB multiplex capacity is limited, therefore the choice for additional services is guided by:

- Lowest bit rate option ;
- No unnecessary duplication of data (e.g. avoiding the same teletext with more than one TV service.)

Appendix 4.1A: HDTV considerations

Introduction

It is expected that in a few years the great majority of households in Europe and elsewhere will own “HD ready” flat screen televisions. In five years, the only television production equipment on the market will be HD. Even today, it is possible to produce holiday videos of better quality than normal TV. HDTV broadcasting via cable, satellite and terrestrial networks is lagging behind, but will develop considerably in the coming five years. 46 per cent of the EBU members have plans to simulcast HDTV with SDTV in the short term. This is triggered in the coming years by major sports events like football World Cup and the Olympic Games and supported by analogue switch-off and a new improved standard for digital terrestrial television: DVB-T2.

Digital Switch-over

According to Geneva 2006 Agreement, analogue terrestrial television stations will cease to have any international recognition after 17 June 2015 (in a number of countries, this date is five years later for

²⁰ DigiTAG report DVB-SSU, implementing system software updates on the terrestrial platform (2007).

²¹ EBU Report – TECH 3316. Monitoring of Access Services, Requirements, Developments and Recommendations, Geneva, February 2006.

²² EBU Report I44-2004, Access Services, June 2004.

analogue television in Band III). Therefore most analogue terrestrial TV transmissions in Region 1 are expected to be switched off before 2015 and in a number of countries before 2020. The countries in the European Union aim to switch-off analogue terrestrial television even before 2012. Analogue switch-off makes frequencies available for digital terrestrial television.

The Geneva 2006 Agreement gives most countries provisions for at least eight digital television multiplexes. Not all these multiplexes may be available for SDTV or HDTV services. A number of multiplexes in Band III may be intended for digital radio (T-DAB) or mobile TV (T-DMB) and in Band IV/V also one or more multiplexes may be used for mobile TV (DVB-H). Furthermore, following decisions of WRC-07 and WRC-12, it may be decided to use (a part of) the frequency range 790 to 862 MHz (TV channels 61 to 69) for mobile telecommunication services.

HDTV scanning formats

The EBU has identified and specified four HDTV production formats:

Table 4.1A.1: HDTV formats

Identification	Pixel per horizontal line	Number of vertical lines	Scanning	Frames/second
720p/50	1280	720	progressive	50
1080p/25	1920	1080	progressive	25
1080i/25	1920	1080	interlaced	25
1080p/50	1920	720	interlaced	50

The 1080i/25 and the 720p/50 formats can also be used for broadcasting, or other forms of secondary distribution, whereas 1080p/25 is currently a production format only. 1080p/50 is termed a "3rd generation" HDTV format, which may be used in future for production, and possibly distribution, purposes.

MPEG 2 or MPEG4

HDTV requires a considerable higher video bit rate than SDTV. Furthermore high quality sound channels, perhaps multichannel sound, requiring up to 0.5 Mbit/s, needs to be included in the multiplex.

With MPEG 2 the video bit rate for good HDTV pictures should be 16 to 18 Mbit/s for a large flat panel screen. This means that only one HDTV service can be transmitted in a multiplex with 64-QAM modulation.

MPEG4 gives a coding efficiency of at least 1.5 times that of MPEG2. An improvement by a factor 2 is expected when MPEG4 technology is mature. Therefore in the longer term a multiplex could carry up to twice as many services using MPEG4 as currently with MPEG2 with similar picture quality.

With MPEG4 the required bit rate for HDTV is currently 10 to 12 Mbits/s. With medium size screens and viewing distance of more than three times the screen height, 8 Mbit/s may be acceptable. In a few years, with improved MPEG4 encoders the required bit rate expected to be 8 to 10 Mbit/s.

HDTV with MPEG4 compression makes two or even three HDTV services in a multiplex possible. With statistical multiplexing the average bit rate could be further reduced, depending on the number of services in the multiplex and picture content.

Table 4.1A.2 summarizes the multiplex capacity that may be possible in a few years.

Table 4.1A.2: Multiplex capacity

Characteristic	DVB-T carrier modulation	
	16-QAM	64-QAM
Multiplex capacity range (in practice)	10 – 18 Mbit/s	15 – 27 Mbit/s
Number of HDTV services with MPEG2	-	1
Number of HDTV services with MPEG4	1-2	2 -3

Because of the very limited HDTV capacity, in Europe MPEG2 is not seen as a viable option for HDTV.

DVB-T or DVB-T2

DVB-T2 is a new transmission standard, it has been specified by the DVB project²³ and an ETSI standard is expected. Early estimates of performance of the baseline specification suggest over 45 per cent bit rate capacity gain for a typical application for the same reception conditions. It has been estimated that the combination of MPEG4 and DVB-T2 could increase the multiplex capacity by 100 per cent to 160 per cent.

EBU estimates that by combining the expected advances in the transmission systems and using statistical multiplexing it should be possible to carry 4 or 5 HDTV services per multiplex for fixed reception, or 2 to 3 HDTV services in a multiplex for portable or mobile reception²⁴.

Examples

In the USA and Australia MPEG2 compression is used for HDTV broadcasting on the terrestrial network. Terrestrial HDTV transmissions started in those countries before MPEG4 compression was available. Once started it is complicated to change to a more efficient compression system or transmission standard because all receivers need to be replaced and a long transition period is necessary.

Technology improvement steps (from MPEG2 to MPEG4 to DVB-T2) tend to take place at regular intervals. It is not always acceptable for market or regulatory reasons to wait for the introduction of HDTV until the next technology improvement step has been implemented. Furthermore, if there is a wait for the success of a new technology, then, in the first years, receivers with the new technology are considerable more expensive.

In France, for instance, it was decided to start HDTV terrestrial transmissions in spring of 2008 using MPEG4 and three free to air HD services in a an unused multiplex. A second HDTV multiplex followed at the end of 2008. In addition some HD-pay services will be introduced by converting existing SD (MPEG4) services into HD (MPEG4).

In the UK HDTV services will start at the end of 2009 around Manchester when analogue TV is switched off in that area. An existing multiplex will be cleared of existing services and used for DVB-T2 and will carry four to five HD services. Regions that have already been switched off by that time will be retro-fitted shortly thereafter, and subsequent regions will have DVB-T2 available from the date of analogue switch-off.

²³ Implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2) DVB Document A133, February 2009.

²⁴ EBU – TECH 3334 Accommodation of HDTV in the GE06 Plan, February 2008.

4.2 Design principles and network architecture

Chapter 4.2 provides background information and guidelines on key topics and choices regarding design principles and network architecture of DTTB networks. The chapter consists of seven sections each containing a subsection with implementation guidelines:

- 4.2.1 Trade-off between network roll-out speed, network costs and network quality;
- 4.2.2 Main reception mode and defining receiving installations;
- 4.2.3 Services for national, regional, or local coverage;
- 4.2.4 Frequency plan and network topology;
- 4.2.5 Head- end configuration;
- 4.2.6 Equipment reserve configurations;
- 4.2.7 Type of distribution network.

Development of a broadcast infrastructure with new technologies is a challenging but complex matter. It is essential that technical staff understands not only the main principles regarding network architecture and network planning, but also the impact of technical choices on the business plan and regulations. In addition to the documents referred to in these guidelines, training sessions and seminars will help in educating staff. In case of limited human resources, external experts may be contracted to assist staff, to perform a number of tasks or to advise the management.

A DTTB network consists basically of one or more head ends, a distribution network and transmitter sites. A block diagram of a typical DTTB network is shown in Figure 4.2.1.

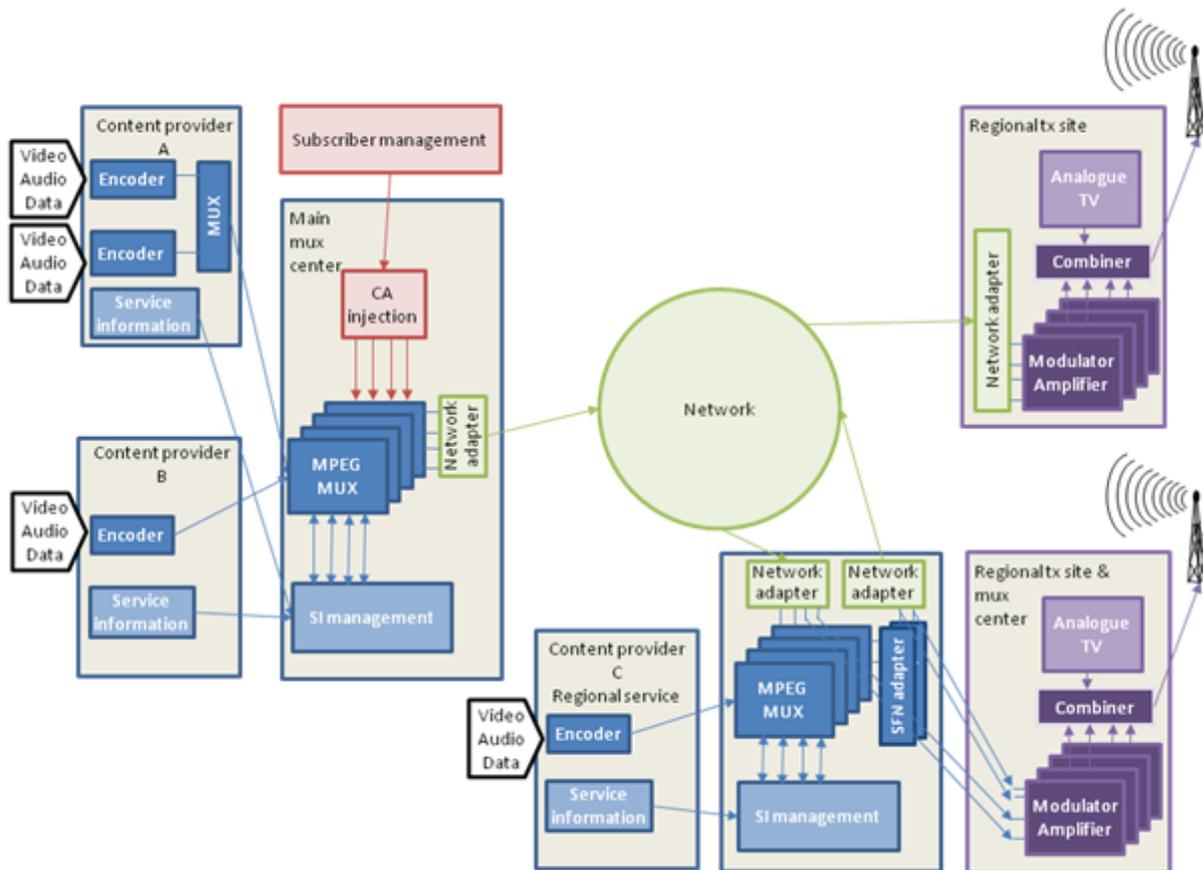


Figure 4.2.1 Typical DTTB network lay out

Roll-out speed of the network, network costs and network quality are interrelated and a trade-off needs to be made depending on the requirements in the business plan or licence conditions.

The head end is the part of the network where the incoming video and audio signals from the studio are compressed (using MPEG2 or MPEG4). The compressed signals, together with the accompanying data signals, are multiplexed into a MPEG Transport Stream (TS). Data signals could contain a variety of services including Service Information, Teletext and video and audio services in the form of a Internet Protocol DataCast (IPDC). The latter could be intended for mobile TV using the DVB-H system.

The MPEG TS is distributed to the transmitting sites via the distribution network.

It is also possible to distribute two independent transport streams to the transmitters and apply hierarchical modulation (see chapter 4.4). One stream can be modulated with “low priority” intended for fixed (rooftop) reception, the other with “high priority” intended for more robust reception conditions with portable reception. The high priority stream could even contain a signal with the DVB-H standard for mobile TV.

If regional or local services are required, normally these services are coded at a regional site and by means of re-multiplexing added to the MPEG TS for the particular regional or local area (see Figure 4.2.1). However, depending on costs of distributions links (among other factors), other solutions may be adopted.

At a transmitting site, each MPEG TS is modulated in a transmitter to provide an OFDM signal with an appropriate system variant (e.g. modulation 64-QAM, code rate 2/3, guard interval ratio 1/32) and converted to the required transmission channel. The RF signals of all, or a number of, transmitters at a site are combined into one antenna. Sometimes, e.g. in case of services with different coverage requirements, more than one antenna, each having a different radiation pattern, is used.

The frequencies to be used should comply with the Geneva Agreement of 2006 (GE06) and compatibility with analogue television services (nationally and in neighbouring countries) should be ensured. In order to protect analogue TV services during the transition from analogue to digital television, it may be necessary to operate digital TV services with restricted power or to use temporary frequencies. Also for practical reasons (e.g. not sufficient room in transmitter housing or mast or mechanical limitations of the mast) it may be necessary to operate digital TV temporarily with restrictions.

The kind of receiving installations has a great impact on design principles and network architecture and also network planning. If DTTB coverage with simple receiving antennas at low height is required (e.g. indoor, outdoor and mobile reception), high transmitter powers and probably Single Frequency Networks (SFN) will be needed. If DTTB coverage with rooftop antennas is required, use of existing sites and frequencies in the same part of the frequency band as for analogue TV is an advantage, because existing receiving antennas (subject to being in good condition) can be used.

The activities regarding design principles and network architecture result in a document describing network principles. These principles take into account the technology choices (see chapter 4.1) and conditions described in the licence (see Part 2), the business plan and service proposition (see Part 3).

4.2.1 Trade-off between network roll-out speed, network costs and network quality

Roll-out speed, networks costs and network quality (expressed in coverage probability, signal availability and number of multiplexes) are interrelated and an optimal balance should be chosen.

Many factors could be relevant in the trade-off between roll-out speed, costs and network quality depending on local circumstances; some are indicated in Table 4.2.1.

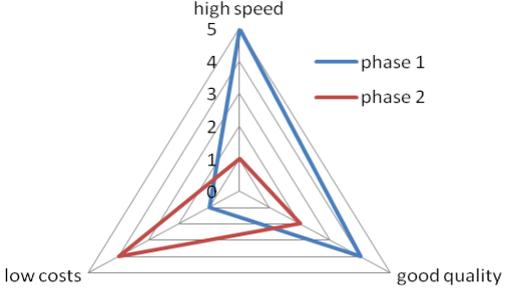
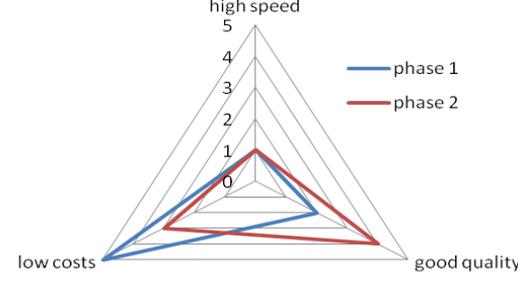
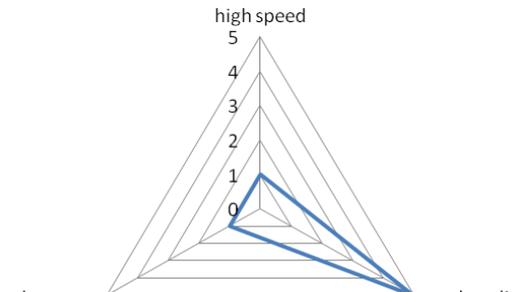
Table 4.2.1: Elements in trade-off between roll-out speed, costs and network quality

Network element	Impact	Generally positive (Y), negative (N) or more or less neutral (O) contribution		
		High roll out speed	Low network costs	High network quality
Use of existing sites	Sites available at limited costs, possibly restrictions to new services	Y	Y	O/N
Use of additional new sites	Extra costs, acquisition time	N	N	Y
Roof top reception	Relative low powers	O	Y	N
Portable reception	Relative high powers and SFN	O	N	Y
Regional/local services	Extra multiplexer(s)	O/N	N	Y
Sufficient human resources	If not, external staff for project planning, supervision and installation	Y	N	O
Reserve equipment	Extra costs, less services interruptions	O	N	Y
Fill-in transmitters	Extra cost, better coverage	N	N	Y
High coverage probability	Relative high power, better coverage	O	N	Y
Temporal transmitting facilities during transition	Better coverage	N	N	Y
Frequency use in accordance with GE06 (see section 4.3.4)	No time consuming international negotiations needed	Y	O	O/Y

The balance in this trade-off could be different for various roll-out phases and various areas (e.g. main population centres and rural areas). Examples of three typical cases are shown in Table 4.2.2. The interrelations between roll-out speed, networks costs and network quality are illustrated in graphical presentations on a subjectively valued five point scale.

Experience in Europe has shown that good coverage is of major importance. In areas where coverage is marginal, service take-up is low and competitive offers (like IPTV, cable TV or satellite TV) obtain an advantage.

Table 4.2.2: Network implementation trade-off examples

Graphical presentation	Trade-off example
 <p>A radar chart with three axes: 'high speed' (top), 'low costs' (bottom-left), and 'good quality' (bottom-right). The scale on the 'high speed' axis ranges from 0 to 5. Two lines represent 'phase 1' (blue) and 'phase 2' (red). Phase 1 has a high score on 'high speed' (around 4.5) and 'good quality' (around 4.5), but a low score on 'low costs' (around 0.5). Phase 2 has a low score on 'high speed' (around 1.5) and 'low costs' (around 1.5), but a high score on 'good quality' (around 4.5).</p>	<p><i>Phase 1</i> Good coverage of main population centres with many multiplexes as soon as possible in order to compete with other means of delivery (cable TV, IPTV).</p> <p><i>Phase 2</i> After phase 1 network roll-out is slower and poor coverage in areas without competition is acceptable.</p>
 <p>A radar chart with three axes: 'high speed' (top), 'low costs' (bottom-left), and 'good quality' (bottom-right). The scale on the 'high speed' axis ranges from 0 to 5. Two lines represent 'phase 1' (blue) and 'phase 2' (red). Phase 1 has a high score on 'high speed' (around 4.5) and 'low costs' (around 4.5), but a low score on 'good quality' (around 1.5). Phase 2 has a low score on 'high speed' (around 1.5) and 'low costs' (around 1.5), but a high score on 'good quality' (around 4.5).</p>	<p><i>Phase 1</i> Roll out of a few multiplexes with similar coverage as for analogue TV, before an Analogue Switch-Off (ASO) date in 2020 and service interruptions due to equipment failure or maintenance are acceptable.</p> <p><i>Phase 2</i> After ASO gradually more multiplexes will be rolled out and better service availability will be obtained.</p>
 <p>A radar chart with three axes: 'high speed' (top), 'low costs' (bottom-left), and 'good quality' (bottom-right). The scale on the 'high speed' axis ranges from 0 to 5. A single blue line represents 'phase 1'. It has a high score on 'high speed' (around 4.5) and 'good quality' (around 4.5), but a low score on 'low costs' (around 0.5).</p>	<p>Good indoor and mobile reception in and around main population centres, with new sites to obtain better coverage in a Single Frequency Network (SFN). Site acquisition, takes a long time and slow network roll-out is acceptable</p>

Implementation guidelines

The optimal balance in the trade-off between network roll-out speed, networks costs and network quality depends to a great extent on the local situation. Network elements contributing to the trade-off are summarized in Table 4.2.3.

In making the trade-off the following points need to be taken into consideration:

- Network quality is of major importance; if network quality is poor at the start of DTTB introduction, service take up will be low and it may take a long time before potential consumers have confidence in the service;
- Communication to the public on the roll-out phases of the project and the areas with good quality reception (the more precise the better) is essential. Also help and advice on purchasing and installing receiving equipment is very important (see also chapter 4.9).

Table 4.2.3: Network elements contributing to the trade-off between network roll-out speed, networks costs and network quality

High roll-out speed	Low network costs	High network quality
<ul style="list-style-type: none"> • Use of existing sites • Sufficient human resources • Frequency use in accordance with GE06 	<ul style="list-style-type: none"> • Use of existing sites • Roof top reception 	<ul style="list-style-type: none"> • Use of additional new sites • Portable reception • Regional/local services • Reserve equipment • Fill-in transmitters • High coverage probability • Temporary transmitting facilities during transition

4.2.2 Main reception mode and defining receiving installations

Receiving installations consist of a receiver (set top box or integrated digital TV set), antenna cable and antenna. The receiver should be equipped to receive the current transmission standard, compression system and (if needed) conditional access system.

The GE06 Agreement defines three reception modes²⁵:

- Fixed reception;
- Portable reception (indoor and outdoor);
- Mobile reception.

For planning a broadcasting service it is important to specify the percentage of locations in a small area (say 100 by 100 m) where reception is possible with a certain receiving installation²⁶. All “small areas” where the required percentage of coverage is reached from the coverage area.

When the required signal strength of analogue television is decreased below the required value, the picture is still visible but becomes gradually noisier. For that reason it is common practice to plan analogue TV services with a location probability of 50 per cent. However a characteristic of digital television is the sharp degradation of quality when the signal to noise ratio and signal to interference ratio drop below the required values. To ensure good DTTB coverage quality, a high percentage of receiving locations should obtain satisfactory reception.

The minimum median field strength values (Emed) for fixed and portable reception given in the GE06 Agreement²⁷ are based on a location probability of 95 per cent²⁸. Also the Reference Planning Configurations (RPC)²⁹ are defined with location probability of 95 per cent; noting that RPC 2 achieves a lower coverage quality for indoor reception.

²⁵ Definitions for reception mode are given in the GE06 Agreement, Chapter 1 to Annex 2, articles 1.3.11 (fixed reception), 1.3.12 (portable reception) and 1.3.13 (mobile reception).

²⁶ A definition of coverage area is given in article 1.2.2 of Chapter 1 to Annex 2 of the GE06 Agreement.

²⁷ Emed values at 200 MHz and 500 MHz for all DVB-T variants are given in GE06 Agreement, table A.3.2.-2 of Appendix 3.2 of Chapter 3 to Annex 2.

²⁸ See GE06 Agreement Chapter 3 to Annex 2, Section 3.2.1.4 and Section 3.2.2.4 relating to fixed and portable reception respectively.

²⁹ Reference Planning Configurations (RPC) are described in the GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.5.

With 95 per cent location probability, in general good reception can be obtained. Location percentage less than 90 per cent may well lead to complaints, in particular when more than one channel needs to be received. For portable reception, location probabilities as low as 70 per cent are sometimes used as a basis for coverage assessment. A number of measures can be taken on the receiving site to improve reception.

Measures to improve reception include:

- Higher receiving location;
- Locating antenna at an optimal receiving position;
- Antenna amplifier with fixed reception and active antenna with portable reception;
- Antenna with higher gain than assumed in the definitions quoted above³⁰;
- Diversity reception (which may give an improvement of 6 to 8 dB, however diversity reception equipment is not generally available).

The required minimum median field strength values for portable, in particular portable B (indoor), reception is much higher than for fixed reception. Table 4.2.4 shows the difference of the minimum median field strength values (Emed) for portable en fixed reception.

Table 4.2.4: Difference of signal strength requirements for portable and fixed reception

Band	Emed difference portable B (indoor) - fixed reception	Emed difference portable A (outdoor) - fixed reception
III	31 dB (power factor: 1200)	21 dB (power factor: 125)
IV/V	37 dB (power factor: 5000)	25 dB (power factor: 300)

Because of the high field strength requirements, portable reception over large areas can, in practice, be achieved only by means of power distribution and use of Single Frequency Networks (SFN).

The Plan entries in the digital Plan of the GE06 agreement are either based on fixed or portable reception. Although a principle choice has been made during the ITU conference RRC-06, in practice, when establishing the network design principles and network architecture, followed by network planning, the choice for reception mode may be reviewed.

Deviation from the reception mode in GE06 will have consequences for the allowed transmitter power or interference levels, see Table 4.2.5.

Table 4.2.5: Impact of use of different reception mode compared specifications of GE06 Plan entries

Defined reception mode for network	GE06 reception mode: fixed	GE06 reception mode: portable
Portable	Power limitations	–
Fixed	–	High interference levels

³⁰ Values used for receiving antenna gain and cable loss In the GE06 Agreement are given in Chapter 3 to Annex 2, Section 3.2.1.2 and 3.2.1.3 for fixed reception and Section 3.2.2.3 for portable reception.

Network planning exercises will show the impact of these power limitations or high interference levels on coverage (see chapter 4.3).

Implementation guidelines

For selecting the reception mode the following guidance can be given:

- Public broadcasting services often have a universal coverage obligation and require nearly full coverage. In practice, in most countries, the universal coverage obligation is related to fixed reception.
- In situations where fixed analogue TV reception is common practice, fixed DTTB reception is facilitated if the existing receiving antennas can be used, provided that:
 - ✘ Analogue TV and DTTB signals arrive from the same direction, hence same sites should be used for analogue TV and DTTB;
 - ✘ Analogue TV and DTTB channels are in the same band (Band III, IV and V), preferably spaced only a few channels, and have the same polarization (horizontal or vertical);
- In situations where (almost) no rooftop antennas are present, installing rooftop antennas may form an obstacle for accepting DTTB services. Indoor portable reception, at least for main population centres should then be the aim.
- In situations where DTTB has to compete with wired services such as cable TV or IPTV, portable reception gives an important advantage.
- A list of receiver specifications should be made. Such a list should include:
 - ✘ Transmission system
 - ✘ Compression system
 - ✘ Conditional access system
 - ✘ Frequency band(s) to be used
 - ✘ Mains voltage and frequency
 - ✘ RF characteristics (sensitivity and selectivity should be such that minimum field strength and protection ratios as listed in the GE06 Agreement are obtained).
- To benefit from low receiver prices, base line specifications of large markets e.g. the European market^{31 32} should be adopted. Also for specifications that are beyond the baseline specifications, such as conditional access systems, larger volumes and lower receiver prices can be obtained by adopting additional specifications of large markets or common specifications with neighbouring countries.
- Agreements should be made with receiver manufacturers to ensure that adequate types of receivers are available in sufficient quantities and in time.

Furthermore it is important to take into account that:

- Practice in Europe has shown that even in cases where analogue TV and DTTB are operating in the same band, many receiving antennas may need to be replaced. After having withstood many storms and rains receiving antennas have deteriorated. The

³¹ An examples of receiver specifications is the 'E-Book'. E-book is the colloquial name given to the IEC standard 62216 for *Digital Terrestrial receivers for the DVB-T system*. This standard defines the basic requirements for every DTT receiver in Europe today.

³² Minimum HDTV receiver requirements of EBU Member broadcasting organizations and discussed in detail with DIGITALEUROPE (the European electronic consumer equipment manufacturers) are presented in EBU document TECH 3333 EBU HDTV Receiver Requirements; User Requirements. Geneva, March 2009.

antenna condition could be still acceptable for a noisy analogue TV picture, but DTTB may show blocks or a black screen.

- Communication to the public is essential regarding the receiving installations to be used and help and advice on purchasing, installing or replacing of receiving equipment (see also section 4.9).

4.2.3 Services for national, regional, or local coverage

The wanted service area for a multiplex of services needs to be clearly defined. In general, services could be destined for national coverage, regional or local coverage. If a service contains partly national and regional or local programmes, even for a short time (e.g. local news or advertising), the whole multiplex should be considered as regional or local because part of the service-package needs to be remultiplexed in order to insert the regional or local service.

The next step is to determine where coders and (re)multiplexers will be located. In the example of Figure 4.2.1, coders and re-multiplexers are placed together. At a central point the national services are multiplexed. A regional service is fed to one of the sites forming a regional network and re-multiplexed at that site. Other solutions are possible e.g. feeding all services (including regional ones) to a central multiplexing centre and distributing the MPEG TS of all multiplexes to each site, where the appropriate TS will be selected and broadcasted.

Operational aspects regarding multiplex location are summarized in Table 4.2.6.

Table 4.2.6: Operational aspects regarding multiplex location

Operational aspect	Multiplex location
Lower equipment costs	Centralized
Easier maintenance and service	Centralized
Lower cost for uncompressed signals from regional studios	Regionalized
Network robustness (limited number of effected transmitters in case of failure)	Regionalized

The division in national, regional and local service areas and the geographical size of the areas is also important for the planning of Single Frequency Networks (SFN) (see section 4.3.2).

Implementation guideline

Service areas for national, regional and local services need to be clearly defined. A high number of regional or local areas leads to extra costs regarding re-multiplex centres or links; if possible the number of regions should be limited.

The choice of re-multiplex locations depends on operational considerations, costs of multiplex equipment and the costs of links. The latter may differ considerably from country to country or part of the country.

In general the location of encoders and (re) multiplexer is close to a studio play-out centre in order to obtain relative short distances for the uncompressed signals.

4.2.4 Frequency plan and network topology

Analogue TV sites are in general also used for DTTB, for reasons of economy. However, additional stations may be needed in cases where:

- The analogue TV network does not cover the complete wanted coverage area;

- Portable or mobile reception is an important requirement and:
 - ⌘ because of the high required field strength and regulatory or practical power limitations power distribution, using SFNs, is applied;
 - ⌘ existing sites, planned for roof top reception, are situated too far from population centres.

On the contrary, experience has shown that, for DTTB, fewer fill-in transmitters are needed than for analogue TV.

The technical characteristics of DTTB stations and analogue TV stations should be in accordance with the GE06 Agreement. The GE06 Agreement contains two Plans, a digital Plan and an Analogue Plan (see Figure 4.2.2).

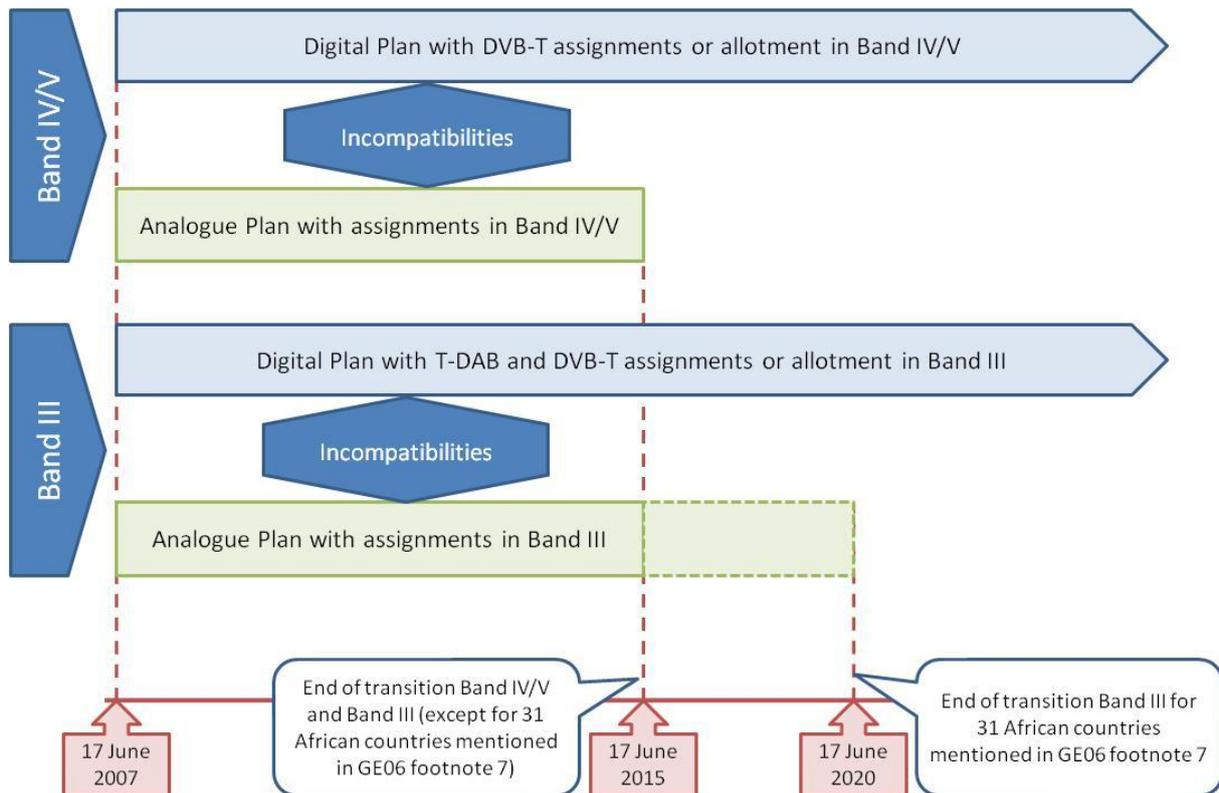


Figure 4.2.2: GE06 Plans

Each of the plans consists of two parts: entries in Band III and entries in Band IV/V. After the expiry of the transition period only the digital Plan remains in existence³³. The transition period is specified in article 12.5 and 12.6 of the GE06 Agreement. The transition period ends on 17 June 2015, however in a number of countries the transition period for Band III ends on 17 June 2020³⁴.

DTTB entries in the digital Plan can be assignments, allotments or a combination of allotments and assignments.

³³ Article 12.8 of the GE06 Agreement allows the continuation of analogue stations on a non-interference and non-protection basis.

³⁴ Note 7, related to Article 12.6 of the GE06 Agreements lists the countries where the transition period for Band III end on 17 June 2020.

In allotment planning³⁵, a specific channel is “given” to an administration to provide coverage over a defined area within its service area, called the allotment area. Transmitter sites and their characteristics are unknown at the planning stage and should be defined at the time of the conversion of the allotment into one or more assignments. Details regarding the allotment area, reception mode and DVB-T variant and a Reference Network³⁶ to determine outgoing interference, are specified in the Plan entry.

In assignment planning³⁷, a specific channel is assigned to an individual transmitter location with defined transmission characteristics (for example, radiated power, antenna height).

In principle a choice can be made of frequencies in Band III and Band IV/V. Band III contains eight channels if a 7 MHz channel raster has been adopted or seven channels in the case of an 8 MHz channel raster³⁸, whereas Band IV/V contains 49 channels of 8 MHz. In a number of countries Band III is also planned for T-DAB (T-DAB Plan entries can be used for T-DMB as well) and some countries may even wish to convert their DVB-T Plan entries into four T-DAB blocks³⁹. A main advantage of Band III is the lower propagation loss and lower minimum median field strength values, resulting in lower power to cover the same area compared to Band IV/V. However, in Band III higher man-made noise levels are present and larger antenna dimensions are required compared to Band IV/V. Furthermore if 7 MHz channels are used, the multiplex capacity is 7/8 of the bit rate in an 8 MHz channel with the same system variant.

During transition, operation of DTTB stations is possibly restricted or totally blocked because analogue TV services in the same country and in neighbouring countries need to be protected. National compatibility problems between DTTB and analogue TV can be identified by:

1. Comparing the DVB-T Plan entries of a given site with the existing use of the site. Obviously when the DVB-T Plan entry is in use for analogue TV, it cannot be used for DTTB until the analogue service is switched off;
2. Performing a compatibility analysis to determine the restrictions needed to protect analogue TV services transmitted from other sites.

International compatibility problems can be divided into three categories:

1. Incompatibilities with entries in the analogue TV Plan;
2. Incompatibilities with entries in the digital Plan;
3. Incompatibilities with existing assignments of other primary terrestrial services.

The international compatibility problems are identified in:

- Bilateral agreements between the administrations concerned;

³⁵ A definition of allotment planning is given in the GE06 Agreement, Chapter 1 to Annex 2 article 1.3.1.

³⁶ A Reference Network is defined in the GE06 Agreement, Chapter 1 to Annex 2 article 1.3.17: A generic network structure representing a real network, as yet unknown, for the purposes of a compatibility analysis. The main purpose is to determine the potential for and susceptibility to interference of typical digital broadcasting networks.

³⁷ A definition of allotment planning is given in the GE06 Agreement, Chapter 1 to Annex 2 article 1.3.2.

³⁸ In the GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.1, tables are given showing the DVB-T channel arrangements in Band III.

³⁹ See ECC Report 116 The possibilities and consequences of converting GE06 DVB-T allotments/assignments in Band III into T-DAB allotments/assignments, Athens, February 2008.

- A country symbol in the digital Plan, in column 28-1, 28-2 or 28-3 in case of a DVB-T assignment and in column 18-1, 18-2 or 18-3 in case of a DVB-T allotment⁴⁰ respectively.

Figure 4.2.3 shows an example of a plan DVB-T plan entry for an assignment on channel 21. In this case agreement should be reached with respect to an assignment in the analogue Plan of Tanzania.

DVB-T MAZERAS										21	
1	15754									12	
2	KEN									13	RPC1
3	KENDT00067									14	474 MHz
4	1									15	21
5										16	
6										17	H
7	KEN									18	50 dBW
8	MAZERAS									19	
9a	-035732									20	ND
9b	0393425									21	90 m
10	122 m									22	184 m
11											

23									
0°	49	67	74	80	94	116	138	160	173
90°	180	182	183	184	184	183	182	180	179
180°	173	166	154	142	102	104	58	63	79
270°	86	88	68	63	58	57	58	60	44

24									
-----------	--	--	--	--	--	--	--	--	--

25									
-----------	--	--	--	--	--	--	--	--	--

26	N									28-2	
27										28-3	
28-1	TZA										

Figure 4.2.3: Example of a Plan entry containing a country symbol in column 28

Because of the required restrictions during transition, DTTB frequency choice may be very limited. Before the related analogue stations have been switched off, some DTTB stations may have severely restricted coverage and at some sites no DTTB frequency may be available. In some cases, it may be possible to improve coverage during transition by selecting (if possible) a frequency for temporary use or by using a SFN. When the related analogue TV stations have been switched-off the restrictions can be removed and the transmitters retuned. However, frequency changes should be avoided as far as possible, because of the involved costs and the burden for viewers to retune their TV sets.

⁴⁰ The three columns refer respectively to assignments in the analogue Plan, entries in the digital Plan, or existing assignments to other primary terrestrial services, of the administration mentioned in the note.

In practice, a frequency change requires retuning of transmitter and combiner filter. In the case of an SFN all transmitters in the SFN must change frequency. If not done at the same time, the SFN is partly a Multi Frequency Network (MFN) and “network gain” does not exist. Poor reception in part of the coverage area may be the result. It should also be noted that the antenna may have differences in radiation characteristics on the old and new frequency (see chapter 4.5), another cause of possible poor reception in part of the coverage area.

A frequency change requires retuning of the receiver. Most DTTB receivers have automatic tuning facilities, but in many cases (re)tuning should be selected in a menu and in some cases after entering a pin code (which may have been forgotten). Therefore frequency retuning is a nuisance to many consumers and help may be necessary. Practice in Europe has shown that frequency changes could lead to complaints. DTTB services could even get a bad reputation and competitive offers (such as IPTV, cable TV or satellite TV) may gain an advantage.

Implementation guidelines

The entries in the digital Plan annexed to the GE06 Agreement are the basis for the DTTB frequency plan (as well as the MTV frequency Plan). However, until analogue switch-off, DTTB services may be severely restricted. If the DTTB frequency is in use at the same site for analogue TV, DTTB services are not possible until after analogue switch-off.

If compatibility problems exist with analogue fill-in stations, a frequency change of some analogue fill-in stations could alleviate the compatibility problem considerably.

Channels can be selected from Band III and Band IV/V. In most countries at least eight DTTB national coverages are available and, in general, one DTTB coverage in Band III (in addition to a number of T-DAB coverages). When Band III is used for DTTB it should be taken into account that a mixture of Band III and Band IV/V channels will be transmitted with the consequence of:

- Need for Band III and Band IV/V transmitting and receiving antennas;
- Use of 7 MHz channel bandwidth in Band III (in most countries) and 8 MHz channel bandwidth in Band IV/V, has consequent need for remultiplexing the Band III services.

Table 4.2.7 gives guidance on the band choice.

In Band III and Band IV/V, frequencies with least compatibility problems have preference. Furthermore in selecting frequencies for DTTB stations the following considerations should be taken into account:

- Preferably the same frequency should be used before and after ASO, in order to avoid frequency changes;
- Any coordination with neighbouring countries should be completed before installation of a station, because the international negotiations may result in power restrictions or a later date of putting the station into operation;
- Preferably DTTB frequencies should not be spaced too far from analogue TV frequencies at the same site, in principle, an existing rooftop antenna could then be used;
- All multiplexes should have similar coverage;
- MTV services in Band IV/V (DVB-H) can use channels below 750 MHz (channels 21 tot 55), in order to avoid interference with GSM services in the same handset;
- Communication to consumers about frequency changes, digital coverage and receiving installation for digital services is essential.

Table 4.2.7: Band selection

Condition	Band choice	Reason
Fixed reception and <ul style="list-style-type: none"> 8 MHz channel raster in Band III Installed base of Band III receiving antennas 	Band III, where available ^{a)}	<ul style="list-style-type: none"> Less power needed compared to Band IV/V
Fixed reception and <ul style="list-style-type: none"> 7 MHz channel raster in Band III Installed base of Band III receiving antennas 12,5 per cent reduced multiplex capacity acceptable compared to 8 MHz Band IV/V channels Band III channels available at all sites fed by the TS ^{b)} 	Band III ^{a)}	<ul style="list-style-type: none"> Less power needed compared to Band IV/V
Fixed reception in other cases	Band IV/V	<ul style="list-style-type: none"> Limited Band III capacity No need to install Band III receiving antennas
Portable reception	Band IV/V	<ul style="list-style-type: none"> Lower man-made noise levels compared to Band III Combined Band III/IV/V portable receiving antenna shows relative poor performance in Band III
^{a)} taking into account protection of analogue TV services and T-DAB and T-DMB requirements ^{b)} in principle it possible to feed transmitters with 7 MHz and 8 MHz channels by one TS, however care must be taken that the net bit rate of the system variant used in the transmitters 7 MHz and 8 MHz channels is higher than the TS bitrate; inefficient spectrum use in the transmitters with 8 MHz channels may occur due to unused capacity.		

4.2.5 Head- end configuration

The multiplex centre consists generally of interfaces, encoders, statistical multiplexer, monitoring and control equipment and ancillary equipment.

In order to achieve a flexible network, a router is installed that can connect each television signal to each encoder input.

In the case of SFNs, the multiplex centre contains equipment for the proper operation of SFNs such as:

- SFN adaptor for injecting a time stamp to allow for different transport delays in the distribution network (e.g. in the case of switching links in telecommunication circuits)⁴¹;
- External clock for synchronization, e.g. by means of GPS;
- Network Time Protocol (NTP) server to control timing of all transmitters and the multiplexer;

⁴¹ More information on the SFN adaptor is given in ETSI TR 101 190 Digital Video Broadcasting (DVB); Implementation guidelines for DVB terrestrial services; Transmission; Section 8.5 The Megafame Solution.

- Uninterruptible Power Supply (UPS) to ensure that critical parts of the installation operate continually e.g. GPS equipment.

Statistical multiplexing is widely used. In a statistical multiplexer bit rate is dynamically allocated to different services depending on the programme content⁴². Compared to a constant bit rate per service, it provides a way to increase multiplex capacity while maintaining picture quality. Statistical multiplexers need to be co-located; regionally inserted programmes can, until now, not be statistically multiplexed.

Information on bit rate requirements is given in:

- section 4.1.2 regarding SDTV and HDTV services.
- section 4.1.6 regarding additional services

Some examples of multiplex configurations are shown in EBU reports. Figure 4.2.4 gives an example for a multiplex capacity of 14.7 Mbit/s and for a multiplex capacity of 20.1 Mbit/s⁴³.

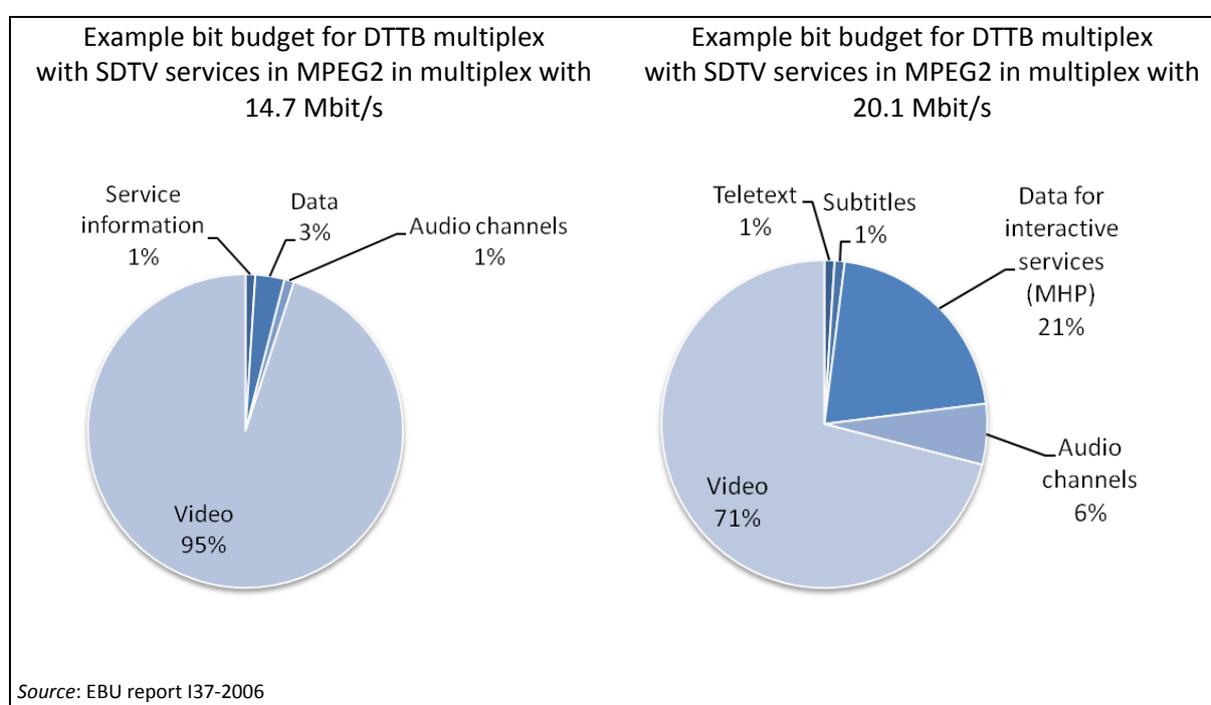


Figure 4.2.4 : SDTV bit budget examples

An example of a multiplex configuration for HDTV is given in Figure 4.2.5⁴⁴.

⁴² EBU report BPN37 Final report on statistical multiplexing, gives by means of questions and answers more information on statistical multiplexing.

⁴³ EBU report EBU doc. I37-2006: Guidelines for the RRC-06. EBU, Geneva May, 2006; Annex 3.

⁴⁴ EBU report EBU – TECH 3312 Digital Terrestrial HDTV Broadcasting in Europe. The data rate capacity needed (and available) for HDTV, Geneva, February 2006; Section 3 The terrestrial option for HDTV broadcasting.

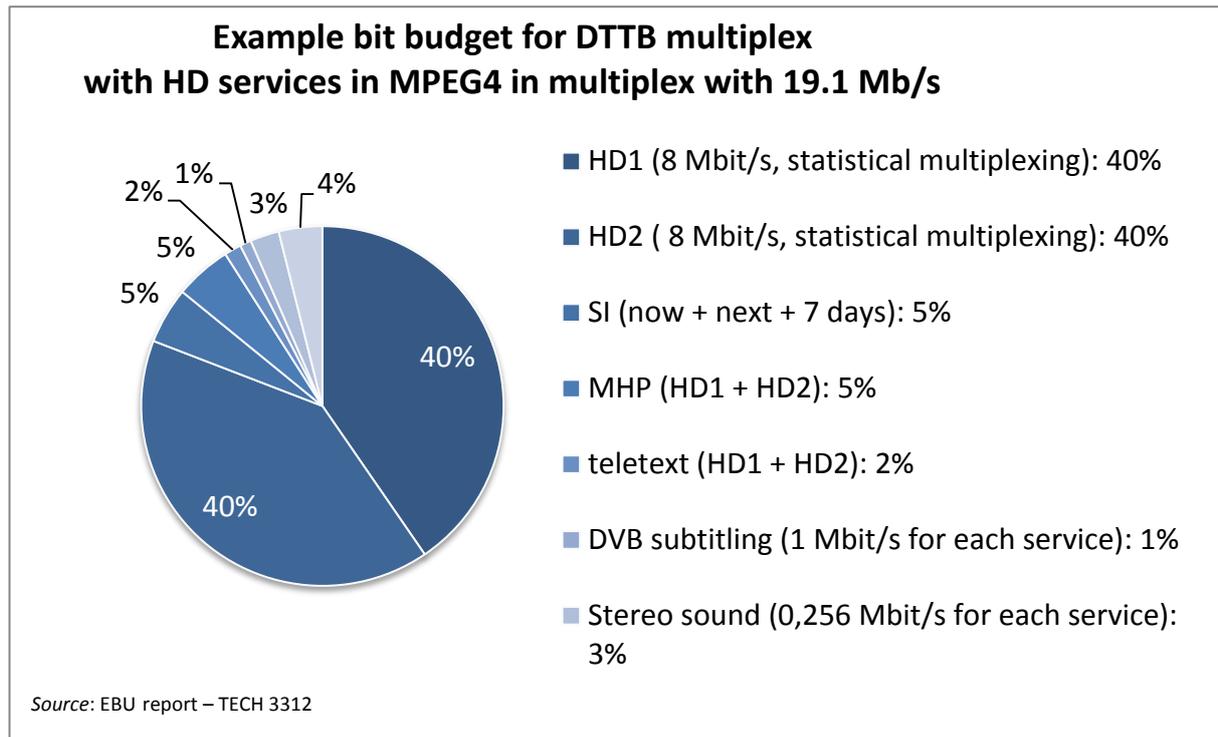


Figure 4.2.5: HDTV bit budget example

Implementation guidelines

Picture quality is a key issue of encoders and statistical multiplexers. When selecting encoder manufacturers, it is important to test encoders in this respect. Testing of a statistical multiplexer is a complex matter, it may be possible to arrange a demonstration or tests at the manufacturer 's premises.

In specifying the bit stream of a multiplex, care should also be taken of the following:

- The bit rate of the multiplex should be lower than the bit rate of DVB-T variant for which the transmitters have been adjusted in order to avoid overflow;
- Teletext may require a separate bit stream depending on the number of teletext pages;
- Packages in the TS should be numbered in a logical way in the Package Identifier (PID);
- A network identifier (one per country and operator) should be obtained at the DVB project office;
- A receiver generated Electronic Programme Guide (EPG), based on the SI is a simple solution requiring only limited bit rate. A receiver-independent EPG produced by a service provider gives the EPG its own look and feel, but requires a considerable bit stream and an adequate Application Programme Interface (API) in the receiver.

4.2.6 Equipment reserve configurations

Service contracts between content distributors and service providers normally contain provisions about the availability of the service. This could be expressed for instance as a percentage of time (measured over a long period) that the service should be on air or a maximum time of interruptions. The service availability requirements could be variable for different parts of the day or the kind of programme. In order to avoid long service interruptions in the case of maintenance or equipment failure, critical parts in the transmission chain should have a certain redundancy, either passive

reserve e.g. in n+1 configuration, or active reserve. Passive reserve has the advantage of unrestricted transmission capacity or radiated power in case of failure or maintenance, but is more expensive.

As with analogue TV transmissions, transmitting antennas are often split in two parts. Each part is fed by a separate cable. In case of failure or maintenance one part of the antenna can be switched off while the station is still operational, albeit with reduced radiated power⁴⁵.

Usually a distribution ring is made in order to feed each transmitting site from two sides. In this way it may not be necessary to have passive reserve in the link equipment.

In addition to appropriate reserve equipment, an adequate equipment monitoring system is needed to identify equipment failures and alert maintenance staff. Operational status of equipment should be visible at a central monitoring centre through a few basic indicators (e.g. on/off, failure, pre-alarm). The Simple Network Management Protocol (SNMP) is a suitable remote control protocol by means of a web browser.

In SFNs synchronization in transmitter timing has been identified as the most important issue for the correct operation⁴⁶, monitoring of transmitter synchronization is therefore important.

Implementation guideline

If several transmitters are used at a site an n+1 reserve configuration is often used. If a site accommodates one or two transmitters it may be appropriate to install instead a double driver unit. The RF power amplifier consists, in general, of several units, thus providing a built-in redundancy. It should be noted that also essential ancillary equipment (e.g. pumps for cooling) should have adequate reserve.

In the multiplex centres, encoders have often n+1 reserve configurations.

Synchronization in SFN transmitter timing has been identified as the most important issue for the correct operation of an SFN. If correct synchronization is lost, transmitters in an SFN may interfere with each other. All elements in relation to synchronization should therefore be equipped in full reserve configuration.

4.2.7 Type of distribution network

There are several ways to distribute the multiplex signals from the head-end to the transmitters⁴⁷. In general the MPEG TS is distributed to the transmitter sites and to regional re-multiplexing centres in the case of regional services (see also Figure 4.2.1). Alternatively the MPEG TS can be modulated at the head end and distributed to the transmitters via analogue links.

In MFNs it is even possible to use off-air reception, e.g. as back-up link. In SFNs this is not possible because the time needed for the demodulation and modulation process in the transmitter exceeds by far the longest time of the guard interval. However SFN fill-in stations are an attractive solution (see section 4.3.3).

⁴⁵ It should be noted that regulations to prevent radiation hazards may restrict maintenance in an antenna that is (partly) in operation. See also Report ITU-R BT.2140, part 1, section 4.5.

⁴⁶ Practical information on SFN operation and monitoring is given in EBU document EBU BPN 075 Single Frequency Network Maintenance, March 2007.

⁴⁷ More detailed information on distribution links are given in Digital Video Broadcasting (DVB); Implementation guidelines for DVB terrestrial services; Transmission aspects (ETSI TR 101 190); Section 7.

For distribution of the MPEG TS the choice is between: optical fibre, Plesiochronous Digital Hierarchy (PDH) or Synchronous Digital Hierarchy (SDH) networks, Asynchronous Transfer Mode (ATM) and satellite distribution. The choice depends on the local telecommunication infrastructure, operational and technical considerations and costs.

Table 4.2.8 shows the main features of these means of distribution.

Table 4.2.8: DTTB distribution links

Type of link	Description	DVB specification
PHD	PDH was designed for digitized signals based on 64 kbit/s. The interface at 34,368 Mbit/s is suitable for the TS.	ETS 300 813
SDH	SDH is a newer alternative to PDH using a simplified multiplexing and de-multiplexing technique and offering improved network management capabilities	ETS 300 814
ATM	ATM ⁴⁸ uses a cell-based multiplexing technique and may be carried over different kinds of transport networks including PDH and SDH. Five different ATM Adaptation Layers (AALs) have been specified for adapting different types of signal to ATM networks. AAL1 or AAL5 may be used for the transmission of an MPEG-2-TS; the main difference is that AAL1 specifies error detection and correction techniques, whereas AAL5 does not.	As for PHD or SDH
DVB-S	The TS can be distributed by satellite using the DVB-S. However, re-multiplexing will be required at each transmitter site to change the SI data to reflect the change of delivery medium.	EN 300 421

The timing of the primary distribution has to be controlled to ensure that it does not induce jitter in MPEG decoders and to ensure stable synchronization of the multiplexers and the OFDM modulators. Each piece of equipment in the programme chain will have a control input to change modes, bit-rates etc. All sites will therefore need to be linked by a control and monitoring network.

Implementation guidelines

The use of digital technology in distribution links (as well as contribution links) will maintain the quality of services throughout the broadcast chain and make efficient use of transport capacity. It also avoids cascading coding and decoding processes⁴⁹ and use can be made of telecommunication networks. Dedicated broadcast links may not be necessary.

⁴⁸ Guidelines for the handling of Asynchronous Transfer Mode (ATM) signals in DVB systems are given in TR 100 815 Digital Video Broadcasting (DVB).

⁴⁹ Advantages and constraints of various transmission systems are analysed in EBU document Tech 3291, Primary distribution of TV signals using MPEG-2 technologies, chapter 2 deals with DTTB and chapter 3 with network requirements.

4.3 Network planning

Chapter 4.3 provides background information and guidelines on key topics and choices regarding network planning for DTTB as well as MTV. The chapter consists of five sections each containing a subsection with implementation guidelines and two appendices:

- 4.3.1 Service trade-off;
- 4.3.2 SFN or MFN;
- 4.3.3 Fill-in transmitters;
- 4.3.4 GE06 compliance of planned stations;
- 4.3.5 Feed back to business plan and service proposition;
- Appendix 4.3A Planning principles, criteria and tools;
- Appendix 4.3B Practical considerations on timing of signals in SFNs.

Network planning is an iterative process between the functions described in this chapter and the functions described in chapter 4.4 or 5.4 (System parameters regarding DTTB or MTV respectively) and chapter 4.5 (Radiation characteristics), with the aim to achieve optimal coverage, multiplex capacity and radiation characteristics within the limits given by the licence conditions and business plan. A flowchart of the activities is shown in Figure 4.3.1.

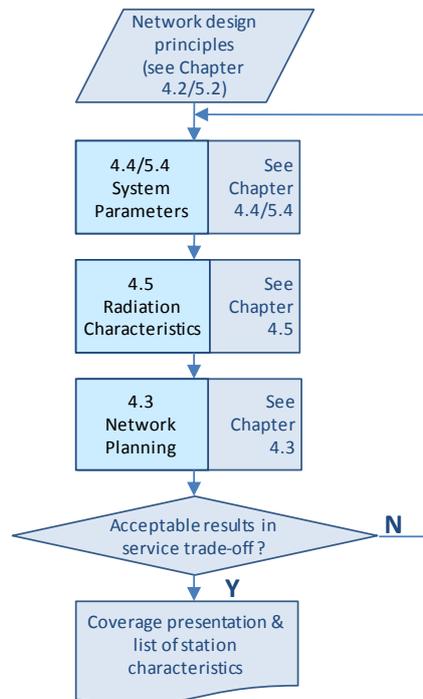


Figure 4.3.1: Network planning iterations

After establishment of design principles, system parameters are defined and radiation characteristics specified, followed by network planning (as described in this chapter).

Depending on the stage of preparations for DTTB or MTV introduction and the data that are available, these functions could be done with lesser or greater accuracy. Normally more detailed assessments are made in the project planning phase than in the preparatory phase (before the licence has been granted).

It is likely that several iterations need to be done before an optimal balance in the service trade-off between transmission costs, service quality and coverage quality between (see section 4.3.1) has been achieved.

Network planning results in coverage presentations and the lists of characteristics of each station. A coverage presentation shows coverage probability (in the presence of noise and interference) in the wanted service area, the number of people or household obtaining the required coverage quality, the system variant and bit rate of the multiplex.

A large part of the network costs is related to the number of sites and investments in transmitters and antennas. It is therefore important to carefully investigate the station characteristics and optimize coverage. With network planning, coverage problems can be identified at an early stage and solutions can be sought before the network is implemented. Furthermore, network planning can be an efficient tool for consumer marketing.

Once DTTB or MTV services have been introduced further developments will likely take place in:

- Market conditions, e.g. competitive offers (cable, satellite, IPTV);
- Consumer demands, e.g. higher quality, more services, mobile TV;
- Regulations resulting from political priorities;
- Technology, e.g. improved compression and transmission systems.

Consequently, a further evolution of DTTB or MTV networks is to be expected⁵⁰.

4.3.1 Service trade-off

In network planning a trade-off needs to be made between transmission costs, service quality and coverage quality. The network elements related in this trade-off are shown in Figure 4.3.2

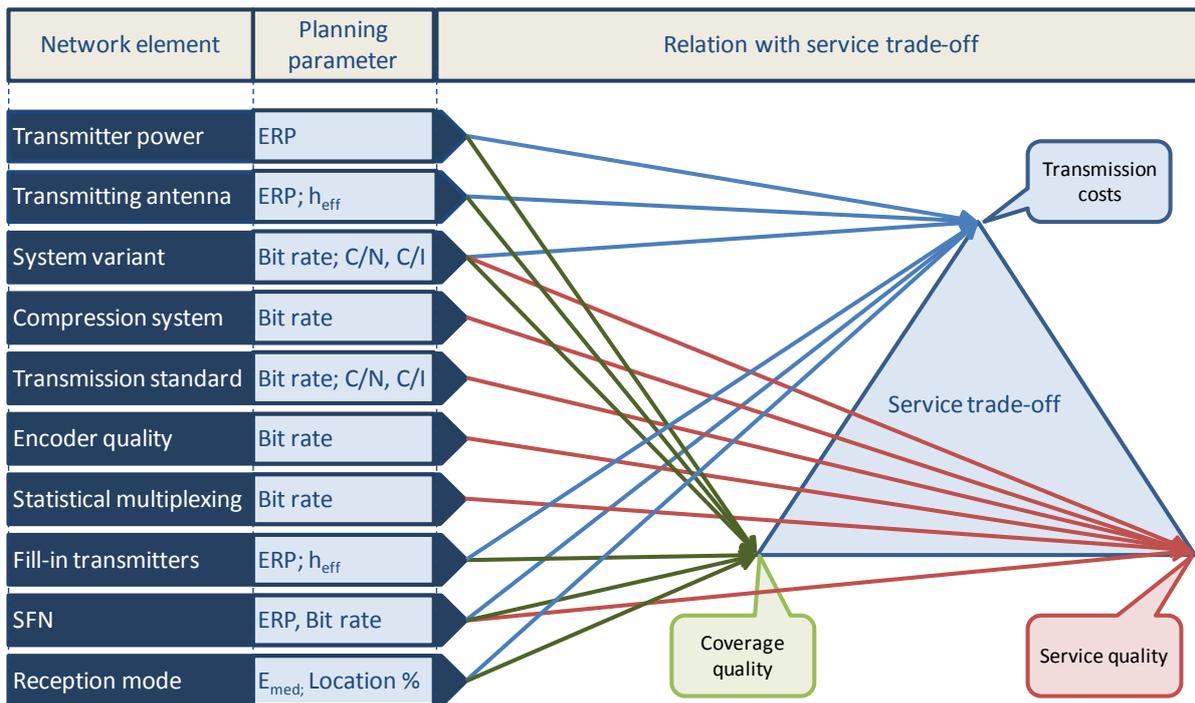


Figure 4.3.2: Service trade-off

⁵⁰ See also Networks in evolution; making changes to the digital terrestrial television platform, DigiTAG, May 2008.

Transmission costs depend to a great extent on the number of stations and the radiation characteristics. Maximum allowed radiation characteristics can be derived from the specifications of each Plan entry in the GE06 Agreement (see section 4.3.4). Furthermore, radiation characteristics may be limited by practical circumstances such as mast space and the facilities at a site. When more power is needed than allowed or practically possible, power distribution by means of a Single Frequency Network (SFN) can be considered (see section 4.3.2). Key topics and choices regarding radiation characteristics are described in more detail in chapter 4.5.

The net bit rate of the multiplex and the number of services in the multiplex determine the bit rate per service and consequently picture and sound quality. Multiplex capacity depends on the compression system, the transmission standard, encoder quality and the choice of system variant (carrier modulation, code rate and guard interval). Key topics and choices regarding systems variants for DTTB and MTV are described in more detail in chapter 4.4 and chapter 5.4 respectively.

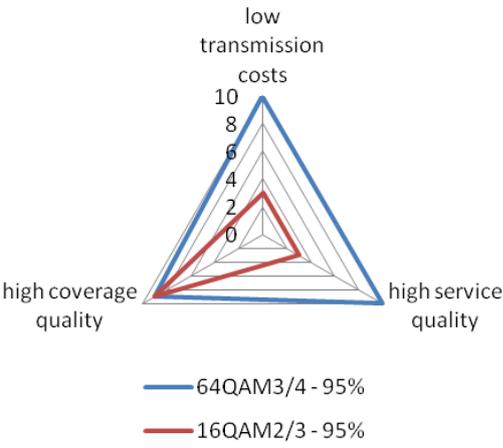
Coverage quality is related to the reception mode (fixed, portable, mobile, handheld) for which the service is planned. In the digital Plan of the GE06 Agreement a location probability of 95 per cent is used for fixed and portable reception. In practice sometimes lower percentages are accepted for portable reception, where it is possible to move the receiving antenna to an optimal position. For mobile (vehicular) reception often a location probability 99 per cent is chosen.

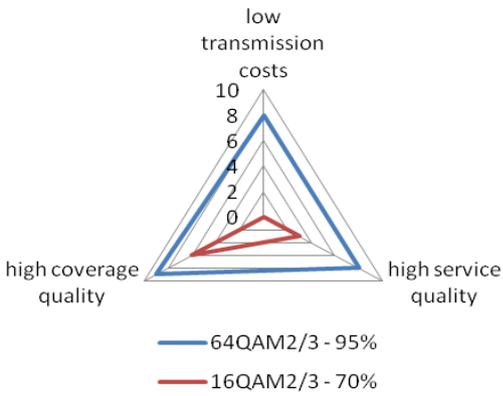
In making the trade-off it should be taken into consideration that:

- Public broadcasters often have a universal coverage requirement for DTTB services;
- Transmission costs should be weighed against the expected revenues;
- Better quality and good coverage result in more viewers; the number of viewers is related, directly (in case of pay TV services) or indirectly (in case of commercial services with advertising) to the revenues.

Two examples of the service trade-off with the DVB-T standard and MPEG2 transmission, are shown in Table 4.3.1. Transmission costs, service quality and coverage quality are illustrated in the graphical presentations on a subjectively valued ten point scale.

Table 4.3.1: Service trade-off examples

Graphical presentation	Trade-off example
 <p>low transmission costs</p> <p>10 8 6 4 2 0</p> <p>high coverage quality high service quality</p> <p>— 64QAM3/4 - 95% — 16QAM2/3 - 95%</p>	<p>1. DVB-T at 500 MHz; Fixed reception</p> <p><i>Case 1 (blue line)</i></p> <ul style="list-style-type: none"> • High service quality: multiplex capacity 27 Mbit/s • High coverage quality: location probability 95 per cent <p><i>Case 2 (red line)</i></p> <ul style="list-style-type: none"> • Medium service quality: multiplex capacity 16 Mbit/s • High coverage quality: coverage probability 95 per cent <p>Difference case 2 and case 1:</p> <ul style="list-style-type: none"> • Power saving of 7 dB (factor 5) • Capacity reduction 11 Mbit/s (41 per cent)

Graphical presentation	Trade-off example
 <p>low transmission costs</p> <p>10 8 6 4 2 0</p> <p>high coverage quality</p> <p>high service quality</p> <p>— 64QAM2/3 - 95%</p> <p>— 16QAM2/3 - 70%</p>	<p>2. DVB-T at 500 MHz; Portable indoor reception</p> <p><i>Case 1 (blue line)</i></p> <ul style="list-style-type: none"> • High service quality: multiplex capacity 24 Mbit/s • High coverage quality: location probability 95 per cent <p><i>Case 2 (red line)</i></p> <ul style="list-style-type: none"> • Medium service quality: multiplex capacity 16 Mbit/s • Fair coverage quality: coverage probability 90 per cent <p>Difference case 2 and case 1:</p> <ul style="list-style-type: none"> • Power saving of 8 dB (factor 6.3) • Capacity reduction 8 Mbit/s (33 per cent)

Implementation guidelines

The service trade-off between transmission costs, service quality and coverage quality should be made by using adequate planning software and an up-to-date transmitter station data base. The more accurate the field strength predictions and the data base, the more reliable are the results. When a population data base is available, the number of households or people (depending on the information given in the data base) obtaining at least the defined coverage probability can be calculated.

Depending on the results, further network planning exercises should be made to optimize radiation characteristics, multiplex capacity and coverage quality within the framework of the business plan or licence conditions, by performing the following activities.

Table 4.3.2: Activities for optimizing service trade-off

Activity	DTTB guidelines	MTV guidelines
SFN optimization	4.3.2	4.3.2
Gap filler planning	4.3.3	4.3.3
System parameters selection	4.4	5.4
Radiation characteristics determination	4.5	4.5
GE06 compliance testing	4.3.4	4.3.4
Feed back to business plan and consumer proposition	4.3.5	4.3.5

4.3.2 SFN or MFN

As with analogue TV, digital TV transmitters can be planned and operated as Multi Frequency Networks (MFN). In addition, multi carrier transmission standards, such as DVB-T, DVB-H and T-DMB, have the advantage that signals from several transmitters arriving at a receiving antenna may

contribute constructively to the total wanted signal. This feature makes it possible to operate transmitters as SFN⁵¹.

The GE06 Agreement gives the following definitions of MFN and SFN:

MFN: a network of transmitting stations using several RF channels;

SFN: a network of synchronized transmitting stations radiating identical signals in the same RF channel.

A combination of MFN and SFN within the same network is also possible. Examples of mixed MFN/SFN configuration are:

- Main transmitters in SFN and main transmitter and related fill-in transmitters in MFN mode;
- Main transmitters in MFN and main transmitter and related fill-in transmitters in SFN mode.

The relative advantages and disadvantages of SFN are indicated in Table 4.3.3:

Table 4.3.3: Comparison of SFN and MFNs

Advantages of SFN compared to MFN	Disadvantages of SFN compared to MFN
<ul style="list-style-type: none"> • Spectrum efficient due to power distribution • Network gain because of simultaneous reception of multiple useful signals • No need to retune when travelling through an area 	<ul style="list-style-type: none"> • No option for local windows in programming • Reduced bit rate due to long guard interval • More complicated frequency planning and operation⁵²

SFNs are restricted in size due to internal network interference also called self interference⁵³. Internal network interference occurs if the following conditions are fulfilled:

1. The time between the signal on which the receiver is synchronized⁵⁴ and signals arriving from other transmitters in the SFN, is more than the length of the guard interval, and;
2. The combined values of the nuisance fields (interfering field strength plus protection ratio minus antenna discrimination, if appropriate) of the signals arriving outside the guard interval exceeds the combined values of the wanted field strengths. In this calculation, the weighting function given by the OFDM transition curve for signal arriving outside the guard interval should be taken into account for each individual signal.

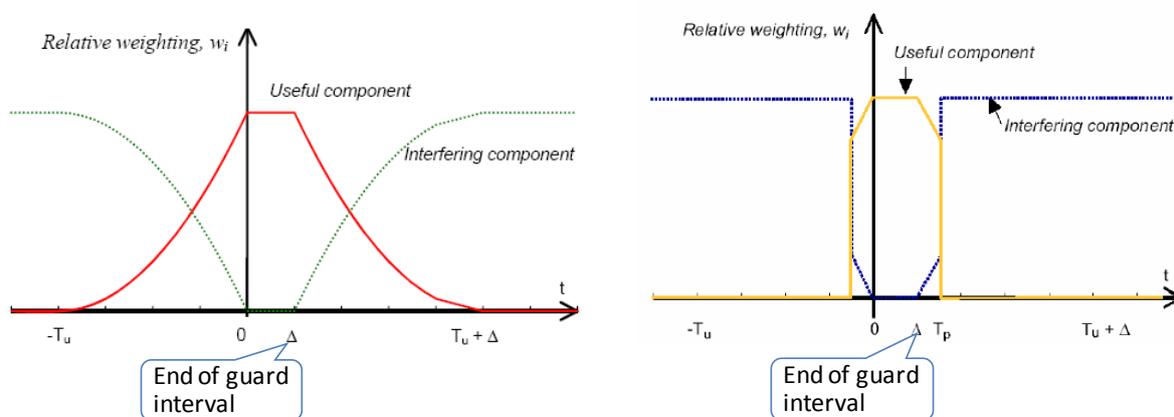
⁵¹ Detailed information on SFN planning is given in EBU document EBU BPN 066 Guide on SFN Frequency Planning and Network Implementation with regard to T-DAB and DVB-T, July 2005.

⁵² EBU document EBU BPN 075 Single Frequency Network Maintenance, March 2007, highlights issues which are generally valid for the day-to-day operation of any SFN based on OFDM technologies.

⁵³ With DVB-T2 the internal self interference restrictions will be reduced compared to DVB-T.

⁵⁴ Different synchronization methods of receivers exist, depending on the manufacturer. In planning it is normally assumed that the receiver synchronizes on the first signal above a certain level. A general review of the possible strategies for FFT window synchronization in OFDM receivers is given in EBU report BPN 059 Impact on Coverage of Inter-Symbol Interference and FFT Window Positioning in OFDM Receivers, May 2003.

The transition curve of signals arriving outside the guard interval is for T-DMB (and T-DAB) signals much more smooth than for DVB-T and DVB-H signals (see Figure 4.3.3). Therefore DVB-T or DVB-H SFNs are much more restricted in size than T-DAB and T-DMB SFNs. In practice it is possible to operate T-DAB and T-DMB SFNs over an extensive area, for instance for national coverage.



Source: EBU report BPN 066

Figure 4.3.3: Weighting curve of delayed OFDM signals; left T-DAB/T-DMB, right DVB-T/DVB-H

In Figure 4.3.3, the following symbols are used:

- W_i is the weighting coefficient for the i -th component;
- T_u is the useful symbol length;
- Δ is the guard interval length;
- t is the signal arrival time;
- T_p is the interval during which signals usefully contribute.

The separation distances between transmitters in an SFN corresponding to first condition mentioned above (signals arrive outside the guard interval) are shown in Table 4.3.4 for different guard intervals with an 8k DVB-T or DVB-H system in an 8 MHz channel bandwidth.

Table 4.3.4: Separation distances between transmitters in an SFN in case the signals arrive outside the guard interval

Length of guard interval in relation to symbol length	Length of guard interval in 8k DVB-T systems	Separation distance when guard interval is exceeded
1/4	μs	>67 km
1/8	112 μs	>34 km
1/16	56 μs	>17 km
1/32	28 μs	>8 km

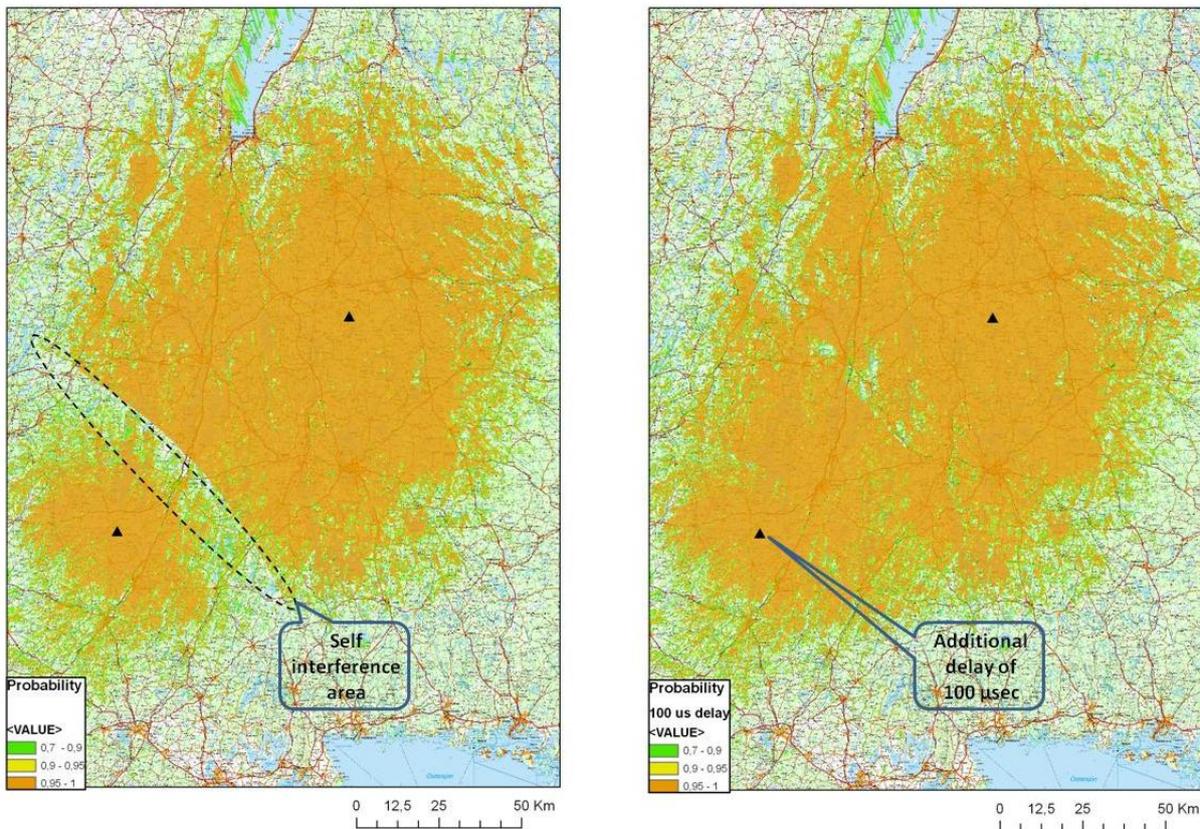
In the case of 2k (DVB-T/DVB-H) or 4k systems (DVB-H), the length of the guard interval and the corresponding separation distance should be divided by 2 and 4 respectively.

The length of the guard interval in the T-DAB and T-DMB standard is 246 μs and the corresponding separation distance 74 km.

To a certain extent, internal network interference can be reduced or resolved; a number of measures are indicated in Table 4.3.5.

Table 4.3.5: Measures to reduce self interference

Measure to reduce self interference	Disadvantage
Increasing guard interval (if longest guard interval is not yet applied), at all transmitters in the SFN	Reduction of net bit rate of the multiplex
Reduction of radiated power of transmitters causing a delay time that exceeds the length of the guard interval	Possibly coverage reduction due to power reduction
Adding an additional delay in the transmitter nearest to the self interference area (see example in Figure 4.3.4)	Possibly coverage reduction elsewhere due to self interference caused by the additional delay
Using more robust system variant at all transmitters in the SFN	Reduction of net bit rate of the multiplex
Using different frequency (if available) for one of the transmitters causing the self interference	Less frequency efficient
Using fill-in transmitter if self interference area is small	Additional cost for new site



Source: DigiTAG

Figure 4.3.4: Example self interference in DVB-T SFN

Appendix 4.3B gives some practical considerations on timing of signals in SFNs.

Another interference problem that could occur in SFNs when two or more signals arrive inside the guard interval with more or less the same level, the so-called zero-dB echo⁵⁵.

Implementation guidelines

In practice, SFNs are mainly used in one or more of the following circumstances:

- High field strength values are needed over large areas, e.g. for mobile, portable or handheld reception;
- No frequencies are available for stations in MFN configuration;
- The related GE06 Plan entry is an allotment.

Transmitters added to an SFN at a later stage may cause self interference problems in areas that had good coverage before. For that reason, as far as possible, all transmitters in an SFN, also the ones that will be implemented later, should be taken into account in network planning.

For SFN planning and coverage optimization, adequate planning software is required together with detailed terrain and clutter information and an up to date transmitter station data base. The more accurate the field strength predictions and the data base, the more reliable are the results.

4.3.3 Fill-in transmitters

Fill-in transmitters, also referred to as gapfillers, are often used for coverage of small areas with poor reception from a main transmitter.

The radiated power of a fill-in transmitter is low and often fill-ins have a directional antenna diagram. Consequently a fill-in transmitter has limited interference potential to other TV coverage areas. For this reason and because the coverage area of a fill-in transmitter is in general shielded from other transmitters, frequency reuse distances can be relatively small.

Fill-in transmitters are fed off-air from a main transmitter or even sometimes from another fill-in. In order to achieve sufficient selectivity the received signal is down-converted to IF and reconverted to the required transmission frequency. The transmission frequency can be different from the received frequency or the same. In the latter case the fill-in transmitter operates as SFN with the main transmitter.

Figure 4.3.5 shows the principle of a fill-in station in SFN mode.

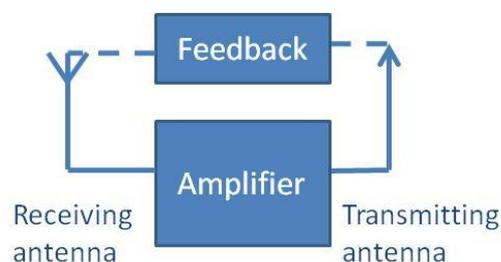


Figure 4.3.5: Principle diagram of a fill-in station in SFN mode

⁵⁵ More information on zero-dB echo is given in EBU document Tech 3327, Network Aspects for DVB-H and T-DMB, Geneva April 2008; annex A3.

To prevent oscillation, the gain of the fill-in transmitting equipment must be lower than the measured feedback. Measured isolation values in Europe range from about 60 to 110 dB⁵⁶. In general a safety margin of 10 dB is applied to the isolation value in order to allow for time variations. Modern fill-in transmitter equipment with advanced echo cancellation allows amplification of 10 to 15 dB above the isolation value.

A calculation example of the allowed radiated power for two cases, a fill-in transmitter with and without echo cancellation, is given in Table 4.3.6.

Table 4.3.6: Calculation example fill in transmitter power

Element	Fill-in transmitter without echo cancelling	Fill-in transmitter with echo cancelling
Measured input signal (Pi)	-75 dBW	-75 dBW
Measured isolation minus 10 dB safety margin (I)	65 dB	65 dB
Gain margin (Gm)	0 dB	10 dB
Maximum gain (I + Gm)	65 dB	75 dB
Output power (Po = Pi + I + Gm)	-10 dBW	-0 dBW
Transmitting antenna gain minus cable loss (Gt)	10 dB	10 dB
Allowed radiated power (ERP = Po + Gt)	0 dBW	10 dBW

The isolation can be improved by:

- Larger separation between receiving and transmitting antenna;
- Increased receiving and transmitting antenna directivity;
- Use of orthogonal polarization between input and output signal.

At VHF, the isolation between input and output signal is lower due to lower antenna directivity and lower free space loss.

If the radiated power is not sufficient to cover the area, either a transmitting frequency different from the receiving frequency should be used (the fill-in operates as MFN) if available, or the fill-in should be fed by microwave link, satellite or cable. In the latter case, the fill in transmitter should be equipped with a modulator.

Experience in Europe has shown that DTTB networks need a lower number of fill-in transmitters compared to analogue TV networks. For example in Sweden the number of fill in sites reduced from about 650 to 400 sites (less than 40 per cent).

Implementation guidelines

Detailed coverage assessment will identify the areas where fill-in transmitters are needed.

Fill-in transmitters are a cost effective and frequency efficient way to improve coverage in small areas, provided that a sufficiently strong input signal can be received. An input level above -55 dBm is generally needed to ensure a good quality output signal. In order to obtain such input values, line of

⁵⁶ Measurements results from five European countries are listed in EBU report BPN005, Terrestrial digital television planning and implementation consideration, third issue, Summer 2001, Section 13.6.3.

sight between the main transmitting antenna and the receiving antenna of the fill in station is likely to be required.

Fill-in transmitters can operate on the same frequency as the main station (SFN), but care must be taken to ensure sufficient isolation between input and output signal. The output power depends on isolation value. For that reason measurements and possibly adjustments are needed at each site and at each frequency before the fill-in station becomes operational.

Fill-in stations with different receive and transmit frequency, have no technical limitation in radiated power.

4.3.4 GE06 compliance of planned stations

Important topics to consider with regard to GE06 compliance of planned stations are:

- Conditions for bringing a Plan entry into operation;
- Application of MTV stations;
- Modifications of the GE06 Plans.

These topics are described below.

Conditions for bringing a Plan entry into operation

The Geneva 2006 Agreement (GE06) was the result of the ITU Regional Radio Conference 2006 (RRC-06)⁵⁷. At the closing ceremony of the conference, Mr Yoshio Utsumi, Secretary-General of ITU, remarked : "The most important achievement of the Conference, is that the new digital Plan provides not only new possibilities for structured development of digital terrestrial broadcasting but also sufficient flexibilities for adaptation to the changing telecommunication environment."

In order to achieve this flexibility, a set of rather complex procedures for implementation (Article 5 of the GE06 Agreement) and modification of the Plan (Article 4 of the GE06 Agreement) were agreed⁵⁸.

Possibilities for flexible implementation of digital GE06 Plan entries are summarized in Table 4.3.7.

Table 4.3.7: Flexible use of Plan entries

Option	Service	Examples	Condition
Different characteristic of a digital Plan entry	Broadcasting	<ul style="list-style-type: none"> • Different location, power, system variant, reception mode • SFNs on basis of allotments or assignments 	Conformity check (GE06, Section II of Annex 4)
Alternative application of digital Plan entry	Broadcasting	<ul style="list-style-type: none"> • DVB-H or T-DMB 	Power density check (GE06, Article 5.1.3)
	Fixed and Mobile	<ul style="list-style-type: none"> • Downlink applications of WiMAX or UMTS 	

In the conformity check, three conditions are verified:

⁵⁷ Documents and related information on RRC-06 can be found on: www.itu.int/ITU-R/conferences/rrc/rrc-06/index.asp.

⁵⁸ Information and guidance on the procedures of the GE06 Agreement is given in EBU BPN 083 Broadcasting aspects relating to the procedures for Coordination and Plan Conformity Agreement in the GE06 Agreement, November 2007.

1. Same channel should be used as the Plan entry;
2. Location of the station should be within 20 km of geographical coordinates of the Plan entry or no more than 20 km outside the allotment area;
3. Interfering field strength, calculated at great number of test points outside the territory, should not exceed the interfering field strength of the Plan entry.

In using a GE06 Plan entry for DTTB transmissions with different characteristics, three situations could occur:

1. The required minimum median field strength values (E_{med}) of the DTTB application is similar to that of the Plan entry.
In this case coverage of the DTTB application will also be similar compared to the DVB-T service related to the Plan entry.
2. The minimum median field strength values (E_{med}) of the DTTB application is lower than that of the Plan entry.
In this case protection of the DTTB application can only be claimed on the (higher) level of the Plan entry. Consequently power requirements are similar to that of the Plan entry and also DTTB coverage will be similar compared to the DVB-T service related to the Plan entry.
3. The minimum median field strength values (E_{med}) of the DTTB application is higher than that of the Plan entry. Consequently power requirements exceed the power specified in the Plan entry and coverage of the DTTB application will be less compared to the DVB-T service related to the Plan entry, unless SFNs are used that are dimensioned in such a way that:
 - a. The interfering potential from the SFN fulfils the conformity check;
 - b. Coverage of national DTTB of MTV transmissions is not adversely affected.

Table 4.3.8⁵⁹ shows some examples of the difference between the minimum median field strength values (E_{med}) of some DTTB applications and DVB-T plan entries respectively.

Table 4.3.8: Examples of differences in minimum median field strength of DTTB applications and DVB-T Plan entries at 650 MHz

DTTB application with same system variant as Plan entry		E _{med} difference (DTTB application compared to Plan entry)		
Class of reception	E _{med}	Plan entry fixed reception (E _{med} = 56 dBμV/m)	Plan entry portable outdoor reception (E _{med} = 78 dBμV/m)	Plan entry portable indoor reception (E _{med} = 88 dBμV/m)
Fixed	56 dBμV/m	0 dB	-22 dB	- 32 dB
Portable outdoor	78 dBμV/m	22 dB	0 dB	-10 dB
Portable indoor	88 dBμV/m	32 dB	10 dB	0 dB

The positive differences, indicated in Table 4.3.8 can be reduced by using a more robust system variant for the DTTB application. The negative differences can be reduced by using a less robust system variant for the DTTB application.

⁵⁹ The minimum field strength values of DVB-T services are taken from the GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.5, table A.3.5-1.

In case 2 (represented by negative margins in Table 4.3.8) the difference between the minimum median field strength values (E_{med}) of the DTTB application and Plan entry could be down to -32 dB. For complete coverage the power and number of sites need to be considerably higher than would be necessary if the Plan entry had similar characteristics as the DTTB application. Therefore in practice these kind of applications are of limited interest.

In case 3 (represented by positive margins in Table 4.3.7), the difference between the minimum median field strength values (E_{med}) of the DTTB application and the Plan entry could be up to 32 dB. In this situation, a dense SFN will be necessary to achieve a coverage of the DTTB application that is similar to the DVB-T coverage represented by the Plan entry.

Some Plan entries can only be brought into use after agreements with neighbouring countries have been reached (see also section 4.2.4), because of :

- Bilateral agreements asking for coordination before the Plan entry is brought into operation
- Remarks in the Plan entry in relation to:
 1. Incompatibilities with entries in the analogue TV Plan;
 2. Incompatibilities with entries in the digital Plan;
 3. Incompatibilities with existing assignments of other primary terrestrial services.

These remarks (if any) are contained in:

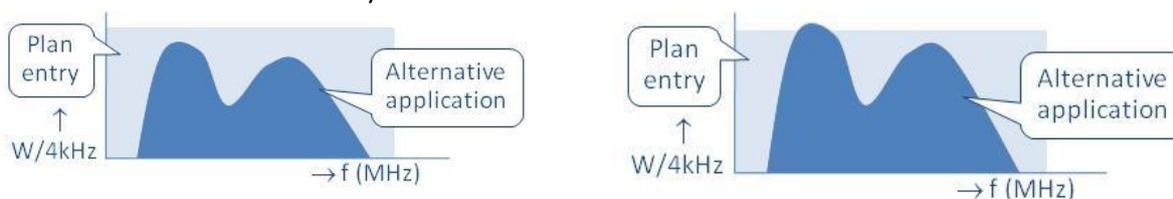
- column 28, in case of a DVB-T assignments;
- column 18, in case of a DVB-T allotment;
- column 26, in case of a T-DAB assignment;
- column 17; in case of a T-DAB allotment.

Application of MTV stations

The digital GE06 Plan contains only T-DAB (in Band III) and DVB-T (in Band III and IV/V) allotments and assignments and no MTV allotments and assignments.

If a GE06 Plan entry is used for an alternative application (e.g. MTV), the power density check needs to be fulfilled. In the power density check, three conditions are verified:

1. The frequency band should be allocated to the relevant service, if the frequency band is not allocated to the relevant service, the alternative application may operate on the condition of not causing unacceptable interference and not claiming protection;
2. The peak power density in any 4 kHz of the alternative application should not exceed the spectral power density in the same 4kHz of the Plan entry (see illustration in Figure 4.3.6);
3. The alternative application should not claim more protection than is afforded to the associated Plan entry.



Spectral power density of alternative application does not exceed the limit

Spectral power density of alternative application exceeds the limit

Figure 4.3.6: Power density check

If a Plan entry is used for another application using OFDM and with the same bandwidth and the same radiated power, the spectrum density is the same as the Plan entry. Therefore T-DAB and DVB-T Plan entries can be used without any restrictions for T-DMB, and DVB-H or DVB-T2 respectively, provided that radiated power and bandwidth are the same.

In practice the following possibilities are considered for implementation of MTV stations under the GE06 Agreement:

In Band III;

- Use of T-DAB assignments or allotments for T-DMB transmissions;
- Use of DVB-T assignments or allotments for T-DMB transmissions, where four T-DMB frequency blocks fit into one DVB-T channel;
- Use of DVB-T assignments or allotments for mobile and handheld applications with the DVB-T standard.

In Band IV/V:

- Use of DVB-T assignments and allotments for DVB-H transmissions, DVB-H is restricted to channels below 56 (750 MHz) in order to obtain the necessary frequency separation with GSM communications in the same handset;
- Use of DVB-T assignments or allotments for mobile and handheld applications with the DVB-T standard.

Coverage of MTV transmission making use of GE06 Plan entries depends on the class of reception for which the MTV services are planned. Four different classes of MTV reception can be identified⁶⁰ :

1. Class A: hand-held portable outdoor reception;
 - ✕ with external (for example telescopic or wired headsets) or integrated antenna;
 - ✕ at no less than 1.5 m above ground level, at very low speed or at rest.
2. Class B: hand-held portable indoor reception;
 - ✕ with external (for example telescopic or wired headsets) or integrated antenna;
 - ✕ at no less than 1.5 m above ground level, at very low speed or at rest;
 - ✕ on the ground floor in a room with a window in an external wall.
3. Class C: hand-held reception inside a moving vehicle (car, bus etc.);
 - ✕ with the receiver connected to the external antenna of the vehicle;
 - ✕ at no less than 1.5 m above ground level, at higher speed.
4. Class D: hand-held reception inside a moving vehicle (e.g. car, bus, etc.);
 - ✕ without connection of the receiver to the external antenna of the vehicle;
 - ✕ with external (for example telescopic or wired headsets) or integrated antenna;
 - ✕ at no less than 1.5 m above ground level, at higher speed.

The minimum median field strength values (E_{med}) of MTV services vary per frequency band, system variant and class of reception. The minimum median field strength values (E_{med}) values at a receiving height of 1.5 m range from⁶¹:

- 61 to 62 dB μ Vm in case of DVB-H in Band IV/V;

⁶⁰ See Section 1.1 of EBU doc. Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007.

⁶¹ See Section 2 of EBU doc. Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007.

- 56 to 68 dB μ V/m in case of T-DMB in Band III.

In general, Class C (vehicular reception) is the least demanding and Class B (hand-held portable indoor reception) is the most demanding in terms of minimum median field strength requirements.

In the same way as described for the case that a Plan entry is used for a DTTB application, in using a GE06 Plan entry for MTV transmissions, three situations may occur:

1. The minimum median field strength values (E_{med}) of the MTV transmission is similar to that of the Plan entry.
In this case MTV coverage will also be similar compared to the T-DAB or DVB-T service related to the Plan entry.
2. The minimum median field strength values (E_{med}) of the MTV transmission is lower than that of the Plan entry.
In this case protection for the MTV service can only be claimed on the (higher) level of the Plan entry. Consequently power requirements are similar to that of the Plan entry and also MTV coverage will be similar compared to the T-DAB or DVB-T service related to the Plan entry.
3. The minimum median field strength values (E_{med}) of the MTV transmission is higher than that of the Plan entry. Consequently power requirements exceed the power specified in the Plan entry and MTV coverage will be less compared to the T-DAB or DVB-T service related to the Plan entry, unless SFNs are used that are dimensioned in such a way that:
 - a. The interfering potential from the SFN fulfils the conformity check;
 - b. Coverage of national DTTB of MTV transmissions is not adversely affected.

Table 4.3.9⁶² and Table 4.3.10⁶³ show some examples of the difference between the minimum median field strength values (E_{med}) of the Plan entry and DVB-H and T-DMB services respectively.

Table 4.3.9: Examples of differences in minimum median field strength of DVB-H and DVB-T Plan entries at 500 MHz

DVB-H (16-QAM-1/2)		E _{med} difference (DVB-H application compared to DVB-T Plan entry)		
Class of reception	E _{med}	Plan entry fixed reception (E _{med} = 54 dB μ V/m)	Plan entry portable outdoor reception (E _{med} = 75 dB μ V/m)	Plan entry portable indoor reception (E _{med} = 85 dB μ V/m)
A	84 dB μ V/m	30 dB	9 dB	-1 dB
B	98 dB μ V/m	44 dB	23 dB	13 dB
C	74 dB μ V/m	20 dB	-1 dB	-11 dB
D	95 dB μ V/m	41 dB	20 dB	10 dB

⁶² The minimum field strength values of DVB-H services are taken from EBU report EBU doc. Tech 3317, but corrected for a receiving height of 10 m (correction factor 16 dB, see GE06 Agreement, Chapter 3 to Annex 2, table 3-3) in order to compare the figures with the minimum field strength values of GE06. The latter are derived from GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.5, table A.3.5-1, but corrected for 500 MHz.

⁶³ The minimum field strength values of MTV services are taken from EBU report EBU doc. Tech 3317, but corrected for a receiving height of 10 m (correction factor 12 dB, see GE06 Agreement, Chapter 3 to Annex 2, table 3-3) in order to compare the figures with the minimum field strength values of GE06. The latter are derived from GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.5, table A.3.5-2.

Table 4.3.10: Examples of differences in minimum median field strength values of T-DMB and T-DAB Plan entries at 200 MHz

T-DMB		Emed difference (T-DMB application compared to T-DAB Plan entry)	
Class of reception	Emed	Plan entry mobile reception (Emed = 60 dBμV/m)	Plan entry portable indoor reception (Emed = 66 dBμV/m)
A	68 dBμV/m	8 dB	2 dB
B	78 dBμV/m	18 dB	12 dB
C	62 dBμV/m	2 dB	-4 dB
D	80 dBμV/m	20 dB	14 dB

The positive differences, indicated in Tables 4.3.9 can be reduced by using a more robust system variant for the DVB-H transmission. The negative differences can be reduced by using a less robust system variant for the DVB-H transmission.

Cases 1 and 2 (represented in Tables 4.3.9 and 4.3.10 by 0 dB and a negative margin respectively) could occur with MTV reception class A and C and Plan entries planned for portable reception. However, in practice the most likely case is 3. The difference between the minimum median field strength values (Emed) of MTV services and Plan entries could be up to 44 dB (in case of DVB-H with reception class B and a plan entry with fixed reception). In this situation, even with a dense SFN, it is not possible in most practical circumstances to achieve a DVB-H coverage that is similar to the DVB-T coverage represented by the Plan entry.

Modifications of the GE06 Plans

In the case where a satisfactory service cannot be obtained by using a Plan entry, it could be considered to request the regulator to modify the Plan entry in accordance with the provisions of Article 4 of GE06. If neighbouring countries are potentially affected by the modification, depending on the characteristics of the Plan entry and the distance to the border of neighbouring countries, agreement of these potentially effected countries is required.

The Article 4 procedure should be completed in about 2¼ years, if no agreement has been reached within that time, the request for modification lapses.

Obviously, before applying Article 4, it should be checked that coverage of national DTTB of MTV transmissions is not adversely affected by the proposed station characteristics.

Implementation guideline

As part of the network planning process, the characteristics of DTTB and MTV stations should be specified in such a way that compliance with GE06 provisions is ensured through:

- Completed international coordination, including the cases identified in the remark column of the Plan entry;
- Fulfilling the conformity check (Section II of Annex 4 of GE06);
- Complying with the power density limit check (Article 5.1.3 of GE06)
- Checking that coverage of national DTTB of MTV transmissions is not adversely affected.

The conformity check, the power density check and the check regarding the remark columns, are carried out by the Radiocommunication Bureau of ITU-R, after a station has been notified by an

administration. It is the duty of the regulator to ensure that DTTB and MTV transmitting sites fulfil these conditions before being brought into operation. However, it is advised that these conditions are taken into account in network planning. If not, restrictions may have to be applied after the equipment has been ordered and installed. Consequently delays, extra costs and loss of coverage may be the result.

The conformity check is a complex procedure for which adequate software is needed, either incorporated in the planning software or as a separate package obtained from ITU-R⁶⁴. The conformity check is of particular importance in case of SFNs based on allotments or assignments, to check that the combined interference potential of all transmitters in the SFN (including the ones that will be in operation at a later stage) does not exceed the interference limits.

MTV services using handheld equipment require high field strengths. Consequently high powers are needed. However, the radiated power is limited by the provisions of the GE06 agreement. In order to achieve satisfactory coverage, dense SFNs will be needed or restricted coverage should be accepted. If the Plan entry used for MTV services is specified for fixed reception, the permissible power is in general too low for viable DVB-H or T-DMB services.

Also national compatibility should be checked with existing or planned DTTB, MTV, T-DAB (in Band III) and other services (if applicable). It may even be necessary to re-plan (part of) the band in order to accommodate MTV services, in particular when Plan entries are used that are specified for fixed reception.

If the conformity check cannot be fulfilled, a modification of the Plan entry may be considered, taking into account that international agreement may be needed.

If a content distributor has good connections with content distributors in neighbouring countries, it could facilitate the international coordination process if the operators concerned agree informally on the modified characteristics. The regulator could then be asked to formally approve the agreement.

4.3.5 Feed back to business plan and service proposition

Network planning results in:

- Coverage presentations showing for the chosen reception mode:
 - ✘ Site locations
 - ✘ Coverage probability (in the presence of noise and interference) in the wanted service area;
 - ✘ Number of people or household obtaining the required coverage quality.
- Lists of characteristics of each station including:
 - ✘ Maximum effective radiated power (ERP);
 - ✘ Horizontal and vertical antenna pattern;
 - ✘ Antenna height;
 - ✘ Site location;
 - ✘ System variant and bit rate of the multiplex.

These data are the bases for predicting transmission costs, potential number of customers and number of services and picture and sound quality of the planned network.

⁶⁴ GE06 Calc software is intended to be an easy-to-use tool to unofficially examine the conformity of notices with respect to the GE06 Plan before sending them to the BR and can be found on www.itu.int/ITU-R/terrestrial/broadcast/software/ge06calc/index.html.

The requirements regarding transmission costs, potential number of customers, number of services and picture and sound quality are described in the network principles resulting from the application of functional block 4.2 (see chapter 4.2). The network principles, in turn, take into account the technology choices and the conditions described in the licence, the business plan and service proposition.

It should therefore be checked that:

1. After the business plan and customer proposition have been prepared or modified, the objectives can be realized with a practical network;
2. After the network plan has been modified or a more detailed network plan is available, the objectives of business plan and customer proposition are still met.

If this is not the case:

1. The business plan and service proposition need to be reviewed.
2. It may also be necessary to negotiate with the regulator amendments to licence conditions or changes of Plan entries through international frequency coordination.

Modification of the network plan is likely to take place at several stages in the process of transition to DTTB and introduction of MTV. For instance:

- Initially, network planning and coverage assessment will be done with limited accuracy, because not all network planning elements are known in detail (e.g. location of new sites, antenna diagrams, radiated power, system variant, interfering transmitters). When precise data are available more detailed network planning will be performed, which could result in modified coverage or station characteristics.
- In the implementation phase, changes to the network implementation plan may have to be accepted for practical reasons. For instance, site acquisition may not be successful, or a new site may be realized at a different location. It may also happen that in the detailed project planning antenna heights or diagrams are specified differently than originally assumed.

Implementation guidelines

Network planning is based on the network principles resulting from the activities described in “Design principles and network architecture” (chapters 4.2 and 5.2 regarding DTTB and MTV respectively). The results of network planning are coverage presentations and list of stations characteristics. Which in turn is an essential input for the business plan and service proposition resulting from the activities described in “Market and business development” (Part 3).

It is necessary to check if the business and service objectives are met through network planning when preparing or modifying:

1. Business plan and service proposition;
2. Design principles and network architecture;
3. Station characteristics.

Changes in the elements listed in Table 4.3.11 require a new network planning exercise.

Table 4.3.11: Elements requiring a new network planning exercise when modified

Elements in business plan, service proposition and network principles	Elements in network plan
<ul style="list-style-type: none"> • Network costs • Potential number of customers • Number of services • Picture and sound quality 	<ul style="list-style-type: none"> • Transmitter power • Antenna gain • Antenna pattern • Antenna height • System variant • Transmission standard • Additional fill-in transmitters • Additional SFN transmitters • Reception mode

The resulting list of station characteristics and coverage presentations are used to check if the objectives of business plan and customer proposition are still met. If not, a review of business plan and customer proposition is needed.

Feedback of network planning to business plan and consumer proposition is likely necessary at several moments in the DTTB or MTV planning process, e.g.:

Table 4.3.12 Review of network planning and business plan and service proposition at different moments in the implementation process

Phase	Business plan and service proposition	Network plan	Purpose
Preparatory phase	<ul style="list-style-type: none"> • Initial proposition 	<ul style="list-style-type: none"> • Initial plan • Limited accuracy, not all data are known 	<ul style="list-style-type: none"> • License application
Network planning phase	<ul style="list-style-type: none"> • Reviewed proposition • Taking into account licence conditions 	<ul style="list-style-type: none"> • Detailed coverage assessment and station characteristics 	<ul style="list-style-type: none"> • Network implementation plan
Network implementation phase	<ul style="list-style-type: none"> • If, necessary reviewed proposition • Taking into account practical modifications to network implementation plan 	<ul style="list-style-type: none"> • If necessary, practical modifications to station characteristics • Detailed coverage assessments 	<ul style="list-style-type: none"> • Communication to public and content providers

Appendix 4.3A Planning principles, criteria and tools

In the tables below, a summary is given of principles, criteria and tools for planning DTTB and MTV services.

Propagation

Table 4.3A.1: Propagation

Principles , criteria and tools	Method/value	Remark
Field strength prediction	<ul style="list-style-type: none"> • Path general propagation curves⁶⁵ • Path specific methods using terrain data bases⁶⁶ 	1
Time percentage for predicting wanted signal	<ul style="list-style-type: none"> • 50 per cent 	
Time percentage for predicting interfering signal	<ul style="list-style-type: none"> • 1 per cent 	
Location percentage for predicting wanted and unwanted signals	<ul style="list-style-type: none"> • 50 per cent 	
Transmission channel characteristic	<ul style="list-style-type: none"> • Fixed reception: Rice • Portable and mobile reception: Rayleigh 	
Terrain data base	<ul style="list-style-type: none"> • Horizontal resolution ≤ 1 km 	2, 4
Ground cover database	<ul style="list-style-type: none"> • Specification depending on national situation 	3, 4
Height loss for reception at different heights than 10 m	<ul style="list-style-type: none"> • ITU-T P.1546 method: see Annex 5, § 9 • Path specific methods: field strength directly calculated at desired height 	5
Building penetration loss	<ul style="list-style-type: none"> • DTTB portable indoor reception <ul style="list-style-type: none"> ⌘ VHF: 9 dB ⌘ UHF: 8 dB • MTV indoor reception⁶⁷ <ul style="list-style-type: none"> ⌘ VHF: 9 dB ⌘ UHF: 11 dB • MTV reception in cars: 8 dB 	6
Standard deviation of the field strength (outdoor)	<ul style="list-style-type: none"> • 5.5 dB 	7
Standard deviation of the field strength (indoor)	<ul style="list-style-type: none"> • DTTB portable indoor reception <ul style="list-style-type: none"> ⌘ VHF: 6.3 dB ⌘ UHF: 7.8 dB • MTV indoor reception⁶⁸ <ul style="list-style-type: none"> ⌘ VHF: 6.3 dB ⌘ UHF: 8.1 dB • MTV reception in moving car: 6.3 dB 	7

⁶⁵ The generally applied method for path general field strength prediction is given in Recommendation ITU-R P.1546 Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz.

⁶⁶ A method for path specific field strength predictions is given in Recommendation ITU-R P.1812 A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands. Several other methods exist.

⁶⁷ Building penetration loss values for MTV planning purposes, based on the ETSI DVB-H implementation guidelines, are given in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.3.3.5.

⁶⁸ Standard deviation values for MTV planning purposes are given in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.3.3.7.

Remarks

1. The method of Recommendation ITU-R P. 1546 and path specific propagation models are implemented in commercially available planning software. The accuracy of the methods can be improved for the local situation by verifying predictions with field strength measurement results.
2. Terrain data with a horizontal resolution of 100 m or less is commercially available. A free worldwide terrain database (Globe) is available with a horizontal resolution of about 1 km. The GLOBE data are available at the website www.ngdc.noaa.gov/mgg/topo/globe.html or can be purchased on CD-ROM.
3. Ground cover data bases are commercially available. An example of ground cover data, also called clutter data, is shown below:

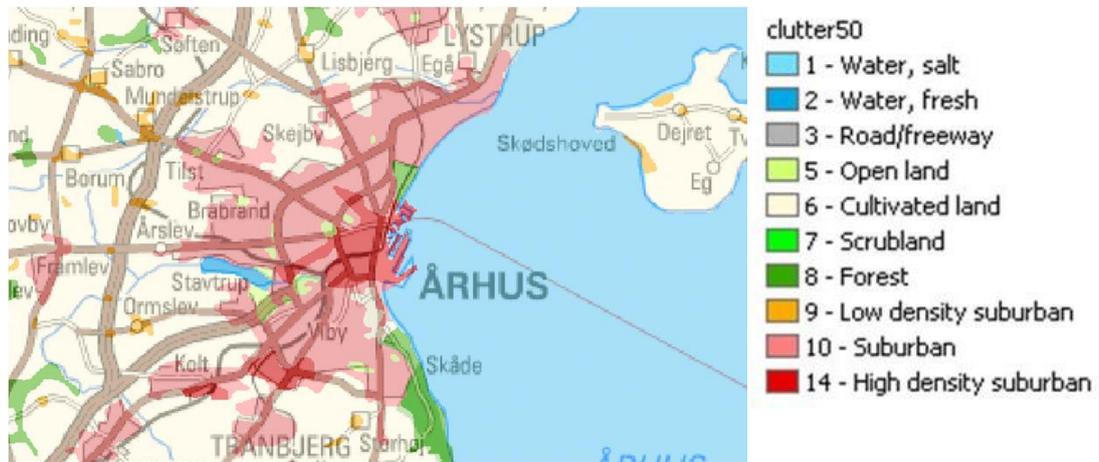


Figure 4.3A.1: Example clutter data

Source: Progira

4. Guidance on the content and format of topographic data suitable for propagation studies is given in Recommendation ITU-R P.1058⁶⁹
5. For initial planning purposes height loss values for portable DTTB reception in suburban areas are⁷⁰:
 - 200 MHz: 12 dB
 - 500 MHz: 16 dB
 - 800 MHz: 18 dB
 For MTV planning purposes the height loss values indicated below are recommended by EBU⁷¹

⁶⁹ Recommendation ITU-R P.1058 Digital topographic databases for propagation studies.

⁷⁰ GE06 Agreement Chapter 3 to Annex 2, Section 3.2.2.1.

⁷¹ Height loss values for MTV planning purposes, based Recommendation IRU-R P.1546 are given in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.3.3.4.

Table 4.3A.2: Height loss for MTV reception

Reception environment	Band III	Band IV	Band V
Urban	19 dB	23 dB	24 dB
Suburban	12 dB	16 dB	18 dB
Rural	12 dB	16 dB	17 dB

6. Building penetration loss depends on type and construction of the buildings. In Europe a large range of values has been measured up to 15 dB for office buildings. The values indicated in the tables are from the GE06 Agreement.
7. Different values of standard deviation may be adopted for various types of ground cover (e.g. open areas, urban areas), also depending on standard deviation of the building penetration loss. Field strength measurements (see also remark 1) are needed to determine the standard deviation for the most common types of terrain and ground cover in a local situation.

Frequency planning

Table 4.3A.3: Frequency planning

Principles, criteria and tools	Method/Value	Remark
Transmitter data base	<ul style="list-style-type: none"> • Format depending on planning software 	1
Receiver noise figure	<ul style="list-style-type: none"> • DTTB: 7 dB • MTV⁷² <ul style="list-style-type: none"> ⌘ T-DMB: 7 dB ⌘ DVB-H: 6 dB 	
C/N	<ul style="list-style-type: none"> • DVB-T: GE06 Agreement⁷³; other transmission standards: see standards specification • MTV: EBU document Tech 3317⁷⁴ 	
Receiving antenna gain minus cable loss	<ul style="list-style-type: none"> • DTTB <ul style="list-style-type: none"> ⌘ Fixed reception Band III: 5dB ⌘ Fixed reception Band IV/V: 7 dB ⌘ Portable reception Band III: -2 dB ⌘ Portable reception Band IV/V: 0 dB • MTV⁷⁵ <ul style="list-style-type: none"> ⌘ Integrated antenna Band III: -17 dB 	2

⁷² Information on MTV noise figures can be found in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.2.1.3 for DVB-H and section 1.2.2.3 for T-DMB.

⁷³ GE06 Agreement Chapter 3 to Annex 2, Appendix 3.2.

⁷⁴ Information on C/N values can be found in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.2.1.2 for DVB-H and section 1.2.2.2 for T-DMB.

⁷⁵ More information regarding MTV receiving antenna gain is given in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.3.3.2.

Principles, criteria and tools	Method/Value	Remark
	<ul style="list-style-type: none"> ⌘ Integrated antenna Band IV: -12 dB ⌘ Integrated antenna Band V: -7 dB ⌘ External antenna Band III: -13 dB ⌘ External antenna Band IV: -8 dB ⌘ External antenna Band V: -3 dB ⌘ Adapted antenna Band III: -2.2 dB ⌘ Adapted antenna Band IV/V: 0 dB 	
Antenna directivity	<ul style="list-style-type: none"> • Fixed reception Band III: max 12 dB • Fixed reception Band IIV/V: max. 16 dB • Portable and mobile reception : none 	2, 3
Polarization discrimination	<ul style="list-style-type: none"> • Fixed reception: max. 16 dB⁷⁶ • Portable and mobile reception: none 	3
Receiving antenna height	<ul style="list-style-type: none"> • Fixed reception: 10 m • Portable and mobile reception: 1.5 m 	
Protection ratios	<ul style="list-style-type: none"> • DTTB versus DTTB, T-DAB, analogue TV: ITU-R BT.1368⁷⁷ • DTTB versus other services: GE06 Agreement⁷⁸ • MTV: EBU document Tech 3317⁷⁹ 	4
Location probability for coverage assessment	<ul style="list-style-type: none"> • Fixed reception: 90 per cent to 95 per cent • Portable reception: 70 per cent to 95 per cent • Mobile (vehicular) reception: 90 per cent to 99 per cent 	5
Combination of multiple signals	<ul style="list-style-type: none"> • Statistical method 	6

Remarks

1. Several transmitter databases may be necessary such as:
 - Database, using data of the GE06 digital Plan and analogue Plan, for interference calculations;
 - National database with actual station characteristics for wanted signal calculations;
 - Variants of the above mentioned databases e.g.:
 - ⌘ containing station characteristics during transition and after analogue switch-off

⁷⁶ Recommendation ITU-R BT.419 Directivity and polarization discrimination of antennas in the reception of television broadcasting.

⁷⁷ Recommendation ITU-R BT.1368 Planning criteria for digital terrestrial television services in the VHF/UHF bands.

⁷⁸ GE06 Agreement Chapter 4 to Annex 2.

⁷⁹ Protection ratios for MTV are given in EBU document Tech 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007; section 1.4.1 for DVB-H and section 1.4.2 for T-DMB.

- ⌘ restrictions requested or negotiated in international coordination (in relation to bilateral agreements or remarks in columns 18 or 28 of the GE06 Plan entries of DVB-T allotment or DVB-T assignments respectively).
- 2. Depending on the receiving antennas in use, different values may be adopted nationally.
- 3. In case of orthogonal polarization, the combined discrimination value of 16 dB should be applied for all angles of azimuth.
- 4. Protection criteria for DTTB transmissions standards not covered by Recommendation ITU-R BT.1368 or the GE06 Agreement or protection criteria for MTV transmissions standards not covered in EBU document Tech 3317, need to established and implemented in the network planning software.
- 5. Normally 95 per cent is taken for good fixed, portable and handheld reception and 99 per cent for good mobile (vehicular) reception. However lower values may be adopted nationally.
- 6. In network planning and coverage calculations normally statistical methods are used for combining multiple interfering signals and in case of SFNs also for combining multiple wanted signals. The Monte Carlo method is the most accurate but also most time consuming. Other often used methods are the Log normal method (LNM) and variant thereof (t-LNM and k-LNM)⁸⁰. One or more of these methods is normally implemented in the planning software.

Coverage presentation

Table 4.3A.4: Coverage presentation

Principles , criteria and tools	Method/Value	Remark
Geographic information system (GIS)	<ul style="list-style-type: none"> • Specification depending on national requirements and planning software options 	1
Population data base	<ul style="list-style-type: none"> • Format depending on national situation 	2
Classification of coverage probability	<ul style="list-style-type: none"> • Fixed, portable and handheld reception <ul style="list-style-type: none"> ⌘ $\geq 70\% < 90\%$ ⌘ $\geq 90\% < 95\%$ ⌘ $\geq 95\%$ • Mobile (vehicular) reception <ul style="list-style-type: none"> ⌘ $\geq 95\% < 99\%$ ⌘ $\geq 99\%$ 	3

Remarks

1. The planning software will contain electronic maps for presenting the coverage area. Some planning software offers also the possibility to present coverage on Google-maps. Advanced Geographic Information Systems contribute to high quality coverage presentations needed for communication purposes.
2. Population data bases are commercially available in many countries and contain the number of people or households per postcode, or coordinate grid system.

⁸⁰ A description of these methods is given in Section 3.4 of EBU report BPN 005 Terrestrial digital television planning and implementation consideration, third issue, Summer 2001.

- Coverage is normally presented in several ranges of location probability in different colours as map overlays. An example of a coverage presentation of an SFN on channel 40 with fixed reception is shown below. In this example the following system variants are applied: Modulation 64-QAM, Code rate 2/3, Guard interval 1/4, Bandwidth 8 MHz. The net bit rate is 19.9 Mbit/s.

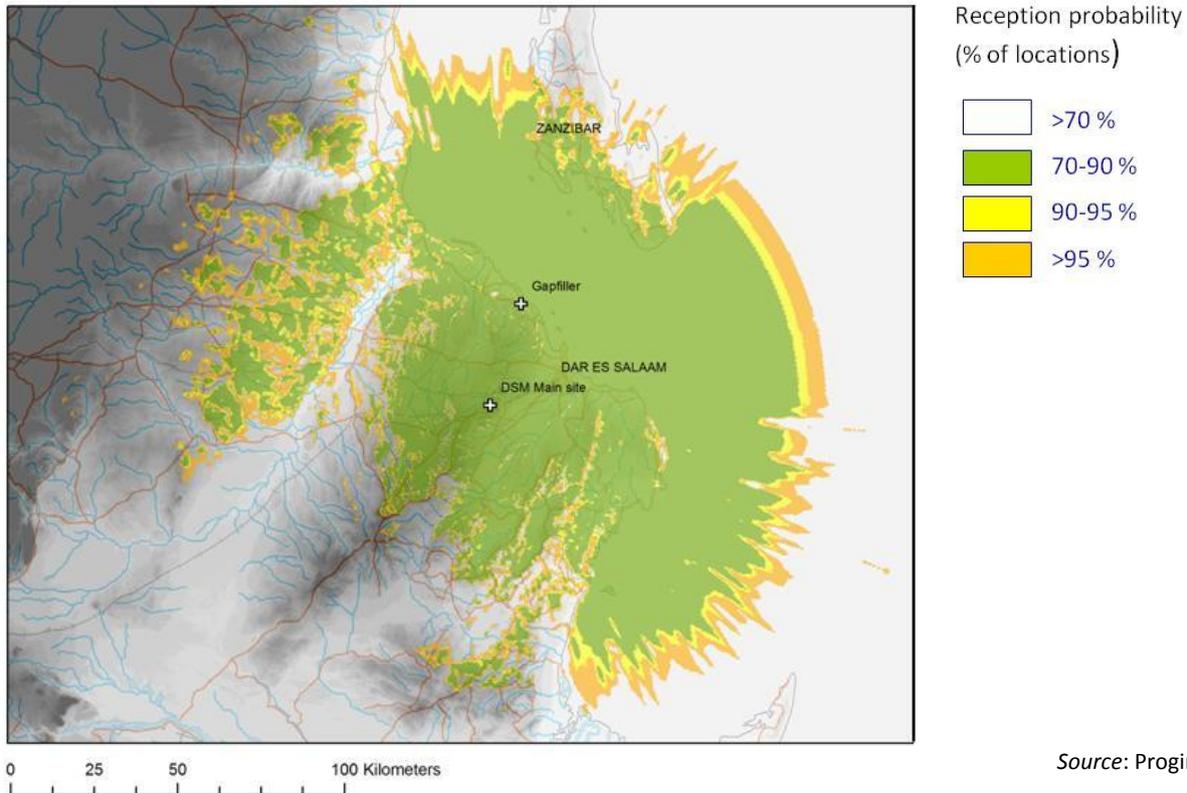


Figure 4.3A.2: Example of a coverage presentation

Appendix 4.3B: Practical considerations on timing of signals in SFN

In an SFN all transmitters of a network use the same channel, have a common coverage area and cannot be operated independently.

When operating an SFN, the signals transmitted from individual transmitters should:

- Be approximately synchronous in time (within 1 μ s);
- Be nominally coherent in frequency (within a few Hz); and
- Have identical multiplex content.

In particular, the time synchronisation needs considerable attention.

In order to obtain the required time synchronisation of each transmitter in the SFN, a Synchronisation Time Stamp (STS) is applied in the multiplex signal to allow for different transport delays in the distribution network (e.g. in case of switching links in telecommunication circuits). With the help of a standard time signal, in practice often GPS, a time delay is provided in the transmitter by comparing the inserted time stamp (STS) with the local time at the transmitter site.

Additional fixed delays are added at each transmitter site to ensure that transmitter equipment from different manufacturers can be operated safely within a single network.

At the receiving site, signals from transmitters in the SFN should, in principle, arrive inside the guard interval. However, in the case of T-DAB and T-DMB, due to the smooth transition curve at the end of the guard interval (see Figure 4.3.3), signals arriving outside the guard interval are not immediately harmful. Sometimes it is necessary to provide an additional delay of signals from one or more transmitters in the SFN in order to resolve internal network interference (see also Figure 4.3.4).

The delay with which the signals arrive at receiving antenna is the composite delay of:

1. Transport network, consisting of:
 - a. Transport network padding delay;
 - b. Transport network path delay;
 - c. Dynamic transport network compensation delay.
2. Transmitter, consisting of:
 - a. Transmitter processing delay;
 - b. Fixed transmitter compensation delay;
 - c. Additional time offset.
3. SFN network, consisting of propagation path delay depending on distance between transmitter and receiver.

In case of 2c., the maximum offset delay is included in the time stamp and the compensation delay at each transmitter is set to achieve the required additional delayed signal.

The three types of delays are illustrated for a T-DMB network in Figure 4.3B.1.

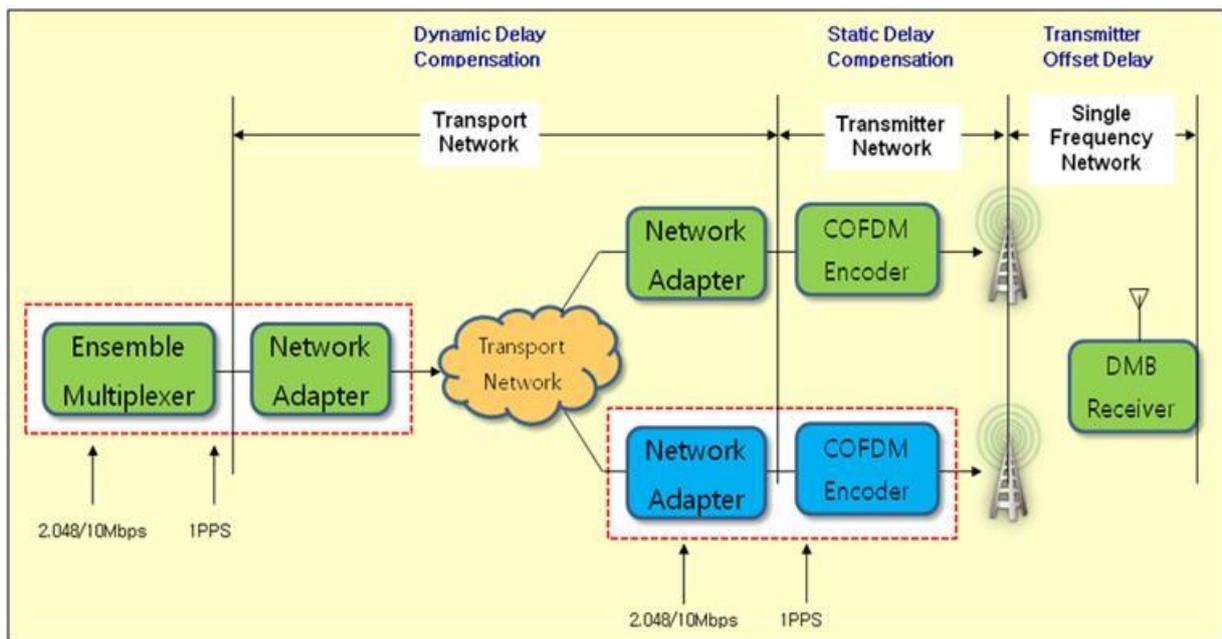


Figure 4.3B.1: Signal delays in the transmission chain

The maximum network delay is set for the whole network and is given by the following formula:

$$T_{max} = T_{tn} + T_{nc} + T_{tx} - T_{offset}$$

Where: T_{max} is the maximum delay time of the network;

T_{tn} is the transport network delay (padding delay plus path delay);

T_{nc} is the network compensation delay;

Ttx is the transmitter compensation delay;
Toffset is the additional time offset.

An example of transport network compensation delay is shown in Figure 4.3B.2. The various delay times are shown in the table below.

Table 4.3B.1: Delay times in example of Figure 4.3B.2

Delays	Tx-1	Tx-2
Maximum network delay (Tmax)	700 μs	700 μs
Transport network delay (Ttn)	200 μs	300 μs
Transport network compensation delay (Tc = Tmax – Ttn)	500 μs	400 μs

In this way the multiplex signal (called Ensemble Transport Interface - ETI in figure 4.3B.2) arrives at the input of the Tx-1 and Tx-2 at the same time.

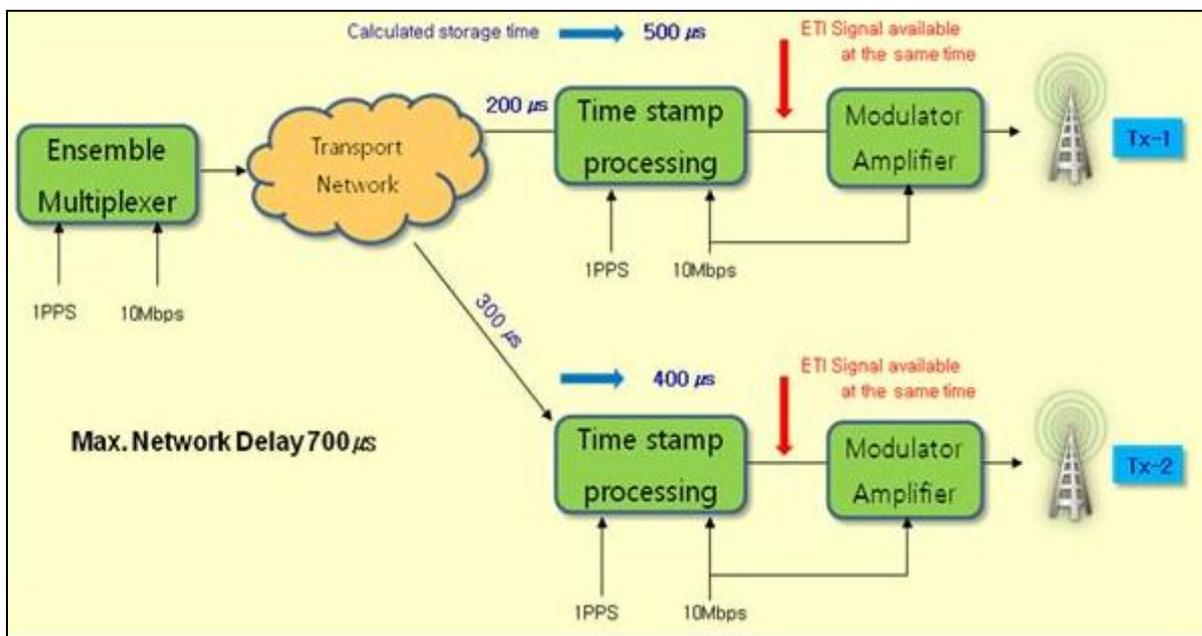


Figure 4.3B.2: Transport network compensation delay

An example of transmitter offset delay is shown in Figure 4.3B.3. In this case the maximum network delay is 600 μs. The various delay times are shown in the table below.

Table 4.3A.2: Delay times in example of Figure 4.3B.3

Delays	Tx
Maximum network delay (Tmax)	600 μs
Maximum offset delay (Toffset)	100 μs
Total time stamp value (Tmax + T offset)	700 μs
Transport network delay (Ttn)	200 μs
Transport network compensation delay (Tmax + T offset) – (Ttn + T offset)	400 μs

Other transmitters in the SFN that do not require the additional offset delays have a transport network compensation delay of 500 μs . The result is that the signals from the transmitter described in the table above are delayed by 100 μs , compared to the signals from the other transmitters in the SFN.

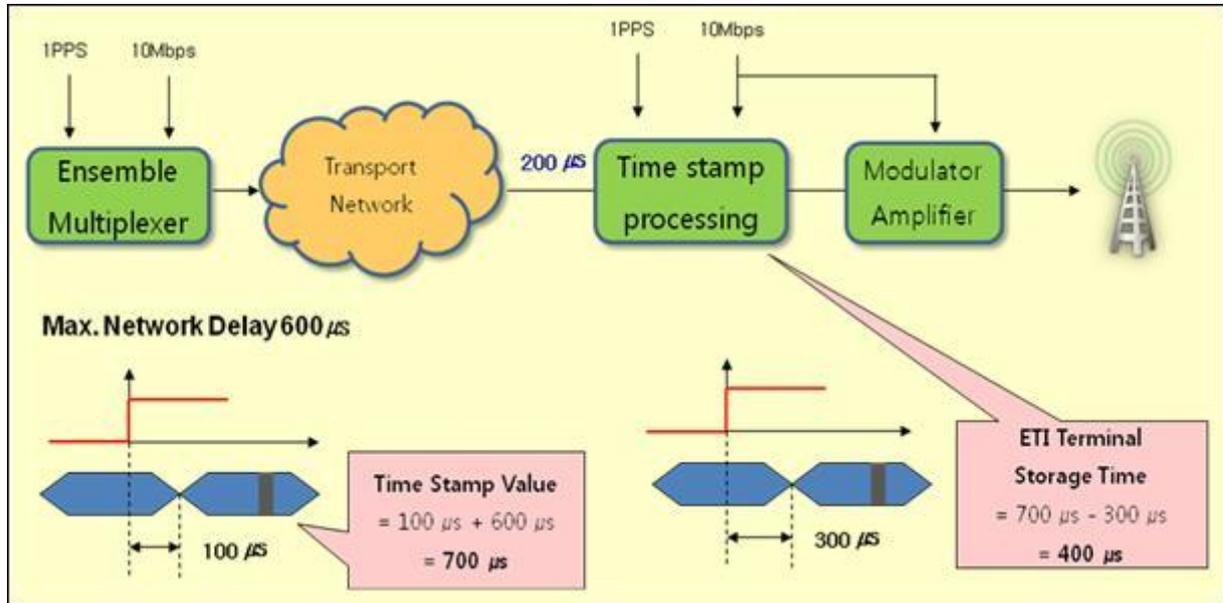


Figure 4.3B.3: Transport network compensation delay and offset delay

4.4 System parameters

Chapter 4.4 provides background information and guidelines on key topics and choices regarding system parameters. The chapter consists of three sections each containing a subsection with implementation guidelines:

- 4.4.1 Fast Fourier Transform (FFT) size;
- 4.4.2 Carrier modulation and code rate;
- 4.4.3 Guard interval.

The choice of system parameters effects:

- The net bit rate of the DTTB transmission;
- The Carrier to Noise ratio (C/N) and Protection ratio (C/I).

On the one hand the system parameters should be chosen in such a way that the net bit rate of the DTTB transmission is slightly higher than the Transport Stream (TS) in order to avoid overflow. On the other hand C/N and C/I are directly related to the radiated power and should be chosen in such a way that the maximum allowed radiated power is not exceeded.

System parameters are therefore a key element in the trade-off between transmission costs, service quality and coverage quality described in section 4.3.1.

The description and examples in this chapter are based on the DVB-T system. For other OFDM systems⁸¹ similar consideration can be made, but the values may be different.

The DVB-T system has 120 possible system variants in non-hierarchical mode consisting of a combination of:

- Two FFT sizes;
- Three types of carrier modulation;
- Five code rates of inner error protection;
- Five guard intervals.

Besides, in the hierarchical mode, in addition to the above mentioned parameters, a choice should be made out of three possible modulation parameters.

4.4.1 FFT size

The Fast Fourier Transform length (FFT) specifies the number of carriers. In the DVB-T system a choice can be made of:

- 1705 carriers, also referred to as “2k”
- 6817 carriers, also referred to as “8k”

In practice the FFT has an impact on:

- The allowable Doppler shift, in case of mobile reception⁸²;
- The length of the guard interval; with 2k the time of the guard interval is four times shorter than with 8k, making 8k more suitable for SFNs (see also section 4.4.3).

The impact of the Doppler effect is shown in Figure 4.4.1 and Figure 4.4.2⁸³. It should be noted that the maximum speed shown in the curves occurs if the vehicle is driving along radials towards or from the transmitter. In all other circumstances the maximum speed is higher.

Figure 4.4.1 shows the maximum speed of DVB-T reception due to the Doppler effect at 800 MHz for a number of system variants.

⁸¹ Report ITU-R BT.2140, Transition from analogue to digital terrestrial broadcasting (final version), Part 2 Section 1.8 gives information on the ISDB-T system.

⁸² Transmission standards that are designed particularly for mobile and handheld reception, e.g. T-DMB and DVB-H are described in Part 5.

⁸³ More information on mobile reception of DVB-T transmissions can be found in EBU report BPN 47 Planning criteria for mobile DVB-T, 22 January 2002.

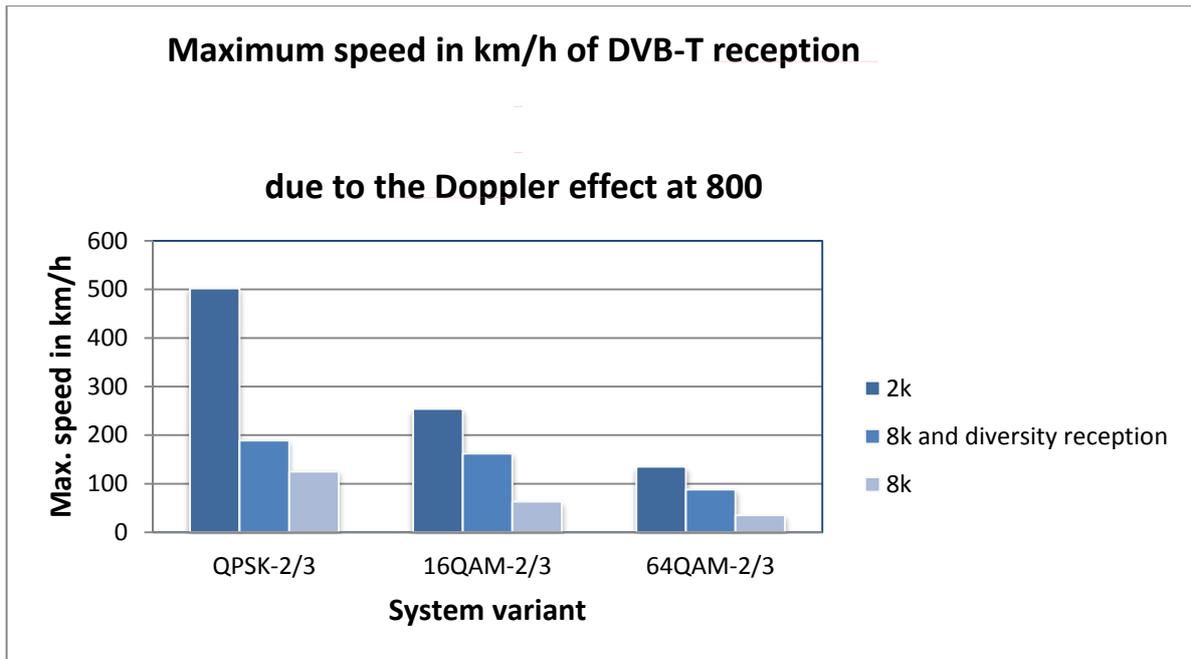


Figure 4.4.1: Maximum speed at various system variants

Figure 4.4.2 shows the maximum speed with system variant 64-QAM with code rate 2/3 at frequencies in Band III, IV and V.

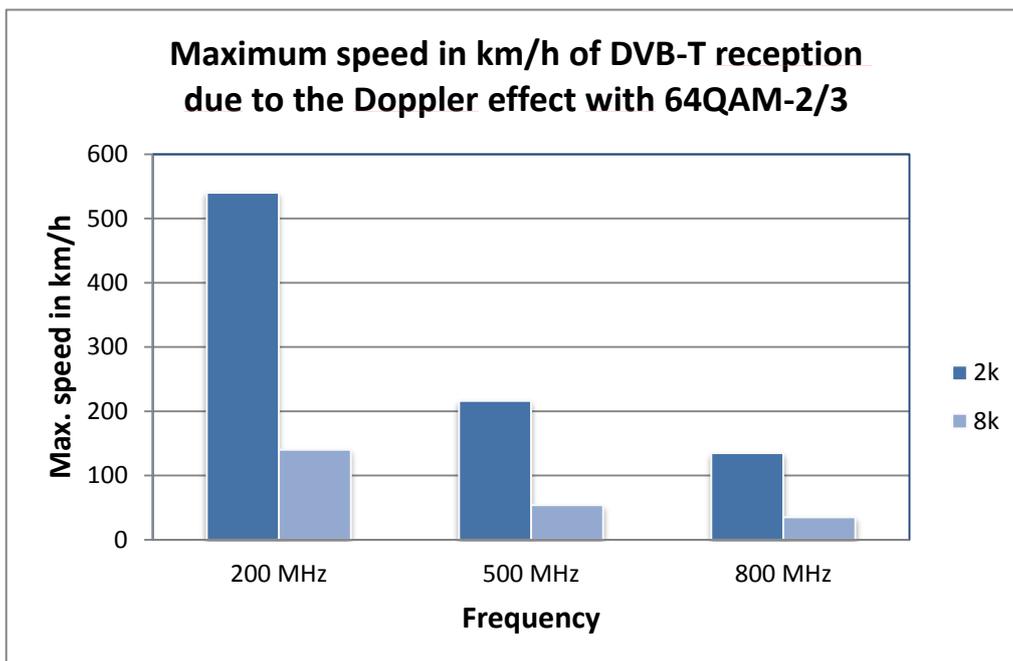


Figure 4.4.2: Maximum speed at various frequencies

From these figures it is clear that 2k is the best option for reception at high speed, however mobile reception with the 8k system variant can be improved considerably by the application of diversity reception⁸⁴. Furthermore, Band III is in particular suitable for mobile reception.

In the early days of DVB-T implementation, 2k chips were less expensive than 8k chips. That was the reason that in the UK, where DVB-T was planned for fixed reception and MFN, 2k has been adopted. However, nowadays there is no difference in receiver prices with regard to 2k and 8k. Most 2k receivers can also demodulate 8k signals.

Implementation guideline

8k is generally adopted for DVB-T.

If mobile reception at high speed is a major requirement, 2k could be implemented. However, SFN operation may be very restricted in that case. Alternatively one of the standards described in Part 5 may be applied.

4.4.2 Carrier modulation and code rate

The DVB-T system has three types of carrier modulation⁸⁵:

- QPSK;
- 16-QAM;
- 64-QAM .

Together with each type of carrier modulation, one of the five inner protection code rates should be chosen: 1/2, 2/3, 3/4, 5/6, 7/8.

The choice of carrier modulation and code rate is a trade-off between data capacity and carrier to noise ratio (C/N). The latter is directly related to the required field strength.

The combination of a lower order modulation and a low code rate is used when field strength requirements are very demanding e.g. in case of portable or mobile reception. The combination of a high order modulation and a high code rate is used when a high data capacity is required e.g. in case of HDTV or a high number of services. However in practice the highest codes rates (5/6 and 7/8) are not much used.

The C/N values and protection ratios are specified for three kinds of transmission channels:

Table 4.4.1: Transmission channels

Transmission channel	Description	Application
Gaussian channel	Reception with no delayed signals and taking into account thermal noise	Reference value
Ricean channel	Reception with a dominant signal and lower level delayed signals and thermal noise	Fixed reception
Rayleigh channel	Reception with several non-dominating signal with different delay times and thermal noise	Portable and mobile reception

⁸⁴ Information on diversity reception can be found in report EBU BPN 47 Planning criteria for mobile DVB-T, 22 January 2002, Section 5.2 and Annex 1.

⁸⁵ An description of carrier modulation in digital transmission systems is given in REPORT ITU-R BT.2140, Transition from analogue to digital terrestrial broadcasting (final version), Part 1, Section 2.4.

Figures 4.4.3 and 4.4.4 show graphical presentations of the C/N values as function of the data capacity for fixed and portable (indoor as well as outdoor) reception⁸⁶.

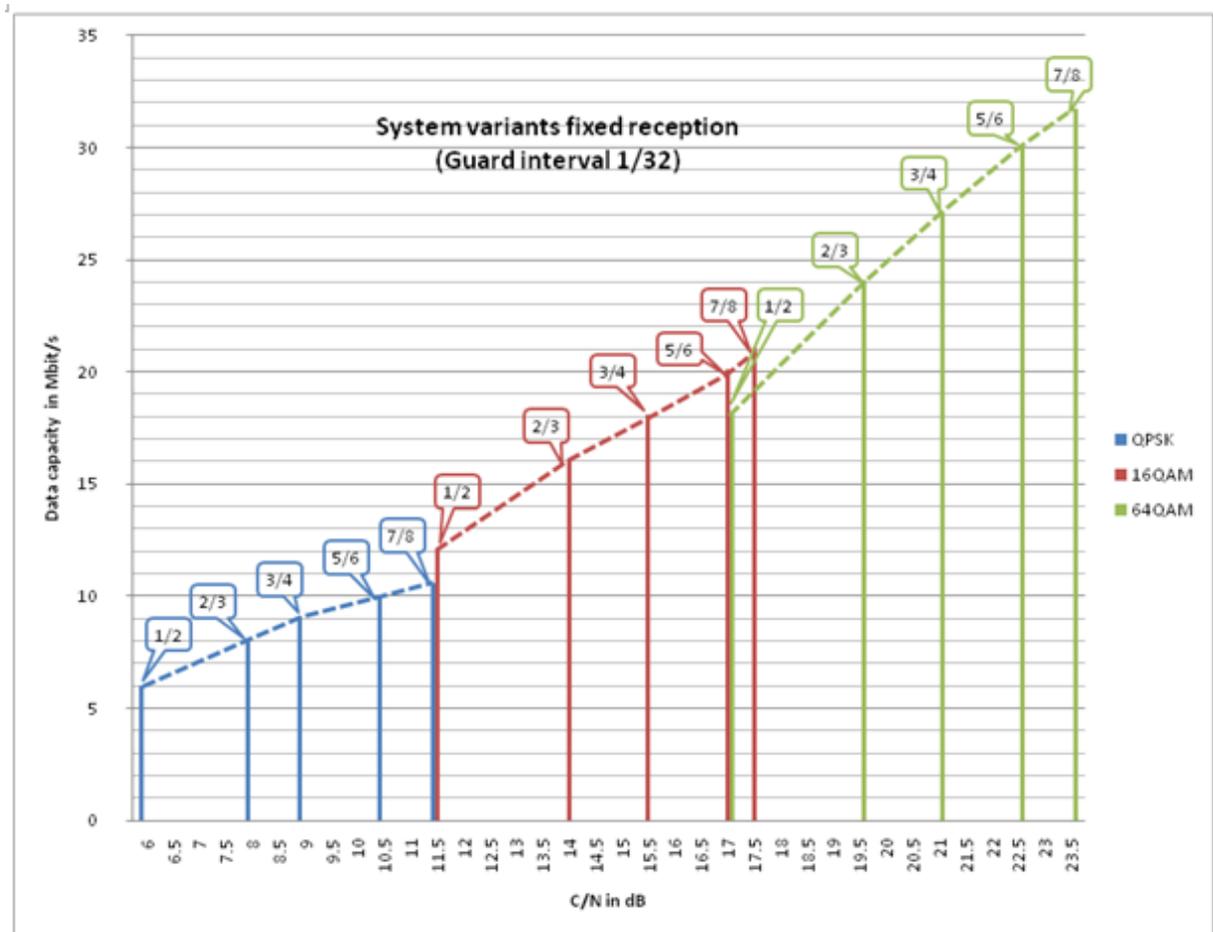


Figure 4.4.3: System variants fixed reception

From the graph it can be concluded that with fixed reception:

- QPSK at code rate 7/8 and 16-QAM at code rate 1/2 require nearly the same C/N value (11.3 dB and 11.6 dB respectively), but 16-QAM at code rate 1/2 provides a higher data capacity (12.06 Mbit/s respectively 10.56 Mbit/s). Therefore QPSK at code rate 7/8 has no useful practical application.
- 16-QAM at code rate 3/4 provides the same bit rate as 64-QAM at code rate 1/2 (18.1 Mbit/s), but requires a lower C/N (15.7 dB and 17.2 dB respectively). Therefore 64-QAM at code rate 1/2 has no useful practical application.

⁸⁶

Figures 4.4.4 and 4.4.3 are based on the GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.1, table A.3.1-1 and table A.3.2-1.

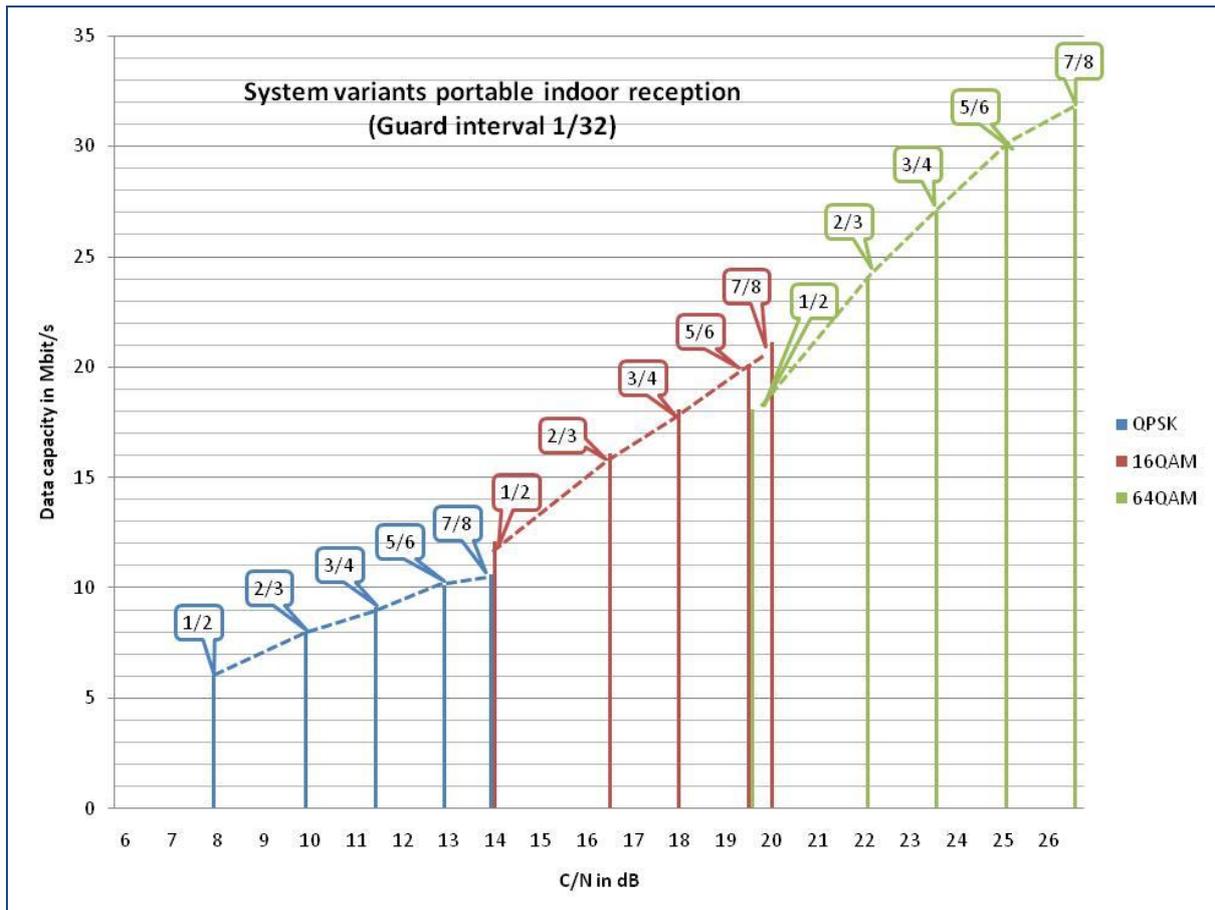


Figure 4.4.4: System variants portable reception

The graph for portable reception shows a similar pattern as for fixed reception, but higher C/N values are needed for the same data capacity.

In addition to the non-hierarchical mode described above, the DVB-T system can also be operated in hierarchical mode⁸⁷. In the hierarchical mode, two independent MPEG transport streams are fed into the transmitter with different net data capacity: a high priority stream and the low priority stream.

The high priority stream is the more robust one and uses QPSK modulation at code rates 1/2, 2/3 or 3/4. The low priority stream is intended for more stable reception conditions and uses either 16-QAM or 64-QAM at codes rates 1/2, 2/3, 3/4, 5/6 or 7/8.

With hierarchical modulation an additional variant, the modulation factor α , with values 1, 2 or 4 needs to be chosen. If α is increased, the high priority stream will be a bit more robust, but the low priority stream will need a higher C/N.

Compared to non-hierarchical, hierarchical modulation needs some overhead capacity.

⁸⁷ More detailed information on the hierarchical mode is given in Digital Video Broadcasting (DVB); Implementation guidelines for DVB terrestrial services; Transmission aspects(ETSI TR 101 190); Section 4.1.3.2.

Hierarchical modulation can for instance be used to broadcast main services over a large area in the high priority stream with portable reception. Whereas the low priority stream, with the high net bit rate, can be used to broadcast for a higher number of additional services with portable reception near the transmitter and with fixed reception in the larger area.

Another possibility is to use the low priority stream for a service package intended for fixed reception and the high priority stream for mobile TV using the DVB-H standard.

Hierarchical modulation is not much used in practice. Probably because service providers consider all services of equal importance, or splitting the multiplex capacity between two kind of services offers not sufficient capacity for each of these services.

The digital Plan of the GE06 Agreement comprises, for DTTB, DVB-T assignments and DVB-T allotments. In case of assignments, either carrier modulation and code rate are specified, or a "Reference Planning Configuration" (RPC), in which a reference C/N is incorporated, is specified. In case of allotments, always a RPC is specified.

Use of a different system variant than specified in the GE06 Plan entry or a system variant having a different C/N value than the one incorporated in the "Reference Planning Configuration" (RPC) specified in the GE06 Plan entry is possible. It does not cause a higher interference potential (if the ERP is not increased), but protection requirements will be different; Table 4.4.2 indicates the impact.

Table 4.4.2 Impact of system variant different form GE06 Plan entry

Choice of system variant	Impact compared to GE06 Plan entry
C/N higher than C/N derived from GE06 Plan entry	Higher nuisance field *) and consequently reduced coverage
C/N lower than C/N derived from GE06 Plan entry	Lower nuisance field *) and consequently increased coverage

*) Nuisance field is the interfering field strength plus protection ratio minus antenna discrimination (if appropriate).

Implementation guidelines

In practice a compromise needs to be made between the two conflicting requirements: high data capacity and low C/N.

Not all possible combinations of carrier modulation and code rate are used in practice:

- QPSK is not much used for rooftop or portable reception because of the low data capacity, but finds an application in case of very high demanding field strength requirements such as handheld reception.
- The higher code rates 5/6 and 7/8 are not much used in practice because of the high C/N values, resulting in high power requirements.
- In general 16-QAM at code rates 2/3 or 3/4 are used with portable reception and 64-QAM at code rates 2/3 or 3/4 are used with fixed reception. But other compromises occur as well in practice. For example 64-QAM at code rate 2/3 with portable reception in case of a requirement for a high data capacity and 64-QAM with codes rates 5/6 or 7/8 in case a very high number services need to be broadcast over a small area.

4.4.3 Guard interval

The guard interval⁸⁸ is an extension of the useful symbol period. Through the guard interval the transmission is to a certain extent immune to interference caused by multipath propagation. Delayed signals, received within the time period of the guard interval, contribute even positively to the wanted signal.

Delayed signals can be distinguished in:

- Passive echoes, caused by reflections to obstacles;
- Active echoes, being signals from other transmissions in the same Single Frequency Network.

The guard interval is generally expressed as the proportion to the length of the useful symbol time. The symbol time is related to the FFT size (number of carriers). Table 4.4.3 shows the guard intervals for DVB-T systems with 7 and 8 MHz channel bandwidths.

Table 4.4.3: Guard intervals in DVB-T

Length of guard interval in relation to symbol length	Length of guard interval in μsec			
	8k DVB-T systems		2k DVB-T systems	
	8MHz	7 MHz	8MHz	7 MHz
1/4	224	256	56	64
1/8	112	128	28	32
1/16	56	64	14	16
1/32	28	32	7	8

There is a trade-off between the length of the guard interval and the data capacity. For a given DVB-T variant, a larger guard interval length implies a lower data capacity⁸⁹. Figure 4.4.5 shows the net bit rate at different guard intervals for three DVB-T system variants.

⁸⁸ A description of the functioning of the guard interval is given in report EBU BPN 066 Guide on SFN Frequency Planning and Network Implementation with regard to T-DAB and DVB-T, July 2005 , Section 2.3 and 2.4.

⁸⁹ The net bit rate for different guard intervals in 7 and 8 MHz channel bandwidth is shown in the GE06 Agreement, Chapter 3 to Annex 2; Appendix 3.1, Table A.3.1-1.



Figure 4.4.5: Bit rate at different guard intervals

Implementation guidelines

In Multi Frequency Networks (MFN), where only passive echoes occur, the lowest guard interval (1/32) is sufficient.

In Single Frequency Networks (SFN) passive and active echoes are present. Depending on the size of the SFN, the guard interval with no or minimal internal network interference should be chosen (see section 4.3.2).

4.5 Radiation characteristics

Chapter 4.5 provides background information and guidelines on key topics and choices regarding radiation characteristics of DTTB and MTV stations. The chapter consists of three sections each containing a subsection with implementation guidelines:

- 4.5.1 Transmitter power and antenna gain;
- 4.5.2 Polarization;
- 4.5.3 Use of existing antennas or new antennas.

The choice of radiation characteristics effects:

- Costs of the DTTB or MTV transmission;
- Coverage quality.

On the one hand, the radiation characteristics should be chosen in such a way that as much as possible use can be made of existing installations in order to restrict investment costs. On the other hand, radiation characteristics are directly related to the coverage quality and should be chosen in such a way that within the limits of the allowed maximum radiated power, coverage is maximized at all frequencies that are transmitted from the site.

Radiation characteristics are therefore a key element in the trade-off between transmission costs, service quality and coverage quality described in section 4.3.1.

The radiation characteristics of each Plan entry in the GE06 Agreement are specified. In case of assignments the characteristics consist of:

- Maximum effective radiated power (ERP)⁹⁰;
- Altitude above sea level;
- Height of the transmitting antenna above ground;
- Maximum effective antenna height⁹¹ (h_{eff}) and the h_{eff} at 36 different azimuths at 10 degrees intervals;
- Antenna attenuation at 36 different azimuths at 10 degrees intervals;
- Polarization⁹²;
- Spectrum mask.

In case of allotments, polarization and spectrum mask are also specified, but ERP, antenna height and h_{eff} of each station should be determined⁹³ on the basis of the "Reference Network"⁹⁴ and the "Reference Planning Configuration"⁹⁵, taking into account the GE06 conformity check (see section 4.3.4).

In addition, national and local regulations may limit the power at a site or field strength near the site due to health hazard and EMC considerations⁹⁶.

4.5.1 Transmitter power and antenna gain

Important topics to consider with regard to transmitter power and antenna gain are:

- Trade-off between transmitter power and antenna gain;
- Horizontal antenna pattern;
- Vertical antenna pattern;
- Combining transmissions into one antenna.

These topics are described below.

Trade-off between transmitter power and antenna gain

The transmitter power of a DTTB or MTV station is defined as mean power, contrary to analogue TV where the peak envelop power is used to express the transmitter power. Transmitter power minus losses in antenna cable and combiner, plus antenna gain is the effective radiated power(ERP).

As with analogue TV there is a trade-off between transmitter power and antenna gain. Table 4.5.1 indicates the main considerations for this trade-off.

⁹⁰ ERP is defined in the Radio Regulations, article 1.162.

⁹¹ The concept of effective antenna height is described in Recommendation ITU-R P.1546 Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz, Annex 1 Section 6 and Annex 5 Section 3.

⁹² Polarization of Plan entries can be horizontal, vertical, mixed or unspecified. In the latter case polarization should be decided nationally.

⁹³ Depending on the licence conditions, station characteristics related to allotments need to be determined by the regular or by the operator.

⁹⁴ Reference Networks are described in the GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.6.

⁹⁵ Reference Planning Configurations described in the GE06 Agreement, Chapter 3 to Annex 2, Appendix 3.5.

⁹⁶ See also Report ITU-R BT.2140 Transition from analogue to digital terrestrial broadcasting; Section 4.5.

Table 4.5.1: Trade-off between transmitter power and antenna gain

Trade-off element	Generally less (-), more (+) or more or less neutral (0) contribution			
	Low transmitter power	High transmitter power	High antenna gain	Low antenna gain
Investment costs	-	+	+	-
Operational costs	-	+	0	0
Space requirements	-	+	+	-
Reception problems near site	0	0	-	+

Digital TV transmitters are available for different power classes, ranging from less than 1 Watt to more than 10 kW in UHF⁹⁷.

In some cases, existing analogue transmitters can be converted to digital by replacing the analogue modulation unit by a digital modulation unit and reducing the power amplification to obtain the required linearity for digital transmissions⁹⁸, taking into account that:

- An analogue TV transmitter with combined video and audio amplification has been equipped with the required 7 or 8 MHz bandwidth filter and can easily be adjusted to digital transmission;
- An analogue TV transmitter with separate video and audio amplification needs to be modified; only the video power amplifier can be used and a band filter should be added;
- Analogue TV transmitters with klystrons are not suitable for digital transmissions because of the non-linear characteristics of the klystron;
- The mean power of a digital transmission from a converted analogue TV transmitter is about 20 per cent of the analogue peak envelop power.

Horizontal antenna pattern

The horizontal antenna pattern shows attenuations, which are frequency dependent. Antennas are classified as:

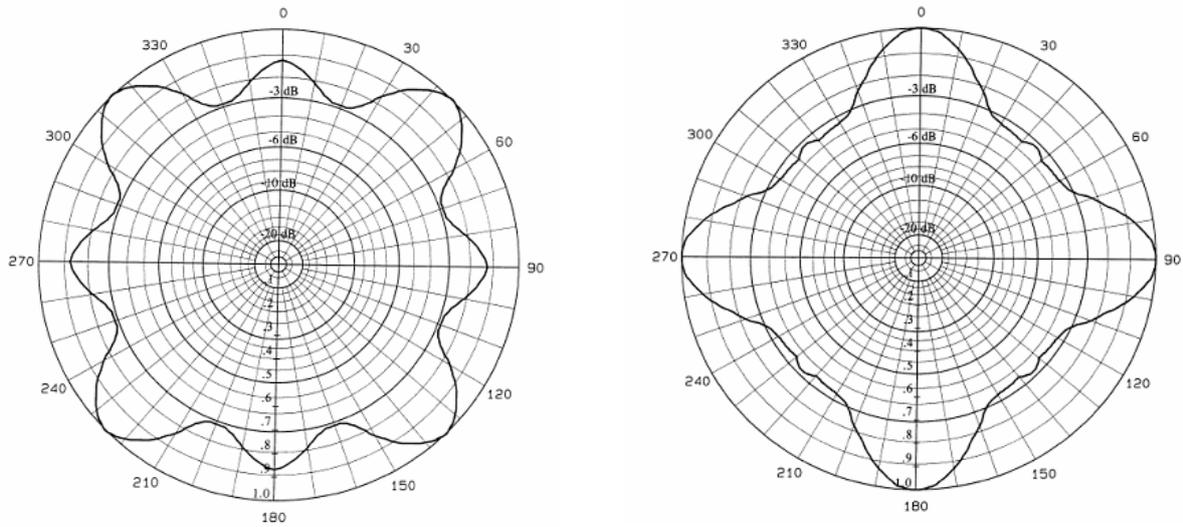
- Non-directional, when no attenuations are needed. Depending on the construction of the antenna, in practice certain attenuations are present (see example in Figure 4.5.1);
- Directional, when attenuations in the radiation pattern are required to protect other services or to adapt the pattern to the form of the wanted coverage area. A practical antenna pattern should satisfy the required attenuations, without exceeding the permitted radiation pattern. This could result in restricted radiation over a large arc (see example in Figure 4.5.2).

⁹⁷ DVB-T transmitter requirements and test procedures are specified in ETSI EN 302 296 Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the digital television broadcast service, Terrestrial (DVB-T); Harmonized EN under article 3.2 of the R&TTE Directive

⁹⁸ See also Report ITU-R BT.2140 Transition from analogue to digital terrestrial broadcasting; Section 3.6.1.

Channel 23

Channel 57



Source: DigiTAG

Figure 4.5.1: Example of horizontal radiation pattern of a non-directional antenna at two frequencies



Figure 4.5.2: Example of a horizontal radiation pattern of a directional antenna

Vertical antenna pattern

The maximum antenna gain depends on the number of tiers of the antenna. More tiers result in a more directional vertical antenna pattern, a higher maximum gain, but also more length and weight, hence increasing requirements for the mechanical strength of the mast. The gain and length of practical non-directional antennas for main stations range from:

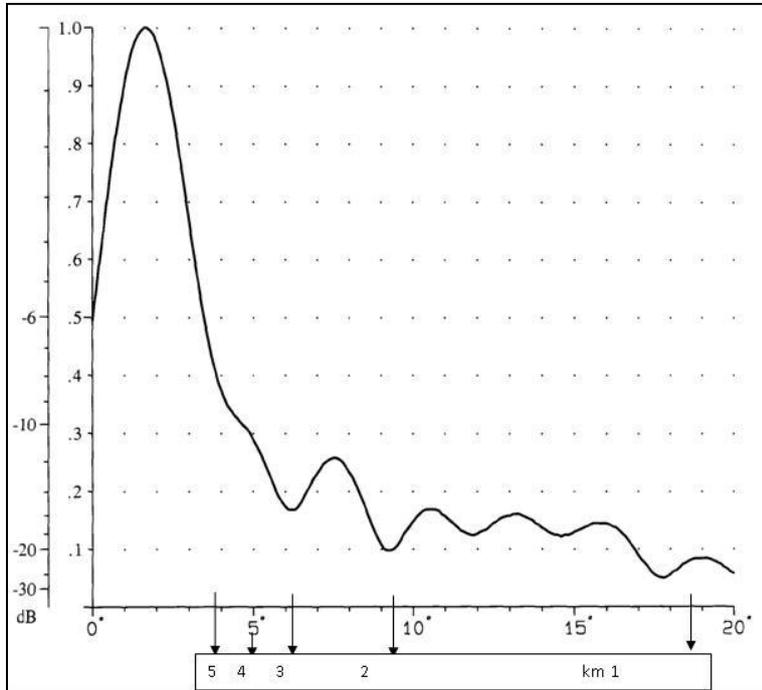
- Band III: 2 to 15 dB; length: 1.2 to 25 m;
- Band IV/V: 7 to 18 dB; length: 2.2 to 18.5 m.

The vertical radiation pattern shows maxima and minima (nulls) (see Figure 4.5.3), causing considerable field strength variations within a few kilometres from the site. In the direction of nulls, reception may be problematic close to the transmitting site. This is more apparent with portable, mobile or handheld reception where high field strength values are required.

To cure reception problems near the site the following two solutions can be applied:

1. Null-fill, but at the cost of some additional gain;
2. An antenna with a lower number of tiers and consequently less gain.

In the direction of maxima of the vertical antenna pattern, high field strength values could be present close to the site and interference to consumer equipment and professional equipment may occur.



Vertical antenna pattern

- Antenna height 350 m
- Eight bays
- Extra null fill below 10°

Source: DigiTAG

Figure 4.5.3: Example of a vertical radiation pattern of an antenna

The main beam of the vertical antenna pattern should be directed towards the coverage area and depending on antenna height and size of the coverage area, a down tilt may be applied (in the example shown in Figure 4.5.3 the down tilt is about 1.7 °). Down tilt has the additional advantage that less power is radiated towards the horizon and therefore causing less interference towards other co-channel services.

Beam tilt can in principle be realized in two ways, mechanically and electrically. Mechanical beam tilt is only used in special occasions. There are two methods for electrical beam tilt:

1. By adjusting the phase of each bay;
2. By adjusting the phase of the main feeder.

Combining transmissions into one antenna

For economic reasons in most cases, all transmissions at a site are combined into one antenna.

In doing so, it should be taken into account that:

- Horizontal radiation patterns are different per frequency (see example in Figure 4.5.1). Because of the rapid failure characteristics of DTTB reception, differences in field strength of more than about 1 dB between two received frequencies in the fringe area could result in good reception of one multiplex and no reception of the other.

- Certain modern type of antennas show less differences at the lower and upper end of the band.
- In case of directional antennas, the reduction will appear on all frequencies, but the amount of attenuation is frequency dependent.
- When attenuations at certain frequencies are not acceptable and there is no space on the mast for an additional antenna, multi-pattern antenna can be considered. With a multi-pattern antenna, each frequency has its own pattern, while using the same physical antenna. This is realized at the cost of power splitters, additional combiners and additional antenna cables.
- The sum of mean power and peak voltage of all transmitters should not exceed the allowed mean power and peak voltage of the antenna system. TV stations are usually designed to allow operation with one antenna half, therefore one antenna half should be capable of handling the full power and peak voltage.

A calculation example of total peak voltage and average power is shown in Table 4.5.2.

Table 4.5.2: Calculation example of peak voltage and mean power in an antenna

Service	DVB-T 1	DVB-T 2	DVB-T 3	DVB-T 4	Analogue TV 1		Analogue TV 2	
Channel	55	37	57	28	42		52	
					Vision	Sound	Vision	Sound
Peak power analogue (Ppa) [W]	n.a.	n.a.	n.a.	n.a.	10000	n.a.	10000	n.a.
Mean power (Pm) [W]	1200	1200	1200	1200	5950	1000	5950	1000
Crest factor (Cs) [dB]	15	15	15	15	n.a.		n.a.	
Peak power digital (Ppd) ([W]	37947	37947	37947	37947	n.a.		n.a.	
Peak voltage of tx (in 50 Ω) (Vp) [V]	1377	1377	1377	1377	1316		1316	
Mean power of tx (Pmt) [W]	1200	1200	1200	1200	6950		6950	
Total peak voltage (Vpm) [V]	1377	2755	4132	5510	6826		8142	
Total mean power (Pmm) [W]	1200	2400	3600	4800	11750		18700	

The following formulas are used in the example in Table 5.4.2:

- Analogue mean power (Pma) = Ppa x 0,595
- Digital peak power (Ppd) = Pm x 10^{Cs/10}
- Peak voltage of digital transmitters (Vp) = √(Ppd x 50)
- Peak voltage of analogue transmitters (Vp) = √2 x √(Ppa_{vision} x 50) + √2 x √(Ppa_{sound} x 50)
- Mean power of analogue transmitters (Pmt) = Pm_{vision} + Pm_{sound}
- Total peak voltage (Vpm) = sum of peak voltages of all transmitters
- Total mean power (Pmm) = sum of mean power of all transmitters

Combiners

The combiner is the unit that combines several transmitter outputs into the same antenna. The transmitter outputs can be DTTB multiplexes, MTV multiplexes and analogue TV. In addition, the combiner filters the output signal to avoid out-of band emissions. Combiners cause some power loss:

- About 0.4 to 0.7 dB for tuneable high power combiners;
- About 0.2 to 0.3 dB for non-tuneable combiners.

A combiner can be very voluminous, depending on the power handling capabilities and the number of multiplexes or analogue TV signals that are combined.

The GE06 Agreement specifies two types of spectrum masks; the spectrum mask for non-critical and sensitive cases⁹⁹. The latter is applied when using adjacent channel digital or analogue TV (in particular when I-PAL is transmitted in the lower adjacent channel relative to the DTTB signal) or to protect other (non-broadcasting) services in adjacent channels. The non-critical spectrum mask requires six filter cavities, whereas the spectrum mask for sensitive cases requires eight filter cavities.

The combiner filters characteristics should comply with the spectrum mask that is specified for frequencies in use.

Graphs showing spectrum masks for T-DAB/T-DMB and DVB-T/DVB-H are shown in Figure 4.5.4 and Figure 4.5.5 respectively.

Implementation guideline

In practice, the choice of transmitter power and antenna gain depends very much on local circumstances and requirements including:

- A desire and a possibility to convert existing analogue TV transmitters into digital ones;
- A desire and a possibility to use existing antennas (see also section 4.5.3);
- Space in transmitter building and space in the mast for a new antenna.

Nevertheless a number of practical guidelines can be given regarding the choice of transmitter power and antenna gain.

General

If additional multiplexes (transmitters) for DTTB or MTV are expected in future, it is advised to take extra space and capacity into account in the design and layout of the transmitter building, antennas, combiners and power supply. Later extensions to the network risk generating high costs as existing equipment and facilities is made redundant and replaced.

Transmitters

When converting an analogue TV transmitter into digital it should be taken into account that:

- The mean power of a digital transmission from a converted analogue TV transmitter is about 20 per cent of the analogue peak envelop power;
- New transmitters can be configured for all standards that are in use. The mean power of a DVB-T or DVB-H transmission of a new transmitter is about 40 per cent of the analogue peak envelop power.

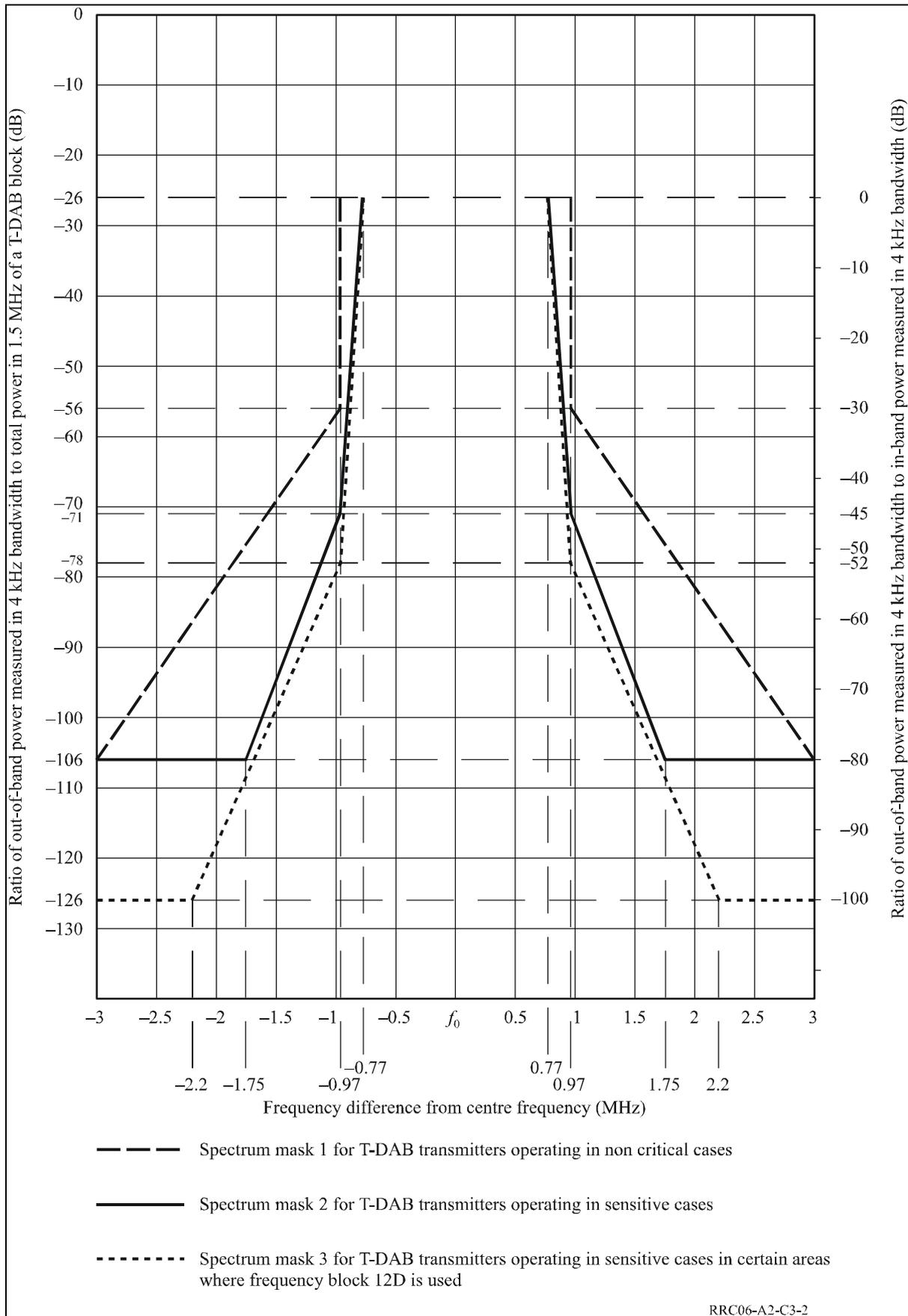
It is common practice to choose a somewhat higher transmitter power than theoretically needed when subtracting antenna gain, feeder loss and combiner loss from the required ERP. A margin in transmitter power can be used (to a certain extent) when in practice it turns out that:

- Antenna gain is lower than expected;
- Losses in feeder and combiner are higher than expected;
- Propagation losses are higher than expected.

Transmitter cooling is in general realized by:

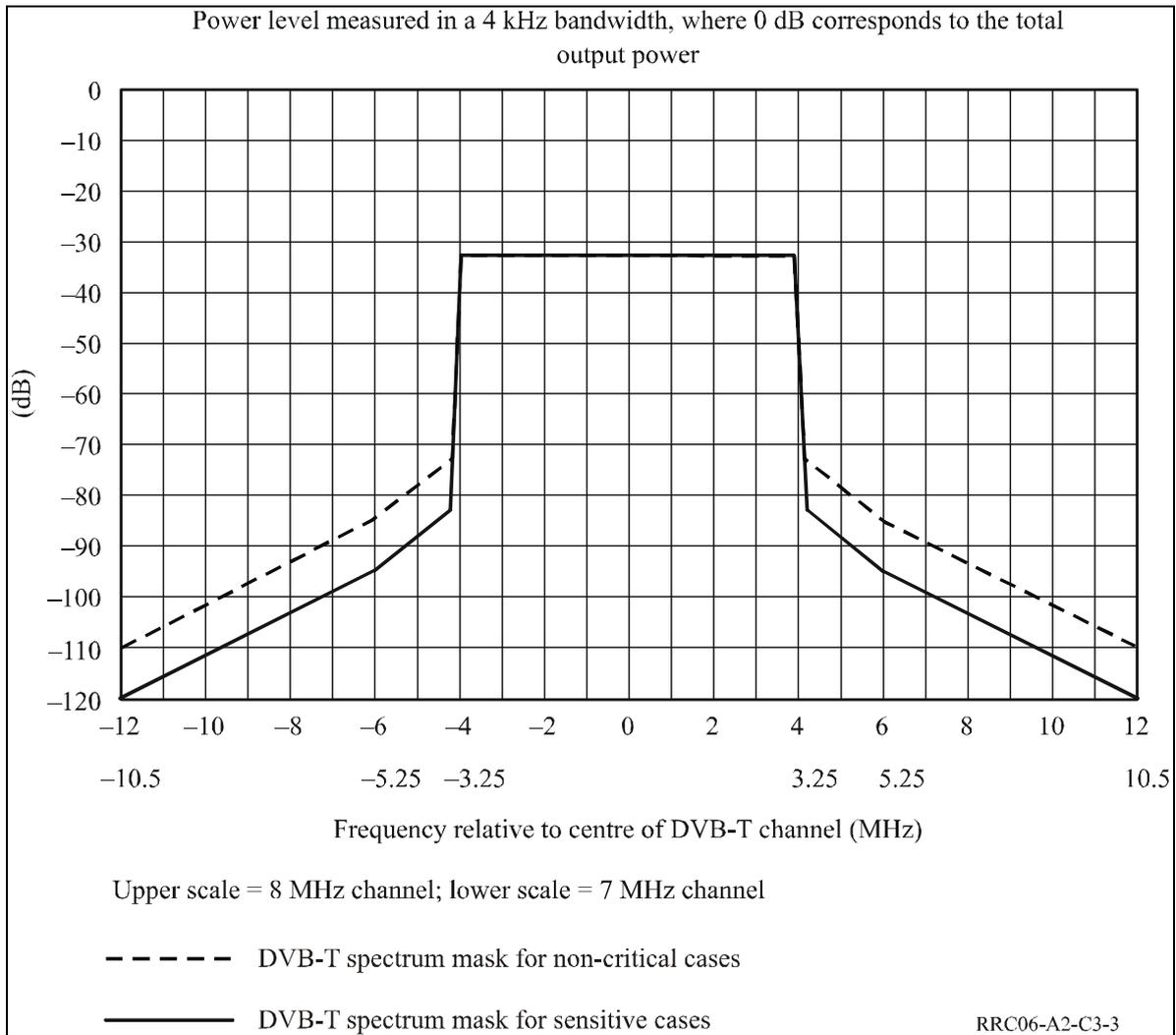
- Air cooling for transmitter powers up to about 1.5 kW;
- Liquid cooling for transmitters powers of about 1 kW or more.

⁹⁹ Spectrum masks for T-DAB, which apply also to T-DMB are specified in the GE06 Agreement, Chapter 3 to Annex 2 Section 3.6.1. Spectrum masks for DVB-T, which apply also to DVB-H are specified in the GE06 Agreement, Chapter 3 to Annex 2, Section 3.6.2



Source: GE06 Agreement

Figure 4.5.4: T-DAB spectrum mask, also applicable to T-DMB



Source: GE06 Agreement

Figure 4.5.5: DVB-T spectrum mask, also applicable to DVB-H

Antenna gain and combiner characteristics

In specifying antennas and combiners the following aspects should be taken into account:

- The maximum allowed effective radiated power in any direction;
- Antenna patterns resulting from network planning (including the conditions of the related Plan entry in the GE06 Agreement);
- Frequency dependent differences of the antenna diagrams of a given antenna (certain modern type of antennas have improved radiation characteristics throughout the frequency band) ;
- In case of fixed reception, high gain antennas are generally chosen;
- In case of portable, mobile and handheld reception, when reception near the site is required, in general antennas with medium gain (up to eight tiers) are chosen;
- Beam down tilt, adapted to the size of the coverage area;
- The spectrum mask specified in the related Plan entry;
- Peak voltage and average power of all transmissions making use of the antenna, plus a margin for future additions or modifications.

It is important to take realistic horizontal and vertical antenna patterns into account in coverage calculations in order to identify:

- Areas of poor reception near the site;
- Differences in coverage of the multiplexes;
- Coverage problems that need to be resolved.

4.5.2 Polarization

The choice of polarization of the transmitting antenna depends in principle on the following considerations.

1. The reception mode,
with fixed reception generally horizontal polarization is chosen. If portable, mobile or handheld reception is a major requirement, vertical polarization is recommended because:
 - ⌘ Portable, mobile and handheld receiving antennas are generally vertically polarized,
 - ⌘ At low receiving height the field strength with vertical polarization is higher than with horizontal polarization.
2. The polarization of the installed rooftop antennas,
if rooftop antennas are installed on a considerable number of houses, the polarization of these rooftop antennas (generally horizontal) should be used, otherwise many viewers have to modify their antenna installations.
3. The need to apply orthogonal polarization between co-channel transmissions, in order to reduce interference (polarization discrimination). However, orthogonal polarization between main transmitting sites is not much used in practice¹⁰⁰.

However, if existing transmitting antennas are used the polarization is given by that of the existing antenna (generally horizontally polarized).

If the existing polarization is not acceptable for DTTB or MTV services and there is no space on the mast for an additional antenna, double polarized antennas can be considered. In this case the antenna panel consist of two independent set of dipoles, horizontally polarized ones and vertically polarized ones. In practice, these kinds of antenna are offered in Band III, to combine horizontally polarized TV (analogue or digital) and vertically polarized T-DAB or T-DMB transmissions. For example in Korea combined antennas are applied with, horizontally polarized TV transmissions and vertically polarized T-DMB transmissions. A drawing of an antenna bay with horizontally and vertically polarized dipoles is shown in Figure 4.5.6.

¹⁰⁰ It should be noted that in the GE06 Agreement polarization discrimination is taken into account (where appropriate) in case of fixed reception. With portable or mobile reception no polarization discrimination has been taken into account.

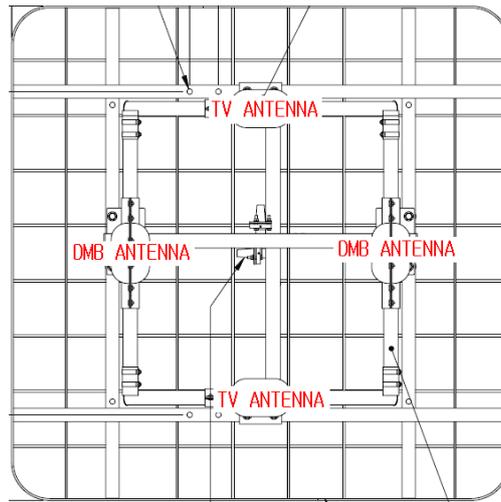


Figure 4.5.6: Combined antenna for horizontally polarized TV transmissions and vertically polarized T-DMB transmissions

Implementation guideline

The choice of polarization is guided by the polarization of existing transmitting and receiving antennas. Table 4.5.3 summarizes the considerations for polarization choice for transmissions in Band III or IV/V, where:

H is horizontal polarization of the transmitting antenna;

V is vertical polarization of the transmitting antenna.

Table 4.5.3: Polarization choice

Transmissions, all combined into one antenna	Use of existing transmitting antenna a)	Use of new transmitting antenna	
		Rooftop antennas in use a)	Almost no rooftop antennas in use
DTTB multiplexes intended for fixed reception	H	H	H
DTTB multiplexes also intended for portable or mobile reception	H	H	V
Combination of DTTB multiplexes intended for fixed reception and MTV multiplex (e.g. T-DMB or DVB-H)	H	H b)	V
Combination of DTTB multiplexes intended for portable or mobile reception and MTV multiplex (e.g. T-DMB or DVB-H)	H	H b)	V
a) assuming that existing antennas are horizontally polarized, if existing antennas are vertically polarized the choice is vertical polarization for all indicated transmissions;			
b) or a double polarized antenna (available for Band III) with MTV transmission in vertical polarization.			

4.5.3 Use of existing antennas or new antennas

When introducing DTTB or MTV services, for cost saving reasons, the aim will be to share the antenna already used for analogue TV services¹⁰¹. The antenna, designed for the analogue TV frequencies and powers on the site, is not necessarily optimal for DTTB or MTV transmissions (see sections 4.5.1 and 4.5.2). In practice, use of existing antennas is not always possible or only with considerable restrictions to the DTTB or MTV services. In Table 4.5.4 a number of issues are indicated that should be considered when existing antennas are used for DTTB or MTV transmissions.

Table 4.5.4: Combination of several transmissions into one antenna

Attention point when using existing antennas for DTTB or MTV	Considerations
Impedance match at frequencies not close to the frequencies for which the antenna was designed	Digital television is less sensitive to impedance mismatch than analogue TV.
Frequency depending radiation pattern	Coverage will differ per frequency.
All transmissions have the same polarization	See section 4.5.2
In case of directional antennas the attenuation will appear on all frequencies	Coverage of transmission with frequencies that require no attenuation is unnecessarily restricted
In case of non-directional antennas, no possibility for attenuations at one or more frequencies if so required	Transmitter power of transmission requiring attenuation in certain directions needs to be decreased with the value of the required attenuation. Coverage in directions where no attenuation is required is unnecessarily restricted
The maximum allowed power and voltage of the antenna is not exceeded	See section 4.5.1

The choice between use of an existing antenna or a new antenna depends on the service trade-off between transmission costs, service quality and coverage quality described in section 4.3.1. Emphasis on low transmission costs tends to the use of existing antennas, while accepting restrictions in DTTB coverage and/or multiplex capacity. Emphasis on good coverage quality tends to the use of new antennas in case the issues mentioned in Table 4.5.4 would lead to restricted DTTB coverage.

The service trade-off could be different at various phases of DTTB introduction, examples are shown in Table 4.5.5.

In the case where an existing analogue TV or DTTB antenna is also used for MTV, similar considerations apply as indicated above with regard to DTTB. However, in the last two phases the combined DTTB/MTV antenna is either a compromise between DTTB and MTV coverage requirements, or is optimized for DTTB services and MTV coverage may not be optimal (see also chapter 4.7).

¹⁰¹ More information on the use of existing or new antennas is given in document EBU BPN005, Terrestrial digital television planning and implementation consideration, third issue, Summer 200; Section 8.

Table 4.5.5: Examples of practical situations regarding the use of existing antennas

DTTB introduction phase	Practical situation	Service considerations
Start of DTTB introduction	<ul style="list-style-type: none"> Analogue TV on same site in operation DTTB frequencies may be in different part of the band than analogue TV frequencies at same site DTTB with restrictions in radiated power in some directions to protect analogue TV services (national and in neighbouring countries) No or limited space for new antenna 	DTTB services restricted: <ul style="list-style-type: none"> Less optimal H pattern DTTB transmitter power reduced to comply with agreed restrictions
Switch-off of analogue TV stations for which restrictions have been agreed	<ul style="list-style-type: none"> Analogue TV on the site in operation DTTB frequencies may be in different part of the band than analogue TV frequencies at same site No or limited space for new antenna 	DTTB services less restricted: <ul style="list-style-type: none"> Less optimal H pattern DTTB transmitter power can be increased (if total permitted power and voltage of antenna is not exceeded)
Switch-off of analogue TV on the same site	<ul style="list-style-type: none"> Existing antenna not needed anymore Aperture of existing antenna can be used for new antenna 	Optimal DTTB coverage with new antenna
End of technical lifetime of existing (analogue TV) antenna	<ul style="list-style-type: none"> Antenna needs to be replaced 	Optimal DTTB coverage with new antenna

Implementation guidelines

Use of an existing antenna is possible if:

1. Digital and analogue TV services have the same polarization;
2. The existing antenna, designed for transmission of the analogue frequencies of that site, will operate satisfactorily at the DTTB frequencies;
3. The horizontal radiation pattern satisfies any restrictions in the radiated power of the digital television which are needed to avoid interference into other services;
4. The vertical radiation pattern allows good portable and mobile reception near the site, if required;
5. The antenna system is capable of handling the total power of all services to be transmitted.

If one or more of these conditions are not fulfilled and cannot be resolved, for technical or regulatory reasons, a new antenna would be the preferred solution, if sufficient space (at the required height) is available on the mast. The new antenna can then be optimized for the digital services.

If not sufficient space is available, it could be considered to remove a half of the existing antenna and replace it by a new antenna for the DTTB or MTV services. Consequently the radiated power of the analogue services is reduced by 50 per cent.

4.6 Network interfacing

Chapter 4.6 provides background information and guidelines on key topics and choices regarding network interfacing. The chapter consists of four sections each containing a subsection with implementation guidelines:

- 4.6.1 Interfaces with head-end;
- 4.6.2 Interfaces between parts in the network;
- 4.6.3 Interfaces between transmitting station and receiving installations;
- 4.6.4 Interfaces between transmitter sites and network monitoring system.

A DTTB network consists basically of one or more head ends, a distribution network and transmitter sites. A block diagram of a typical DTTB network is shown in Figure 4.2.1. The players involved in DTTB network operations are (see also chapter 1.2 and Figure 1.2.3):

- Multiplex operator;
- Service provider;
- Content distributor.

In practice one organization may encompass more than one role.

Satisfactory service delivery depends on the successful operation of all players involved. For a smooth hand-over of responsibilities it is needed that service level agreements (SLA) are made between the players involved regarding:

- Signal availability;
- Coverage;
- Video and sound quality;
- Compliance with the transmission standard and systems.

As part of the latter also interfaces need to be defined.

The network is interfaced with:

- The studio facilities that deliver video, audio and data signals;
- The receiving installation of the consumer via the radio interface;
- The network operations centre for monitoring and remote control of the network.

Furthermore in the network there are interfaces between the head end and the distribution network.

4.6.1 Interfaces with head-end

Already with analogue TV more and more parts of the programme production facilities are becoming digital. Tapeless recording, digital archives and IP based production are common place in more and more studios. With the introduction of DTTB the whole broadcast chain will eventually be digital. A complete digital broadcasting chain, from programme production to the consumer, has major advantages, such as:

- The possibility to deliver higher quality services (including HDTV) and enhanced services (e.g. electronic programme guide, access services, interactive services);
- The avoidance of cascaded encoding and decoding processes with the inherent loss of quality.

At present not all studios can produce digital TV signals. For these studios it is possible to offer analogue TV signals to the head-end of a DTTB network. However, picture and sound quality is less than it could be with a digital programme feed.

For studios with digital output signals, there are several possibilities to feed signals from the studio to the head end:

- Uncompressed video and audio, together with data.
The digital interface between the studio output and the encoder input is made using the Serial Digital Interface (SDI)¹⁰² with a data rate of 270 Mbit/s. A related standard, known as high-definition serial digital interface (HD-SDI), has a nominal data rate of 1.485 Gbit/s. These standards are designed for operation over short distances with coaxial cable or optic fibre. Consequently encoders should be located on, or close to the studio premises.
- A service package consisting a number of services (video, audio and data) MPEG encoded and multiplexed into a Transport Stream (TS) or a single service (video, audio and data) MPEG encoded.
The services are compressed and multiplexed into the MPEG Transport stream¹⁰³. The interfaces between (re)multiplexers and the distributions links are generally Asynchronous Serial Interface, or ASI¹⁰⁴. It is electrically identical to an SDI signal and is always 270 Mbit/s. Sometimes Ethernet is used.
- Satellite feed;
In the case of remote studios or programmes from international content providers, the TS could be transported via satellite links e.g. using the DVB-S specification. However, a re-multiplexing operation will be required at each transmitter site to change the SI data and to reflect the change of delivery medium.

Implementation guideline

Full benefit of digital broadcast delivery is achieved if programmes are produced and distributed between the different production facilities and the MPEG encoders in digital format. The SDI interface is recommended for use between studio facilities and the MPEG encoders. However, SDI links are designed for short distances, therefore MPEG encoders should be located at, or close to the studio centre.

For interfacing with the MPEG TS, the ASI interface is recommended.

4.6.2 Interfaces between parts in the network

A summary of the internal network interfaces in a DVB-T network is shown in the table below.

Implementation guideline

Between the different parts in the networks, interfaces should be used that are specified for the transmission standard in use¹⁰⁵.

¹⁰² The SDI interface for digital broadcasting is described in Recommendation ITU-R BT.656 Interfaces for digital component video signal in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601 (Part A).

¹⁰³ MPEG-TS is a communications protocol for audio, video, and data. TS is specified in MPEG-2 Part 1, Systems (ISO/IEC standard 13818-1). It is also known as ITU-T Rec. H.222.0.

¹⁰⁴ ETSI TR 101 89, 1Digital Video Broadcasting (DVB); Professional Interfaces: Guidelines for the implementation and usage of the DVB Asynchronous Serial Interface (ASI), addresses interoperability issues specific to ASI data transmission links.

¹⁰⁵ An overview of interfaces for DVB can be found at www.dvb.org/technology/standards/.

Table 4.6.1: Network interfaces

Network interfaces	Interfaces specification
MPEG TS inputs and outputs (from encoders to multiplexers, between (re) multiplexers, from (re) multiplexers to network adaptor)	<ul style="list-style-type: none"> Asynchronous Serial Interface (ASI)
Network adaptor (between MPEG TS and distribution link)	<ul style="list-style-type: none"> PHD network; ETS 300 813¹⁰⁶ SDH networks; ETS 300 814¹⁰⁷

4.6.3 Radio interface between transmitting station and receiving installations

The radio interface could be described by a field strength for a specified percentage of time and locations, or as the probability to obtain a satisfactory reception at a location (see also chapter 4.3 Network planning). In both cases also the receiving installation (receiver, receiving antenna) should be defined (see section 4.2.2).

The description of a field strength only takes into account:

- Received signal from one transmitting site;
- Reception quality in the presence of noise.

The description of reception probability is advised as it can take into account:

- Received signals from more than one wanted transmitter in case of an SFN;
- Reception quality in the presence of noise and interference.

In making service level agreements, sometimes there is a pressure (from lawyers) to guarantee a field strength or reception probability. It should be noted that field strength and reception probability cannot be guaranteed because factors are involved that are beyond control of the content distributor such as:

- Time varying atmospheric conditions that affect the field strength level of wanted and interfering stations;
- Local receiving conditions that affect the field strength level of wanted and interfering stations;
- Radiation characteristics of interfering stations¹⁰⁸ ;
- Locally generated man made noise.

Predicted field strength and coverage probability, as described in chapter 4.3, are statistical values and therefore difficult to measure in practice at a given location and time. It should also be noted that all predictions have a limited accuracy. Coverage predictions can however be improved by correcting predicted results with measurement results.

¹⁰⁶ The European Telecommunication Standard ETS 300 813 specifies the transmission of MPEG-2 Transport Streams (TS) between two DVB interfaces within Plesiochronous Digital Hierarchy (PDH) networks working in accordance with ITU-T Recommendation G.702.

¹⁰⁷ The European Telecommunication Standard ETS 300 814 specifies the transmission of MPEG2 Transport Streams (TS) between two DVB interfaces within Synchronous Digital Hierarchy (SDH) networks working in accordance with ITU-T Recommendation G.707.

¹⁰⁸ It will be assumed that interfering stations will operate within the conditions specified in the GE06 Agreement.

For the sake of defining coverage probability as a radio interface, in principle, two situations can be predicted:

1. The coverage probability that will finally exist when all transmitters (wanted as well as interfering digital TV transmitters) are in operation and analogue TV switched off;
2. The coverage probability that will exist at the moment that a particular transmitter is taken into operation, without taking into account the transmitters in an SFN that become operational at a later stage and interfering stations that will be switched off or installed later.

The first case does not represent the coverage situation at the moment of introduction of a service and may not, therefore, be suitable as a tool for defining the radio interface as part of a service level agreement.

In the second case, information is needed about the actual status of analogue and digital TV transmitters in neighbouring countries (which may not be available). Furthermore the calculations need to be repeated after each change in the network.

Implementation guidelines

The recommended way to describe the radio interface is by means of reception probability.

Reception probability (and also field strength) should be predicted by means of adequate network planning software which includes, among others:

- A reliable transmitter data base (also from neighbouring countries);
- Up-to-date terrain and clutter data bases;
- Propagation prediction models suitable for the country concerned and preferably corrected with results of field strength measurement for the most common types of terrain.

The parties involved should agree on the coverage assessment method (see also chapter 4.3).

4.6.4 Interfaces between transmitter sites and network monitoring system

Service contracts between content distributors and service providers normally contain provisions about the availability of the service. This could be expressed, for instance, as a percentage of time (measured over a long period) that the service should be on air or a maximum allowed time of interruptions. The service availability requirements could be variable for different parts of the day or for the kinds of programmes.

In order to avoid long service interruptions in case of maintenance or equipment failure, critical parts in the transmission chain should have a certain redundancy (see section 4.2.6).

In addition to appropriate reserve equipment, an adequate equipment monitoring system is needed to identify equipment failures and alert maintenance staff. The actual operational status of equipment should be visible at a central monitoring centre through a few basic indicators (e.g. on/off, failure, pre-alarm). The Simple Network Management Protocol (SNMP)¹⁰⁹ is a suitable remote control protocol by means of a web browser.

¹⁰⁹ Simple Network Management Protocol (SNMP) is used in network management systems to monitor network-attached devices for conditions that warrant administrative attention. SNMP is a component of the Internet Protocol Suite as defined by the Internet Engineering Task Force (IETF).

In practice, different ways are used for transmission of equipment status information e.g.:

- Switched data link;
If the status of equipment at a transmitting site changes, automatically a connection is made via public switched telephone network (PSTN) and the equipment status information is exchanged. If the operator requires further information, a PSTN data link is established to the transmitter site and the required information is sent to the operator. Also commands can be given by the operator e.g. for switching on a reserve transmitter.
- Fixed data link via the distribution network;
If the status of equipment at a transmitting site changes, an automatic message will be sent to the operations centre e.g. using the Ethernet standard. Also, information requests from the operator or commands to the transmitter site are made in this way.

Implementation guidelines

Modern equipment, including digital transmission equipment, allows remote control via SNMP and a web browser.

4.7 Shared and common design principles

Chapter 4.7 provides background information and guidelines on key topics and choices regarding shared and common design principles. The chapter consists of three sections each containing a subsection with implementation guidelines:

- 4.7.1 Application of shared and common design principles;
- 4.7.2 Site and antenna sharing;
- 4.7.3 Multiplex sharing.

DTTB and MTV networks have different objectives and are likely to be different in:

- Transmission standard;
- Transmitter power;
- Antenna radiation characteristics;
- Net bit rate per multiplex;
- Number of sites;
- Coverage requirements;
- Network roll-out.

Nevertheless, if design, planning and roll out of DTTB and MTV networks are carried out together or at least performed in a coordinated way, efficiency and synergy gains could be achieved by:

- Sharing of sites and transmitting antennas;
- Common use of the multiplex;
- Simultaneous project and resource planning.

However, by doing so, compromises may have to be accepted in the performance of the DTTB services, the MTV services or both, because it is unlikely that the shared network elements have optimal characteristics for both the DTTB and MTV services.

It should be noted that similar considerations can also be made for:

- DTTB and T-DAB networks in Band III;
- MTV and T-DAB networks in Band III.

4.7.1 Application of shared and common design principles

In practice, shared and common design principles of DTTB and MTV networks will be considered in these cases:

- DTTB and MTV services are operated by the same organization;
- DTTB and MTV operators wish to obtain efficiency and synergy gains by cooperating;
- Obligations are imposed by government, e.g. for site sharing.

Shared and common design principles of DTTB and MTV networks should preferably be considered as early as possible in the process of transition to DTTB and introduction of MTV as it may affect the two main trade-offs in network design and planning:

1. The trade-off between network roll-out speed, network costs and network quality, as described in section 4.2.1;
2. The trade-off between transmission costs, service quality and coverage quality, as described in section 4.3.1.

In making these trade-offs, it should be taking into account that:

- On the one hand, shared use and common activities will offer efficiency and synergy gains and consequently lower investment costs;
- On the other hand, the requirements of DTTB and MTV services may be so much different that roll-out schemes, multiplex capacity and coverage quality of DTTB services, MTV services or both do not comply with the business plan and service proposition.

The choices made with regard to shared and common design principles have also an impact on the activities related to other functional blocks, as illustrated in Figure 4.7.1 and Table 4.7.1.

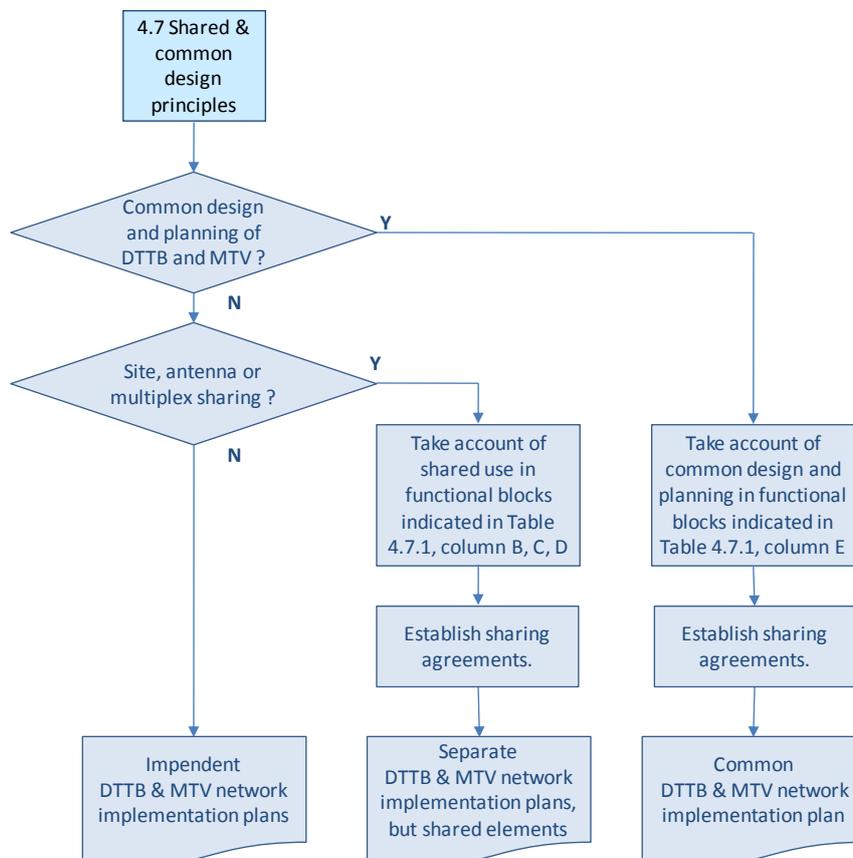


Figure 4.7.1: Impact of choices regarding shared and common design principles on other functional blocks

Table 4.7.1: Functional blocks and chapters related to choices regarding shared and common design principles

A Related functional blocks	B Site sharing		C Antenna sharing		D Multiplex sharing		E Common design and planning	
	DTTB	MTV	DTTB	MTV	DTTB	MTV	DTTB	MTV
Design principles and network architecture	4.2	5.2	–	–	4.2	5.2	4.2	5.2
Network planning	4.3	5.3	4.3	4.3	4.3	4.3	4.3	4.3
System parameters	–	–	–	–	4.4	5.4	4.4	5.4
Radiation characteristics	4.5	4.5	4.5	4.5	–	–	4.5	4.5
Transmitting equipment availability	–	–	4.8	5.8	–	–	4.8	5.8
Network roll-out planning	–	–	–	–	–	–	4.9	5.9

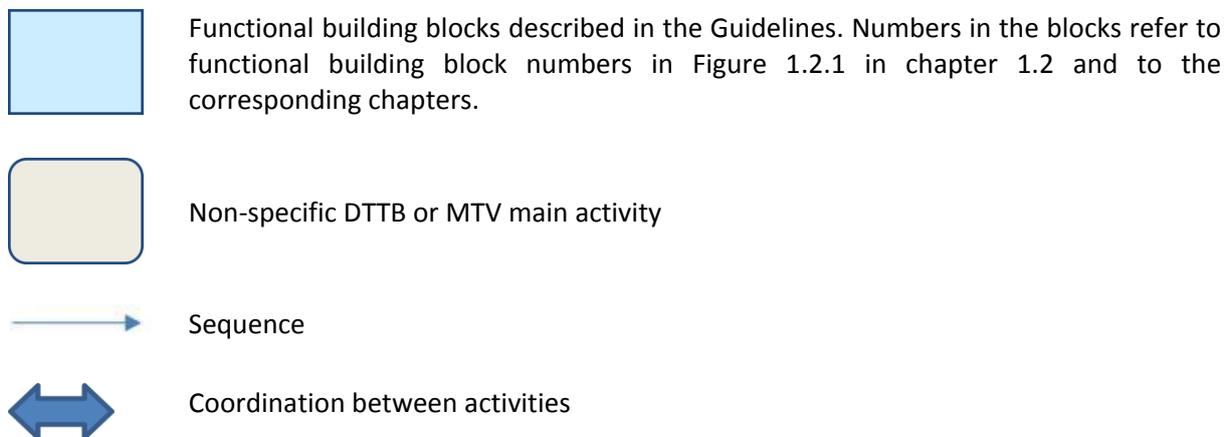
Site and antenna sharing is further described in section 4.7.2 and multiplex sharing in section 4.7.3.

Implementation guidelines

Figure 4.7.2 shows three practical examples of the activities, in various phases of network implementation, for different degrees of application of shared and common design principles:

1. DTTB and MTV are operated by the same organization and a maximum benefit will be obtained from shared use of the network and common use of resources;
2. DTTB and MTV are operated by different organizations who wish to use site sharing and antenna sharing as much as possible;
3. DTTB is operated by a broadcast network operator and MTV is operated by a mobile operator and both operators use their own existing sites (TV sites and mobile base stations respectively), in which case shared and common design principles are limited to avoiding interference.

The symbols used in Figure 4.7.2 have the following meaning:



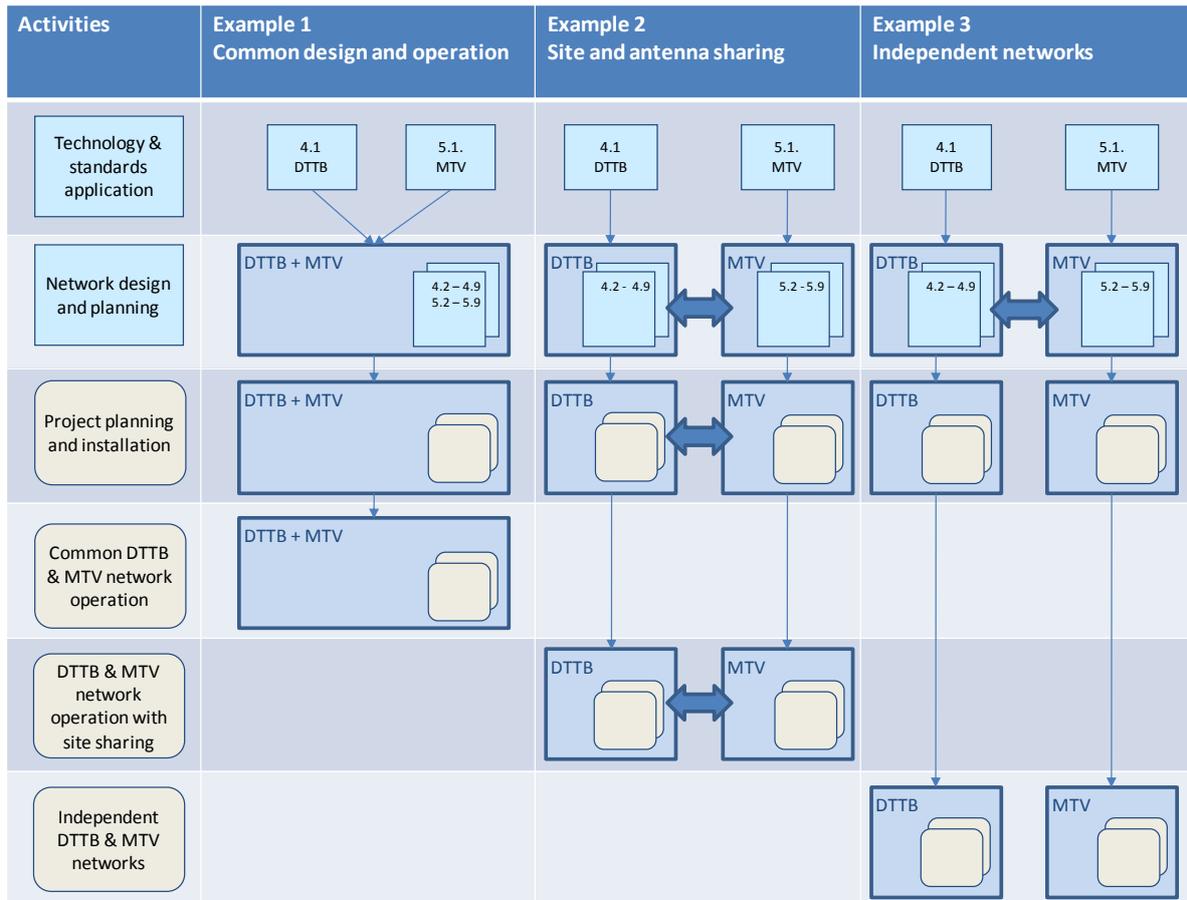


Figure 4.7.2: Examples of application of shared and common design principles for DTTB and MTV networks

In the first example, after the technology choices have been made, all further activities for DTTB and MTV are carried out together. In this way, optimal choices for site sharing and antenna sharing (and possibly multiplex sharing) will be achieved (see also sections 4.7.2 and 4.7.3). Efficiency and synergy gains will also be achieved in project planning, resource planning and site acquisition because:

- DTTB and MTV network planning, project planning and site acquisition can be done simultaneously by the same teams of experts;
- Network roll out and installation can be done simultaneously by the same teams of experts.

Furthermore DTTB and MTV transmitters from the same supplier can be used with the advantage of:

- Price discounts that may be achieved because of the higher volume accounts;
- Fewer spare parts in stock are required;
- Easier in maintenance.

Finally the DTTB and MTV networks will be operated and maintained together by using the same monitoring system and by the same team of experts.

In the second example the DTTB and MTV networks are operated separately, but coordination between the operators takes place by establishing site and antenna sharing agreements covering among others:

- Fees for using facilities of the other operator;
- Access to sites for installation and maintenance;
- Priorities in using limited space in buildings and masts;
- Information exchanges regarding intended future use, installations and antenna characteristics.

As MTV networks may consist of a higher number of sites than DTTB networks and consequently not all DTTB and MTV transmissions are co-sited, adjacent channel interference may occur. In these cases also coordination between the operators is needed to resolve adjacent channel interference (see section 4.7.2).

A further step in a coordinated approach could be that e.g. the MTV licence holder contracts the DTTB operator for network planning, project planning, installation or maintenance.

In the third example DTTB and MTV networks are designed, planned, projected and installed separately and the operators use different sites. However, coordination between the operators is needed in order to resolve adjacent channel interference (see section 4.7.2).

4.7.2 Site and antenna sharing

Site sharing has the advantage that existing facilities (building, power supply, monitoring system, distribution links, reserve equipment, mast, antenna) can be shared by DTTB and MTV services. Even in the case that shared use is not decided yet, in designing transmitting stations it is recommended to take into account future extensions of transmission equipment (DTTB or MTV). Later extensions may risk generating high costs as existing equipment and facilities is made redundant and replaced.

However, site and antenna sharing may involve a compromise between the economic advantages of common use of facilities on the one hand and limitations in the choice of technical characteristics on the other hand, in particular the use of a common antenna. If a common antenna is used for DTTB and MTV services it should be taken into account, regarding both the DTTB and MTV frequencies, (see also section 4.5.3) that:

- Impedance match should be satisfactory;
- The radiation pattern is frequency dependent and should be acceptable;
- Polarization is the same, where different polarizations for DTTB, if aimed at fixed reception, and MTV may be preferred;
- In case of directional antennas, the attenuation will appear on all frequencies, whereas different antenna patterns may be required for DTTB and MTV services; consequently the maximum radiated power on either DTTB or MTV transmissions may have to be reduced in order to comply with the required radiation restrictions;
- In case of non-directional antennas, there are no possibilities for attenuation, if so required;
- The maximum allowed power and voltage of the antenna is not exceeded;
- The vertical radiation pattern (null-fill and beam down tilt) is the same, whereas for MTV more null-fill and more beam tilt may be required than for DTTB.

DTTB and MTV antenna requirements may differ so much that coverage of DTTB or MTV service would be restricted too much if a common antenna were used. A separate antenna may be considered in that case. However available space on the mast or the mechanical strength of the mast may not allow an additional antenna or only an antenna with limited aperture and thus limited gain.

Alternatively, consideration could be given to replacing the existing antenna by a combined DTTB/MTV antenna e.g.:

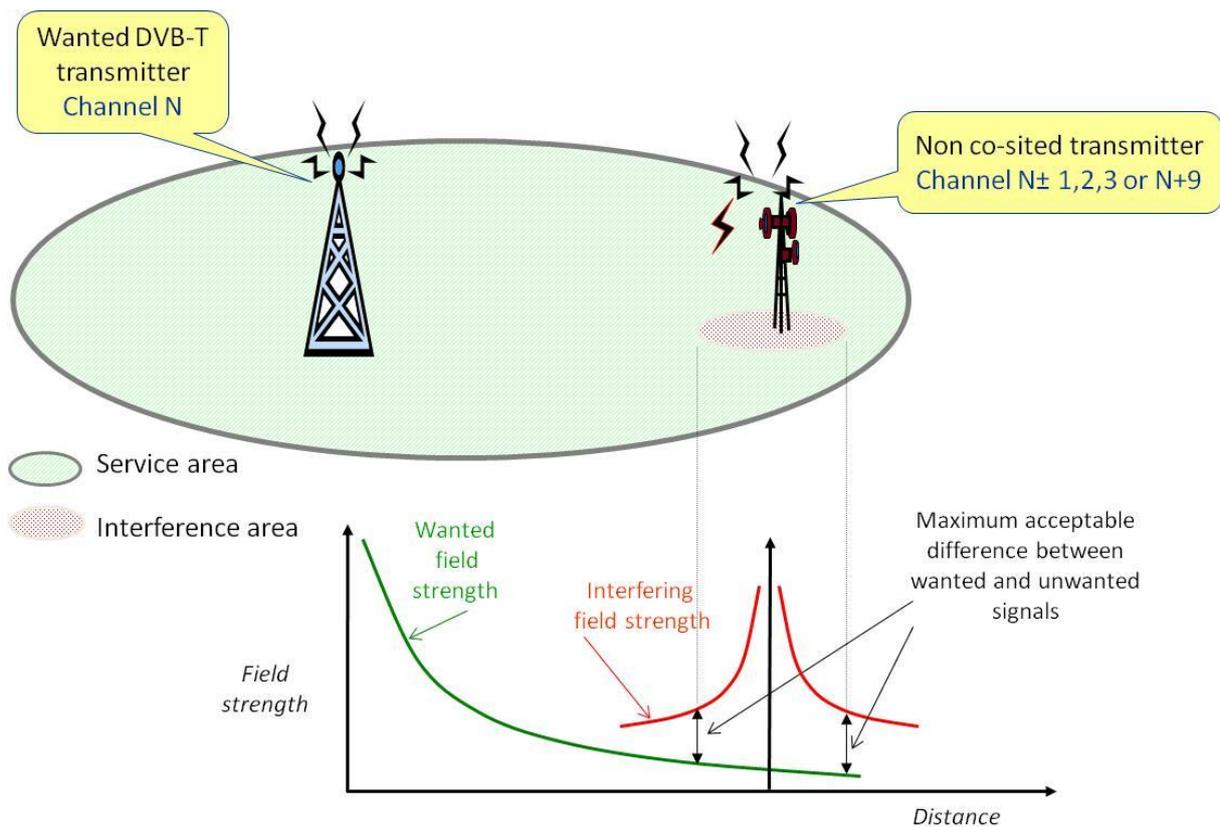
- A double polarized antenna, which consists of panels with sets of horizontally polarized dipoles and sets of vertically polarized dipoles. These types of antennas are applied in Korea where in Band III, horizontally polarized TV transmissions and vertically polarized T-DMB transmissions make use of the same physical antenna (see also chapter 4.5, Figure 4.5.6);
- A multi pattern antenna, with each frequency having its own pattern, while using the same physical antenna. This is realized at the cost of power splitters, additional combiners and additional antenna cables.

Before making a decision on the common use of antennas, the trade-off between transmission costs, service quality and coverage quality, as described in section 4.3.1., should be analysed carefully.

An additional advantage of site sharing is the avoidance of interference zones around the sites due to adjacent channel interference. This type of interference may occur around non co-sited stations and use of:

1. The first, second or third adjacent channels on both sides of the of the wanted channel, or;
2. The image channel.

This situation is illustrated in Figure 4.7.3.



Source: DigiTAG

Figure 4.7.3: Adjacent channel interference near non co-sited transmitters

It should be noted that the non co-sited transmitter could be a DTTB or MTV transmitter, but also a mobile base station (if mobile services are allocated in or near Band III, IV or V). Even mobile terminals could cause adjacent channel interference at short distances around the terminal.

Adjacent channel interference can be resolved or limited by the measures indicated in Table 4.7.2.

Table 4.7.2: Measures to resolve adjacent channel interference

Measure to reduce adjacent channel interference	Disadvantage
Cross polarization	Only effective in case of fixed reception
Power reduction and antenna adjustment of interfering transmitter	Reduction of coverage of interfering transmitter
Adequate frequency separation	Other frequency (not being $N\pm 1, 2, 3$ or $N+9$) needed
Fill-in transmitter (in SFN on channel N) to cover interference area	Costs

In practice, site sharing may be complex when different network operators make use of the site. Priority rules have to be established for use of limited space in buildings and masts and clear agreements have to be made regarding responsibilities, costs and maintenance for use of common equipment. In a number of countries governments have regulations for site and antenna sharing.

Implementation guidelines

For economic and technical reasons it is advantageous to take into account (as far as possible) the requirements of all DTTB and MTV networks in the preparatory, planning and implementation processes. If not all requirements are known, e.g. if MTV networks will be licensed and implemented at a later stage, at least provisions for future extensions may be implemented such as:

- Space in design and layout of transmitter buildings;
- Capacity of the power supply;
- Margin in peak voltage and average power of transmitting antennas;
- Transmitting antennas with broadband radiation characteristics.

4.7.3 Multiplex sharing

It is possible to share a multiplex between DVB-T and DVB-H. In doing so, fewer frequencies (transmitters) are needed but, obviously, the data capacity of the DVB-T and DVB-H signals in a shared multiplex are more limited than in the case where dedicated DVB-T and DVB-H multiplexes were used.

A multiplex can be shared between DVB-T and DVB-H in two ways:

1. The MPEG Transport Stream (TS) contains the compressed audio and video of the DVB-T services, together with audio and video in the form of IPDC (Internet Protocol DataCast)¹¹⁰ of the DVB-H services;

¹¹⁰ See ETSI TS 102 468 V1.1.1 (2007-11); Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Set of Specifications for Phase 1

2. Two independent MPEG Transport Streams (TS) in hierarchical modulation (see also chapter 4.4). One stream can be modulated with “low priority” intended for fixed (rooftop) reception, the other with “high priority” intended for mobile DVB-H reception.

In the first method all data in the transport stream are modulated and coded according to one of the DVB-T system variants. If the system variant is chosen to achieve fixed DVB-T reception, DVB-H coverage is unlikely to be satisfactory. If a system variant for robust reception conditions is chosen, which may satisfy DVB-H reception, the net bit rate for DVB-T is unlikely to be satisfactory.

With the second method, different coverage is obtained for the two transport streams at the cost of some overhead capacity.

Before making a decision on multiplex sharing between DVB-T and DVB-H, the trade-off between transmission costs, service quality and coverage quality as described in section 4.3.1 should be analysed carefully.

Implementation guideline

Multiplex sharing between DVB-T and DVB-H could be considered if not enough frequencies are available for both DTTB and MTV services.

Hierarchical modulation of two transport streams, one with “low priority” for the DVB-T services, the other with “high priority” for DVB-H services offers the best solution.

However, in practice hierarchical modulation is not much used. Most service or multiplex providers prefer dedicated multiplexes for DVB-T and DVB-H because:

- A full multiplex has a higher bit rate capacity compared to a shared multiplex;
- No sharing agreements are needed when different service or multiplex providers are involved for the DVB-T and DVB-H services.

4.8 Transmission equipment availability

Chapter 4.8 provides background information and guidelines on key topics and choices regarding transmission equipment availability. The chapter consists of two sections each containing a subsection with implementation guidelines:

4.8.1 Market research;

4.8.2 Technical specifications.

A DTTB network consists basically of one or more head ends, a distribution network and transmitter sites (a block diagram of a typical DTTB network is shown in Figure 4.2.1). When existing sites are used, some transmission equipment may be reused for DTTB, some equipment may need to be expanded and some new equipment needs to be installed. Table 4.8.1 lists the main digital transmission equipment units in a DTTB network and indicates if equipment installed for analogue TV transmissions can be reused or not.

In addition to the transmission equipment listed in Table 4.8.1, ancillary equipment is needed such as power supply, cooling, monitoring and control system, which needs to be expanded.

Availability of transmission equipment is considered in this chapter in relation to the following activities:

- Specification of technical characteristics of the transmission equipment in the DTTB implementation plan;

- Verifying if the specifications can be met by equipment that is normally available on the market;
- Drafting specifications for tenders to purchase equipment.

Table 4.8.1: Transmission equipment

Transmission equipment unit	Related guidelines	Possible re-use of analogue TV equipment
Head end	4.2.5	Not present in analogue TV; needs to be installed.
Distribution network	4.2.7	Not recommended.
Transmitters	4.5.1	Possible to adapt certain types of analogue TV transmitters. It is likely that new DTTB transmitters are needed because, during transition, analogue TV transmitters continue to be operational and in most cases more DTTB frequencies are available at a site than analogue TV frequencies
Combiner	4.5.1	Needs to be expanded, retuning may be necessary. Appropriate filtering is needed to comply with the required spectrum mask.
Antenna	4.5.1 4.5.2 4.5.3	Reuse depends on the considerations given in chapter 4.5 including the maximum peak voltage and average power specifications.
Mast	4.5.1 4.5.3	Mast space and mechanical specifications may limit the possibilities for mounting new antennas.

4.8.1 Market research

A large range of DTTB transmission equipment is available on the market from many manufacturers¹¹¹. Market research of the availability of transmission equipment is important in order to get an impression of:

- Practical ranges of transmitter power and antenna gain;
- Technical specifications;
- Operational data, such as mean time between failures (MTBF),
- Warranty conditions, including delivery of spare parts in case of failure;
- Services regarding installation, repair and maintenance;
- Training facilities;
- Price indications;
- Delivery times.

In general, all suppliers offer transmission equipment that can be configured to all television standards in use, including analogue TV. Transmitter powers range from less than 1 Watt to more than 10 kW.

¹¹¹ For instance at the exhibitors list of IBC, www.ibt.org/page.cfm?action=ExhibList/ListID=1/t=m/goSection=6, suppliers of delivery equipment and many other types of equipment, can be selected.

Transmitter cooling is in general realized by:

- Air cooling for transmitter powers up to about 1.5 kW;
- Liquid cooling for transmitters powers of about 1 kW or more.

Liquid cooling has the advantage of a smaller footprint and less acoustic noise.

Transmitters can be delivered for installation in a transmitter building and air cooled type of transmitters also in compact outdoor shelters.

In order to avoid long service interruptions in case of maintenance or equipment failure, transmitters should have a certain redundancy, either in a passive reserve configuration, active reserve configuration, or with a built-in redundancy. If several transmitters are used at a site, an n+1 reserve configuration is often used. If a site accommodates one or two transmitters it may be appropriate to install instead a double driver unit. The RF power amplifier consists, in general, of several units, thus providing a built-in redundancy. Furthermore network operators often keep in stock at a central place a few critical units, e.g. driver units.

Transmitting antennas can in general be distinguished in four types as shown in Table 4.8.2.

Table 4.8.2: Transmitting antenna types

Antenna type	Application
Panel	<ul style="list-style-type: none"> • Arrays of several panels per tier, to achieve directional or non-directional patterns • Horizontal and vertical polarization • Suitable for triangular, square and round towers or masts
Turnstile or superturnstile	<ul style="list-style-type: none"> • Excellent unidirectional pattern • Horizontal polarization • Suitable for top mounting, mast diameter in centre of antenna should be small relative to the wavelength • Cost effective
Yagi	<ul style="list-style-type: none"> • Directional pattern • Horizontal and vertical polarization • Light weight • Low power transmissions
Special purpose antennas	<ul style="list-style-type: none"> • Examples • Centre fed collinear antenna, narrow band, vertical polarization, top mounting • Indoor relay antennas • Dual polarization antennas

Examples of antenna gains of practical (non-directional) antenna systems for main stations are shown in Table 4.8.3.

Table 4.8.3: Examples of antenna gains (non-directional) for main stations

Band	Type	Number of tiers	Gain relative a dipole	Antenna height
III	Panel	1 to 8	About 2 to 15 dB	About 1.2 to 25 m
III	Super turnstile	2 to 16	About 4 to 13 dB	About 3 to 24 m
IV/V	Panel	2 to 16	About 9 to 18 dB	About 2.2 to 18.5 m
IV/V	Super turnstile	2 to 16	About 7 to 16 dB	About 2.2 to 18 m

Implementation guidelines

A first impression of equipment specifications can be obtained from datasheets that can be downloaded from the equipment supplier’s websites. Furthermore, a number of manufacturers can be asked to supply information or quotations based on the operational requirements and required redundancy.

It may also be useful to visit large broadcasting shows like the NAB Show in Las Vegas or the IBC in Amsterdam. At these shows, most transmission equipment suppliers are present and, in a short period, a number of them can be visited and detailed information can be obtained about the equipment.

4.8.2 Technical specifications

All transmission equipment should comply with the choices made resulting from the application of the guidelines described in the following chapters (see also Figure 4.8.1):

- 4.1 Technology and standards application;
- 4.2 Design principles and network architecture;
- 4.3 Network planning;
- 4.4 System parameters;
- 4.5 Radiation characteristics;
- 4.6 Network interfacing;
- 4.7 Shared and common design principles.

The choices on system parameters, resulting from the application of the guidelines in chapter 4.4, are mainly included to specify the system variants for which the various transmitters have to be adjusted. In principle, it is not necessary to specify the system variant in the specifications for purchasing equipment, because all transmission equipment should be able to operate on all system variants of the chosen transmission standard.

Equipment specifications of several suppliers, obtained in the market research, can be compared to check the state of the art of the equipment and get an impression of the characteristics that could normally be expected.

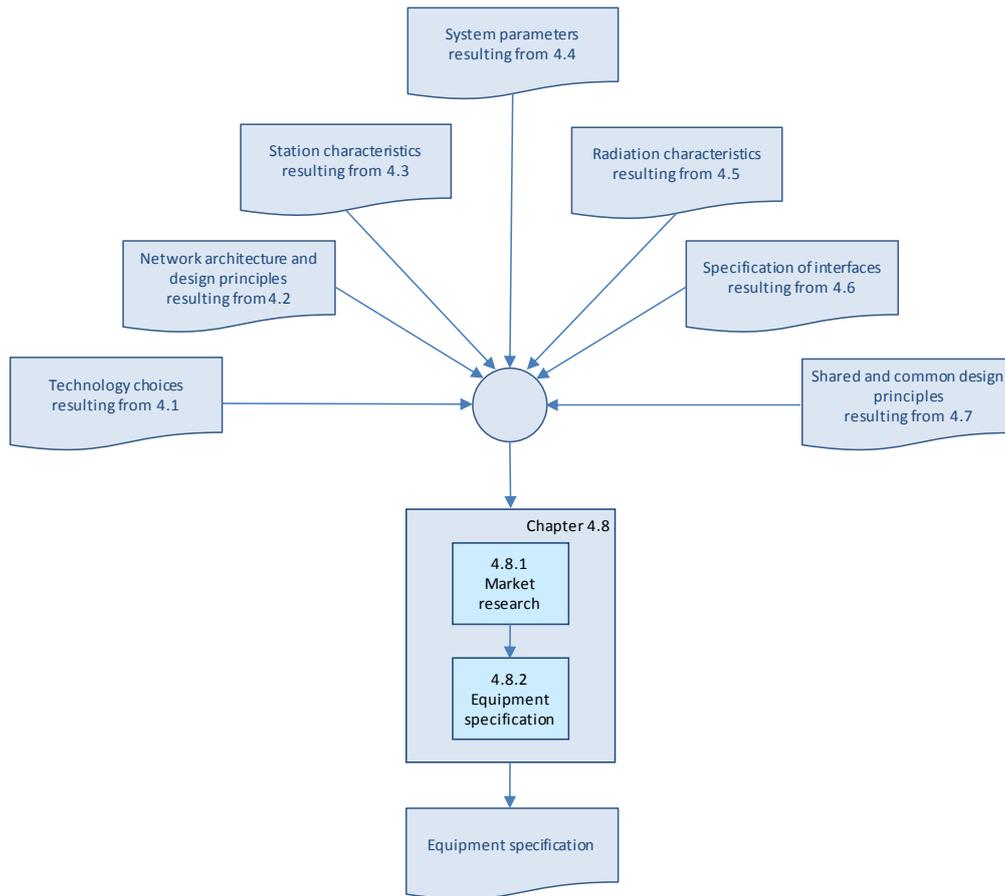


Figure 4.8.1: Order of actions before transmitting equipment can be specified

Implementation guidelines

The main elements for the specification of transmission equipment are listed in Table 4.8.4.

Table 4.8.4: Main elements for specification of transmission equipment

Main elements of transmission equipment specifications	Related Guidelines	Remarks
Transmission standard and systems	4.1.3 4.1.4 4.1.5	Transmission standard, compression system and conditional access system (if needed) need to be specified with reference to appropriate international specifications
Operational requirements	4.2.3 4.2.4 4.3.2 4.3.3 4.3.5 4.5.1 4.5.2 4.7.2	Operational requirements include the number of multiplexes, number of transmitter and remultiplexing sites, transmitter powers, antenna characteristics, site and antenna sharing requirements, SFN/MFN, number and type of fill-in transmitters.
Monitoring and remote control	4.2.6	Operational status of equipment should be visible at a central monitoring centre through a few basic indicators (e.g. on/off, failure, pre-alarm).

Main elements of transmission equipment specifications	Related Guidelines	Remarks
Required reserve configurations	4.2.6	Active parts in the transmission chain should always have a certain redundancy, either passive reserve e.g. in n+1 configuration, or a built-in redundancy.
Interfaces	4.6.1 4.6.2 4.6.4	The interfaces between the network and the studio and the interfaces between parts of the network need to be specified with reference to appropriate international specifications
Specifications supplied by manufacturers	4.8.1	In general it is not necessary to specify equipment in detail. A number of manufacturers can be asked to supply information or quotations based on the operational requirements and required redundancy. In some cases it may be arranged to perform tests at the premises of the manufacturer.

4.9 Network roll-out planning

Chapter 4.9 provides background information and guidelines on key topics and choices regarding network roll-out and planning. The chapter consists of three sections each containing a subsection with implementation guidelines:

- 4.9.1 Test transmissions;
- 4.9.2 Implementation plan;
- 4.9.3 Information to end consumers.

The objective of network roll-out planning is to establish a network implementation plan, taken account of regulatory, commercial and technical provisions.

4.9.1 Test transmissions

Before introducing operational DTTB services, test transmissions are often carried out in order to verify the technical performance of the network and to demonstrate DTTB services.

Test transmissions can be set up as a temporary arrangement, to be dismantled when the tests have been carried out. It can also be a permanent setup, meant as prelaunch of DTTB services. In the latter case, modifications or adjustments may be made depending on the tests results.

For all kinds of tests it is important to:

- Specify the precise objectives (which questions should be answered by the tests);
- To prepare test protocols;
- To allocate sufficient resources (budget and staff), because test equipment is expensive and tests are labour intensive.

Four kinds of test can be identified:

1. Site test;
2. Coverage measurements;
3. Receiver tests;
4. Demonstrations.

These tests are described below.

Site tests

The objectives of site test could be to check if transmission equipment operates within the specifications, e.g.:

- Modulation Error Rate (MER) and carrier to noise ratio (C/N);
- Radiation characteristics;
- SFN synchronization and timing.

The antenna performance is an important element in the radiation characteristics. However antenna measurements are complex and expensive. Some operators carry out helicopter measurements to verify horizontal and vertical antenna patterns. Figure 4.9.1 shows an antenna measurement by helicopter. With these types of measurements all TV frequencies at the site are measured in one flight.



Source: Progira

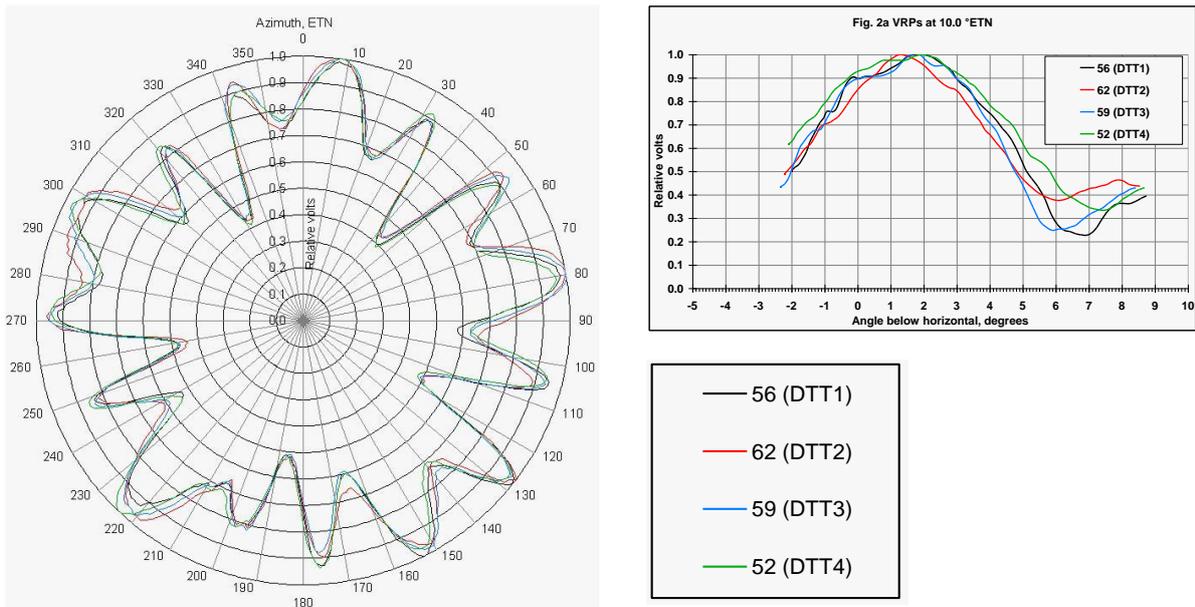
Figure 4.9.1: Helicopter measurements

An example of results of helicopter measurements is shown in Figure 4.9.2.

On the left hand side of Figure 4.9.2 the measured horizontal antenna diagram on each of the four frequencies at the site is shown. On the right hand side the measured vertical antenna diagram at one of the bearings with a maximum in the horizontal pattern (in the example 10°) has been plotted as function of the angle below horizon.

The results of helicopter measurements can be used:

- To check if the antenna pattern is within the specifications and as basis for discussion with the supplier if this is not the case;
- As input for detailed coverage assessment calculations.



Source: Veritair

Figure 4.9.2: Example of results of helicopter measurements at a site with four DTTB frequencies

Coverage measurements

The objective of coverage measurements is to verify, e.g.:

- Field strength prediction models in order to adjust parameters in the prediction model to the local environment;
- Planning criteria, in order to adapt some of the criteria, e.g. field strength standard deviation, or minimum required field strength values;
- Indoor reception, e.g. to achieve better understanding of field strength distribution in a room, or to determine building penetration loss values in the local situation;
- Field strength values if needed for commissioning of services.

Indoor measurements are very time consuming. A statistically relevant number of measurements need to be done in different types of buildings and at different locations in a room. Obviously, permission is needed from the inhabitants to enter the premises and to carry out the measurements.

Figure 4.9.3 gives an impression of a field strength measurement set up in a living room.



Source: Nozema

Figure 4.9.3: Indoor measurements in a living room

Instead of very time consuming indoor measurements, often operators content themselves with outdoor mobile measurements¹¹², with a correction factor added to present indoor reception. An example of results of mobile measurements, corrected for indoor reception, is shown in Figure 4.9.4 and 4.9.5.

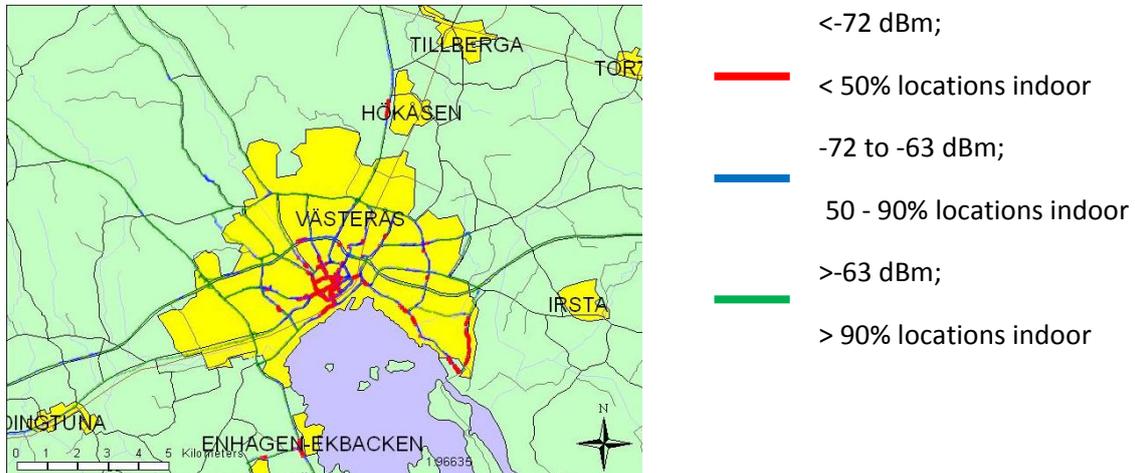


Figure 4.9.4: Example of DTTB mobile measurements at channel 57

Source: Progira

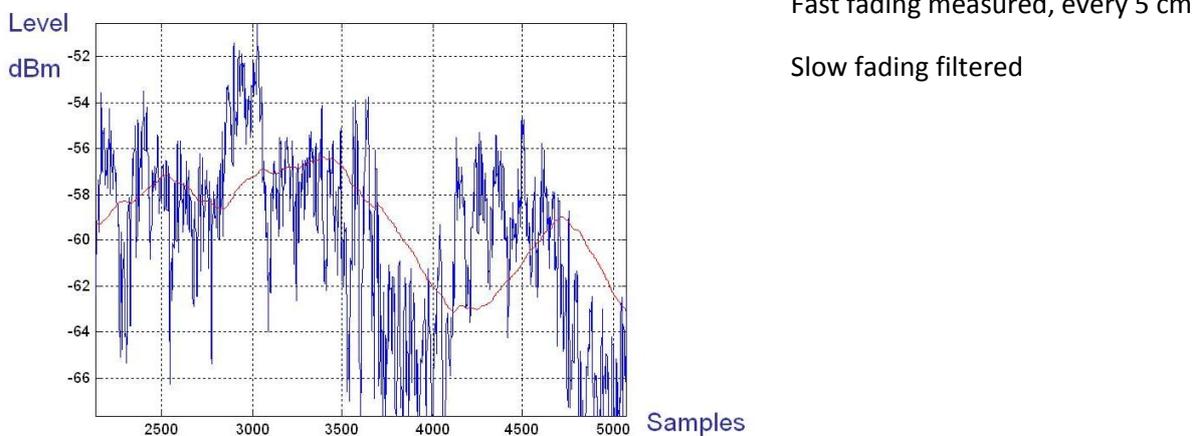


Figure 4.9.5: Example of mobile measurement data; 250 metre in a suburban area

Source: Progira

Receiver tests

The objectives of receiver tests could be to verify, e.g.:

- RF performance (including SFN synchronization);
- Service Information (SI) and Programme Specific Information (SPI) performance;

¹¹² Mobile measurements are described in more detail in Section 5.9.2.

- System Software Update (SSU);
- Conditional Access (CA), if required.

The service provider could recommend to use receivers that passed these tests successfully.

Demonstrations

Objectives of demonstrations could be, e.g.:

- To verify acceptability of the service proposition¹¹³:
 - ✘ Picture and sound quality;
 - ✘ Services bouquet;
 - ✘ Ability of viewers to adjust their receiving installations.
- To promote DTTB services with, e.g.:
 - ✘ Politicians and officials;
 - ✘ Key persons in the broadcast industry;
 - ✘ Journalist;
 - ✘ Local dealers.

Technical tests and demonstrations have very different purposes and should not be mixed. Before starting demonstrations the correct technical performance of the network should be guaranteed.

Implementation guidelines

Before DTTB services become operational it is essential to perform technical tests and to check service performance under different operational conditions.

When DTTB services are introduced for the first time in an area, it is recommended to succeed the technical test with service demonstrations to familiarize market parties, including local dealers of terminal equipment, with the service performance.

Furthermore, technical tests are recommended after each change in the multiplex to check if most used receiver types in the market perform as expected.

4.9.2 Implementation plan

The network implementation plan should take account of:

- Obligations imposed by the regulator;
- Commercial decisions expressed in business plan and service proposition;
- Technical choices made in dealing with other functional blocks related to DTTB networks.

A summary of obligations, decisions and choices that are important to roll out planning are indicated in Table 4.9.1 below

Table 4.9.1: Obligations and choices determining roll-out planning

Functional blocks to be taken into account	Reference	Elements for roll-out planning
License terms and conditions	2.6	<ul style="list-style-type: none"> • Roll-out timing and coverage obligations • Frequency availability during and after transition
ASO planning and milestones	2.14	<ul style="list-style-type: none"> • Analogue switch-off dates per area • Minimal simulcasting periods

¹¹³ The information related to audience research and analysis regarding MTV described in Section 5.9.3 is to a great extent also relevant to DTTB services.

Functional blocks to be taken into account	Reference	Elements for roll-out planning
Receiver availability considerations	3.2	<ul style="list-style-type: none"> • Agreements with receiver manufacturers and local dealers about time, quantities and types timing of receivers available for sale
Business planning	3.4	<ul style="list-style-type: none"> • Commercial roll-out priorities regarding areas and timing
Design principles and network architecture	4.2	<ul style="list-style-type: none"> • Roll-out speed, as a trade-off between networks costs and network quality • Regional and national services
Network planning	4.3	<ul style="list-style-type: none"> • List of station characteristics and coverage presentations in different implementation phases, before and after ASO
Transmission equipment availability	4.8	<ul style="list-style-type: none"> • Delivery times

In addition account should be taken of operational conditions such as:

- Resources and capacity of the content distributor;
- Time periods for acquiring new sites;
- Limitations in the use of existing facilities (site, mast, antennas);
- Time periods in which sites have limited access, or working circumstances are unfavourable, due to weather conditions;
- Minimal service interruptions.

The above mentioned obligations, choices and conditions could be conflicting in some cases and interim solutions may be necessary. The choice for interim solutions is also a trade-off between roll-out speed, network costs and network quality, as described in section 4.2.1. Some examples of interim solutions are:

- Delayed introduction of DTTB services in some areas;
- Temporary transmitting equipment (e.g. transmitter or antennas) at some sites;
- Temporary sites;
- Reduced coverage.

The implementation plan generally consists of several phases. Two main phases are:

- DTTB implementation before analogue TV switch-off;
- DTTB implementation and modifications to already existing sites after analogue TV switch-off.

In addition to both main implementation phases, sub phases could be planned for introduction of DTTB stations, taking account of e.g.:

- Regional areas;
- Areas covered by one SFN;
- Population distributions;
- Type of station (e.g. main stations, gapfillers).

In an implementation phase the following steps can be identified:

- Test transmissions;
- Communication to end consumers;
- Putting DTTB site into operation.

Implementation guideline

The roll out plan should be made on the basis of:

1. Obligations from the regulator given in:
 - ✘ License terms and conditions;
 - ✘ ASO planning and mile stones.
2. Commercial decisions given in:
 - ✘ Service proposition and business plan;
 - ✘ Agreements with receiver manufacturers and dealers.
3. Technical choices made regarding:
 - ✘ Design principles and network architecture;
 - ✘ Network planning;
 - ✘ Transmission equipment availability.

Any remaining freedom left in planning roll-out is often used to satisfy practical considerations. Examples of such practical consideration are:

- Main sites implemented first and fill-in transmitters implemented last, however with priority given to areas where people live or work that have a great influence in the media world (politicians, journalists, regulators, managers of other players in the value chain);
- Combining DTTB equipment installation with already planned transmitter or antenna replacements;
- Start of DTTB introduction at a site close to the headquarters of the content distributor. The first DTTB introduction is likely to require more attention than further DTTB introductions when experience has been gained. A site close to the headquarters is therefore more efficient;
- Preceding operational DTTB services by a relatively long test period to obtain sufficient time for testing and have flexibility in allocating resources to testing;
- Installations requiring relatively long service interruptions during periods in which TV watching is limited (night time, holiday periods), and avoiding periods with major sports or national events.

4.9.3 Information to end consumers

The DTTB implementation plan has to take into account many different obligations, commercial and technical choices and operational considerations. The resulting plan is often very complex and is likely to consist of several phases. Furthermore DTTB service quality may be different in the various phases of introduction. End consumer support, as described in chapter 3.5 is therefore essential.

End consumer support should be based on realistic data concerning coverage, service quality and implementation schedules. These data should be made available as part of the network implementation plan.

In the transition from analogue to DTTB several network elements that have a direct impact on reception will change. Consequently, the consumer may have to adjust, modify or replace parts of the receiving installation in order to receive all DTTB services with good quality. Changes to receiving installations that may be necessary in the transition to DTTB are listed below.

1. Retuning of the receiver resulting from:
 - ✘ Frequency changes (of analogue TV or DTTB transmissions);
 - ✘ Introduction of new DTTB multiplexes;
 - ✘ Installation (or removal) of fill-in transmitters.

2. Installation of improved receiving antennas (more gain or antenna amplifier), because:
 - ⌘ DTTB frequencies are in another part of the UHF band than analogue TV frequencies, or change of frequency of existing DTTB services to a frequency outside the bandwidth of the receiving antenna;
 - ⌘ The DTTB transmitting antenna has (temporary) restrictions;
 - ⌘ The system variant is changed to a less robust one with higher capacity;
 - ⌘ The receiving location is situated in an area with internal SFN interference;
 - ⌘ New DTTB multiplexes with frequencies outside the bandwidth of the current antenna.
3. Replacement of the receiver or set-top-box because:
 - ⌘ Introduction of DTTB services requires a DTTB set-top-box (STB) or integrated digital TV set (IDTV);
 - ⌘ Transmission system is changed (e.g. to DVB-T2) and, or presentation format is changed to e.g. HDTV;
 - ⌘ Compression system is changed e.g. from MPEG2 to MPEG4.
4. Antenna adjustment as a result of changing to another azimuth bearing to improve reception of the transmitter after:
 - ⌘ Installation (or removal) of fill-in transmitters;
 - ⌘ Installation of new DTTB sites;

Communications tools used in practice are:

- Websites;
- Telephone helpdesks;
- Advertisements in newspapers, magazines, radio and TV;
- Road shows organized by the service provider;
- Information from local dealers (who have to be well informed in advance);
- Information channels in the DTTB multiplex;
- Information on teletext.

The application of these communication tools will depend on the practical situation and the access consumers have in general to these means of communication.

Much of the guidelines on communication on ASO (see chapter 2.15) are also valid for communication on DTTB introduction and changes in DTTB networks.

The basis for the information to consumers is the detailed coverage assessments resulting from network planning (see chapter 4.3). These data have to be converted to presentations that suit the different means of communication.

An example of a website in Sweden is shown in Figure 3.5.3 in section 3.5.3.

Implementation guidelines

Introduction of DTTB services is likely very confusing for the end-consumer. Information to the consumer is therefore essential regarding:

- Changes in the network and reception possibilities of each multiplex in the various phases of introduction;
- Information and help about modifications to receiving installations that have to be made in order to have good DTTB reception.

The various players in the value chain (see Figure 1.2.3 in chapter 1.2) have different responsibilities and different needs for communication with the end consumer. Very clear agreements have to be made between the various players about the information that is communicated to the consumers. Confusing or even conflicting information should be avoided. The best solution is one central point for communication.

Glossary of abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
64-QAM	64-state Quadrature Amplitude Modulation
AAL	ATM Adaptation Layer
API	Application Programme Interface
ASI	Asynchronous Serial Interface
ASO	Analogue Switch-Off
ATM	Asynchronous Transfer Mode
ATSC	Advanced Television system Committee (USA)
AVC	(MPEG4) Advanced Video Coding
C/I	Carrier to Interference ratio
C/N	Carrier to Noise ratio
CAS	Conditional Access System
CI	Common Interface
CRT	Cathode Ray Tube
DTMB	Digital Terrestrial Multimedia Broadcast
DTTB	Digital Terrestrial Television Broadcasting
DVB	Digital Video Broadcasting
DVB-H	Digital Video Broadcasting – Handheld
DVB-S	Digital Video Broadcasting – Satellite
DVB-T	Digital Video Broadcasting – Terrestrial
DVB-T2	Digital Video Broadcasting – Second Generation Terrestrial
EBU	European Broadcasting Union
EMC	Electro-Magnetic Compatibility
Emed	Minimum median field strength value
EPG	Electronic Programme Guide
ERP	Effective Radiated Power
ETI	Ensemble Transport Interface
ETSI	European Telecommunication Standards Institute
FFT	Fast Fourier Transform
GE06	Geneva Agreement of 2006
GIS	Geographic Information System
GPS	Global Positioning System
GSM	Global System for Mobile communications
HD-SDI	High-Definition Serial Digital Interface
HDTV	High Definition Television
h_{eff}	effective antenna height
IDTV	Integrated Digital TV set
IF	Intermediate Frequency
IPDC	Internet Protocol DataCast
IPTV	Internet Protocol Television
ISDB-T	Integrated Services Digital Broadcasting-Terrestrial
ITU	International Telecommunication Union
ITU-R	ITU- Radiocommunication Sector
MER	Modulation Error Rate
MFN	Multi Frequency Network
MPEG	Moving Picture Experts Group
MTBF	Mean Time Between Failures
MTV	Mobile Television

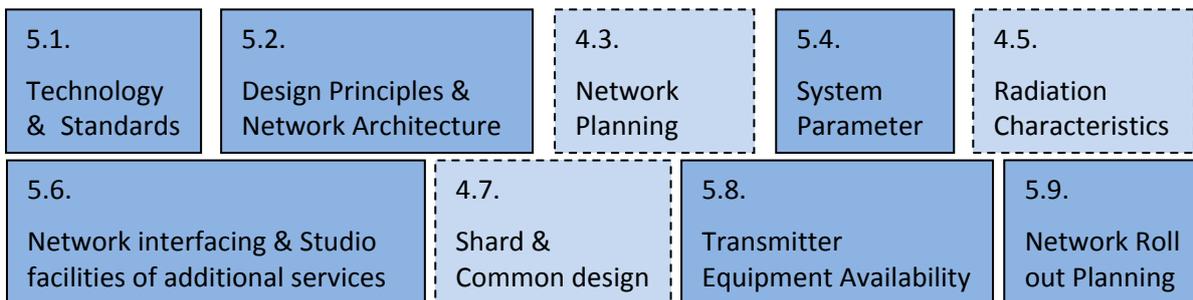
NTP	Network Time Protocol
OFDM	Orthogonal Frequency Division Multiplex
PAL	Phase Alternating Line; analogue colour TV system
PDH	Plesiochronous Digital Hierarchy
PID	Package Identifier
PSTN	Public Switched Telephone Network
QPSK	Quadrature Phase Shift Keying
RF	Radio frequency
RPC	Reference Planning Configurations
RRC-06	Regional Radiocommunication Conference in 2006
SDH	Synchronous Digital Hierarchy
SDI	Serial Digital Interface
SDTV	Standard Definition Television
SECAM	Séquentiel couleur à mémoire; analogue colour TV system
SFN	Single Frequency Network
SI	Service Information
SLA	Service Level Agreement
SMS	Subscriber Management system
SNMP	Simple Network Management Protocol
SPI	Programme Specific Information
SSU	System Software Update
STB	Set-Top-Box
STS	Synchronization Time Stamp
T-DMB	Terrestrial - Digital Multimedia Broadcasting
T-DAB	Terrestrial - Digital Audio Broadcasting
TS	Transport Stream
Tx	Transmitter
UHF	Ultra High Frequencies
UPS	Uninterruptible Power Supply
VBI	Vertical Blanking Interval
VHF	Very High Frequencies
VSB	Vestigial Side Band
WRC-07	World Radiocommunication Conference in 2007
WRC-12	World Radiocommunication Conference in 2012

Part 5

MTV networks

Introduction

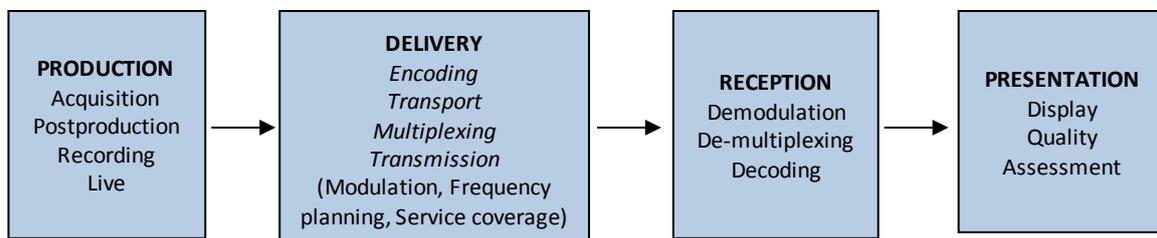
The MTV networks are represented by Layer D in the functional framework for the guidelines (see chapter 1.2). The functional building blocks related to MTV networks are shown below. Because of the similarity of the issues, guidelines regarding Network planning, Radiation characteristics and Shared and common design principles are covered in Part 4 in chapters 4.3, 4.5, and 4.7 respectively.



Choices regarding the above mentioned functional building blocks should be made in such a way that the licence conditions are fulfilled and that the business objectives are met. In doing so, optimum solutions should be found between, often conflicting, requirements regarding picture and sound quality, coverage quality and transmission costs.

Some of the issues regarding technology choices, frequency planning and network planning may also be relevant to regulators, depending on the roles and responsibilities of regulator and network operator in a country.

A diagram of the broadcasting chain¹ is illustrated as below to get a better understanding of the layer. The figure includes four main conceptual blocks, namely the production block, the delivery block, the reception block and the presentation block (see diagram below).



Part 5 of these Guidelines addresses mainly the Delivery block, but the impact on the other conceptual blocks of the broadcast chain is indicated.

¹ See Report ITU-R BT.1833 Transition from analogue to digital terrestrial broadcasting; Part 1, section 1.8.2, The digital broadcasting chain.

5.1 Technology and standards application

MTV services provide viewers with an innovative media service. MTV services are attracting considerable attention worldwide and are expected to soon become another norm for television viewing. Viewers can enjoy MTV services anywhere and anytime through various receivers such as handheld, portable and car-mountable.

Nowadays there are many kinds of MTV standards; DVB-H, T-DMB, ISDB-T_{SB}, media FLO, CMMB, etc². Since the specification in details of these standards is explained in the above materials, only the key factors will be mentioned in this guideline. Various tests are under way to overcome the limit of service which is based on streaming techniques by the data transmission technology and the cohesion. And soon commercial service will be provided; media FLO³, DVB-IPDC, MBMS, and OMA broadcast⁴, etc.

This guideline provides standards used for services in operation and will only discuss those standards that do not infringe on the GE06 Agreement. Therefore chapters of this guideline focus on the DVB-H (Digital Video Broadcasting-Handheld) which was modified from DVB-T (Digital Video Broadcasting-Terrestrial) for mobile services and T-DMB (Terrestrial-Digital Multimedia Broadcasting) which was originated from T-DAB (Terrestrial-Digital Audio Broadcasting) and add video services and advanced data services. The reason why this guideline mentions only DVB-H and T-DMB is as follows.

- Regarding MTV, the GE06 Agreement (Article 3.1) accepted the DVB-T and T-DAB standards. DVB-T can certainly be used for mobile services but DVB-T is more suitable for fixed and portable services and as the receivers are not prepared for the mobile services in the market, DVB-H was developed with 4k mode for more effective mobile services and decreased battery consumption of DVB-T handheld receivers. These are the reasons this guideline focuses on DVB-H. Also, DAB-IP (DAB-Internet Protocol) can be used for mobile services, but the standard was only tested in the UK and the solutions for DAB-IP standard such as commercial head-end equipment and receivers are not prepared in the market. Therefore this guideline will not include DAB-IP when deciding the MTV standard.
- DVB-H and T-DMB have been implemented with trial or commercial services in several countries in Region 1 (including several African countries) and elsewhere^{5,6}. It is assumed that most of the African countries will adopt the DVB-H or T-DMB⁷.

The object of this chapter is to provide the best selection of technology for optimized MTV network and MTV services.

The main activities are to review and give a comparison of the basic technologies of MTV and the characteristics of system for MTV services, as follows:

- Comparison of MTV standards;

² Recommendation ITU-R BT.1833 Broadcasting of multimedia and data applications for mobile reception by handheld receivers.

³ www.floforum.org/technology/MF_WP_TechOverview.pdf

⁴ www.openmobilealliance.org

⁵ See www.worlddab.org/

⁶ See www.dvb.org/about_dvb/dvb_worldwide/index.xml

⁷ In reply to a questionnaire in the first phase of the ITU project on the digital broadcasting transition roadmap in Africa, it is indicated that one African country adopted the T-DMB standard, four African countries adopted the DVB-H standard and two African adopted a different standard.

- Selection of a MTV standard within the limits given by national and international regulations and policies;
- Decision of formation of services and channels;
- Case study of MTV services in the other regions (T-DMB / DVB-H);
- Review of encryption system (if needed);
- Review of type and system for additional services such as EPG (electronic programme guide), BIFS (binary format for scene), interactive services, etc.

Reviewing the MTV channel formation comes before the actual selection of a transmission standard and system. MTV channel formation is independent from the transmission standard and is established as part of the programme production and head-end construction process. The choice on the MTV channel formation has an impact on the broadcast delivery process and the choice in the delivery process is of great importance for the MTV services.

Worldwide MTV standards⁸ use similar compression systems. The systems related to compression and encryption are principally independent from the transmission standard. However, a number of systems for additional services are standard dependent.

The choice of the MTV channel formation, transmission standard, encoding system, conditional access system and systems for additional services should be made within the framework of relevant legislation and regulations (see chapter 2.1, 2.3, 2.4, 2.6) and market and business development decisions (see chapter 3.4). In addition, the framework of shared and common design principles (see chapter 4.7) can be used for the co-construction with DTTB (Digital Terrestrial Television Broadcasting) facilities.

The following sections give guidelines for the review and comparison of the basic technologies of MTV and the characteristics of system for MTV services.

5.1.1 Comparison of MTV Standards

A research that compares technical factors and the state of relevant countries should be done as described below to either select one standard among many MTV standards or to decide various system parameters.

- Research on technical options such as each of the standards channel bandwidth, modulation techniques and compression mode. For the technical review, refer to various resources from different organizations such as ITU, EBU, DVB, WorldDMB and EU.
- It is important to understand the particular facts and the unique state of play in each relevant country with regard to MTV development (e.g. frequency usability, channel demand, indoor reception, reception within the complete building area and operating Single Frequency Networks (SFN)).
- Write a comparison table of DVB-H and T-DMB to easily understand each standard's special qualities and the state of play in relevant countries.

Implementation guidelines

To date, MTV has been implemented in many countries in all regions; it is probably no longer necessary to perform technical tests for selecting or investigating a transmission standard because these transmission standards have proven their performance in practice. However, there are distinct differences between transmission standards in technical behaviour and in frequency management.

⁸ Recommendation ITU-R BT.1833 broadcasting of multimedia and data applications for mobile reception by handheld receivers (page 9: compression systems / page 17-20: MTV standards).

In addition, service and channel requirements are important issues for selecting a MTV standard, so these issues with technical items have to be included in the items to be compared.

Table 5.1.1 shows typical values of the main characteristics of T-DMB and DVB-H implantations.

Table 5.1.1: Main characteristics of MTV standards

Items	T-DMB	DVB-H
Frequency	Band-III (174-240MHz)	Band-IV/V (470-862MHz)
Bandwidth	1.536 MHz	5/6/7/8 MHz
Bit-rate availability ¹⁾	3.5Mbps at 6MHz (3-Multiplex in 6MHz, 1.152Mbps*3 = 3.456Mbps)	7.5Mbps at 6MHz
Modulation	DQPSK	QPSK / 16QAM / 64QAM
Number of channels (bit-rate: 384Kbps) ¹⁾	9-video channels at 6MHz	19-video channels at 6MHz
Transmission mode	Eureka-147 Stream Mode (OFDM)	OFDM
Channel coding and error correction methods	Reed-Solomon Coding (204,188 T=8), Convolution Interleaving	Inner code: convolutional code, mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8 Outer Code : RS (204, 188, T = 8) IP outer channel code : MPE-FEC RS (255,191)
Required C/N ²⁾	9.6dB at 120km/h	18dB at 120km/h
Video service format	Video: MPEG-4 Part 10 AVC (H.264)	Video: MPEG-4 Part 10 AVC (H.264), VC-1 (optional)
	Audio: MPEG-4 Part 3 ER-BSAC	Audio: AAC+
	Additional data: MPEG-4 BIFS Core2D Profile	Additional data: DVB-IPDC(Internet Protocol Data Cast) /OMA BCAS
Audio service format	MPEG 1/2 Layer 2 (MUSICAM)	HE AAC v2 AMR-WB+
	AAC+	
	Visual-Radio : the same as video service format exception the video frame-rate(2-5 frame/sec)	
Data service format	MP4 file, JPEG, PNG, MNG, BMP, etc. ASCII text, etc.	3GP and MP4 file, JPEG, GIF, PNG Character encoded (3GPP timed text) or bitmap
Particular national requirements (for example)	Frequency availability: O/X (whether or not)	Frequency availability: O/X (whether or not)
	To meet the required channels: O/X	To meet the required channels: O/X
	To meet the required indoor reception rate: O/X	To meet the required indoor reception rate: O/X
	To meet the required coverage under their unique conditions: O/X	To meet the required coverage under their unique conditions: O/X
	To meet the required spill over issues: O/X	To meet the required spill over issues: O/X

- 1) For an easy comparison, 6MHz and 384 kbps at 6 MHz are equally applied to two standards. If different bit-rate or bandwidth is applied, the number of channels is changed. In practice, 256-544 kbps is applied to video services according to their intentions.
- 2) For an easy comparison, only the typical figure is mentioned. There are many options for modulation; code rate, frequency and location etc.; according to the options, the figures are changed⁹.

It is possible to have an approximate comparison between two standards if the technical qualities and state of play in relevant countries are compared overall, as listed in the table above. More items that are of interest to the relevant countries can be added and then analysis and testing on more detailed items can take place to enable selection of a MTV standard in the next section (5.1.2).

5.1.2 Selection of MTV standard

To select the MTV standard, decision makers (regulators, broadcasters, etc.) have to consider many aspects such as technology, frequency, carrying capacity, contents, cost, viewers, receivers and capability of extension.

To select the MTV standard, the technology and economy parts are to be thoroughly reviewed and considered. There are many papers that compare two standards from the point of view of technology¹⁰ and economy¹¹.

Issues are compared in Table 5.1.2:

Table 5.1.2: Comparison of MTV standards

Items	T-DMB	DVB-H	Remarks
Frequency character	Band III	Band IV/V	Free space loss : Band III < Band IV/V T-DMB : advantage for large coverage
Frequency allocation	With DAB	With DTTB	T-DMB: advantage for countries that have already allocated Band III for DAB services
Bit-rate usability	3.5 Mbps at 6 MHz	7.5 Mbps at 6 MHz	DVB-H: advantage for countries that want many services
Number of channels	9 channels at 6 MHz	19 channels at 6 MHz	DVB-H: advantage for countries that want multi-channel services
Requirement of content supply	Low	High	T-DMB: advantage for countries that have low capability for content supply
Construction cost for production facility	Low	High	T-DMB: advantage for countries that have low budget for facility construction
Construction cost for transmission facility	Low	Very high	DVB-H: disadvantage for large coverage DVB-H: disadvantage for indoor receiving

⁹ Refer to EBU-TECH 3317 'Planning parameters for hand held reception'.

¹⁰ EBU doc. Tech. 3327, Network aspects for DVB-H and T-DMB EBU, April 2008.

EBU doc. Tech. 3317: Planning parameters for hand-held reception EBU, July 2007.

¹¹ EBU trev-299: What's difference between DVB-H and DAB, July 2004 / EBU trev-305 : Broadcasting to handhelds, January 2006 / EBU trev-305 : An economy analysis of DAB & DVB-H, January 2006.

Items	T-DMB	DVB-H	Remarks
Needs of viewers	To meet the core needs	To meet the various needs	
Kinds of receivers	Variety	Limited	T-DMB: phone, car, laptop, handheld, USB, PDA, PMP, and STB. DVB-H: phone, car, USB, handheld
Price of receivers	Cheap	Expensive	T-DMB: scale of economy of chip set and module, competition among the manufacturers
Business model	Variety	Variety	
Capability of extension	AT-DMB ¹²		AT-DMB technologies finished technical test and are preparing the new services.

Implementation guidelines

Technical items are very important factors to select the MTV standard; however T-DMB and DVB-H technology are already verified through commercial service in other countries and in many papers¹³.

Therefore decision-makers have to compare the strong and weak points of the two standards based on conditions such as frequency availability, construction budget and viewers' needs.

For example, a country which requires large coverage and limited capability of content supply is recommended to select T-DMB, whereas a country which requires small coverage, has a high density of population, and plentiful production facility is recommended to select DVB-H. Another way (multi-standard / hybrid method) is for DVB-H to be used in main cities and T-DMB to be used in rural areas; this method requires preparation of a common receiver but can be a new solution.

The selection of a MTV standard depends on each country's situation rather than technical superiority.

5.1.3 Formation of services and channels

MTV services have various formations of services and channels because they can carry many services and channels in a multiplexer. Both MTV services (T-DMB / DVB-H) can be composed of video, audio and data services depending on the broadcaster's service plan. Each service can also be composed of

¹² AT-DMB : Advanced T-DMB which provide existing T-DMB plus more high quality services (and bigger screen) by introducing hierarchical modulation technology, TTA.KO.0070, Specification of the Advanced Terrestrial Digital Multimedia Broadcasting(AT-DMB) to mobile, portable, and fixed receivers.

¹³ EBU doc. Tech. 3327, Network aspects for DVB-H and T-DMB EBU, April 2008
 EBU doc. Tech. 3317, version 2: Planning parameters for hand-held reception, concerning the use of DVB-H and T-DMB in Bands III, IV, V and 1.5 GHz. EBU, July 2007
 ETSI TR 102 377 Digital Video Broadcasting (DVB) ; DVB-H Implementation Guidelines, Nov 2005
 ETSI EN 302 304 Digital Video Broadcasting (DVB); Transmission System for Hand held Terminals (DVB-H)
 ETSI TS 102 428 Digital Audio Broadcasting (DAB); DMB video service; User Application Specification
 ETSI EN 300 401 Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers

many channels which are allocated with appropriate bit-rates according to carrying capacity and target quality of service. The examples are shown in Table 5.1.3.

Table 5.1.3: Typical MTV standard characteristics

Standard	Service	Channels (bit-rate: kbps)			Remarks
		Video	Audio	Data	
T-DMB (1152 kbps at 1.536MHz)	Case-1	VC-1 (460) VC-2 (460)	AC (112)	DC-1 (64) DC-2 (56)	Audio: minimal Visual Radio Data: BWS, EPG
	Case-2	VC-1(472)	AC*3 (384)	DC-1 (96) DC-2 (72) DC-3 (128)	AC*3: enhanced Visual Radio DC-1: BWS / DC-2: EPG DC-3: enhanced TPEG
	Case-3	VC-1(496) VC-2(496)		DC-1 (64) DC-2 (96)	Video: added BIFS Data: TPEG, BWS and EPG
DVB-H (7296 kbps at 6MHz)	Case-1	VC*15(5760)	AC*5 (800)	DC (544) CAS (192)	VC*15: normal video service Audio: enhanced Visual Radio Data: enhanced BWS and ESG
	Case-2	VC*10(3840) VC*5(2400)	AC*3 (384)	DC (160) CAS (192)	VC*10: normal video service VC*5:primum video service Data: ESG
	Case-3	VC*10(3840) N-VOD*5 (2400)		DC (544) CAS (192)	VC*10: normal video service VC*5:near VOD service

The acronyms used in Table 5.1.3 have the following meaning:

VC:	Video Channel / AC: Audio Channel / DC: Data Channel
N-VOD:	Near - Video on Demand
TPEG:	Transport Protocol Experts Group
BWS:	Broadcast Web Site
EPG:	Electronic Programme Guide
ESG:	Electronic Service Guide
BIFS:	Binary Format for Scene description

Implementation guidelines

After selecting the MTV standard, broadcasters have to decide which service they want to provide. They only have to select a suitable format which can meet their needs because the MTV technologies have been verified already through commercial service and many papers.

Factors to be considered when deciding the formation of services:

- Desired services;
- Desired numbers of channel at each service;
- Types and numbers of charged services;
- Types and numbers of interactive services;
- Target quality (screen size, audio mode, complexity of BWS and depth of TPEG service etc.);
- Target viewers (demographic, region, etc.);

- Needs of viewers (contents, fee and schedule etc.);
- Outline of business models;
- Capability of content supply;
- Human resource for operating those services;
- Facilities for those services etc.

Broadcasters can decide the format of services and channels on the basis of the factors above. The format of services and channels is a key decision in the provision of successful MTV services because all viewers' needs are included in this formation of services.

5.1.4 Case study of MTV services in the other regions (T-DMB / DVB-H)

There are several MTV standards in the world and they are in commercial service or trial service in many countries. For example, T-DMB is in commercial service in Korea, Ghana, Norway, and China, and in trial service in France, Italy, Egypt, and Malaysia; DVB-H is in commercial service in Italy, Finland, Austria, Netherlands, and in trial service in Germany, Morocco, and Vietnam. From the countries which have a commercial MTV service, this guideline will highlight the use of different MTV standards using case studies from Korea¹⁴ (for T-DMB) and from Italy (for DVB-H¹⁵).

The reasons why these two countries were chosen are because:

- These two countries have been providing commercial services since 1 December 2005 in Korea and 5 June 2006 in Italy respectively;
- These two countries have many subscribers, channels, and receivers;
- These two countries have considerable experience with pay service, additional services, and audience behaviours.

T-DMB in Korea

Overview

Under the EUREKA-147 DAB system, audio services using the MPEG-1/2 audio layer 2 (MUSICAM), data services closely related to audio services (PAD: programme associate data), and data services independent of audio services (NPAD: non-programme associate data) are all possible. T-DMB enhances EUREKA-147 to deliver video services by applying MPEG-4 technology to the EUREKA-147, even in a moving vehicle. Moreover, it upgrades the data service specification of EUREKA-147 DAB and adds new data services technologies such as MPEG-4 BIFS (Binary Format for Scene description), traffic and travel information service (TPEG), disaster broadcasting technology (enhanced EWS¹⁶; Emergency Warning System), conditional access technology (CAS) and combines the technology of broadcast and mobile telecommunication network etc.

Service concept of T-DMB

The service concept of T-DMB services is shown in Figure 5.1.1

¹⁴ <http://eng.t-dmb.org/>, <http://dmb-alliance.org/>

¹⁵ www.dvb-h.org/Services/services-Italy-3Italia.htm

¹⁶ TTAS.KO-07.0046/R2, Interface Standard for Terrestrial Digital Multimedia Broadcasting (T-DMB) Automatic Emergency Alert Service

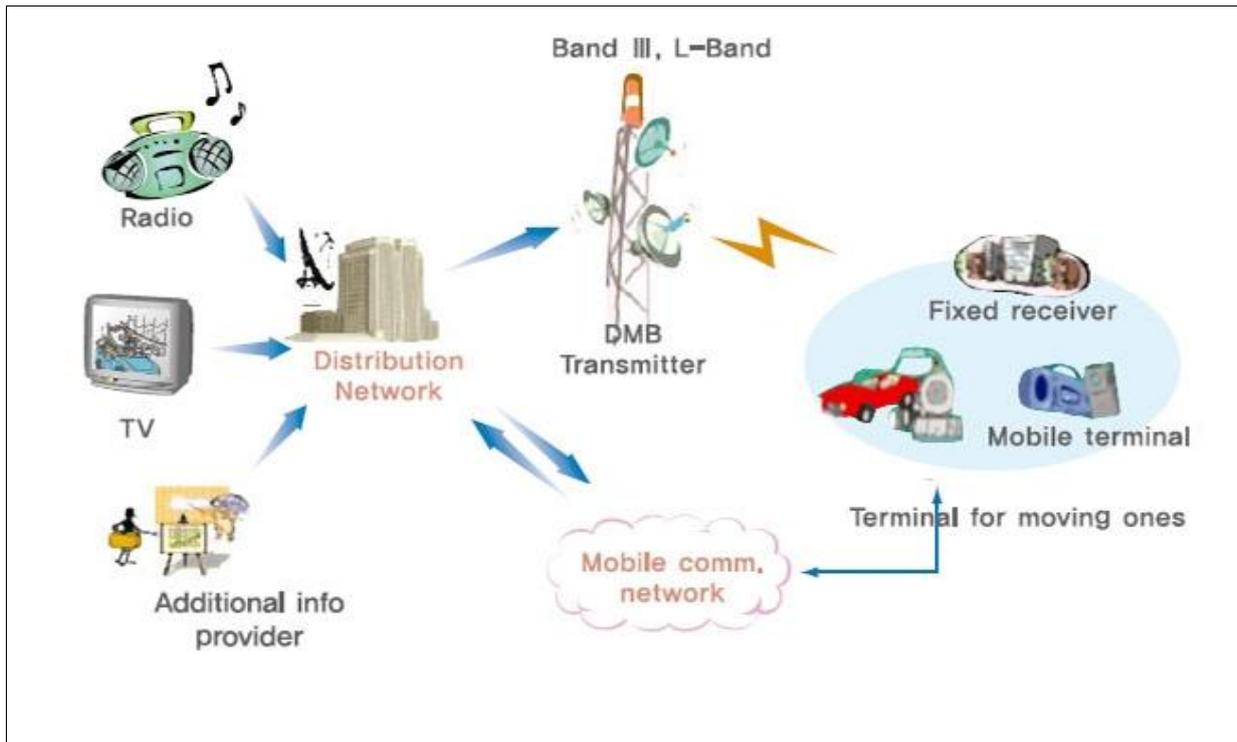


Figure 5.1.1: T-DMB service concept

Technology parameters

The main technology parameters used in Korea are:

- Frequency: Band-III (174-216 MHz);
- Bandwidth: 1.536 MHz;
- Guard Interval: 246us;
 - Modulation Mode: QPSK (Quadrature Phase-Shift Keying);
 - Transmission Mode: Eureka-147 Stream Mode;
 - Video service format;
 - ⌘ Video: H.264 | MPEG-4 Part 10 AVC (advanced video coding) baseline profile, level 1.3;
 - ⌘ Audio: MPEG-4 Part 3 ER-BSAC (bit sliced arithmetic coding);
 - ⌘ Additional Data: MPEG-4 BIFS Core2D Profile;
- Audio Compression: MPEG 1/2 Layer 2(MUSICAM) / AAC+;
- Multiplex: MPEG-4 over MPEG-2, MPEG-4 SL(Sync Layer), MPEG-2 TS(PES);
- Channel Coding: Reed-Solomon Coding (204,188), Convolution Interleaving;
- Required BER(Bit Error Rate) performance: under 10^{-8} ;

Services

Main features of the services are:

- Launch date : 1 December 2005;
- Business model: free of charge service (TPEG and EPG in data channel are pay services);
- Coverage: nationwide (including all subways in metropolitan area).

A summary of the services offered in Korea is shown in the table below.

Table 5.1.4: Summary of T-DMB services in Korea

Broadcasters	Frequency block (Center frequency: MHz)	Video(9-channels) (bit-rate: kbps)	Audio(10-channels) (bit-rate: kbps)	Data(7-channels) (bit-rate: kbps)
U1 Media	8A (181.280)	U1(440)	U1 radio(128)	U1 Data(144)
		U MTN(440)		
YTN DMB	8B (183.008)	mYTN (512)	TBN (160)	4DRIVE (256)
			Satio Top Music (128)	NBEEN (80)
				Broad&tv(16)
Korea DMB	8C (184.736)	UBS (496)		UBS Data (32)
		MBC NET (496)		CBS Data(128)
MBC	12A (205,280)	my mbc (544)	MBC Radio (160)	MBC Data (192) (BWS:64) (TPEG:128)
			MBN (128)	
			Arirang (128)	
KBS	12B (207.008)	UKBS STAR (424)	UKBS MUSIC (112)	UKBS Clover (192) (BWS:96) (TPEG:96)
		UKBS HEART(424)		
SBS	12C (208.736)	SBS u TV (544)	SBS V-Radio (128)	SBS ROADi (128)
			tbs V-Radio (128)	
			KDMB (128)	

Receivers

A wide variety of receivers is available in the Korean market:

- 54-manufacturers, 700-kinds, 20million-devices (2009.5);
- Samsung, LG, PenTech, Hyundai-autonet, i-river, i-navi, fine digital, Cowon, etc.

DVB-H in Italy

The main features of the “3 Italia”-TV Digital Mobile service are indicated below.

General

- Coverage: Italy (nationwide)
- Service launch date: 5 June 2006
- Subscribers / users: 600,000 - up to May 2007
- Business model: Pay-TV, Free-to-Air, Pay-per-view
- Service content: 12 channels (Mediaset, Rai, Sky, La3 Live, La3 Sport)
- Tariffs: daily, weekly or monthly packages, with or without other services included. Pay-as-you-go users can access the mobile TV service at EUR 4 per day, EUR 9 per week, EUR 19 per month or EUR 29 for three months. Alternatively, subscribers can pay EUR 29 per month getting free access to all digital mobile TV services, access to 3 Club on 3 Mobile Portal, free national calls and one GB/month of mobile broad-band Internet.

As of June 2008, RAI 1, RAI 2, Mediaset, Sky Meteo 24, Current TV and La3 are made available free-to-air to those with DVB-H receivers. La3 is an in-house channel, showing sports, music and entertainment programming.

Technology parameters

- Transmitters: more than 1000 transmitters with power ranging from 5 W to 2.5 KW covering 85 per cent of population (48 million people);
- Frequency band: 474-746 MHz, CH 21-55;
- DVB-H parameters: FFT = 8k; Modulation QPSK; FEC = 1/2; Guard Interval = 1/8; MPE-FEC = 3/4; Time slice = 2 sec;
- Amount of bandwidth used for DVB-H: All no hierarchical modulation;
- Video and Audio format: H.264/AAC+;
- Interactivity platform: FastESG from EXPWAY - compliant with DVB-IPDC specifications;
- Conditional access / DRM type: CAS-Nagravision; Gemplus / Encryption system: ISMACryp.

Receivers:

Samsung F510, Samsung P910, Samsung SGH P910, LG HB620, LG U900, LG U960, Momedesign MD5, Garmin 900T, Onda DH502HS USB device for watching on a PC. 3 Pocket TV (a handheld device with a 4.3" display, using USIM and supporting SD cards)

Implementation guidelines

There are two commercial services under GE06 in the world: T-DMB and DVB-H. These standards for commercial services have both advantages and disadvantages. Depending on requirements of each country, suitable standards can be selected.

The selection of standards is the process of trade-off between numbers of services and quality of services. The multiplex capacity can be made after choosing standard and multiplex composition (see chapter 5.2) and then the network planning has to be considered too (see chapter 5.3). But in order to achieve an acceptable quality and optimal MTV network, it is advisable to bench-mark from these case studies.

5.1.5 Encryption system

Encryption is generally applied to provide a conditional access for viewers that are entitled to receive a service and to prevent unauthorized use. Payment or citizenship of a country can be the condition for access in the case where programme rights are geographically limited. In general, access is obtained by a number key. When a viewer fulfils the access conditions (i.e. possesses the right authentication and has paid for the services) an authorization signal is transmitted and the viewer can have access to the services.

For this type of encryption system, CAS (Conditional Access System) and DRM (Digital Rights Management) technology are used. Figure 5.1.2 shows the diagram of CAS and DRM process for mobile broadcasting. This process consists of the following steps:

- Multimedia source is scrambled in the CAS server;
- The scrambled signals are delivered to the client via the broadcasting network;
- Also, an encrypted entitlement is transmitted to each receiver by using EMM (entitlement management message);
- An encrypted CW (Control Word) is delivered to every receiver by using ECM (entitlement control message);
- To get the CW, the receiver uses an IC card to cryptanalyze the ECM by using the key delivered by the EMM;

- Finally, the scrambled multimedia source, which is delivered through broadcasting network, is descrambled at the client's device.

In the reverse direction, client requests and charging information are returned to the CAS operator through the telecommunication network (the interactive return-channel); the issues about using rights of delivered contents are controlled with the DRM.

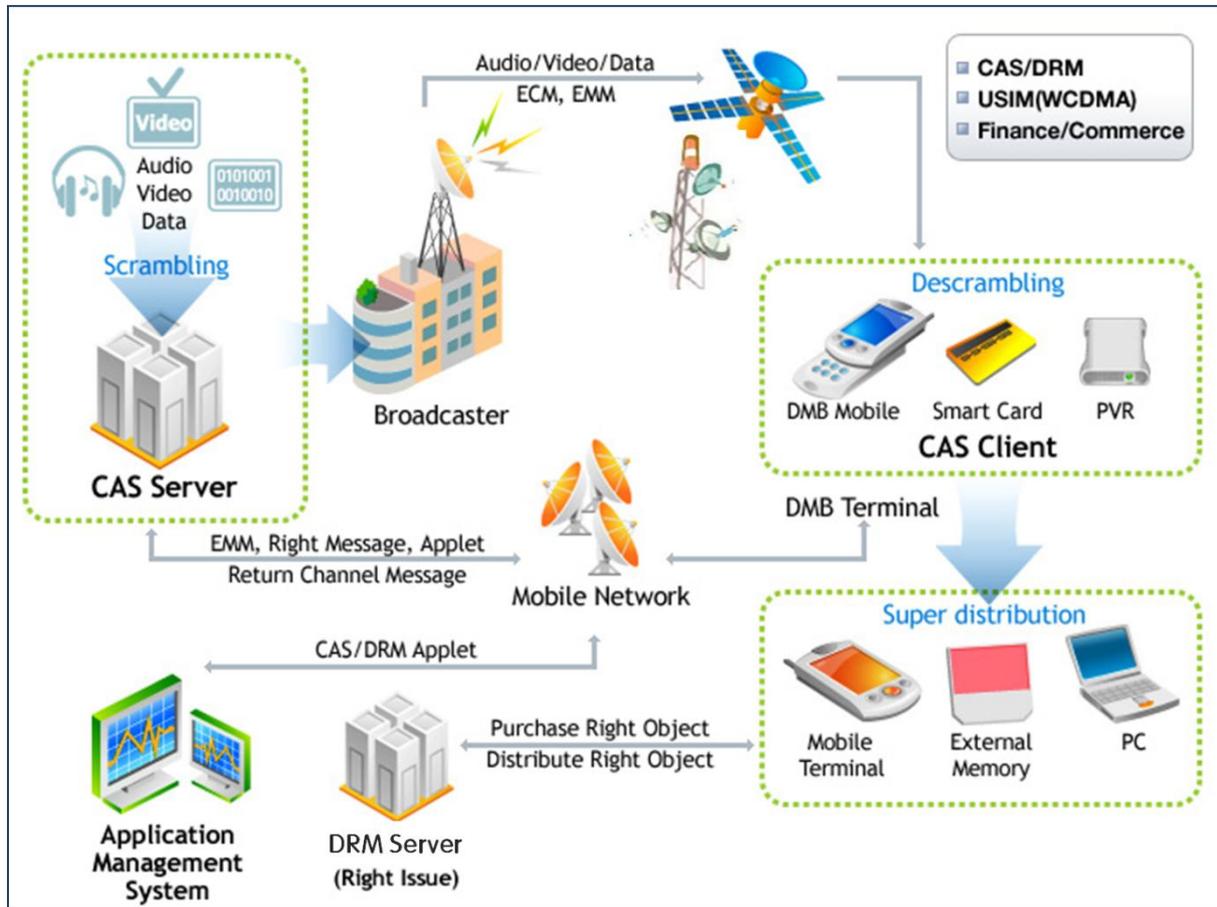


Figure 5.1.2: Diagram of CAS and DRM system

Implementation guidelines

Choosing a conditional access system is a trade-off between costs of the system and security (the expected or reported chances of hacking the system). The required bit-rate for CAS (including SMS) depends on the number of subscribers (users), therefore the format designers have to reserve a suitable bit-rate for CAS. On the other hand, it is essential that receivers are matched with the CAS, so CAS designers have to cooperate with receiver manufacturers in the design of the CAS. In general, the providers of CAS will propose reasonable solutions for each condition and the designers can select a suitable CAS solution through trade-off between costs, required bit-rate and security of system.

5.1.6 Additional services

In addition to the main signal which consists of video, audio and data channels, a variety of other services may be implemented, either in connection with the MTV service (PAD: programme associate data) or independent of it (NPAD: non programme associate data).

Such services could include:

- Multiplex Configuration Information (MCI): the MCI is generated in the head-end and contains information on configuration of multiplex and transmitted through the FIC (Fast Information Channel);
- Service Information (SI): the SI is generated in the head-end, contains information on current and future programmes, and is transmitted through the FIC;
- Emergency Warning System (EWS): the EWS is generated in the head-end, contains emergency warning information by using data from an external emergency warning organization, and is transmitted through the FIC;
- Traffic Message Channel (TMC)¹⁷: the TMC is generated in the head-end, contains traffic information by using data from an external traffic information gathering organization, and is transmitted through the FIC;
- Dynamic Label Segment (DLS): the DLS is generated with text type in the radio studio, contains NPAD (variety notices, news, event introductions and programme information etc.) and PAD (introduction of song title, singer, lyric, album, concert and so on), and is transmitted through the audio channel;
- Slide Show (SLS): the SLS is generated with image type in the radio studio, contains NPAD (variety notices, news, introduction of events and programme information etc.) and PAD (introduction of song title, singer, lyric, album, concert and so on), and is transmitted through the audio channel;
- Binary Format for Scene description (BIFS): the BIFS is generated in the TV studio and contains variety notices, introduction of actors/story/place/PPL, programme information, M-commerce and so on, and is transmitted through the video channel;
- Electronic Programme Guide (EPG)¹⁸
 - ✘ Receiver generated and based on the SI; this simple solution requires no production facilities and has only a limited bit rate;
 - ✘ Dedicated EPG is produced by a service provider; this gives the EPG its own look and is the concept of the service provider, but requires a considerable bit stream and an adequate Application Programme Interface (API) in the receiver.

Implementation guidelines

Capacity needed for additional services can reach up to 10 per cent of the multiplex capacity. MTV multiplex capacity is limited so that the choice for additional services is guided by:

- Lowest bit rate option;
- No unnecessary duplication of data.

However, the additional services that cannot be provided through existing media are unique and could therefore attract audience interest. Furthermore, some services such as BIFS and SLS can become good business models; these additional services are therefore recommended for commercial broadcasters who want to earn benefits from MTV services.

¹⁷ ETSI TS 102 368: "Digital Audio Broadcasting (DAB); DAB - TMC (Traffic Message Channel)".

¹⁸ ETSI TS 102 818: "Digital Audio Broadcasting (DAB); XML Specification for DAB Electronic Program Guide (EPG)" / ETSI TS 102 371: "Digital Audio Broadcasting (DAB); Transportation and Binary Encoding Specification for DAB Electronic Program Guide (EPG)".

There are many kinds of systems for additional services in the market. SLS, DLS and BIFS authoring tools are designs based on a general PC and the interface part between MTV equipment and the tools are included. Therefore broadcasters can easily introduce systems for additional services with reasonable prices.

5.2 Design principles and network architecture

The objective of this chapter is to provide information for optimized network design and effective network architecture. The main activities are to review and define the key factors of network design and network architecture, as follows:

- Trade-off between network costs and service quality;
- Trade-off between radiation characteristics, multiplex capacity and coverage;
- Selection of main transmission mode;
- Review of services for national, regional, or local coverage;
- Review of use of existing sites and/or new sites;
- Review of head- end configuration: ENC (encoder), MUX (multiplexer), Monitor, Divider;
- Review of STL: type of distribution network;
- Review of network topology for MTV;
- Review of network roll-out phases: basic transmitters, repeaters, gap fillers.

To implement MTV services after selecting the MTV standard, broadcasters have to design the MTV network. It will be necessary to design the MTV network with a focus on technical and economical efficiency. These principles can be met by a trade-off between factors such as transmission modes, network costs, service quality, multiplex capacity and service formation. Broadcasters also have to consider other network architectures, for example STL, electric power, CAS, cooling system and monitoring system.

The following sections give guidelines for the key topics and choices regarding design principles and network architecture of MTV.

5.2.1 Trade-off between factors

Taking into account the standard which selected at the former section, broadcasters have to design the MTV network with consideration for technical and economic efficiency. In order to achieve this, there are some trade-offs among the factors for optimal network design e.g.:

- Transmission mode and performance;
- Trade-off between radiation characteristics, multiplex capacity and coverage;
- Trade-off between network costs and service quality;
- Services for national, regional, or local coverage and network construction costs;
- Use of existing sites and/or new sites;

Transmission mode

Firstly, the trade-off among transmission modes will be considered. There are three transmission modes for DVB-H; 2k mode, 4k mode and 8k mode. The 4k mode constitutes a new Fast Fourier Transform (FFT) size in addition to the native DVB-T 2k and 8k FFT sizes. All other parameters being the same, the new 4k size offers the same performance as the other two modes in AWGN (additive white Gaussian noise), Rice and Rayleigh channels. The real objective of the new 4k mode is the performance enhancement in mobile reception.

The current DVB-T standard provides excellent mobile performance with 2k modes, but with 8K modes the performance is unsatisfactory, especially with reasonable receiver cost/complexity. On

the network planning side, the 2k mode implements a short guard interval which effectively prevents its usage in the allotment type of planning, where rather large geographical areas are covered with one frequency (i.e. Single Frequency networks-SFN). For these reasons, a compromise mode between the 2k and 8k, would allow acceptable mobile performance on the receiver side whilst allowing more economical and flexible network architectures¹⁹. The incorporation of a 4K mode provides a good trade-off for the two sides of the system: spectral efficiency for the DVB-H network designers and high mobility for the DVB-H consumers. Also, the 4K mode increases the options available to flexibly plan a transmission network whilst balancing coverage, spectral efficiency and mobile reception capabilities²⁰.

Meanwhile, T-DMB provides four transmission modes; mode I, mode II, mode III, and mode IV. Mode I is the most suitable mode for terrestrial Single Frequency Networks (SFN) in the VHF Band III, because it allows the largest transmitter separations. Mode II is preferred for use by medium-scale SFNs in the 1.5 GHz band. Larger transmitter spacing can be accommodated by inserting artificial delays at the transmitters and by using directive transmitting antennas. Mode III is appropriate for cable, satellite and complementary terrestrial transmission at all frequencies since it can be operated at all frequencies up to 3 GHz for mobile reception and has the greatest tolerance of phase-noise. Mode IV is also used in the 1.5 GHz band and allows larger transmitter spacing in SFNs. However it is less resistant to degradation at higher vehicle speeds²¹. Mode II, III, and IV cannot be used for T-DMB in Africa because it does not coincide with ITU's frequency allotment plan²².

Network Designers have to select the optimal mode considering the conditions and target services, such as reception behaviour, receiver type and distance between transmitters, frequency availability and coverage plan. However, 4k or 8k modes are likely to be chosen for DVB-H (see also chapter 5.4) and mode I for T-DMB.

Radiation characteristics

Secondly, the trade-off between radiation characteristics is considered. There is a large number of system variants available for DVB-H (also, T-DMB). Different modulation schemes (QPSK, 16-QAM and 64-QAM) can be combined with different code rates and Multi Protocol Encapsulation - Forward Error Correction (MPE-FEC).

As always in network planning, there will be a need to make a trade-off between transmission capacity (bit rate) and the coverage quality (or the size of the coverage area) provided. Higher capacity requirements mean that a less robust system variant needs to be used, resulting in higher power and/or more sites needed to cover a specified area. This will increase the investment cost as well as the operational cost of the network.

From a consumer's point of view it seems desirable to provide indoor handheld reception, which is the most demanding receiving mode. In order to provide indoor reception with sufficient quality in most cases, there will be a need to use more robust system variants such as QPSK with a code rate such as 1/2 with MPE-FEC 3/4. It is generally effective to use SFNs (dense or medium sized) to provide indoor coverage due to the signal diversity provided by the different transmitters in the network. However it is necessary to choose a sufficiently long guard interval, adapted to the structure and the size of the network in order not to create problems arising from self-interference.

¹⁹ Refer to EBU-TECH 3317 'Planning parameters for hand held reception (page-7).

²⁰ Refer to ETSI TR 102 377V1.2.1 'Digital Video Broadcasting (DVB); DVB-H Implementation Guidelines (page-35).

²¹ Refer to EBU-TECH 3317 'Planning parameters for hand held reception (page-12)

²² Refer to GE06 Agreement Article 3, T-DAB frequency allotment plan in 174-230MHz band.

In the single (high power) transmitter case, a short guard interval may be used, resulting in a higher net bit rate available to provide the services.

In general, high power with a suitable modulation scheme (e.g. QPSK) and a suitable code rate (e.g. 1/2) results in wide coverage and a good reception rate but this combination would lead to low transmission capacity (low bit-rate availability). Therefore designers have to consider various issues for example intended services (required bit-rate), propagation issues, indoor reception rate, and interference issues.

Table 5.2.1 shows a comparison of each modulation type versus C/N and bit rate availability (C/N in dB for PER=10⁻⁴ in typical urban channel for single antenna receiver²³ .

Table 5.2.1: Modulation type vs. C/N and bit rate availability

Expected mobile performance in TU6 channel profile									
GI = ¼				2k		4k		8k	
Modulation	Code-rate	Bit-rate (Mbps)	C/N Rayleigh (dB)	C/N min (dB)	500MHz (at C/N min+3dB) (km/h)	C/N min (dB)	500MHz (at C/N min+3dB) (km/h)	C/N min	500MHz (at C/N min+3dB) (km/h)
QPSK	½	4.98	5.4	13.0	365	13.0	242	13.0	119
	2/3	6.64	8.4	16.0	291	16.0	194	16.0	97
16-QAM	½	9.95	11.2	18.5	246	18.5	166	18.5	86
	2/3	13.27	14.2	21.5	207	21.5	136	21.5	65
64-QAM	½	14.93	16.0	23.5	162	23.5	108	23.5	54
	2/3	19.91	19.3	27.0	84	27.0	58	27.0	32

Network costs and service quality

Thirdly, the trade-off between network costs and service quality is considered. There are various kinds of head-end and transmission equipment with considerably different prices, reliability and stability. Also the cost and quality depend on the system design plan, for example, equipment redundancy, construction of new sites specifically for mobile services and modulation schemes (which affect receiver complexity). In general the more costs the better service quality, however designers have to consider the economic efficiency which includes the number of services, quality of video or audio channels, equipment redundancy, minimum reception field strength and degree of indoor reception rate.

Coverage

Fourthly, coverage is considered. A MTV service has to cover all areas because the audience can travel within or across any type of area such as urban, rural, mountains, coastal, road, indoors even subways and tunnels. Therefore, the best approach would seem to be to cover all areas using a single solution. However, the all-in-one approach is somewhat inefficient in economic and technical aspects because the costs for such a system would be too much and require too much time and effort to construct. Furthermore, the all-in-one approach is undesirable for the strategy of service promotion

²³ Quoted from ETSI TR 102 377 v1.2.1, 2005-11
 Refer to EBU-TECH 3327 network aspects for DVB-H and T-DMB (page-11)

and implementation of locality of services. Therefore, the gradually expanding approach is preferred and recommended.

Sites

Finally, the use of existing sites or building of new sites is considered. The best approach is to use existing sites because this can reduce costs by common use of the basic infrastructure (e.g. cooling system, electric power supply facility and tower) and operational man power. It is useful for propagation prediction as reference can be made to the coverage of existing services (e.g. FM) on the site. However there are some restrictions; more sites are necessary for MTV due to the higher field strength required for mobile reception conditions and additional sites are required to achieve efficient coverage design for MTV. The reasons are that existing TV networks are designed mainly to target residents with roof top yagi antennas. Whereas, MTV networks have to be designed to cover the receivers with whip or rod antennas.

Therefore the recommended approach is to use existing TV sites and then additionally building new sites where specially needed for MTV services.

Implementation guidelines

The trade-off between wanted service grade and economical aspects are deeply dependent on conditions such as the target of services, existing transmitter sites and grade of viewers' interests. Therefore network designers have to undertake an extensive review of economical as well as technical aspects.

Taking into account the trade-off between technical factors, target of services and economic factors, the following are recommended:

- Transmission mode for T-DMB: Mode I with code rate=1/2, FEC=3/4, when the requirement is for extensive coverage with a single frequency (SFN), good reception rate and robustness during high speed movement and to use a Band III frequency in conformity with GE06 agreement.
- Transmission mode for DVB-H: 4k or 8k mode (see also chapter 5.4) with GI=1/4, code rate=1/2, FEC=3/4 when the requirement is for extensive coverage with a single frequency (SFN), good reception rate and robustness during high speed movement and use of a frequency in conformity with GE06 agreement (With these recommended figures, 25 or more video channels can be accommodated in a multiplex, with a speed of 170km/h or more and CNR of 18dB). Of course, different transmitting parameters can be chosen, e.g. Modulation QPSK; FEC = 1/2; Guard Interval = 1/8; MPE-FEC = 3/4; Time slice = 2 sec. The effective transfer rate, the reception capacity (which affects BER) and the SFN design factor are modified according to the change of transmission parameter as above. The results for the parameters chosen have been described and demonstrated in many papers²⁴ and need not be discussed further here.
- Modulation mode for T-DMB: QPSK because of receiver simplicity and in conformity with ITU recommendations.
- Modulation mode for DVB-H: 16-QAM because of good bit rate availability and reasonable receiver complexity.

²⁴

EBU – TECH 3317 Planning parameters for hand held reception.

ETSI TR 102 377 V1.4.1 (2009-04) Digital Video Broadcasting (DVB);DVB-H Implementation Guidelines.

ETSI TR 102 401 V1.1.1 (2005-05) Digital Video Broadcasting (DVB);Transmission to Handheld Terminals (DVB-H); Validation Task Force Report.

- Use a combination of existing sites and newly constructed sites for MTV; this provides a good solution in terms of cost and good reception rate.
- Medium power transmitters with SFN because this can cover shaded areas in the coverage by diversity of transmission sources.
- Redundancy of transmitter and multiplexer, on the other hand non-redundancy or N+1 architecture of repeater and encoder; it is a good solution in terms of cost and good reliability.
- The gradually expanding approach regarding the coverage extension plan; it is a good solution in terms of cost and degree of technical difficulty.

5.2.2 Network architecture: Head-end

Figure 5.2.1 shows the basic diagram of a MTV service system. As we can see in this basic diagram, the MTV network is composed of content provision, head-end, transmission and additional parts such as STL, monitoring system, CAS and additional service authoring. Among these components, production and transmission parts are treated in other chapters so the head-end part is dealt with mainly in this chapter.

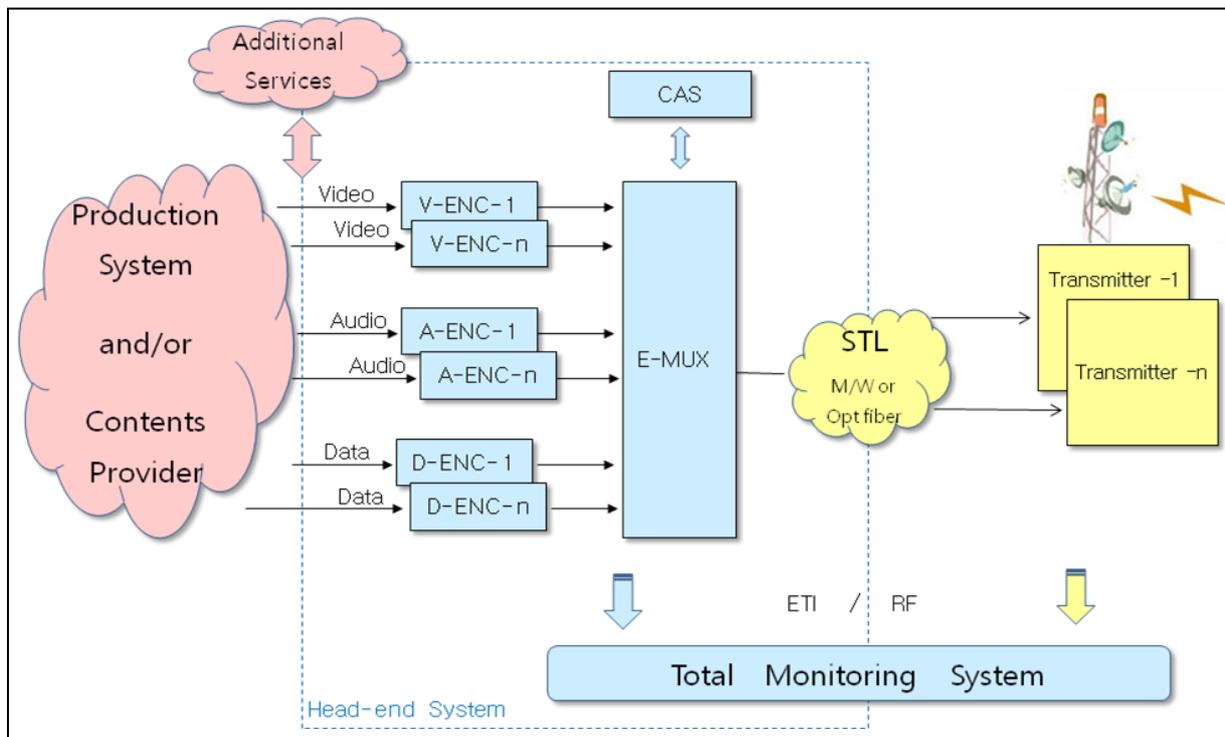


Figure 5.2.1: Basic diagram of MTV system

The configuration of the head-end part is absolutely dependent on the formation of services and channels. These are decided according to: the formation of services and channels, the types and numbers of encoders and authoring tools for additional services, the complexity of scale of the CAS and the complexity of the monitoring system.

Video encoders for video services accept various inputs such as composite NTSC/PAL, SDI (Serial Digital Interface)²⁵, or S-video / analogue stereo, or AES/EBU²⁶. These signals are compressed according to the compression standard (MPEG-4 part 10 AVC / MPEG-4 ER BSAC or AAC+). Output signals are generated using UDP (User Datagram Protocol)²⁷, DVB-ASI (Digital Video Broadcasting - Asynchronous Serial Interface), ETI (Ensemble transfer Interface)²⁸ and STI-D (Service Transport Interface –D)²⁹. Furthermore, additional data services are included by using multiplexing technology such as MPEG-4 part 1 BIFS, OD, and packetizing. There are many kinds of in/out signal formats, however these signals do not have special technical superiority and the various options are provided for connection flexibility.

Audio encoders for audio services accept various inputs such as stereo, or signals using the AES/EBU interface. Audio signals are compressed according to MPEG-2 part 1/2 or AAC+. Similar to video, output signals are generated using UDP, DVB-ASI, ETI and STI-D. Furthermore, various additional services are incorporated, such as PAD, DLS, and SLS. In addition, visual radio services may be made available by using video encoding technology but with a different video frame rate.

Data encoders for data services accept various inputs. These signals are processed with MOT (Multimedia Object Transfer)³⁰, IP tunnelling (Internet Protocol Datagram Tunneling)³¹ and TDC (Transparent Data Channel)³² technology. Output signals are generated using UDP, ETI and STI-D.

As multiplexing equipment, the ensemble multiplexer accepts various inputs such as STI, ETI and UDP via G.703³³ or G.704³⁴; the input signals are multiplexed and configured according to the required bitrates, number of channels, data capacities etc. These signals deliver STI and ETI formatted data via G.703 or G.704.

Meanwhile the CAS and monitoring system are added for controlling subscribers and monitoring services.

Implementation guidelines

Among the network architecture, head-end equipment in the MCR (master control room) is the core part of the MTV services. MTV service plans such as source encoding method, channel configuration, and bit-rate allocation are implemented with head-end equipment in the MCR. Items such as type and quality of services, programme schedules are implemented in this process.

This implies a trade-off between price, performance and function and provision for flexibility, extensions and modifications.

²⁵ SMPTE 259M

²⁶ EBU tech 3250, specification of the digital audio interface (The AES/EBU interface)

²⁷ www.ietf.org/rfc/rfc0768.txt?number=768

²⁸ ETSI ETS 300 799: "Digital Audio Broadcasting; Distribution interfaces; Ensemble Transport Interface (ETI)".

²⁹ ETSI ETS 300 797: "Digital Audio Broadcasting; Distribution interfaces; Service Transport Interface (STI)".

³⁰ ETSI EN 301 234: "Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) protocol".

³¹ ETSI ES 201 735: "Digital Audio Broadcasting (DAB); Internet Protocol (IP) Datagram Tunneling".

³² ETSI TS 101 759: "Digital Audio Broadcasting (DAB); Data Broadcasting – Transparent Data Channel (TDC)".

³³ ITU-T REC G.703

³⁴ ITU-T REC G.704

Also, a proper redundancy or back-up system, for example active-standby or passive standby (e.g. N+1 configuration), a monitoring and auto-alarming system and an effective cooling system should be taken into account.

It is also important to ensure skilled system engineers, periodical maintenance and preparation of replacement parts.

5.2.3 Network architecture: transmission

Before making the coverage plan, the frequency allotment and assignment plans have to be made. Regulators have the authority to make those plans in conformity with GE06 agreements therefore the coverage plans made by network designers have to observe the frequency allotment and assignment plans made by regulators.

Regulators allocate MTV frequencies in their country in conformity with GE06 agreements (for the details, refer to section 4.3.4 GE06 compliance of planned stations) and in accordance with the MTV service policy which includes the number of broadcasters and coverage plans for nationwide/wide area/local area.

There are many issues of interest regarding the frequency allotment plan, such as interference with co-channel or adjacent-channel services, MFN or SFN and spill over. Network designers have also to consider SFN aspects, which include guide interval, space between transmitters, static or dynamic delay (details of these issues will be treated in another chapter).

After having prepared service plans, such as service and channel formation, bit-rate allocation, and content supply and having designed the head-end system according to the service plans, finally the network plan has to be made. This includes propagation modelling for coverage planning through network topology, roll-out phases and construction of unit transmission sites (including STL).

The first step is to make a network organization map that covers the whole target service area. There are three approaches to make the map:

1. Construction of new sites;
2. Using existing sites;
3. Using existing sites plus new sites.

MTV's reception condition is very demanding and all areas have to be covered different from fixed TV services. So, new approaches are necessary to guarantee proper receiving rate. The new approach of existing sites adding to new sites is recommended.

The second step is to make roll-out phases considering technical and economic aspects.

- Firstly, a network design plan is made to cover the core areas such as metropolitan areas or big cities. The main transmitter should be placed in the targeted audiences' location such as densely populated habitations, urban centre and mobile routes for the effective site planning (use the existing site);
- Secondly, the plan has to focus on expanding the service coverage, for example the provinces or the countryside. A repeater should be placed to cover the second priority location (use the existing site), and extra repeaters may need to be added in the areas that cannot be covered from the second stage (new site to be exploited).

It is recommended that the transmitter and the repeater should be located making full use of the existing sites considering financial and geographical factors.

- Finally, shaded locations should be covered, such as group of buildings, tunnels and subways. Gap-fillers may need to be placed to get good quality reception in poor

reception areas in the local area (where the line of sight is blocked by artificial or geographical barriers) and in strategic key places (such as highways, main roads, tourist areas and shopping areas). These gap-fillers are new facilities required only for mobile broadcasting and these can easily be co-installed at the repeater or the base station sites of a mobile company and use a commercialized ICS (Interference Cancellation System) type of on-channel repeater.

The final step is to make a plan for construction of unit transmission sites which include STL (studio to transmitter link) installation. There are many activities involved in the construction of a transmission site, for example finding space for transmitters and antennas, installation of transmitter, antenna, feeder and cooling system.

For cost reduction or due to space restrictions, common-use of existing antenna system, feeder, and/or cooling system is reviewed under satisfying of technical issues. In addition, there are two methods for providing the STL; leased optical fibre link or directly operated micro wave link (fortunately, an STL for T-DMB is easily made by using the auxiliary E1 port in a micro wave link).

Figure 5.2.2 shows an example of a T-DMB basic transmission system. The STL receiver terminals receive DMB signal from a production site. The received DMB signal is divided into the main transmitter and sub transmitter. A suitable transmitter is connected to the antenna under control of the ACU(automatic change unit). The specified DMB signal is transmitted through the antenna.

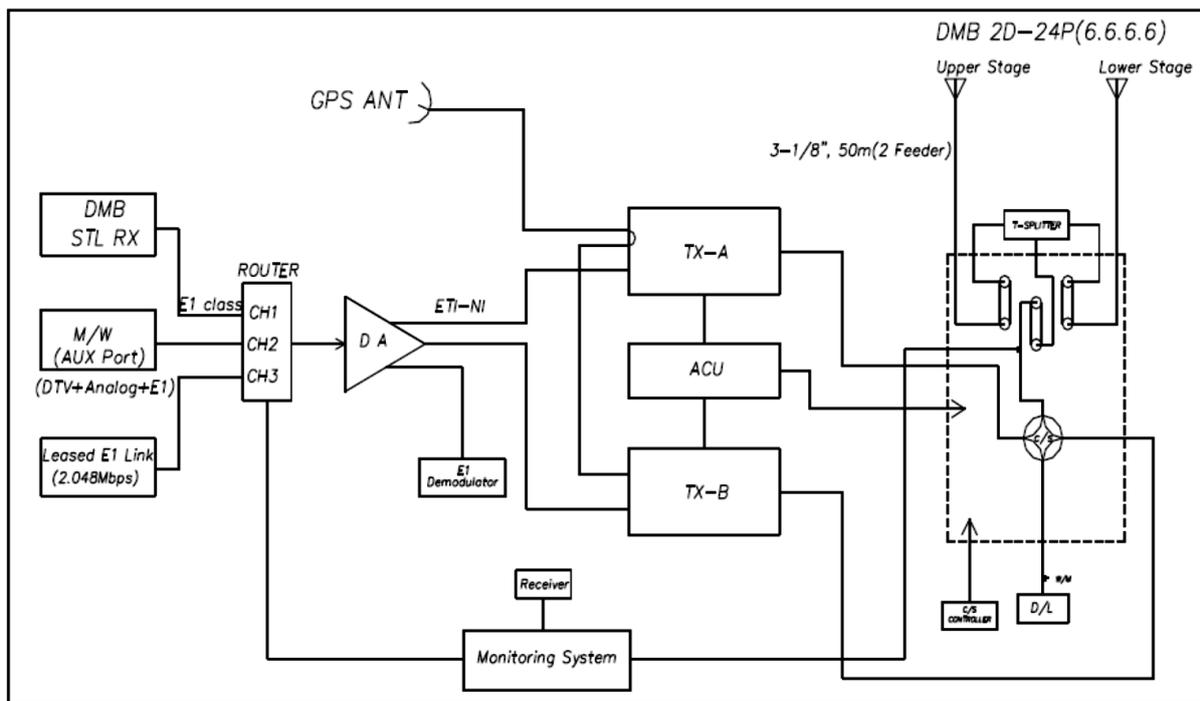


Figure 5.2.2: Example diagram of T-DMB basic transmission system

Implementation guidelines

It is recommended to make a network organization map using a simulation tool and/or with reference to existing TV/FM coverage maps. Propagation simulation tools are very useful for designing the transmission network (simulation tools need the precise geographic information and transmission specifications which might restrict use in some countries because this information is not available). The simulation result is also used to make a plan for repeater arrangements. Meanwhile, TV/FM coverage maps may be used to obtain an initial impression of MTV coverage. As a rule of

thumb, coverage of a 10 kW FM service is similar to the coverage of 2 kW T-DMB service. Figure 5.2.3 shows the result of field test.

Specifications of each service are:

FM

Frequency	97.3 MHz;
ERP	27 kW;
Antenna	CP-dipole/16-pannel, height; 629 + 48m.

T-DMB (T-DAB)

Frequency	207.008 MHz;
ERP	15.09 kW;
Transmission mode	Mode I, code-rate; 1/2, FEC; 1/2;
Antenna	Omni-directional/vertical/2-dipole/24-pannel, height; 629 + 48m.

The example comparison with FM coverage as shown above may be used as initial impression. For more detailed estimation, it is better to refer to the Appendix of 4.3 for coverage assessment (Appendix A to chapter 4.3 Planning principles, criteria and tools).

After constructing the basic transmission site, field strength tests are necessary to check whether the transmission system was properly installed and is operating normally. Furthermore, measurements can be made to assess the coverage area.

The repeater arrangement plan, made by using a simulation tool, is modified according to the field test result.

In the process of repeater arrangement and construction, it is important to consider the provision of the signal link. A exclusive link is expensive and it may be difficult to get a licence for the frequency. There is a good solution in market: the use of an on-channel repeater with ICS (Interference Cancellation System) technology. This type repeater can be used not only in medium power (1-20 W) repeaters for open areas but also low power (below 1 W) repeaters for use in-buildings and tunnels. On the other hand, a leakage coaxial (LCX) cable is good solution for long tunnels or subways.

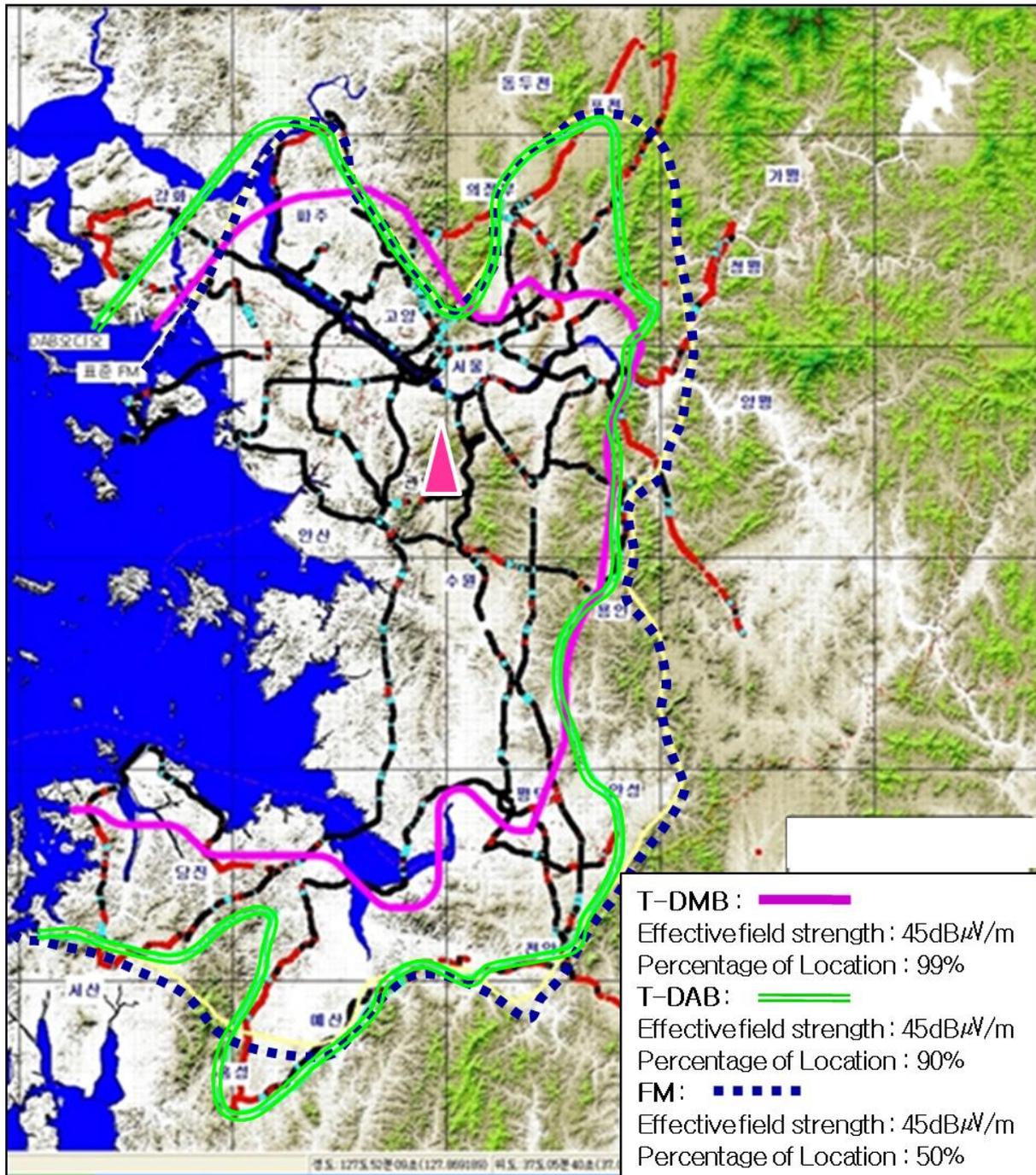


Figure 5.2.3: Result of field test of T-DMB, T-DAB and FM

Figure 5.2.4 shows the example of a diagram of a subway repeater system. A Yagi antenna outside of the subway station receives an on-air T-DMB signal from transmitter. The received signal is then amplified by an amplifier in the telecom room. The amplified signal is transmitted by using an omnidirectional antenna in the subway building and by using a leakage coaxial cable in the subway tunnel.

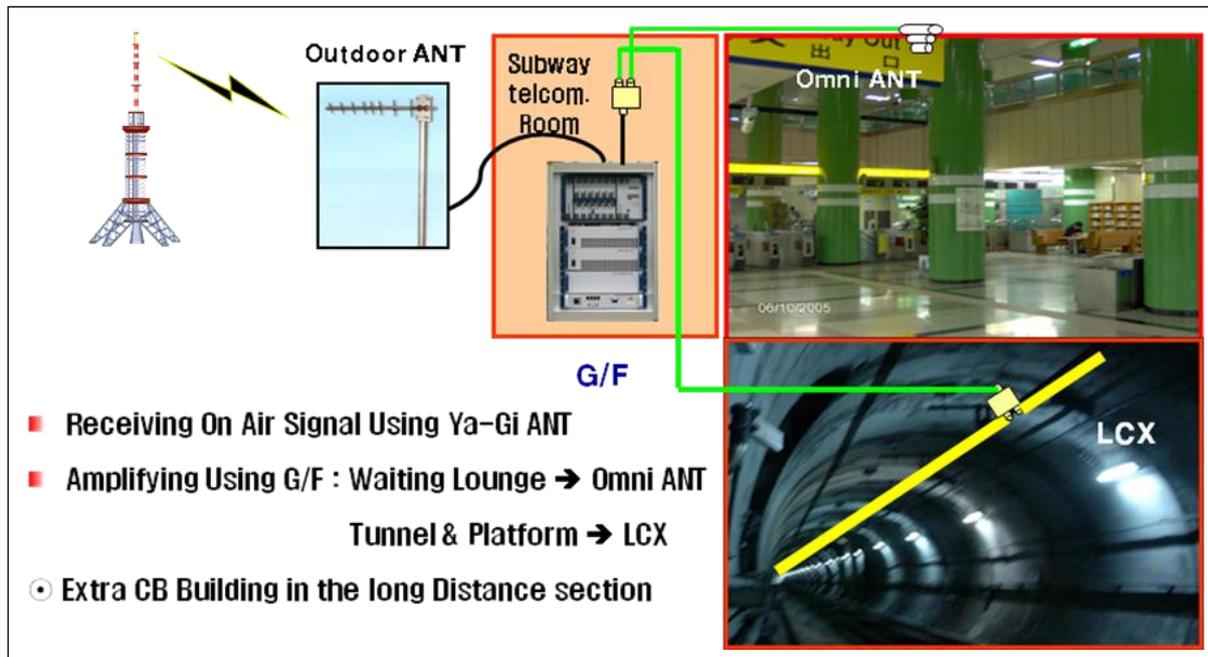


Figure 5.2.4: Example of diagram of subway repeater system

5.3 Network planning

Guidelines regarding MTV network planning have been incorporated in chapter 4.3 because of the similarity of the issues involved.

5.4 System parameters

The objective of this chapter is to select system parameters by a trade-off between coverage, multiplex bit rate and radiation characteristics, which serve as input to the network planning.

The main activities are:

- Evaluation of FFT size (DVB-H; 4K mode/8k mode, T-DMB; mode I);
- Evaluation of carrier modulation;
- Evaluation of code rate;
- Evaluation of guard interval.

System parameters are a key element in the trade-off between transmission costs, service quality and coverage quality described in section 5.2.1.

The following sections give guidelines for the key topics and choices regarding system parameters. For reasons mentioned in the previous chapter (5.1 Technology and standards application) the description and examples are based on the DVB-H and T-DMB system.

5.4.1 FFT size

As described in the previous chapter (5.2 Design principles and network architecture), 4k mode/8k mode is used as the transmission mode of DVB-H. The 4k mode enhances the inefficiency of the 2k mode in terms of network planning and eases the terminal implementation complexity of 8k mode to

suit mobile broadcasting. In some cases, the 8k mode is used to meet specific conditions such as high multiplex capacity and large SFN.

In the case of T-DMB, the discussion will be restricted to mode I which is in conformity with frequency assignment in Africa (the GE06 Agreement allotted Band III for T-DAB in Africa region) and is effective for designing SFNs.

The Fast Fourier Transform (FFT) length specifies the number of carriers:

- The number of carriers in T-DMB mode I is 1 536
- The number of carriers in DVB-H 4k mode is 3 096

In practice the FFT has an impact on

- The allowable Doppler shift decides the allowable speed of mobility of the user under a mobile reception environment;
- The length of the guard interval decides the allowable delay time of delayed signals to overcome multipath signal interference (within 264 μ s in the case of T-DMB) and the separation distance between transmitters in SFN (96 km in the case of T-DMB) (See also section 5.4.3).

The impact of the Doppler effect is shown in Figure 5.4.1 for DVB-H 4k mode and 8k mode and Figure 5.4.2 for T-DMB mode I. It should be noted that the maximum speed occurs if the vehicle is driving along radials towards or from the transmitter. In all other circumstances the maximum speed is higher.

Figure 5.4.1 shows the maximum speed of DVB-H reception due to the Doppler effect at 474 MHz for different system variants and 4k mode and 8k mode³⁵.

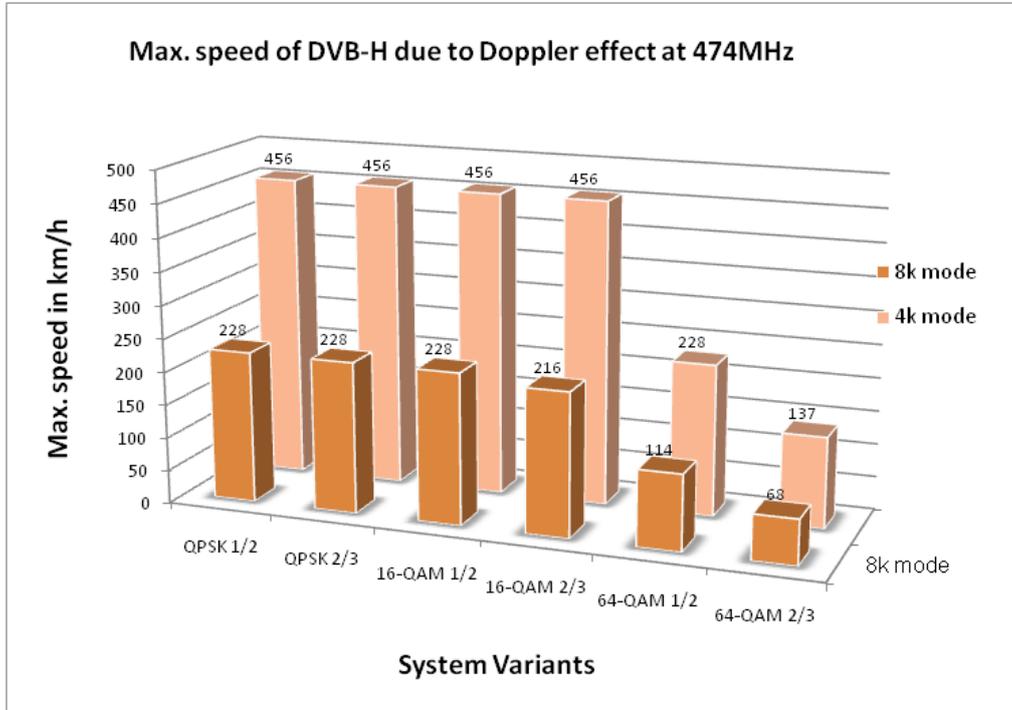


Figure 5.4.1: Maximum speed of DVB-H at each mode

³⁵

Refer to EBU – TECH 3317, Planning parameters for hand held reception, page-48.

The equation for identifying the correlation between maximum speed and frequency in T-DMB is as follows³⁶:

$$\beta = f_{\max} \times Ts = (v \times f_o / c) \times Ts = v \times Ts / \lambda \text{ (equation 5.4.1)}$$

The reference value for β is 0.08 for 4 dB degradation at approximately 10^{-3} BER in the most difficult multipath conditions (dispersive Doppler effect, constant probability density of the received power over the 2π range of reception in the horizontal plane, as opposed to a simple Doppler shift). Putting these figures into above equation 5.4.1:

$$\beta = Ts \times fo \times v / c = 0.08 = Tu \times fo \times v / c = 0.064 \text{ (equation 5.4.2)}$$

Equation 5.4.2 represents the speed versus frequency curves with the symbol duration Tu as a parameter. This is a function of the mode.

For $c = 3 \times 10^8$ m/s equation 5.4.2 we obtain:

$$Tu \times fo \times v = 0,064 \times 3 \times 10^8 = 19.2 \times 10^6 \text{ (equation 5.4.3)}$$

with: Tu = useful symbol duration in seconds; fo = frequency in Hz and v = vehicle speed in m/s.

When in equation 5.4.3, fo is expressed in MHz and v in km/h then:

$$v = 70 / (Tu \times fo) \text{ (equation 5.4.4)}$$

$$fo = 70 / (Tu \times v) \text{ (equation 5.4.5)}$$

By means of equation 5.4.4 the maximum speed can be calculated that is possible at a certain frequency. By means of equation 5.4.5 the maximum frequency can be calculated that is possible at a certain vehicle speed.

EXAMPLES: Calculation of the maximum speed v that is possible in the 4 modes I, II, III, IV for a nominal frequency fo of 200MHz, 1.5GHz, 1.5MHz and 3GHz respectively.

– Mode I: $Tu = 1 \text{ ms} = 0.001 \text{ s}$ and $fo = 200 \text{ MHz}$

From equation 5.4.4: the maximum speed is $70 / (0.001 \times 200) = 345 \text{ km/h}$

– Mode IV: $Tu = 500\text{ms} = 0.0005 \text{ s}$ and $fo = 1.5 \text{ GHz} = 1\,500 \text{ MHz}$

From equation 5.4.4: the maximum speed is $70 / (0.0005 \times 1\,500) = 593 \text{ km/h}$

– Mode II: $Tu = 250 \text{ ms} = 0.00025 \text{ s}$ and $fo = 1.5 \text{ GHz} = 1\,500 \text{ MHz}$

From equation 5.4.4: the maximum speed is $70 / (0.00025 \times 1\,500) = 186 \text{ km/h}$

– Mode III: $Tu = 125 \text{ ms} = 0.000125 \text{ s}$ and $fo = 3 \text{ GHz} = 3\,000 \text{ MHz}$

From equation 5.4.4: the maximum speed is $70 / (0.000125 \times 3\,000) = 186 \text{ km/h}$

Figure 5.4.2 shows the maximum speed of T-DMB mode I with different frequencies.

³⁶ ETSI TR 101 496-3 V1.1.2 (2001-05) DAB guidelines and rules for implementation and operation part-3 broadcasting network, page-54~59). Refer to EBU – TECH 3317, Planning parameters for hand held reception, page-48.

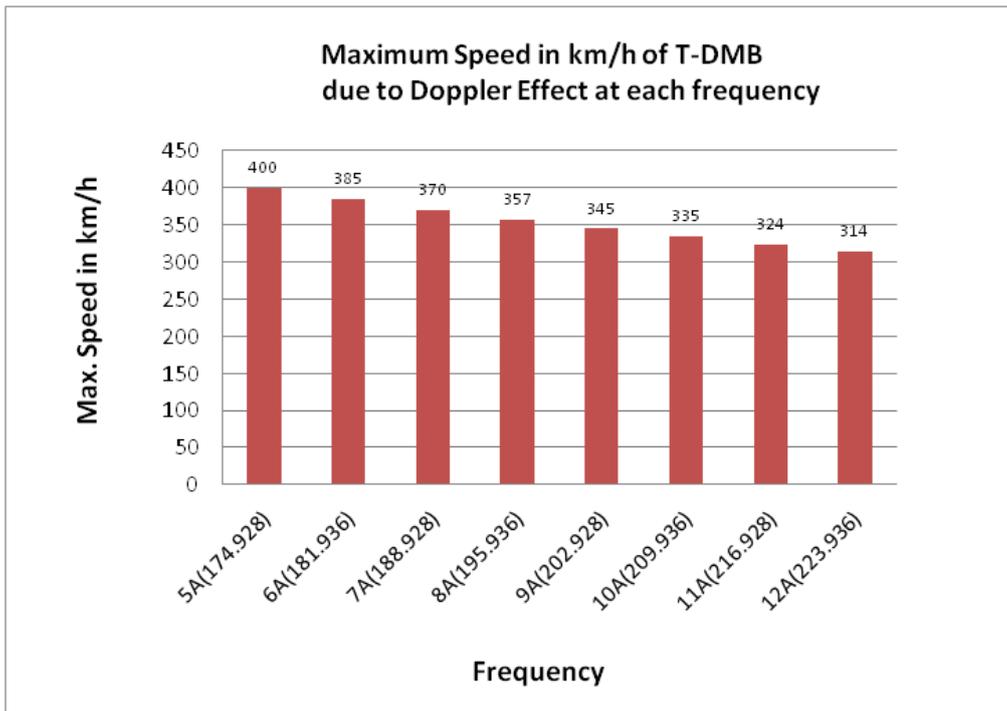


Figure 5.4.2: Maximum speed of T-DMB with different frequencies

Implementation guidelines

Mode I is used as the transmission mode of T-DMB.

4k mode and 8k mode are used as the transmission mode of DVB-H. With GI 1/4, 16-QAM, CR-2/3, and PER 10^{-4} , good reception is possible at speeds shown in Table 4.5.1.

Table 5.4.1: Maximum speed with DVB-H reception at different frequencies

Frequency	Max. speed with 4k	Max. speed with 8k
474 MHz	456 km/h	216 km/h
746 MHz	290 km/h	138 km/h

5.4.2 Carrier modulation and code rate

The DVB-H system has three types of carrier modulation:

- QPSK;
- 16-QAM;
- 64-QAM.

Meanwhile, The T-DMB system has one type of carrier modulation: QPSK.

Together with each type of carrier modulation, one of the five inner protection code rates should be chosen: 1/2, 2/3, 3/4, 5/6, 7/8.

The choice of carrier modulation and code rate is a trade-off between data capacity and carrier to noise ratio (C/N). The latter is directly related to the required field strength.

The combination of a lower order modulation and a low code rate is used when field strength requirements are very demanding e.g. in case of portable or mobile reception. The combination of a

high order modulation and a high code rate is used when a high data capacity is required e.g. in case of a high number of services. However in practice, in particular for mobile broadcasting, the highest codes rates (3/4, 5/6 and 7/8) are not much used.

The C/N values and protection ratios are specified for three kinds of transmission channels:

Table 5.4.2: Transmission channels and application

Transmission channel	Description	Application
Gaussian channel	Reception with no delayed signals and taking into account thermal noise	Reference value
Ricean channel	Reception with a dominant signal and lower level delayed signals and thermal noise	Fixed reception
Rayleigh channel	Reception with several non-dominating signal with different delay times and thermal noise	Portable and mobile reception

As demonstrated in the above table, the Rayleigh channel is applied to mobile broadcasting, with the following C/N value demanded by the Gaussian channel and the Rayleigh channel of DVB-H³⁷:

Table 5.4.3: Required C/N value of DVB-H

Modulation	Code rate	Gaussian MPE-FEC CR=3/4	Static Rayleigh MPE-FEC CR=3/4
QPSK	1/2	2.4	3.9
QPSK	2/3	4.3	6.9
16-QAM	1/2	8.3	9.7
16-QAM	2/3	10.4	12.7

Each modulation for actual mobile and hand held reception as well as C/N and available bit-rate required by code rate are as follows³⁸:

Table 5.4.4: Modulation vs. code rate / bit-rate / minimum C/N value

4K mode, GI=1/4, 8 MHz , PER=10 ⁻⁴			
Modulation	Code rate	Bit-rate(Mbps)	C/N min (dB)
QPSK	1/2	4.98	13.0
QPSK	2/3	6.64	16.0
16-QAM	1/2	9.95	18.5
16-QAM	2/3	13.27	21.5
64-QAM	1/2	14.93	23.5
64-QAM	2/3	19.91	27.0

³⁷ EBU – TECH 3317 Planning parameters for hand held reception, page-10

³⁸ ETSI TR 102377.v1.4.1(2009-04) DVB-H implementation guideline, page-35.

As demonstrated by the examples in the previous section (5.1.3 Formation of services and channels), MTV using DVB-H technology aims to provide around 20 video channels and other services, so a bit rate of approximately 10 Mbps is required. 16-QAM modulation is a reasonable choice to meet such demand.

Furthermore, in a poor reception environment, such as $\lambda/4$ -long antenna and high speed (150 km/h) of travel, 64-QAM with high C/N demand can have many restrictions in use, as it requires complexity of the receiver and enhanced output of the transmitter.

QPSK provides high-quality reception, but since the bit-rate is too marginal to offer 20 or more services, there are a lot of restrictions in designing the formation. However, if the reception environment is very poor and a relatively small number of services are planned, it can be a reasonable choice.

T-DMB, on the other hand, has low available bit-rate but the modulation and code rate are set to provide an optimal mobile broadcasting reception performance: modulation is QPSK and code rate is 1/2.

In addition, to allow a more flexible choice, the development of AT-DMB (Advanced T-DMB)³⁹ was completed; it provides high resolution, mobility, and at the same time, an improved reception performance by using hierarchical modulation and other diverse modulation methods.

Implementation guidelines

Taking diverse issues into consideration, the recommended modulation and code rate for mobile broadcasting are as follows:

- In the case of DVB-H; 16-QAM, 1/2 or 2/3;
- In the case of T-DMB; QPSK, 1/2.

In order to serve specific purposes or unique conditions, choices other than the abovementioned recommendations—and technical implementation to satisfy them—can also be made.

5.4.3 Guard interval

General description on guard interval can be found in section 4.4.3 (Guard interval). This section deals with issues of particular relevance to mobile broadcasting.

- Guard interval lengths of DVB-H at 8MHz (4k mode is used for mobile broadcasting)

Table 5.4.5: Guard interval lengths of DVB-H at 8MHz

Guard interval	Transmission mode		
	8k mode	4k mode	2k mode
1/4	224 μ s	112 μ s	56 μ s
1/8	112 μ s	56 μ s	28 μ s
1/16	56 μ s	28 μ s	14 μ s
1/32	28 μ s	14 μ s	7 μ s

³⁹ TTA.KO-07.0070(09.6.18) „Specification of the Advanced Terrestrial Digital Multimedia Broadcasting (AT-DMB) to mobile, portable, and fixed receivers.

- Guard interval lengths of T-DMB (Mode I is used due to frequency allotment of GE06)

Table 5.4.6: Guard interval lengths of T-DMB

Mode	Mode I	Mode II	Mode III	Mode IV
Guard interval length	246 μ s	62 μ s	31 μ s	123 μ s

Implementation guidelines

For mobile broadcasting, the size of the designed Single Frequency Network (SFN) has to be taken into consideration, while the longest possible guard interval length is required in order to properly respond to the interference generated through multipath propagation (refer to section 4.3.2):

- As for DVB-H, GI = 1/4 (112 μ s) is recommended;
- As for T-DMB, 246 μ s of mode I is selected as guard interval length.

5.5 Radiation characteristics

Guidelines regarding radiation characteristics of MTV networks have been incorporated in chapter 4.5 because of the similarity of the issues involved.

5.6 Network interfacing and studio facilities of additional services

The objective of this chapter is to define network interfaces and prepare studio facilities for creating additional services.

In this chapter, we will discuss the factors for the link between studio and head end system (and/or CAS) and for the interface for monitoring equipment. We will also discuss the factors for the preparation of the authoring system for additional service (Use the existing TV studio and radio studio for the production of basic video and audio).

In addition, for the Radio interface and interface with the monitoring centre, refer to section 4.6.3 (Radio interface between transmitting station and receiving installations) and section 4.6.4 (Interfaces between transmitter sites and network monitoring system).

5.6.1 Connection between studio and head end system

The number and types of sources supplied to one multiplexer is numerous. In order to consolidate and multiplex the different sources (programmes or content), factors such as signal quality, credibility and cost issues should carefully be considered.

In-house signals can be delivered easily by base-band signal format (SDI; Serial Digital Interface, SMPTE 259M, AES/EBU). However, signals from an external programme or content provider is more complex in that one has to consider factors such as signal distortion and delay. Fortunately, a large portion of this issue can be solved thanks to the digital transmission technology.

Also, because there are external link rental businesses, there is a choice of signal delivery using either optical fibre link or microwave link. MUX operators only have to consider the stages from CDR (Central Distribution Room) to MTV MCR (Master Control Room). In the case of renting an external link for signal transmission, transmitting the signal in base band format will be expensive. Thus, it will be much more competitive in terms of expense and robustness of the signal to reduce the size to the

level that the MTV service can accept or to contract the MTV service signal format beforehand (reduced to H.264 and in ETI format for T-DMB video).

Moreover, for connection among head-end equipment within MCR such as an encoder/MUX/monitoring device, it is important to pay attention to the input specification, since most equipment provides ETI/STI/UDP (user datagram protocol)/TCP (transmission control protocol).

Implementation guidelines

The following must be considered so that head-end equipment can accept various sources;

- Be flexible with head end input specification so that it can accept various types of signal format;
- In the case of a unique signal format, use an all-purpose converter so that the head end equipment can convert the unique signal to that of an acceptable format;
- Prepare a reference clock (GPS receiver) for signal synchronisation and be flexible with clock input specification (1 PPS, 10 MHz, 2.048 MHz);
- In the case where signal transmission fails due to the distance (over 500m) between the in house production facilities and head end, set an additional divider (or amplifier) mid-way or use an optical fibre link system (transmitter - optical fibre link - receiver).

5.6.2 Production facility for data services or additional services

MTV service provides diverse data services and additional services, unlike existing TV or radio services. Examples of this are TPEG service within the Data Channel, BWS service and BIFS (video channel additional service), SLS and DLS (radio channel additional service). For these special services, new systems that were not embedded in the existing facilities must be included. Also, CAS for charged services and subscription management and EWS (emergency warning system) will be required additionally.

TPEG⁴⁰

TPEG (Transportation Protocol Expert Group) is a protocol to provide traffic information for navigation devices. The service transmits various traffic and road related information to mobile users. The most typical application of TPEG service is to broadcast CTT (Congestion and Travel-Time information), CTT-SUM (CTT summary information), SDI (Safety Driving Information), POI (Point of Interesting), RTM (Road Traffic Message).

Figure 5.6.1 shows the diagram of TPEG service. The traffic information aggregator aggregates traffic information from various providers such as centre of city traffic information, road management office, vehicle accident part of police office, drivers, etc. The broadcaster encodes the provided traffic information by using an encoder and authoring tools and transmits the encoded traffic information. At the terminal, the received signal is decoded and overlaid onto the map in the terminal. Integrated traffic information is displayed on the screen with music or guide announcements.

⁴⁰ TTAS.KO-07.0034, Terrestrial Digital Multimedia Broadcasting Systems; Specification of the Traffic and Travel Information services for VHF Digital Multimedia Broadcasting (DMB) to mobile, portable and fixed receivers.

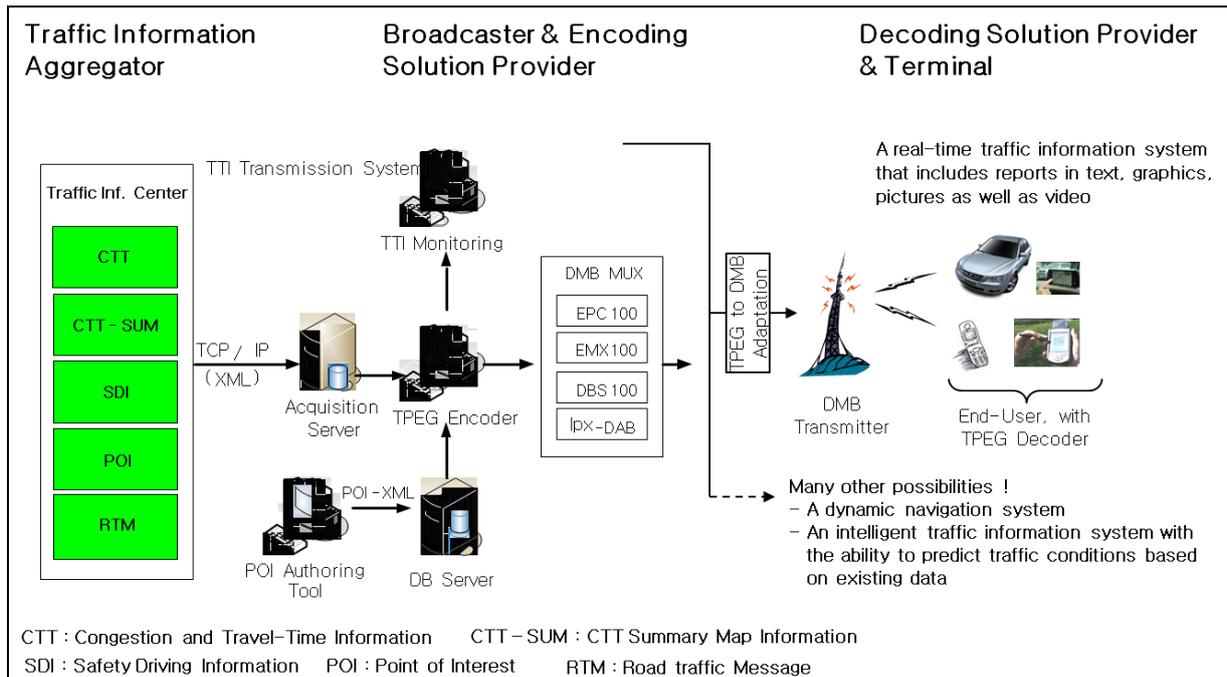


Figure 5.6.1: System diagram of TPEG service

BWS

BWS (Broadcasting Website Service) provides HTML data through independent data channels. HTML content such as weather, news, culture and art and travel information are transmitted repeatedly by the carousel concept and the receiver stores and retrieves the carousel data by local interaction.

BIFS Service

BIFS (Binary Format for Scene) service, also known as Interactive Data Service, is based on MPEG-4 technology. BIFS service uses 2D and 3D to enable users to transmit video or data simultaneously or selectively using image, text or video other than audio/video broadcasting. It also provides interactive features, enabling interactive services to user requirements.

Figure 5.6.2 shows the block diagram of BIFS system. Various source clips for example picture, graphic, text are authored to provide additional services. The authored contents are re-multiplexed with exciting audio or video programme. At the terminals, the multiplexed signals are de-multiplexed and displayed.

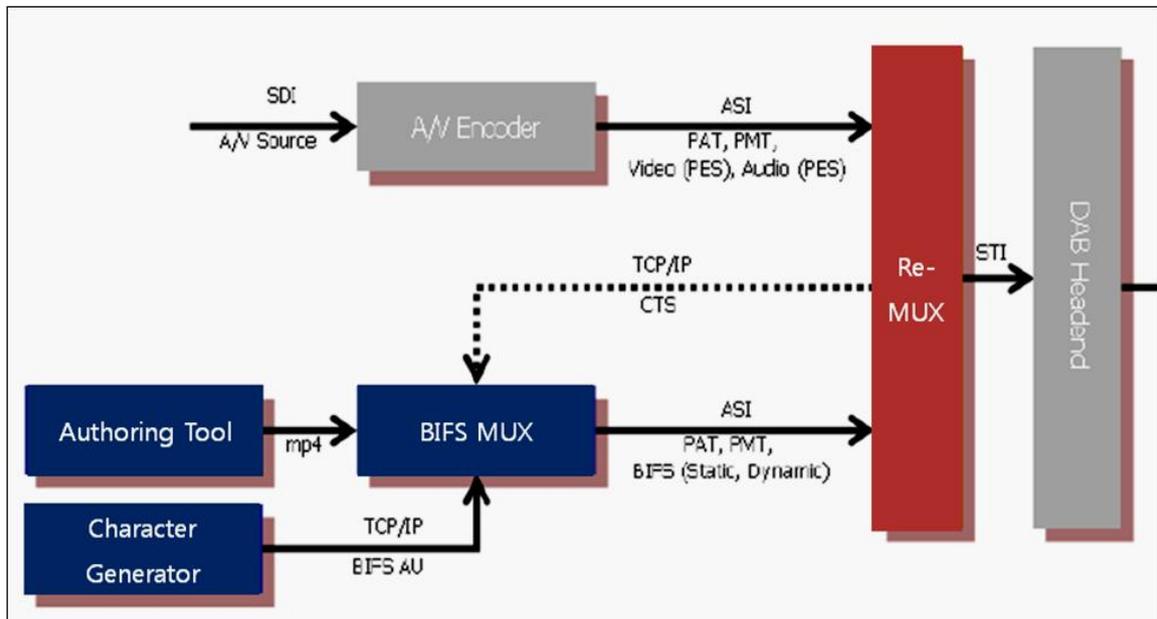


Figure 5.6.2: Block diagram of BIFS system

CAS Service

CAS (Conditional Access System) is a control system for pay service and consists of:

- Customer Management System;
- Billing System;
- Monitoring System;
- Conditional Access.

It encrypts broadcasting signals via REMUX process for T-DMB system protection. It provides blocking of access by unauthorized terminals to prevent unauthorized service use and illegal contents distribution and support effective pay services. Figure 5.6.3 shows the diagram of CAS. Section 5.1.5 (Encryption system) gives a more detailed description of the CAS.

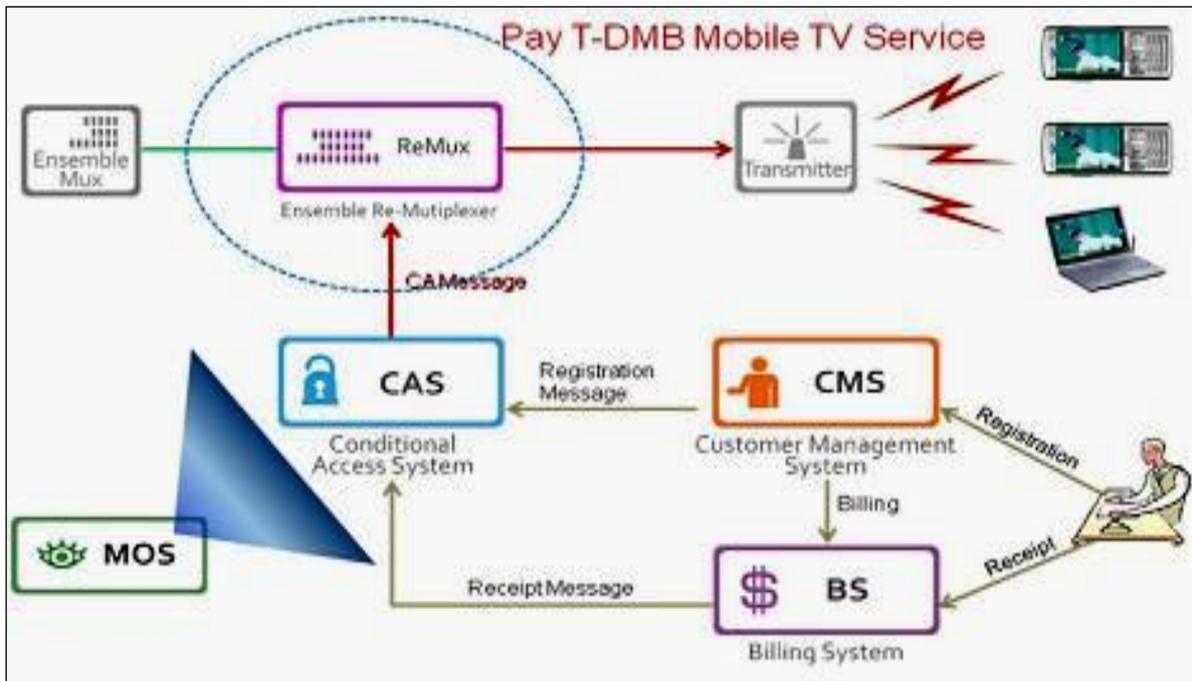


Figure 5.6.3: Diagram of CAS

Emergency Broadcasting System

T-DMB service provides a feature that broadcast information on natural calamities or disasters (typhoons, earthquakes, tsunamis or emergencies) in real time, anytime and anywhere for public safety. In other words, FIDC (Fast Information Data Channel) and EWS (Emergency Warning Systems) within T-DMB system detects a disaster and reminds terminal users of an immediate urgency or alerts users at the scene of disaster to prepare for emergency via interactive service. Figure 5.6.4 shows the diagram of the disaster warning system.

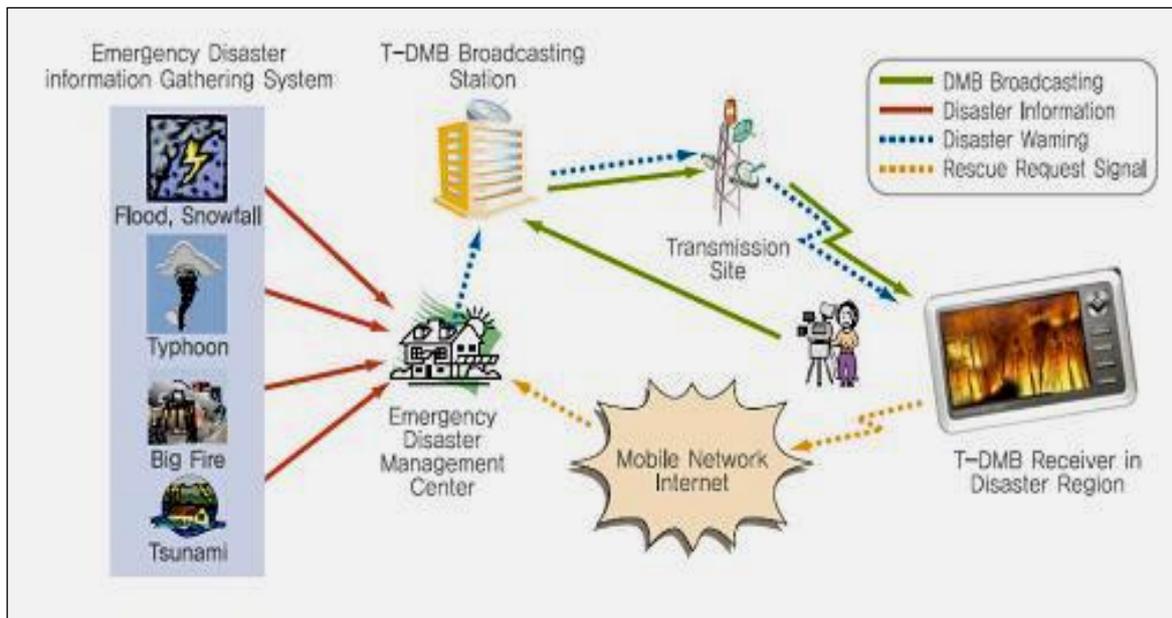


Figure 5.6.4: Diagram of disaster warning system

Implementation guidelines

A separate area and equipment are needed for additional services such as TPEG (data channel service), BWS, BIFS, SLS, and DLS. For CAS and EWS, the additional equipment should be installed in the MCR.

- TPEG; edit signals from the external traffic information centre to an appropriate signal format for MTV. Install encoding equipment in data channel centre.
- BWS; acquire an area for production/management and prepare a system to align and update information from various sources such as news centre, travel data D/B etc.
- BIFS/SLS/DLS; obtain an area for production/management and prepare a system to edit meta-data and to generate new information.
- CAS; generally, a solution for CAS is realized/maintained by a separate supplier and equipment for interfacing with existing Head-end system is embedded in MCR.
- EWS; equipment for interfacing emergency information transmitted from an external party with existing Head-end system and devices for monitoring should be added in MCR.

5.7 Shared and common design principles

Guidelines regarding shared and common design principles of DTTB and MTV networks have been incorporated in chapter 4.7, because of the similarity of the issues involved.

5.8 Transmission equipment availability

The objective of this chapter is to review and draft the transmission equipment availability to comply with network architecture, design principles, and network planning.

The main activities are;

- Drafting of equipment specifications
- Market research including price indications and delivery time
- Testing of equipment

Transmission equipment should comply with the transmission standard and system specifications defined and based on the abovementioned conditions, and accordingly, the planned services may be implemented. In addition, specifications of the transmitter, antenna, studio-to-transmitter link (STL) and other transmission equipment are to be defined and the price and delivery time of the equipment confirmed. As the next step, before installing the equipment at the transmission site, any operational abnormality of equipment is examined through a rigorous operation test.

In addition, although the issues in chapter 4.8 that are mainly relevant to DTTB, many parts of 4.8 can also be applied to MTV.

5.8.1 Transmission equipment specification

Transmission equipment consists of a transmitter, antenna, and STL. Tables 5.8.1 and 5.8.2 show the specifications of a T-DMB transmitter⁴¹ and antenna respectively.

⁴¹ An example of specifications for DVB-H transmitter can be found in www2.rohde-schwarz.com/file_8941/NHNV8300_dat_en.pdf

Transmitter specification

Table 5.8.1: Specification of transmitter

Items		Specification (examples)	Remarks
T-DMB Transmitter	frequency	VHF (170 - 250 MHz)	Check compliance with local frequency specification
	Power	Power amplifier 1000 Wrms	Check whether the power specification can cover the planned coverage area
	Input impedance	75 Ohm ETI Input impedance or High Impedance ETI Input (>10kOhm)	Check compliance with input specification and electrical property
	AC Power supply	90 V to 265 V / 60 Hz	Check compliance with local AC power supply specification
	Dimension	600*2200*1000	Need to be verified to review method and cost of delivery, space for installation, and building load
	Weight	330kg	
Sub items		Mains power buffer capacitor battery	Need to be reviewed for temporary operation in case of AC power supply disorder
		DAB Band-pass filter 6 Cavities VHF 170 MHz to 240 MHz	Check to avoid adjacent channel interference
		Operational manual	Check availability of translation into local language

Antenna specifications (including feeder)

Table 5.8.2: Specification of antenna

Items		Specification (examples)	Remarks
Antenna System	Frequency range	VHF (170 - 250 MHz)	Check compliance with frequency specification designated for the relevant transmitter
	Power rating	rated for 2.4 kW (average power) per input	Check acceptability of the planned output power taking potential increase of output into account
	Impedance	50ohm	Check consistency with transmitter output impedance
	connector	Single 7/8" EIA Input	Check compliance with feeder specification

Items		Specification (examples)	Remarks
	VSWR	≤1.05 in the operating channels	Review possible reduction of transmission efficiency due to reflection wave
	polarization	Horizontal / Vertical	Vertical polarization is favoured over horizontal polarization under mobile transmission environment
	Lightning Protection	All Metal Parts DC Grounded	Avoid lightning accidents
	Gain	8dB	Means of increasing ERP
	Wind Load	1.36kN (150km/h)	Need to be verified to review method and cost of delivery, space for installation, and building and tower load
	Dimension	1300*1300*660	
	Weight	38kg	
Coaxial Feeder and Accessories		Cell flex feeder cable including drum	
		7/8" EIA Connector	
		7/8" EIA Coupling Element	
		Earthing kit	
		Hoisting Stocking	
		Cable clamp / RSB clip	

STL

Factors to consider and the robustness of the STL (studio-to-transmitter link) depend on where the multiplexer and transmitter is installed. Here, transfer quality guarantee, measure to minimize delays in transfer and emergency plan to counteract sudden loss or quality degradation of signals are the key considerations.

Two types of can be distinguished:

- Leased optical link: Signal is transmitted through a link leased by network operator. Factors including guarantee of signal credibility, distance between transmission site and operator terminal, smooth interfacing with broadcast equipment, and detour path or countermeasure in emergency situation are to be reviewed;
- Self-operated microwave link: Link is operated directly by broadcasters. Factors including availability of a frequency suitable for the distance between studio and transmission site, and availability of LOS (line of sight) need to be reviewed.

Implementation guidelines

Besides the abovementioned specifications, review the following factors based on the use of existing infrastructure, cost-efficiency, and availability of manpower.

Transmitter: Cooling system, air chamber, remote-control, generator, UPS (uninterruptible power supply system)

Antenna: Consider different types of antenna or combination with other media depending on availability of space for tower installation

STL: Review possibility of multiplexing with links operated by other service providers, network operators, or platforms

5.8.2 Market research of transmission equipment

Price, delivery schedule, installation support, operational training, follow-up maintenance service, and accessibility to spare parts are key considerations when introducing transmission equipment. In addition, it is essential to verify whether the equipment is in conformity with the aforementioned specifications and the broadcasting site condition, such as air cooled/water cooled type, size, weight, etc. Performance, operational ease, and reliability of the manufacturer are other criteria to be taken into consideration. While performance will be examined in the next step through a test process, operational ease needs to be identified through comparison and analysis of availability of manpower, distance between the transmission site and broadcasting station, and other conditions of the broadcaster and features of the transmission equipment.

Transmitter

- Price: Reasonable price for the transmitter can be simply selected by comparing prices offered by different manufacturers; check whether cost for delivery, customs, installation, training, and spare parts are included in the price;
- Delivery time and method: Make sure in-time delivery to the broadcaster is guaranteed, and if equipment manufacturer is a foreign company, check where and how the delivery will be made;
- Installation support and operation training: Check scope of support for installation and operational training provided by the manufacturer;
- Follow-up service and availability of spare parts: Check follow-up service measures, e.g. repair and maintenance and supply method and warranty period of spare parts for emergency use.

Antenna

- Consider the same factors as the transmitter in terms of price, delivery schedule, support measures, and follow-up service;
- As electrical properties of antennas are affected by mechanical damage, delivery method and other measures for stable supply are of key consideration;
- Since installation of transmission equipment require expertise, availability of support from an installation expert or instruction for proper installation process and method need to be ensured.

Implementation guidelines

Manufacturers of transmission equipment provide a wide range of products with different prices and diverse features, such as equipment type, delivery time, and scope of support. Detailed and in-depth negotiations with the manufacturers need to be based on technical, environmental, and political conditions relevant to the broadcaster.

There are a multiple number of transmission equipment manufacturers as listed below; not only global companies but domestic companies can be considered for certain services. For installation of transmission equipment, domestic companies might be considered, as installation per se does not necessarily require technical expertise related to mobile broadcasting. Ability to comply with requirements from the equipment manufacturer and faithfully fulfil supervisory activities of broadcasting engineers is key criteria when selecting the company.

Selection of equipment manufacturers can be guided by:

- Transmitter manufacturers: global manufacturers⁴²
- Antenna manufacturers: global manufacturers⁴³
- Installation companies: Domestic companies

5.8.3 Testing of transmission equipment

Several tests need to be conducted to examine the mechanical and electrical properties of major transmission equipment, such as transmitter and antenna. Criteria for the test include: credibility and stability regarding mechanical properties and diverse tests regarding electrical properties. Refer to the Appendix 5.8 A: Testing of transmission equipment in detail; items in this appendix are based on T-DMB standard.

Implementation guidelines

A thorough review of the specifications provided by the manufacturer is as important as the price in the selection of transmission equipment for purchase. Most of the characteristics regarding the equipment are described in the specification; the most important item to check is whether these characteristics comply with the specification described in the above section (5.8.1) as well as the requirements from the broadcaster.

This examination process will verify the characteristics provided in the specifications. The verification will allow broadcasters to make any further requests deemed necessary for the manufacturer to meet these conditions or to demand customization to achieve desired characteristic.

In addition, as the laboratory test result can differ from the post-installation outcome, it is essential to extensively check whether it complies with the specifications after installation.

However, even with thorough examination for excellent performance and installation, unless the manufacturer's requirements (for example; ambient temperature, proper supply voltage, and rated output maintenance) are met, the equipment will fail to operate normally or maintain its ratings. It is therefore of absolute importance to meet the specifications for ambient environment while the equipment is in operation.

Appendix 5.8A Testing of transmission equipment in details

Transmitter

- **Mechanical properties** (credibility and stability)
 - Temperature test: Test operate at -20°C and +50°C for four hours respectively and check changes of properties, including output, frequency, out-of-band emission, spurious emission, harmonics, and frequency response.
 - DC voltage regulation: Measure no-load and loaded output voltage of power supply using DC voltage meter to check whether output voltage is within rated range (±5 per cent) based on the following formula:

$$\text{Voltage regulation (\%)} = \frac{V_o - V}{V} \times 100 (\%)$$

V_o : No-load P/S voltage, V : Rated power supply output voltage.

⁴² R&S, Harris, itelco, Thomson, Plisch, etc. / www.dvb-h.org/products.htm

⁴³ RFS, ADC, high-gain, R&S, etc.

- RIPPLE content: Use an oscilloscope to measure DC voltage and AC voltage included in DC voltage on the side of power supply output, and check whether the value calculated based on the following formula is within rated range ($\pm 3\%$)
$$\text{RIPPLE content} = V_{pp} / V_d \times 100 (\%)$$
$$V_{pp}: \text{AC voltage (p-p)}, V_d: \text{DC voltage.}$$
- Heat generation test at continuous operation: After operating the transmitter for eight consecutive hours, measure the temperature of designated spots using surface thermometer. The outcome value of the below formula has to be 50°C or below:
$$\text{Degree} = \text{Measured temperature } (^\circ\text{C}) - \text{ambient temperature } (^\circ\text{C})$$
Measurement point: Internal temperature of transmitter, cooled exhaust temperature, power amp heat sink, exciter, heat sink at power supply, power transformer temperature, mask filter temperature, combiner, out cable.
- Stability of transmission output: While operating for four consecutive hours or longer, check whether the change in output power is within rated range of $\pm 0.5\text{dB}$ every hour. Check the same for changes in frequency.
- Stability of intermittent operation: Repeat switching on/off every 0.3 second (0.1 second for switching off, 0.2 second for switching on) for five times or more using power intermittence tester or by manually operating AC input power switch to check changes in output and any abnormal operation of the transmitter.
- Stability of changes in supply voltage: Using voltage adjuster, adjust rated voltage of AC input supply voltage by $\pm 10\%$ to check whether change in DC voltage is within rated range ($\pm 3\%$), and measure operational abnormality of the transmitter, oscillation frequency, and changes in output.
$$\text{Voltage regulation } (\%) = (V_o - V) / V \times 100(\%)$$
$$V_o: \text{DC voltage at higher/lower limit supply voltage,}$$
$$V: \text{DC voltage at rated supply voltage}$$
- Efficiency: Measure the current, voltage, and AC input current to check whether the efficiency is higher than rated value (70%)
$$\text{Efficiency} = \text{Output voltage (V)} \times \text{output current (A)} / \text{input power (W)} \times 100 (\%)$$
- Harmonics content: Measure harmonics content of voltage output using harmonic wave meter. The generated harmonic back current has to be 5 per cent or below (including distortion of test power supply).
- Insulation resistance: Insulation resistance measured using DC 500V Megger among the input, output, and the case has to be $5 \text{ M}\Omega$ or higher.
- Internal pressure test: When imposing AC 1.5 kV (10 mA) for one minute on the input, output, and the case respectively, internal pressure tester should not display short-circuit or be short-circuited.
- **Electrical property**
 - Measure transmitter output (use Power Meter with 5 per cent or higher accuracy): Read process value displayed by the power meter at output port to check whether output is within $\pm 0.5 \text{ dB}$ of rating.
When using analogue power meter, output has to be within 12 per cent (higher limit) to -11 per cent (lower limit) range. $[10 \log (P1/P0) = \pm 0.5\text{dB}]$
 - Measuring out-of-band spectrum of an emission (FCC MASK)
 - $\pm 0.77\text{MHz}$ offset from centre frequency: $-26\text{dB}@4\text{KHz RBW}$
 - $\pm 0.97\text{MHz}$ offset from centre frequency: $-71\text{dB}@4\text{KHz RBW}$
 - $\pm 1.75\text{MHz}$ offset from centre frequency: $-106\text{dB}@4\text{KHz RBW}$

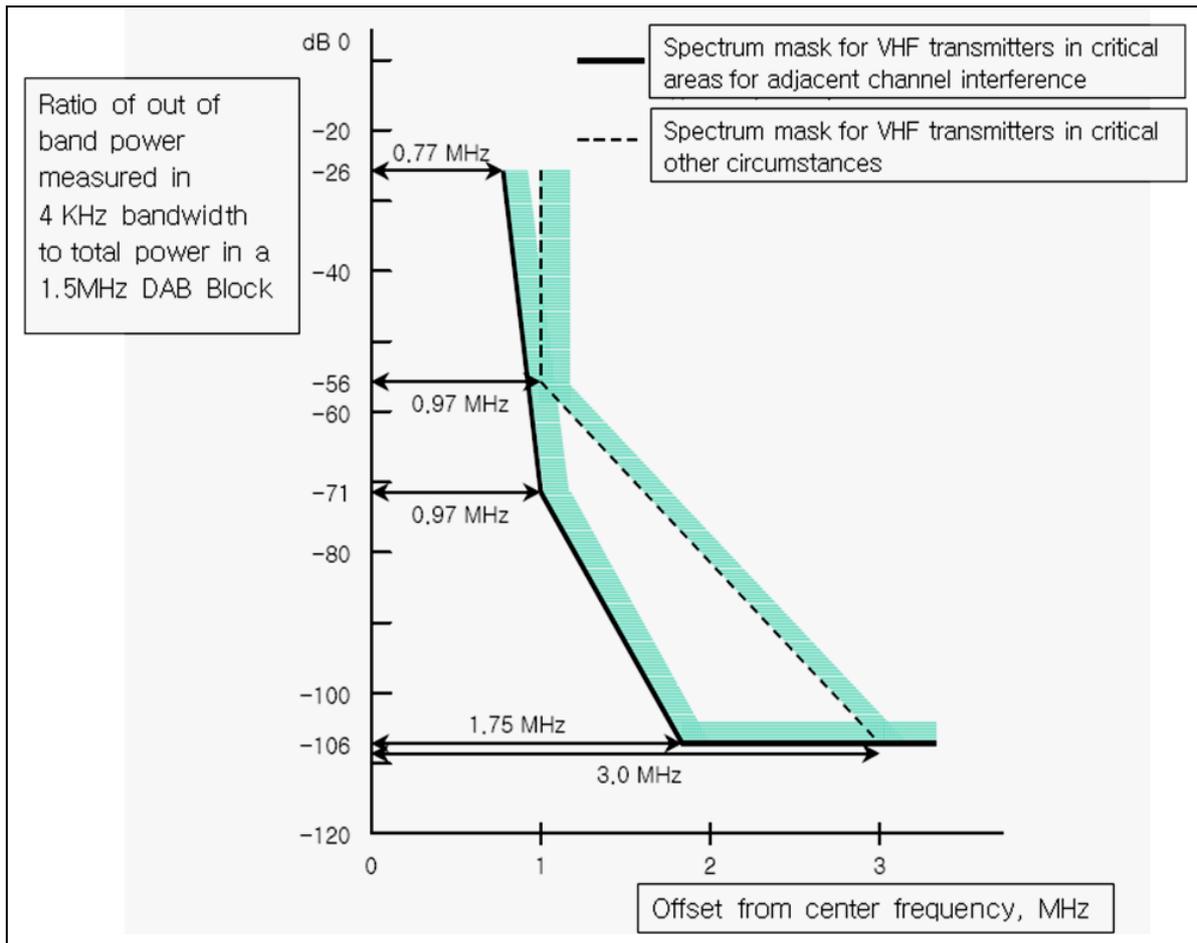


Figure 5.8A.1: Diagram of spectrum mask

- Measure spurious and harmonics: Check whether the value is 70dBc or $46+10\log(PY)$. (*PY = average power of carrier wave).
- Frequency response (in-band ripple): Using spectrum analyser, check whether changes in in-band amplitude meet ± 1 dB range of transmission bandwidth (RBW 30 KHz).
- Group delay property: Switch network analyser format to DELAY and set scale to AUTO to check whether in-band group delay is within $\pm 2.5\mu s$ range.
- Frequency tolerance: Using frequency counter, measure frequency of output signal ($f_0 +$ set up single frequency) to verify whether frequency is within ± 10 Hz range from centre frequency.
- Frequency bandwidth: Using spectrum analyser, measure occupied bandwidth to check whether the value equals 1.536 MHz.
- Effective-transfer rate: Measure transfer rate using DMB analyser to check whether the rate is between 0.8 Mbps and 1.7Mbps range.
- Service signal format: Measure transfer cycle using DMB analyser to check whether programme association table (PAT) is within 500ms, programme map table (PMT) within 500ms, programme clock reference (PCR) within 100ms, object clock reference (OCR) within 700ms, and composition time stamp (CTS) within 700 ms.

Using DMB analyser, measure video signal to check the following:

In the syntax for picture parameter sets:

The value of "num_slice_groups_minus1" is "0",
the value of "redundant_pic_cnt_present_flag" is "0"

In the syntax for sequence parameter sets:

The value of "pic_order_cnt_type" is "2",
the value of "num_ref_frames" is "3"

Using DMB analyser, measure audio signal to check the following:

epConfig for AudioSpecificConfig(): 0

frameLengthFlag for GASpecificConfig(): 0, DependOnCoreCoder: 0

sba_mode for bsac_header(): 0

ltp_data_present for general_header(): 0

Check slide show, BWS, TPEG reception using DMB analyser;

Check any occurrence of BER, video frame error, audio frame error, and FIFS error using DMB analyser.

- Input VSWR (voltage standing wave ratio): Measure return loss within frequency band of transmitter, convert measured value into VSWR, and check whether it is within 1.2

VSWR 1.2 = Return Loss 20.8dB;

- Input mode operation test: By altering the setting of ETI signal generator to NI (G.703) and NA (G.704), check whether it is automatically recognized without interruption, and using the DMB analyser, check errors in different factors

- Transmitter input sensitivity test: Input ETI signal generator output by attenuating and distorting as described below into the transmitter:

Amplitude: 2.37V±10% threshold;

Jitter: 1.5UI@20Hz to 100kHz, 0.2UI@18kHz to 100kHz;

Overshoot: 237mV ± 20% threshold;

Pulse width: Lower limit 194ns, upper limit 269ns threshold.

During the test, check normal recognition of inputs by transmitter and check normal operation of different factors using DMB analyser.

- Peak power vs. PAPR (peak to average power ratio): Measure PAPR against peak power using power meter to ensure peak power level does not exceed 13dB of average power level.

Antenna

- **Mechanical property**

- Temperature test: Apply temperature test prescription mandated in the specification with priority. If there is no special instruction, check for cracks, deformation, and other abnormalities after 30 minutes at -20°C and +45°C respectively.

- Internal pressure and insulation resistance test: It has to be 1000 MΩ or higher when measured with DC 1000V Megger Tester.

- Allowable wind pressure test: This test is to be conducted for every possible direction, including the front and the side. Actual wind pressure given in the specification has to be applied for the allowable wind pressure test, but if such application is impossible, convert wind speed into wind pressure load, and conduct the test as described below:

Wind pressure load (kg) $P = C \times A \times Q$

A: Area of antenna (m^2) = Width (W) × Height (H)

Q: Wind pressure coefficient (round type: 0.7, panel: 1.2)

G: Air density - kg m/s (0.1293)

V: Wind speed (m/sec)

C: $1/2 * GV^2 =$ Velocity pressure (kg), wind pressure coefficient applied to $1m^2$ (kg/1m²)

Equally apply the same load as the calculated wind pressure load on the antenna to check any abnormality.

- Air leak test: Conduct air leak test in order to prevent penetration into RF feeder of the antenna and antenna system; before assembling the antenna panel and after installing the system, inject 3.2 kg/cm² air into RF input port, submerge connected and welded parts into water to check on bubbles and air leakage for three minutes.

- **Electrical property**

- VSWR (Voltage Standing Wave Ratio): Install the antenna to be measured at 3λ (wavelength) height above the ground or higher, calibrate the network analyser within the frequency range that includes the operating frequency band of the antenna, and measure the VSWR of the antenna to verify whether the measured value fits within the specification.

- Radiated gain: Measure electric field strength of the standard antenna and the measured antenna to calculate the relative gain according to the following formula:

Absolute gain = Relative gain + 2.15 (dBi)

Relative gain = Field strength of the measured antenna – field strength of loss-free $\lambda/2$ dipole

2.15 (dBi) is the gain of isotropic antenna of half wave dipole

Field strength of isotropic antenna: $E_1 = \frac{\sqrt{30 P_T}}{R(\text{km})}$ (mV/m)

Field strength of $\lambda/2$ dipole antenna: $E = \frac{7\sqrt{P_T}}{R(\text{km})}$ (mV/m)

Regarding loss-free $\lambda/2$ dipole antenna: Absolute gain = field strength of $\lambda/2$ dipole antenna / field strength of isotropic antenna = 2.15dBi

Radiated gain: $G_a(\text{dB}) = A_a - A_0 + G_0$

A_a : Field strength (dB) of measured antenna

A_0 : Field strength (dB) of standard antenna

G_0 : Radiated gain (dB) of standard antenna

or radiated gain: $G_a(\text{dB}) = 20 * \log (E_a / E_0) + G_0$

E_a : Received voltage (μV) of measured antenna

E_0 : Received voltage (μV) of standard antenna

G_0 : Radiated gain (dB) of standard antenna

- Measuring radiation front to back ratio of antenna: Orient the measured antenna to source antenna (0°) and adjust the source antenna up, down, left, right to maximize field strength. Turn the direction of measured antenna 180° , record the field strength, and calculate with the following formula:

Front to back ratio = Field strength of 0° direction – field strength of 180° direction

Front to back ratio FBR (dB) = $A_F(\text{dB}) - A_R(\text{dB})$

$A_F(\text{dB})$: Field strength at the main radiation direction (0°) of the antenna

$A_R(\text{dB})$: Field strength at the opposite radiation direction (180°) of the antenna

or $FBR(\text{dB}) = 20 * \log (E_F / E_R)$

EF (dB): Received voltage (μV) at the main radiation direction (0°) of the antenna

ER (dB): Received voltage (μV) at the opposite radiation direction (180°) of the antenna

- Attenuation of branch cable: Calibrate the network analyser without the cable for the to-be-measured antenna, then detach measurement cable and connect the former between the two ports to read the attenuation displayed in the network analyser.
- Insertion loss of power divider: Measure insertion loss to check whether the value by direction is within the allowed range:

$$\text{Insertion loss} = 10 \log \frac{1}{n} \text{ (dB)} \quad n: \text{ distribution pole}$$

Distribution tolerance has to be within the below described ranges:

Within 0.5 dB for UHF range

Within 0.2 dB for VHF range

5.9 Network rollout and planning

The objective of this chapter is to provide comprehensive master plan and implementation schedule for the MTV services through the activities described below:

- Construction of Pilot transmission system
- Evaluation of service quality from field test
- Research of consumer demand from audience survey

This chapter will focus on designing a pilot system and developing a service roll-out plan, which will be based on factors considered for the diverse conditions and situations mentioned above.

In this process, a pilot system will be installed and the technical feasibility and required complementary measures will be derived by conducting a field test and analysis. In addition, a plan for a nationwide service, measures to improve reception, and other technical initiatives will be defined.

At the same time, with technological analysis and planning, it is necessary to conduct a survey on audiences' response to identify the demand for services or viewing pattern.

Based on collective consideration of data acquired through the abovementioned process and funding, contents development, and manpower planning, the final version of the service roll-out plan can be confirmed, which will enable the launch of diverse and comprehensive promotion activities.

In addition, although the issues in chapter 4.9 that are mainly relevant to DTTB, many parts of 4.9 can be applied to MTV.

5.9.1 Pilot system construction

The objective of constructing a pilot system is to test diverse functionalities through a pilot operation and acquire data that will serve as the foundation for future planning. To achieve this goal, a highly flexible transmission system, an infrastructure for the transmitting station, prevention of crosstalk with other channels, and other technical preparations need to be completed along with assembling a skilled workforce, funding expenses for operation, solving licence-related issues (frequency/output), and other general preparatory measures.

The scale of the pilot system will differ depending on the purpose pursued by the broadcaster but, generally, it can be categorized into three different levels of scale: maximum, medium, and minimum.

- Maximum scale: Complete system with simple production, transfer, and transmission parts (a pilot service system that can be converted to commercial use immediately after resolving contents- and licence-related issues);
- Medium scale: Consists of the transfer and transmission parts (a system that enables tests on channel composition and transmission properties);
- Minimum scale: Consists of the signal generator and transmission part (only allows transmission property test).

Example cases and projected approximate cost are presented in the Figure 5.9.1, 5.9.2, and 5.9.3 (based on Korea's T-DMB):

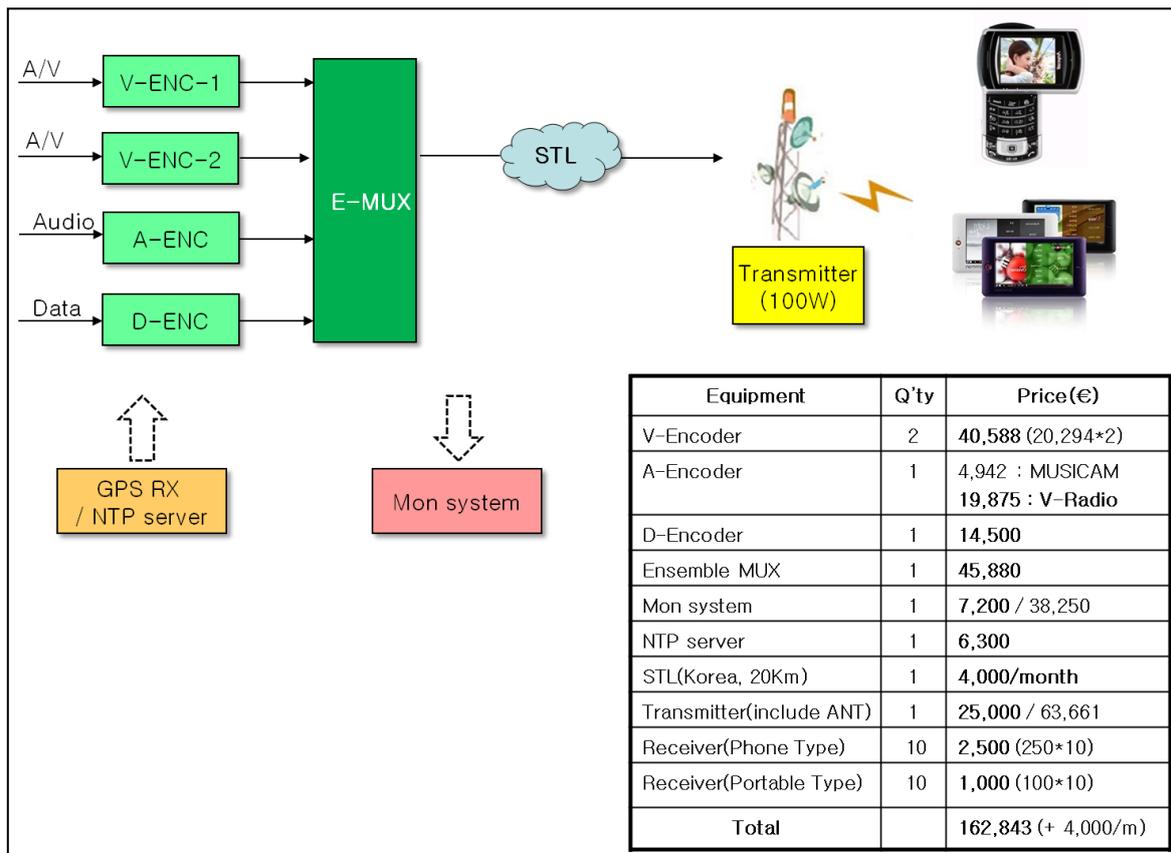


Figure 5.9.1: Diagram of maximum scale pilot system

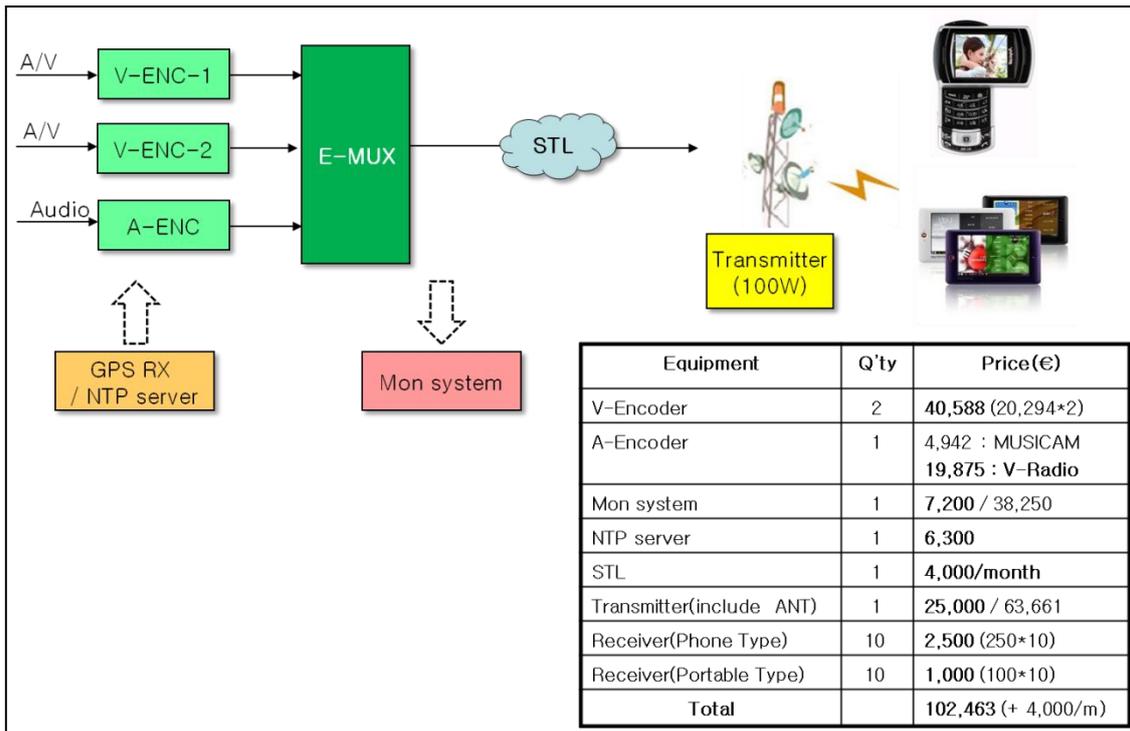


Figure 5.9.2: Diagram of medium scale pilot system

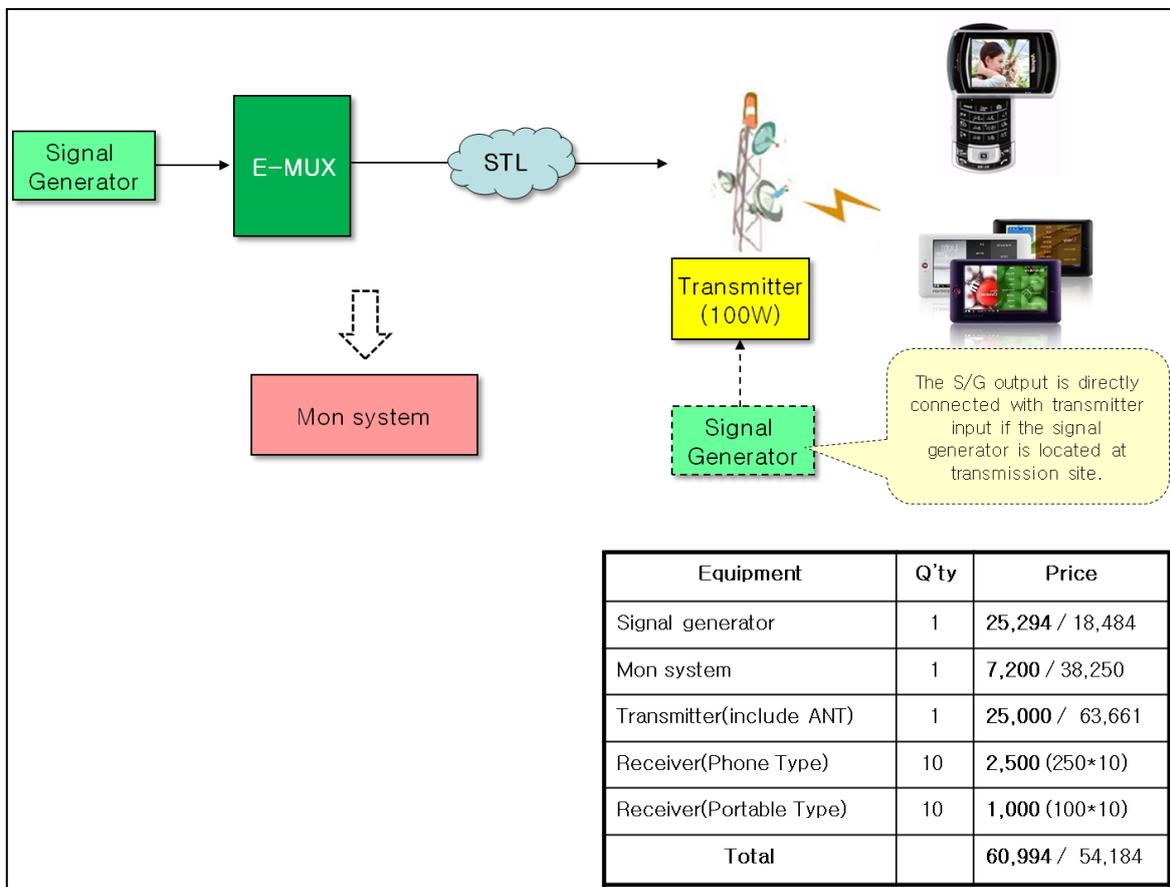


Figure 5.9.3: Diagram of minimum scale pilot system

Implementation guidelines

In obtaining the licence for a pilot system operation, it is important to secure some flexibility in the specifications. If the output is licensed with flexibility, it is a useful means to verify coverage projection and to check interference with other media using adjacent frequencies. It also allows broadcasters and the audience to familiarize themselves with the system during the pilot service period and adjust to the commercial service without major difficulties.

Selecting the site to install the transmission equipment for the pilot system is another important factor to consider. Factors, such as: restrictions in utilizing the site infrastructure, distance from the broadcasting station and the range of expected coverage, need to be reviewed prior to choosing the site.

Furthermore, it is recommended to install the MTV head-end system within the broadcasting station for convenient content distribution, tests of diverse items, altering channel composition, changing default values of each channel's configuration and ease of equipment operation and maintenance.

It is also critical to nurture mobile broadcasting experts during the pilot service period. While terrestrial broadcasters have a number of experts in the existing services of TV and radio, mobile broadcasting is a brand new area with little prior experience. Not only are all the adopted technologies digital, but a new concept of multiplexing is introduced. To respond to such needs, it is essential to secure expertise in the new fields through basic training on theory as well as proactive participation of field engineers in the pilot broadcasting.

In addition, broadcasters need to take into account that establishing and operating the pilot system will generate certain costs. Funding the implementation of new equipment won't be a critical issue as they can be used later for commercial services but, as for efficient cost management for links, operation, and labour, it is essential to have a detailed plan and systematic preparation in order to acquire as much knowledge and information as possible during the pilot period.

5.9.2 Field test and analysis

Once the pilot system is established, diverse trials will be conducted through the actual use of the system. Beyond testing the basic functionality of receiving broadcasts while on the move, the technological basis for commercialization has to be built-up through collecting, analysing, and organizing to enable the use of this diverse technical data. Previous chapters presented the theoretical or empirical explanations for service quality changes according to changes in diverse parameters. The verification of such projection and changes, as well as whether they meet the requirements of the broadcaster, can be conducted through a rigorous field test, which requires strenuous effort and extensive expertise. ETI analyser and RF measurement systems are useful tools available in the market for conducting field tests and analysis to assist broadcasters in these diverse trials.

Field test and analysis process

1. Set basic transmission parameters: Refer to previous chapters to set transfer parameters (code-rate, Guide Interval, MPE-FEC) and reception parameters (reception mode, transmission, antenna pattern);
2. Conduct field measurement: Use ETI analyser, RF measurement system and spectrum analyser to measure field strength, bit error-rate, and C/N ratio while on the move;
3. Make approximate checks to assess whether the field measurements meet the desired outcome;
4. Categorize and consolidate data: Consolidate measurement data for each measuring tool in database files;

5. Process and analyse data: Properly mark consolidated data and document whether the requirements were met;
6. Change parameters: If parameters set in step 1 do not meet the requirements or, if another verification process for potential quality improvement is needed, set up new parameters;
7. Repeat steps: With the received signal using the newly set parameters, repeat steps 2 to 5.

Implementation guidelines

The conventional RF measurement system used for analogue or digital TV is a system to measure transmission in a fixed reception environment therefore, to a certain extent, it is different from the RF measurement system for mobile broadcasting. Thus, a new system to measure and analyse transmission status in the mobile environment has been developed; a brief description and field measurement case examples are provided in Appendix 5.9.A: measurement system for MTV and field measurement case examples.

5.9.3 Audience research and analysis

The aim of building a pilot system and conducting a trial broadcasting is divided into two main areas; technical preparation and identifying the needs of the audience. Subsequent to previous sections that provide comprehensive descriptions of the technical preparation process, this section will focus on the process of identifying the needs of the audience.

Research of audience needs can be divided into the following technical and service aspects.

- Research of audience needs from the technical aspect:
 - Reception coverage requirements: width, depth, specific region;
 - Quality: Resolution, audio quality;
 - Terminal requirements: Type, function, size, price;
 - Terminal performance: Reception sensitivity (transmission output), screen size, screen brightness, UI (user interface), battery life.
- Research of audience needs from the service aspects:
 - Demographic information: Gender, age, education, occupation, income level, use of other media, telecommunication fee, broadcast subscription fee;
 - Level of awareness: Recognition, intention to use, free/charged service, willingness to pay, satisfaction level, necessities, reason for use;
 - Desired number of channels: Number of video, audio, and data channels;
 - Genre preference: Soap opera, news, entertainment, sports, documentary, education, art, culture, history, fashion;
 - Viewing pattern: When and where, how long and how often.

To obtain accurate statistics, it is essential to have the largest possible sample size and to collect data from diverse segments. Analysing and consolidating data gathered through these research activities will serve as a foundation for developing plans for technical preparation and service roll-out.

The following are recommendations on how to consolidate and utilize data:

- Reception coverage requirements: Decide and Prioritize issues for output and network design;
- Quality: Decide on bit-rate allocation and receiver screen size;
- Terminal requirements: Establish service strategies by type of use (for use in cars, mobile phones, high-end and low-end services);

- Terminal performance requirements: Set up strategies for programming and content configuration;
- Demographic information: Identify target customer;
- Awareness: Establish promotion strategy and estimate subscription fee;
- Desired number of channels: Develop strategies for channel configuration;
- Genre preference: Establish programming strategy and content distribution plan;
- Viewing pattern: Identify target service and establish programming strategy.

5.9.4 Developing the Master Plan

The details of the master plan can be divided generally into content, infrastructure, and operation, each of which requires significant amount of time and effort to be developed. The master plan can differ substantially depending on government policy, environment, broadcaster's intention, and audience demand. The direction of services, and content distribution strategy, as well as a matching plan for infrastructure construction, will be decided based on these high-level criteria. It is also a necessity to establish a strategy for the operation of the established system and profitability projection.

The following is the description of the main criteria for establishing the master plan.

- Content (related section; 5.1.3 and 5.9.3) :
 - Channel configuration: Multiplexer operation plan including the number of video, audio, and data channel, bit-rate allocation, and channel lease;
 - Programming: A programme scheduling plan including programme genre by channel, content, length, allocation, and proportion by format;
 - Securing content: Plan re-transmission, in-house production, re-production, outsourcing, and purchasing.
- Infrastructure:
 - Production facility: Decide on whether to use existing facilities, build new studios, or use sub-contracted production facilities to meet the content securing plan, size and level of facility, and the construction plan including the budget plan (related section; 5.2.3);
 - Transmission(head-end) facility: Develop a plan for building the transmission facility, including size, weight, and budget regarding equipment configuration, purchase, and installation, in order to implement the programming plan (related section; 5.2.2);
 - Transmission (RF) facility: Plan to build a central transmitting station, relay stations, and repeaters for perfect reception, and plan to expand coverage to provide nation-wide services (related section; 5.2.1, 5.2.3, 5.8.2, and 4.7).
- Operation:
 - System operation: Plan for staffing and repair and maintenance for the established facilities;
 - Programme/production/ transmission operation: Develop plans for manpower and budgeting regarding programme production, programming, traffic control, transmission, and advertising;
 - Additional service development: Establish development and operation plan for additional services, such as BIFS, DLS, SLS, besides the already existing audio and video services (related section; 5.1.6).
 - Business model development: Plan to develop and operate diverse new services, such as TPEG, BWS, VOD and push service (down load automatically the booked contents for late-

night, near VOD), that can generate income and meet the demands of the audience in a different way from the existing media (related section; 5.1.4).

- Profitability projection: Project expenses regarding content, infrastructure, and operation, and develop a projection report on profit generated through advertising, additional services, and data service (related section; 5.1.5).

Implementation guidelines

Once an actual system is prepared and a plan for future services is established for broadcasting, a proactive work plan for promotion has to be established to allow audiences to enjoy the benefits of mobile broadcasting. Securing a broad audience base is an indispensable condition for early stabilization of the service and future success in the business, for which plans for promotion, audience targeting, and terminal penetration strategy are to be established. The following points should be taken into account when preparing such a plan.

- Promotion and targeting audiences:
 - Promotion through existing media: Service launch date, contents, features of service, special promotion programme and other extensive promotion activities, and financial support for advertising new terminals;
 - Promotion using terminals distribution channel: As the newly introduced mobile broadcasting requires purchase of new terminals, promotion campaigns at mobile telecommunication agencies and terminals retailers can be effective;
 - Special events: Host special events to promote the launch of service, such as open broadcasting through existing media and special discount offers for terminals;
 - Consider operation of call centres and a website for customer complaints and requests, as well as service instructions;
 - Initially secure an audience base through development of bundled services in a link-up with the existing media or mobile telecommunications and time-limited discount offers.
- Terminal dissemination strategy:
 - Establish close cooperation system with terminal distributors through promoting diverse services and introducing functionalities of the terminals via existing media;
 - Establish a close cooperation system with terminal distributors to align the embedding of new functions for the implementation of diverse services, UI tuning, roll-out schedule, roll-out units, etc.

Appendix 5.9A Measurement system for MTV and field measurement case examples

RF measurement system for mobile broadcasting

- Main function:
 - Coverage measurement; TII (Transmitter Identification Information), CIR (Channel Impulse Response), Sync, Field strength, BER (bit error ratio), longitude, latitude, etc.;
 - Multi field strength measurement; RF spectrum, Field strength (up to 6 broadcasters);
 - DMB Video measurement; TP error, RS (Reed Solomon) error, Frame error, PSI (Programme Service Information) error, Clock error, etc.;
 - Analysis; post-processing of measured data, tracing specific error point;
 - Geographic Information; Tx site view, geographic altitude profile, concentric circle.

- Main feature:
 - Main server (CPU: Intel Dual-core 3.2GHz, OS: MS Window XP, memory: 2GB, HDD: 36GB, Graphic card: video 125MB, RDI card, NI-GPIB card);
 - DAB receiver (DAB752);
 - field strength meter (ESPI);
 - Oscilloscope (NI-20 MS/s);
 - GPS receiver;
 - RF magnet-mount Antenna (K51164);
 - Electronic Map.
- Block diagram and map

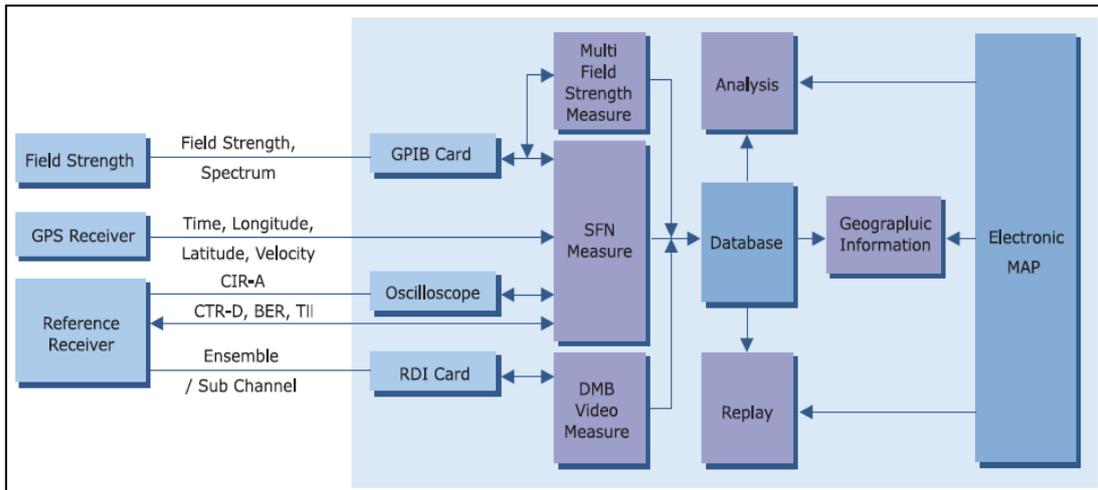


Figure 5.9A.1: Block diagram of measurement system

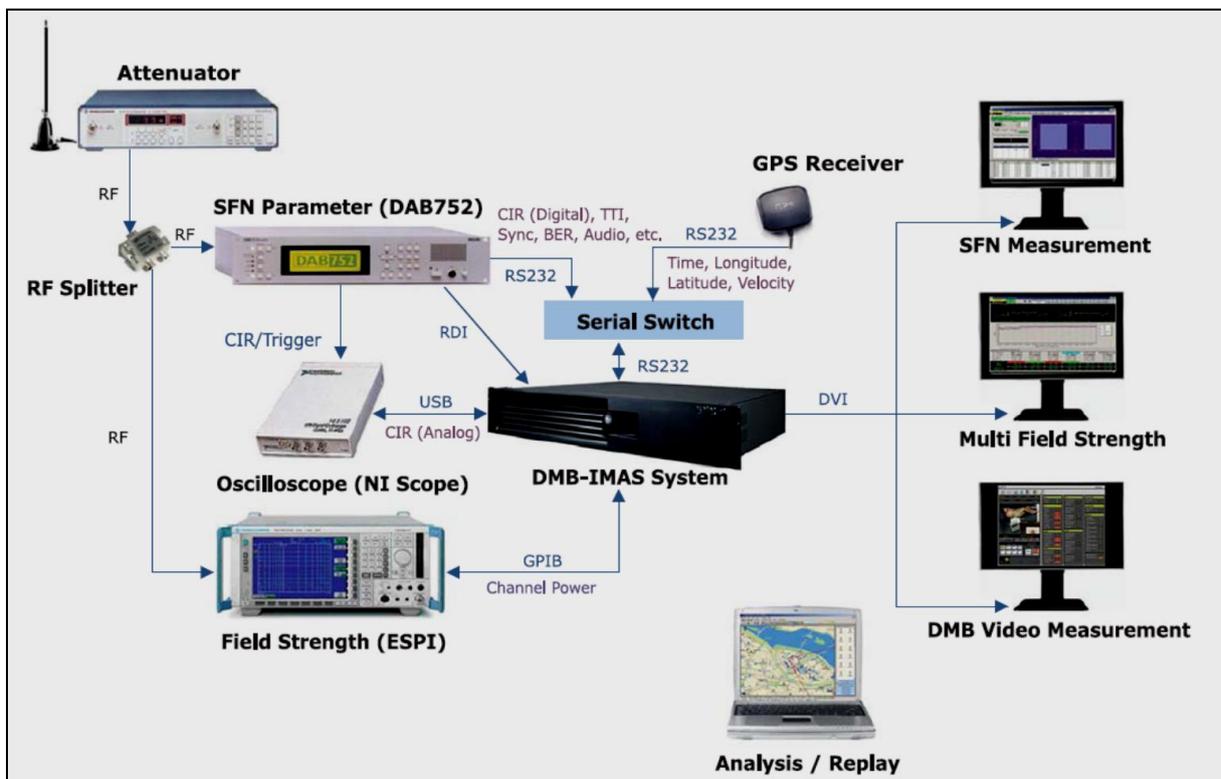


Figure 5.9A.2: Diagram of measurement system

Working processes of the measurement system are briefly explained below.

- T-DMB signal which were captured from an antenna installed on the roof of the vehicle is delivered to the DAB receiver (DAB 752) through appropriate attenuation; various parameters such as CIR, TTI, BER, and audio are forwarded to the DMB-IMAS system which is the main body of this measurement system.
- The RF signals, through the attenuator, are also delivered to the field strength measurement system (ESPI); the data of field strength from ESPI output are forwarded to the DMB-IMAS system.
- Meanwhile, various geometrical (geographical) information of the measurement point supplied by the GPS receiver is also delivered to the DMB-IMAS system.
- Various information which was collected from various measurement equipment are integrated and analysed in the DMB-IMAS system, and then the resulting data is displayed at the monitor: SFN measurement, multi-field strength, and DMB video measurement.

It should be noted that the presented system above is an example of a “full-set” system installed in a sport utility vehicle with the whole set of equipment; antenna, diverse meters, power generator, etc. A portable system that implements most of the system functions in a laptop or PC environment is also available on the market.

Actual examples of application

- Field strength marked on the map

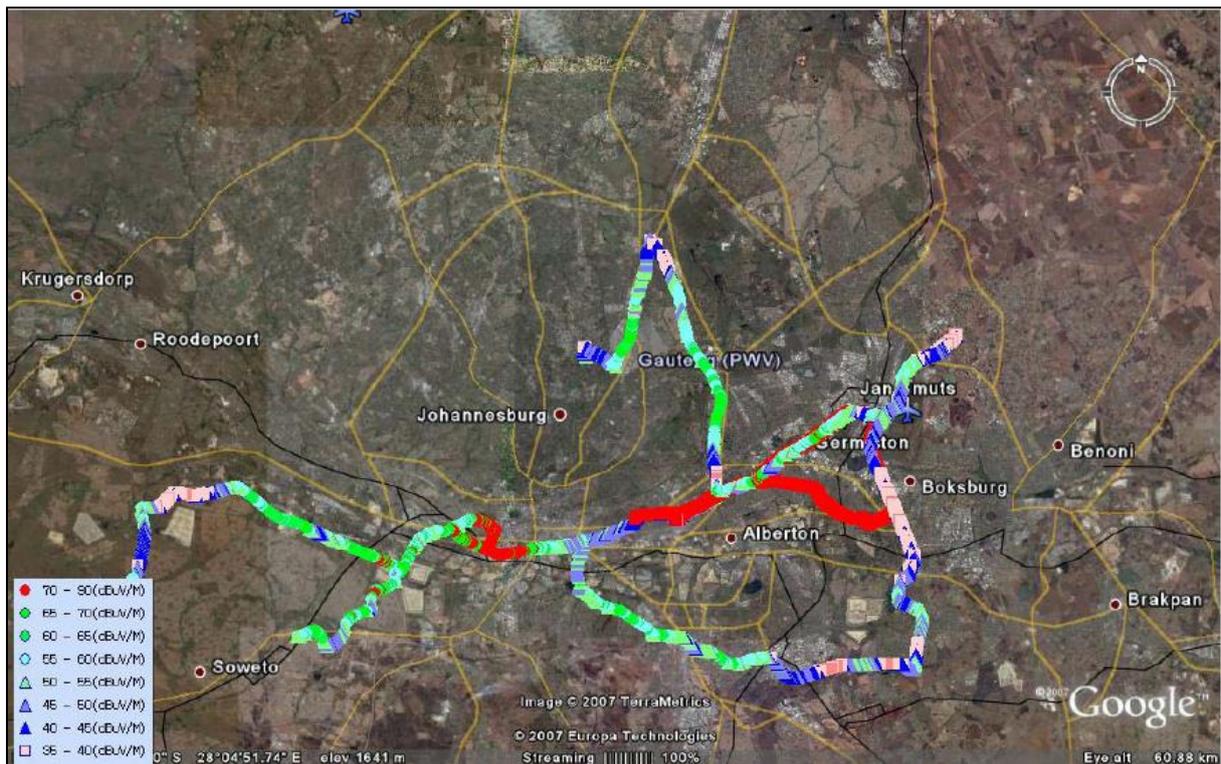


Figure 5.9A.3: Result of field test in band III (239.2 MHz)

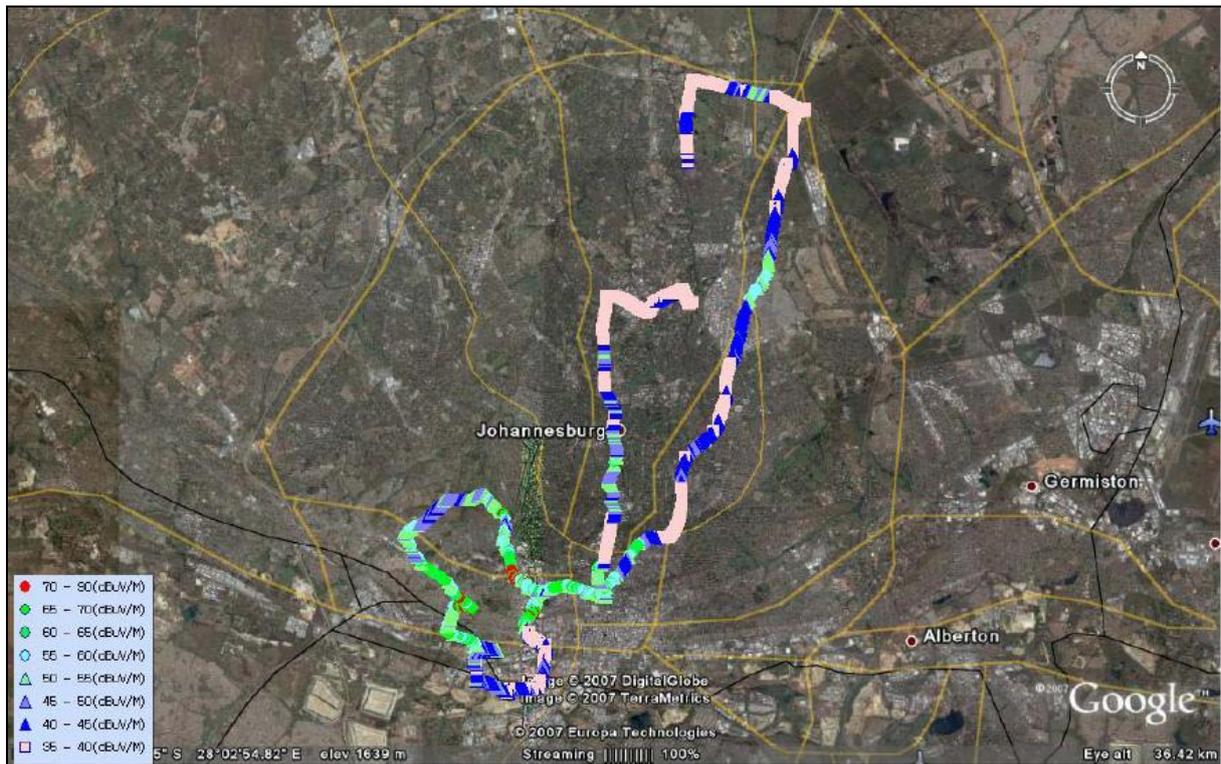


Figure 5.9A.4: Results of field test in L band (1466.6566 MHz)

- Analysis result

Items	Band III	L-Band
Total measured length of road (km)	205.692	57.942
Length of road in signal shadow (below 70 uV/m, red colour in the map) (km)	40.67	0
Average speed of a measurement vehicle (km/h)	35.370	25.87
The ratio of the shadowed and un-shadowed part of the road (%)	17	0

Glossary of abbreviations

16-QAM	16- quadrature amplitude modulation
AAC+	Advanced Audio Coding Plus
ACU	Automatic Change Unit
AES/EBU	Audio Engineering Society / European Broadcasting Union
API	Application Programme Interface
AT-DMB	Advanced Terrestrial-Digital multimedia Broadcasting
AWGN	Additive White Gaussian Noise
BER	Bit Error Ratio
BIFS	Binary Format for Scene description
BWS	Broadcasting Website Service
C/N	Carrier to Noise ratio
CAS	Conditional Access System
CDR	Central Distribution Room
CIR	Channel Impulse Response
CMMB	China Mobile Multimedia Broadcasting
CTS	Composition Time Stamp
CTT	Congestion and Travel-Time information
CTT-SUM	CTT Summary
CW	Control Word
DAB+	Digital Audio Broadcasting Plus
DAB-IP	Digital Audio Broadcasting-Internet Protocol
DLS	Dynamic Label Segment
DQPSK	Differential quadrature phase shift keying
DRM	Digital Rights Management
DTTB	Digital Terrestrial Television Broadcasting
DVB-ASI	Digital Video Broadcasting - Asynchronous Serial Interface
DVB-H	Digital Video Broadcasting-Handheld
DVB-IPDC	Digital Video Broadcasting-Internet Protocol Data Casting
DVB-T	Digital Video Broadcasting-Terrestrial
EBU	European Broadcasting Union
ECM	Entitlement Control Message
EIA	Electronic Industries Alliance
EMM	Entitlement Management Message
EPG	Electronic Programme Guide
ESG	Electronic Service Guide
ETI	Ensemble transfer Interface
EUREKA-147	European Research Coordination Action-147
EWS	Emergency Warning System
FFT	Fast Fourier Transform
FIC	Fast Information Channel
FM	Frequency Modulation
GPS	Global Positioning System
HE AAC v2	High-Efficiency Advanced Audio Coding version 2
HTML	Hyper Text Markup Language
ICS	Interference Cancellation System
IMAS	Integrated Measurement and Analysis System
IP tunneling	Internet Protocol Datagram Tunneling
ISDB-T _{SB}	Integrated Service digital Broadcasting-Terrestrial <small>Sound Broadcasting</small>
ITU	International Telecommunication Union

LCX	Leaky coaxial cable
LOS	Line of Sight
MBMS	Multimedia Broadcast and Multicast Service
MCI	Multiplex Configuration Information
MCR	Master Control Room
media FLO	media Forward Link Only
MFN	Multi Frequency Network
MOT	Multimedia Object Transfer
MPE-FEC	Moving Picture Encoding Forward Error correction
MPEG-1 Layer 2	Moving Picture Experts Group-1 Masking Pattern Adapted Universal
MUSICAM	Sub-band Integrated Coding And Multiplexing
MPEG-4 PART 10 AVC	Moving Picture Experts Group-4 Part 10 Advanced Video Coding
MPEG-4 PART 3	Moving Picture Experts Group-4 Part 3 Enhanced Resolution- Bit Sliced
ER-BSAC	Arithmetic Coding
MTV	Mobile Television
NA	Network Attached
NI	Network Independent
NPAD	Non-Programme Associate Data
NTSC	National Television System Committee
N-VOD	Near - Video on Demand
OCR	Object Clock Reference
OFDM	Orthogonal frequency division multiplexing
OMA broadcast	Open Mobile Alliance broadcast
PAD	Programme associate data
PAL	Phase Alternation by Line
PCR	Programme Clock Reference
PDA	Personal Digital Assistants
PMP	Portable multimedia player
PMT	Programme Map Table
POI	Point of Interesting
PSI	Programme Service Information
RS	Reed Solomon
RTM	Road Traffic Message
SDI	Safety Driving Information
SDI	Serial Digital Interface
SFN	Single Frequency Network
SI	Service Information
SLS	Slide Show
SMPTE 259M	Society of Motion Pictures and TV Engineers 259M
STB	Set-Top Box
STI-D	Service Transport Interface–D
STL	Studio to Transmitter Link
S-video	Super video
TCP	Transmission Control Protocol
T-DAB	Terrestrial-Digital Audio Broadcasting
TDC	Transparent Data Channel
T-DMB	Terrestrial-Digital multimedia Broadcasting
TII	Transmitter Identification Information
TMC	Traffic Message Channel
TPEG	Transport Protocol Experts Group
UDP	User Datagram Protocol
UI	User interface

UPS	Uninterruptible power supply system
USB	Universal Serial Bus
VHF	Very High Frequency
VOD	Video on Demand
VSWR	Voltage standing wave ratio

Part 6

Roadmap development

Introduction

Part 6 (Roadmap development) deals with a set of generic roadmaps regarding the whole process of transition to DTTB and introduction of MTV by the regulator and DTTB and MTV Network Operator and Service Provider. It covers functional building blocks 6.1 to 6.3 of layer E of the functional framework described in chapter 1.2. These functional building blocks are depicted below.



 = Government led
 = Market led

The guidelines for each of the functional building blocks 6.1 to 6.3 are addressed in the subsequent chapters of Part 6.

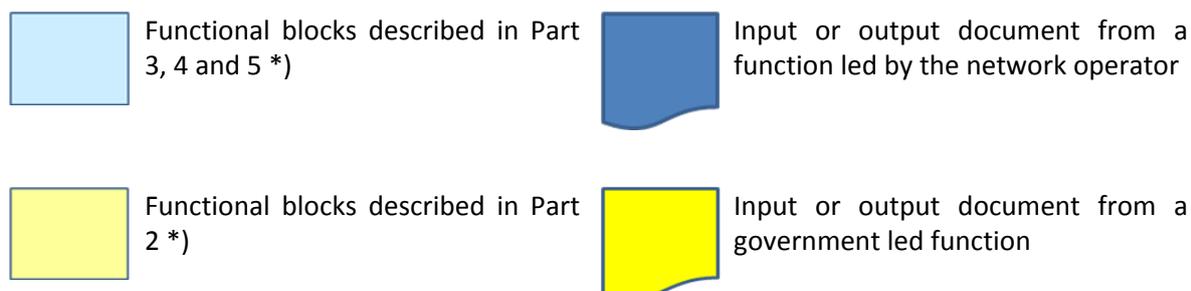
A roadmap is a plan that matches short-term and long-term goals and indicates the main activities needed to meet these goals. Developing a roadmap has three major uses:

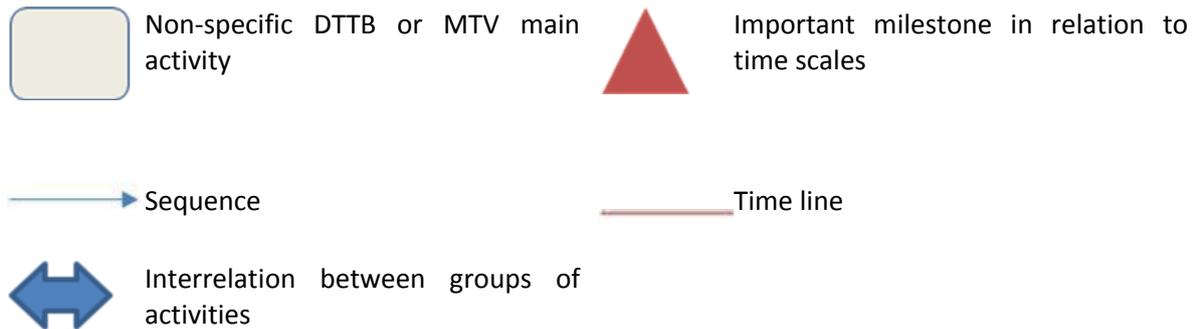
- It helps to reach consensus about the requirements and solutions for transition to DTTB and introduction of MTV;
- It provides a mechanism to help forecast the key mile stones for the transition to DTTB and introduction of MTV;
- It provides a framework to help plan and coordinate the steps needed for transition to DTTB and introduction of MTV.

The roadmaps shown in this Part represent a generic case of transition to DTTB and introduction of MTV. In practice the roadmap may differ, depending on:

- The choices that have already been made and key topics that have already been addressed;
- The responsibilities of the organization for which the roadmap is made.

This Part contains a number of graphs. The symbols used in these graphs have the following meaning:





*) Numbers in blocks in the roadmap refer to functional block numbers in Figure 1.2.1 in chapter 1.2 and to the corresponding chapters.

6.1 Roadmap for the regulator

Chapter 6.1 provides background information and guidelines on key topics and choices regarding the development of a roadmap for transition to DTTB and introduction of MTV by a regulator. The chapter consists of three sections:

- 6.1.1 Construction of a roadmap;
- 6.1.2 Generic roadmap for transition to DTTB and introduction of MTV by a regulator;
- 6.1.3 Implementation guidelines.

6.1.1 Construction of a roadmap

The roadmap for transition to DTTB and introduction of MTV by a regulator is divided in four phases:

1. DTTB and MTV policy development;
Based on the existing national telecom, broadcast and media acts and international agreements (including the Geneva 2006 Agreement), policy regarding DTTB and MTV introduction is established.
2. Analogue switch-off (ASO) planning;
Taking into account the DTTB and MTV policy, analogue switch-off planning is made before licensing policy and regulation is concluded.
3. Licensing policy and regulation;
Based on the DTTB and MTV policy and the ASO planning, the licensing policy and regulations is developed.
4. License administration;
After licences have been granted, the fulfilment of the licence conditions has to be verified and operational stations have to be notified to ITU.

In each phase a number of functional blocks (see Figure 1.2.1. of chapter 1.2) have to be addressed. Guidelines regarding key topics and choices of these functional blocks are described in the corresponding chapters.

For each of the functional blocks, the main activities for carrying out the function have to be identified. These main activities may be supplemented by main activities that are not specific for DTTB or MTV, but are nevertheless needed for a successful transition to DTTB and introduction of MTV.

Examples of such non-specific DTTB or MTV activities are:

- Consultation with market parties;
- International frequency coordination;
- Notification of frequency assignments to ITU.

The roadmap is constructed by placing the relevant functional blocks in each phase in a logical order and in a time frame. It is important that the order of activities to be carried out by the different players, including the regulator, fits with each other. Hence, for determining the order of the functional blocks, information exchange and negotiations between market parties and the regulator is essential.

A graphical illustration of the process described above is shown in Figure 6.1.1.

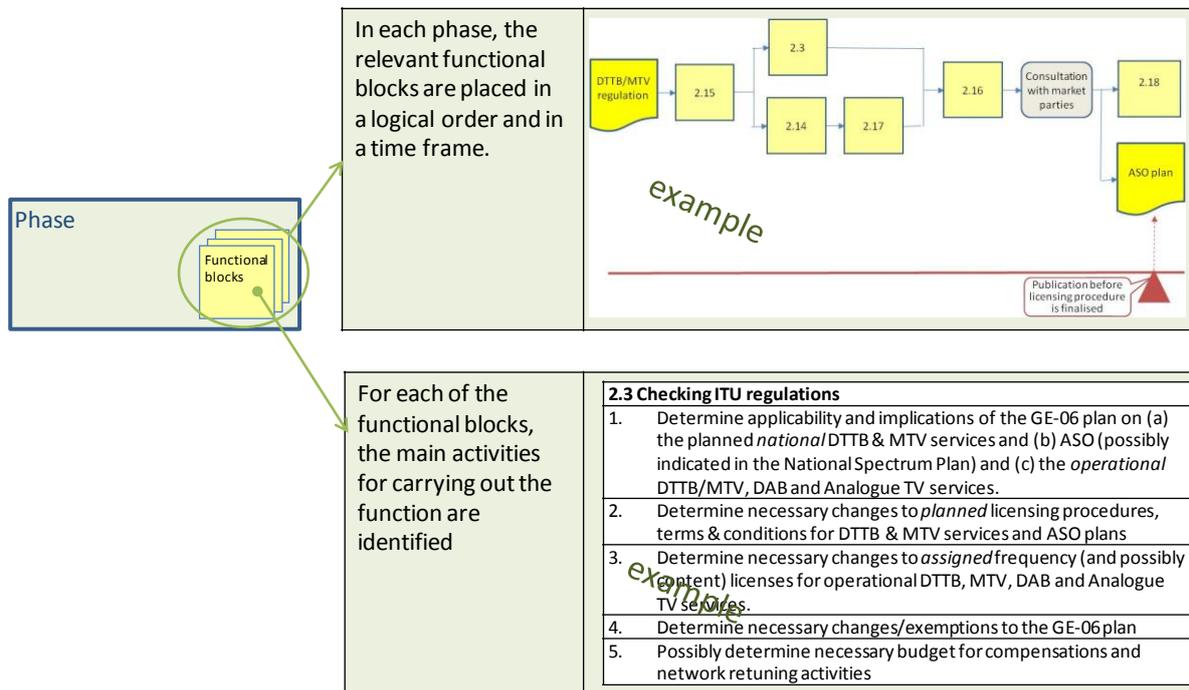


Figure 6.1.1: The process is described by phases, functional blocks and main activities

The functional blocks connected to each of the four phases of the roadmap are shown in Figure 6.1.2.



Figure 6.1.2: Functional blocks related to each of the four phases of the regulator's roadmap for transition to DTTB and implementation of MTV

It should be noted that Figure 6.1.2 represents a generic case. The actual selection of functional blocks may differ from country to country, in particular regarding the following functions:

- In some countries some of the technical choices and part of the network planning is done by the regulator, these functions are described in Part 4 and 5 and are indicated with dotted lines in the roadmaps in this chapter.
- The mandate and tasks of the national digital broadcasting committee are likely to differ from country to country. In the roadmap given in this chapter it is assumed that the committee deals with DTTB and MTV policy and regulations only. It is also possible that the committee deals with (parts of) the licensing procedure. For ASO planning a different committee is assumed. However, the ASO committee could be the same as the DTTB/MTV policy committee.

The four phases can be carried out sequentially, but in practice often the first three phases are carried out partly in parallel with regular checks for verifying if results of these phases are still in line (see Figure 6.1.3).

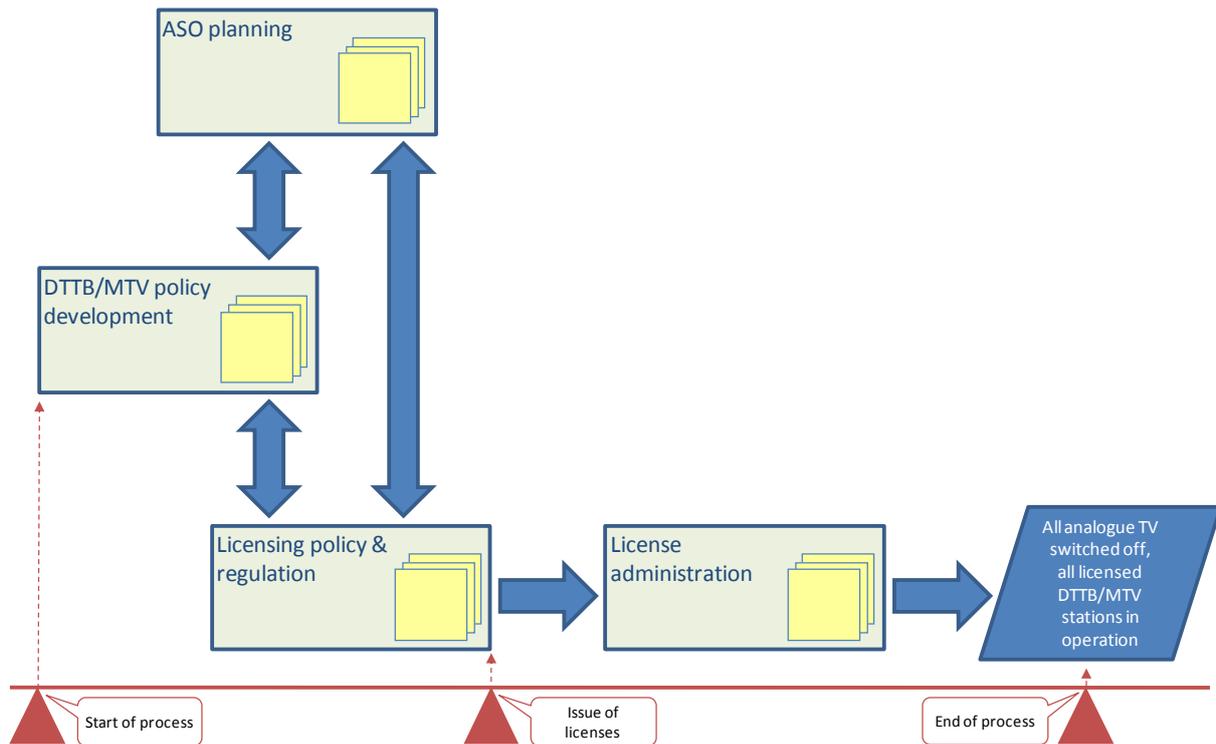


Figure 6.1.3: Interrelation between the four phases of the roadmap

There is no clear marker that will indicate the start of the process. The start could be triggered by the wish of broadcasters to introduce DTTB or MTV services, or by mobile operators wishing to use part of the “Digital Dividend” for mobile services. Sometimes governments initiate the process, taking into account that the Geneva 2006 Agreement stipulates that the transition period ends on 17 June 2015 and for a number of countries¹ on 17 June 2020 with regard to Band III.

The process ends when all analogue TV is switched-off and all DTTB and MTV stations are in operation without any restrictions that were necessary to protect analogue TV.

6.1.2 Generic roadmap for transition to DTTB and introduction of MTV by a regulator

The four phases of the roadmap are described in the following sections.

¹ The countries with a prolonged transition period in Band III are listed in footnote 7 related to Article 12 of the Geneva 2006 Agreement.

6.1.2.1 DTTB/MTV policy development

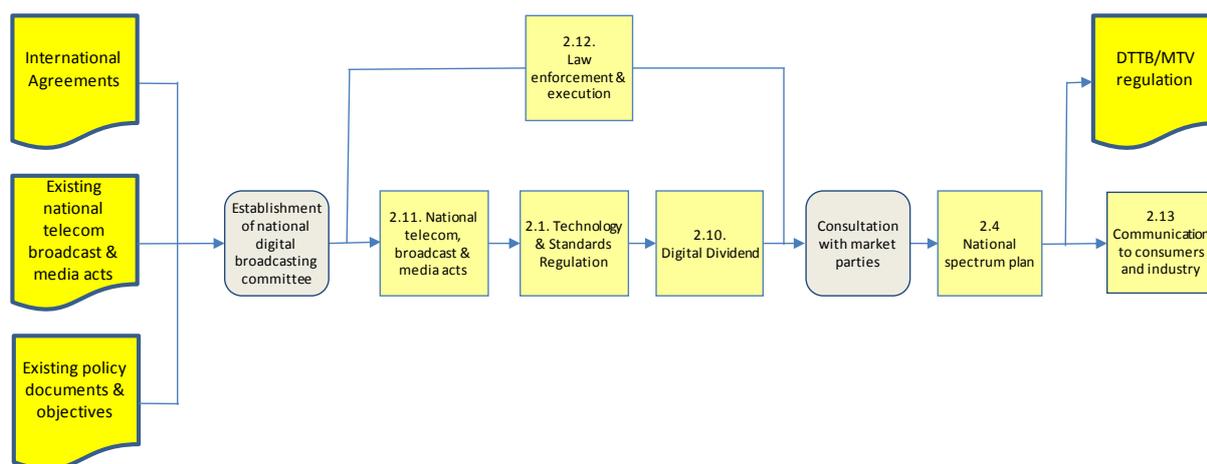


Figure 6.1.4: Phase 1 of the roadmap; DTTB/MTV policy development

Input data

International agreements, including the Geneva 2006 Agreement, and existing relevant legislation and policy documents are the basis for establishing the DTTB/MTV policy.

Establishment of a national committee

Normally the first step is to set up a national digital broadcasting committee. DTTB and MTV introduction is a complex process, involving many players and many interrelations between the players. Good communication between all players (government and market parties) is essential. Therefore a DTTB introduction committee, in which all players are represented, would be advisable. In practice these kinds of committees could have different forms and mandates, ranging from informal set-ups to official government led commissions or independent organizations taking final decisions.

National Telecom, broadcast and media acts

Taking into account the advice of the national committee, existing relevant documents and acts will be reviewed by carrying out the activities related to functional block 2.11 National Telecom, broadcast and media acts (see Table 6.1.1).

Table 6.1.1: Main activities related to proposing changes in national telecom, broadcast and media acts

2.11 Proposing changes in national telecom, broadcast and media acts	
1.	Make inventory of current Legislation
2.	Map inventory on DTTB/MTV introductions and compare with 'best practices'
3.	Identify gaps and draft proposals for additional and/or changes in Legislation (based on 'best practices')
4.	Determine planning for changes in the law and determine 'must haves' for launching DTTB/ASO and MTV

Preparing technology and standards regulations and defining digital dividend

The above mentioned activities are followed by the activities related to functional blocks:

- 2.1 Technology and standards regulations (see Table 6.1.2);
- 2.10 Digital dividend (see Table 6.1.3).

Table 6.1.2: Main activities related to the preparation of technology and standards regulations

2.1 Preparing technology and standards regulations	
1.	Carry out market research/surveys to identify industry and consumer needs for standardization
2.	Determine minimum set of receiver Standards for the DTTB and MTV market, based on the market developments and the <i>planned</i> licensing procedures, terms and conditions
3.	Map on existing standardization policies/rules and determine additional standardization needs
4.	Assess impact on industry and end consumers
5.	Determine receiver requirements and include in frequency licence terms and conditions and/or media permits and authorizations
6.	Determine communication messages, planning, standardization/testing bodies and methods (including logos and labelling)
7.	Update, if necessary National Spectrum Plan and Legislation

Table 6.1.3: Main activities to identify possible allocations for the digital dividend

2.10 Defining digital dividend	
1.	Analyse current and future market developments and possibly conduct market consultation(s) in the broadcast (and telecoms) industries
2.	Assess current and future market needs for DTTB and MTV services, possibly based on formulated Legislation and Policies
3.	Assess available spectrum after ASO, based on ASO plans, National Spectrum Plan and ITU-R Regulations
4.	Map spectrum needs on available spectrum and determine priorities and assign spectrum to Broadcasting
5.	Possibly draft spectrum re-farming plans and compensation schemes (for network and receiver re-tuning activities), reserve budgets
6.	Update National Spectrum Plan and align licence Terms and Conditions for DTTB and MTV services

Convergence of broadcasting and telecommunication services (e.g. by introducing MTV, or combined DTTB and internet TV services) may initiate the need to review the entities dealing with law enforcement and execution. Functional block 2.12 deals with these issues and the main activities are listed in Table 6.1.4. These activities are preferably carried out in parallel to the activities related to 2.1, 2.10 and 2.11, but could also be carried out later. Introduction of DTTB and MTV is not dependent on it but, once introduced, law enforcement and execution in relation to DTTB and MTV will be more effective.

Table 6.1.4: Main activities related to reviewing national institutions

2.12 Reviewing law enforcement and execution	
1.	Make inventory of current regulatory bodies
2.	Map inventory on DTTB/MTV introductions and compare with 'best practices'
3.	Identify gaps and draft proposals for additional regulatory bodies and/or changing existing bodies (based on 'best practices')
4.	Determine planning for either establishing new regulatory bodies or changing existing bodies and determine 'must haves' for launching DTTB/ASO and MTV

Consultation with market parties

Consultation with market parties will take place in order to inform the market parties about the DTTB and MTV policy and to receive feedback from the market parties about the practical implementation of the policies. As far as necessary, the policies will be modified taking into account the comments from the market parties.

Update of national spectrum plan

The next step is to carry out the activities for updating the national spectrum plan (functional block 2.4), as listed in Table 6.1.5.

Table 6.1.5: Main activities for updating the national spectrum plan

2.4 Update of the national spectrum plan	
1.	Make an inventory of current spectrum use in the broadcast bands(bands III, IV and V)
2.	Register use and provide rules for self-registration
3.	Carry out market analyses and consultations and forecast future spectrum needs
4.	Determine re-farming needs and assess impact on existing and future users (including service and financial impact), possibly reserve budget for re-farming efforts and damages
5.	Determine publication content, dates and formats for the National Spectrum Plan
6.	Determine budget for spectrum management and administrative fees

Communication

The DTTB/MTV policy development phase ends with a set of documents describing regulations for transition to DTTB and introduction of MTV and communication plans regarding the DTTB and MTV policy and regulations. The communication plans are drafted by carrying out the activities related to functional block 2.13 Communication to end consumers and industry (see Table 6.1.6 below)

Table 6.1.6: Main activities related to communication to end consumers

2.13 Communication to end consumers and industry	
1.	Make inventory of communication scope
2.	Determining the key communication moments and topics
3.	Determine communication tools for each target group/audience
4.	Instruct communication bodies and committees

6.1.2.2 Analogue switch-off planning

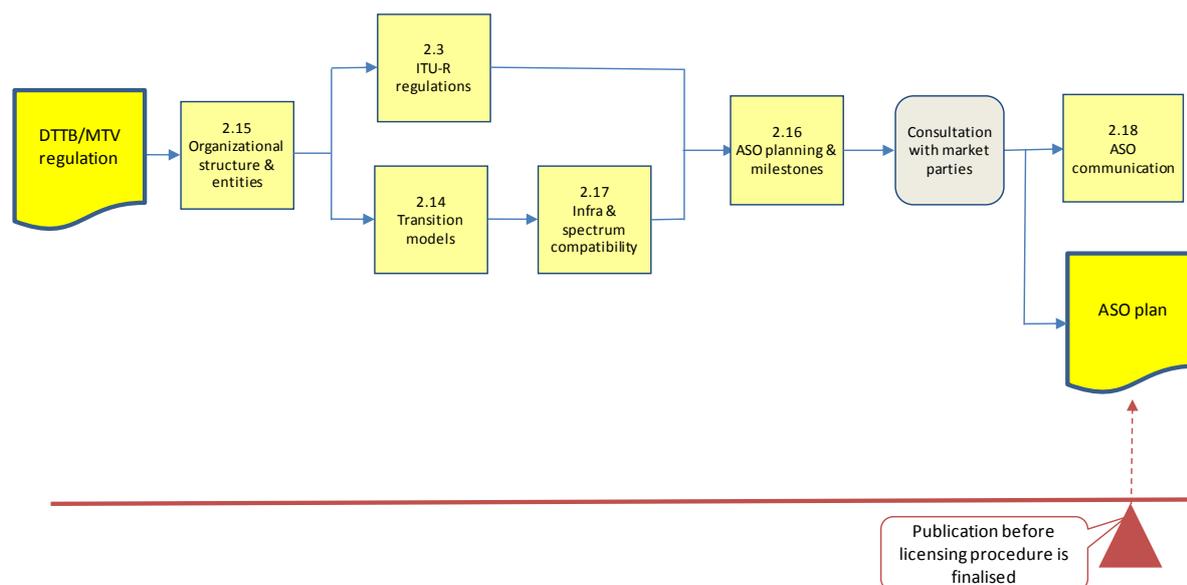


Figure 6.1.5: Phase 2 of the roadmap; analogue switch-off planning

Input data

The national DTTB and MTV regulations resulting from phase 1 of the roadmap is the basis for the analogue switch-off (ASO) planning.

Establishment of organizational structures and entities

The first step is to perform the activities relating to functional block 2.15 (Organizational structures and entities) as indicated in Table 6.1.7.

Table 6.1.7: Main activities related to the establishment of organizational structures and entities

2.15 Establishment of organizational structures and entities	
1.	Establish overall coordination needs
2.	Form or extend special purpose vehicle, establish clear mandate
3.	Establish budget and communication means (air-time, website, etc)

ASO planning

These activities are followed by the actual ASO planning through the activities related to functional blocks:

- 2.3 ITU-R regulations, as far as appropriate to ASO (see Table 6.1.8);
- 2.14 Transition models (see Table 6.1.9);
- 2.16 ASO planning and milestones (see Table 6.1.10);
- 2.17 Infrastructure and spectrum compatibility (see Table 6.1.11).

Table 6.1.8: Main activities related to checking of ITU-R regulations

2.3 Checking ITU regulations	
1.	Determine applicability and implications of the GE06 Plan on (a) the planned <i>national</i> DTTB and MTV services and (b) ASO (possibly indicated in the National Spectrum Plan) and (c) the <i>operational</i> DTTB/MTV, DAB and Analogue TV services.
2.	Determine necessary changes to <i>planned</i> licensing procedures, terms and conditions for DTTB and MTV services and ASO plans
3.	Determine necessary changes to <i>assigned</i> frequency (and possibly content) licences for operational DTTB, MTV, DAB and Analogue TV services.
4.	Determine necessary changes/exemptions to the GE06 Plan
5.	Possibly determine necessary budget for compensations and network retuning activities

Table 6.1.9: Main activities related to defining transition models

2.14 Defining transition models	
1.	Check existing Legislation and policies for Public (and commercial) television service (e.g. FTA) and coverage stipulations (e.g. nationwide coverage)
2.	Check ITU-R Regulations and any existing/formulated receiver regulations for impact on ASO
3.	Carry out market research on ASO affected viewers/listeners. Identify any hidden viewers/listeners (2 nd television sets, regional programming, prisons, etc.), Identify impact and risk areas
4.	Analyse and assess complexity and size of network modifications and receiver transitions
5.	Involve and discuss ASO with Content Aggregators (esp. Public Broadcaster) and consumer associations
6.	Decide transition model (simulcast period and ASO phasing)

Table 6.1.10: Main activities related to setting up ASO planning and milestones

2.16 Setting up ASO planning and milestones	
1.	Draft comprehensive ASO planning (milestones and activities) and assign tasks and responsibilities (including core project management team)
2.	Establish ASO project monitoring framework and reporting structure
3.	Identify ASO project risks and draft risk mitigation plans (including fall back and/or roll back scenarios)

Table 6.1.11: Main activities related to identifying infra and spectrum compatibility

2.17 Identifying infrastructure and spectrum compatibility	
1.	Check Legislation, ITU-R Regulations, National Spectrum Plan and establish service priorities and acceptable interferences levels
2.	Assess available antenna space and sites and site/antenna sharing possibilities/options
3.	Calculate inference levels, service coverage and check EMC compatibility
4.	Develop site transition scenarios (including temporary installations and sites)
5.	Assess costs, time lines and service impact

Consultation with market parties

After the ASO planning has been formulated, consultation with market parties will take place. The purpose of this consultation is to inform the market parties about the ASO planning and to receive feedback from the market parties about the practical implementation. As far as necessary the policies will be modified, taking into account the comments from the market parties.

Communication

Taking into account the comments received from the consultation with the market parties, the final ASO plan will be adopted and the ASO communication plan (functional block 2.17) will be drafted. The activities related to the drafting of the ASO communication plan are listed in Table 6.1.12.

Table 6.1.12: Main activities related to drafting ASO communication plan

2.17 Drafting ASO Communication Plan	
1.	Draft communication plan (including target audiences, timing, means, etc.)
2.	Continuous alignment with ASO planning
3.	Determine and establish compensation schemes and systems, include in communication plan

The ASO plan should be taken into account in the licence terms and conditions.

6.1.2.3 Licensing policy regulation

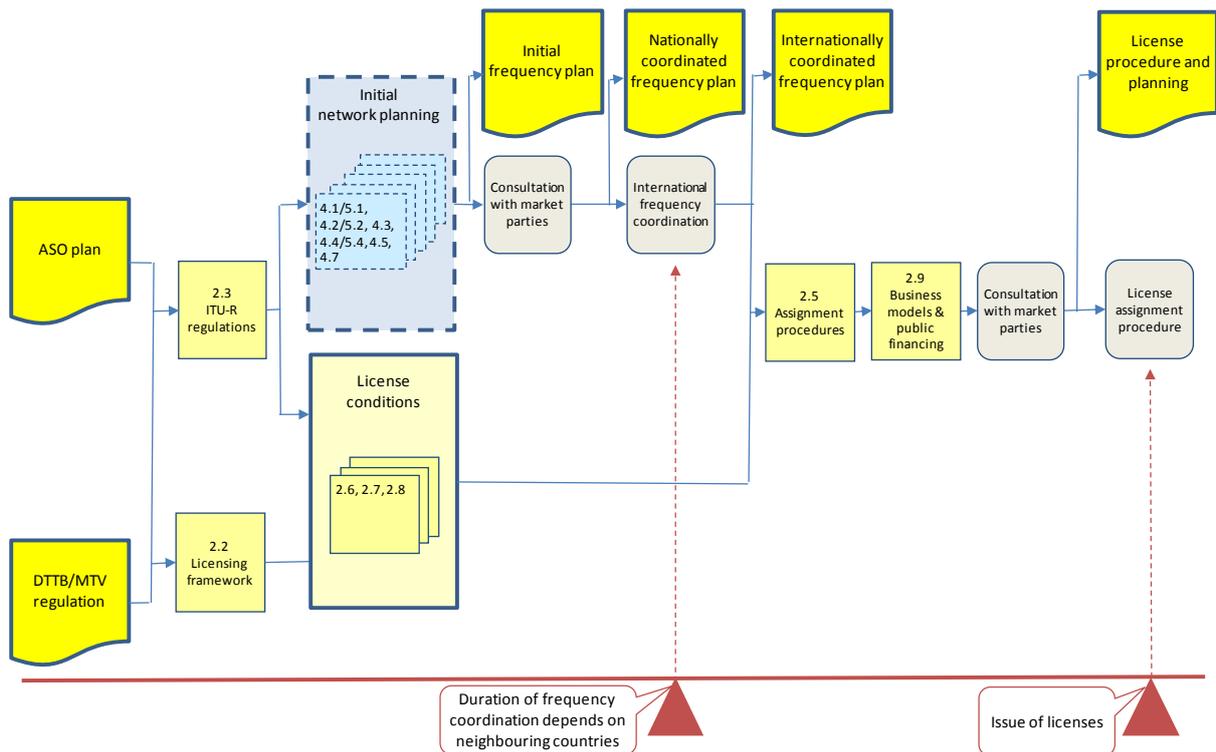


Figure 6.1.6: Phase 3 of the roadmap; licensing policy and regulation

Input data

Licensing policy and regulations will be developed with the DTTB/MTV regulations and the ASO plan, resulting from phase 1 and phase 2 of the roadmap respectively, as input.

ITU-R regulations

Functional block 2.3 (ITU-R regulations), is addressed with the aim to identify the frequency assignments or allotments that are available according to ITU-R regulations and in particular the GE06 Agreement (where this applies). The activities, as far as appropriate to this part of the roadmap, are listed in Table 6.1.8 in subsection 6.1.2.2.

Establishment of technical criteria

A series of activities takes place in order to establish the technical criteria of the DTTB /MTV stations. The activities are described below.

Initial network planning

In some countries, some of the technical choices and part of the network planning is done by the regulator. These functions are indicated with dotted lines in the roadmap. The related activities are listed in chapters 6.2 and 6.3 for DTTB and MTV networks, respectively.

Depending on the detail with which the regulator wants to prescribe station characteristics and coverage that should be achieved, the activities related to the functional blocks 4.1 to 4.7 and 5.1 to 5.7 regarding DTTB and MTV respectively, may involve detailed calculations with advanced planning software. This is in particular the case when:

- The GE06 Plan entries are allotments and the regulator wants to licence assignments;
- A certain degree of coverage will be defined in the licence.

In functional blocks 4.3, as described in the guidelines in chapter 4.3, the results of network planning exercises are compared with the principles defined in step 4.2 (Design principles and network architecture), which in turn is based on business plan and customer proposition. In the case where the regulator is carrying out these activities, instead of business plan and customer proposition, network planning results should be compared with the objectives formulated in DTTB/MTV regulation and ASO plan.

Consultation with market parties in international frequency coordination

The activities related to functional blocks 4.1 to 4.7 and 5.1 to 5.7 result in a network plan, of which three versions will be needed:

1. The initial network plan;
2. The national coordinated network plan in which the comments from the market parties are incorporated;
3. The internationally agreed network plan in which the agreements with neighbouring countries have been incorporated.

Between the first and second network plan consultation with market parties will take place. The purpose of this consultation is to inform the market parties about the network plan and to receive feedback from the market parties about the practical implementation.

Between the second and the third network plan international frequency coordination will take place, in accordance with the provisions of the Geneva 2006 Agreement (where this applies). In the case where detailed network planning is carried out by the licence holder or network operator, international coordination is done at a later stage at the request of the licence holder or network operator.

Establishment of administrative licence regulations

In this series of activities the administrative licence regulations will be established. These activities are described below.

Licensing framework

First the licensing framework is set up by carrying out the activities related to functional block 2.2, Licensing framework (see Table 6.1.13).

Table 6.1.13: Main activities related to the setting up of a licensing framework

2.2 Setting up the licensing framework	
1.	Make inventory of current licensing framework and check applicability for DTTB and MTV service introductions
2.	Assess and evaluate different options for licensing DTTB and MTV services
3.	Assess compatibility with ASO plans and National Spectrum Plan
4.	Possibly revise current licensing framework and assess impact
4.	Draft planning for licence assignment, framework changes and update National Spectrum Plan (and possibly Legislation)

Defining licence conditions

With the results of functional block 2.2 and the information on the available assignments or allotments resulting from functional block 2.3 (ITU-R regulations), the licence conditions will be defined by carrying out the activities related to functional blocks:

- 2.6 License terms and conditions (see Table 6.1.14)
- 2.7 Local permits (see Table 6.1.15)
- 2.8 Media permits and authorizations (see Table 6.1.16)

Table 6.1.14: Main activities related to formulating licence terms and conditions

2.6 Formulating license terms and conditions	
1.	Check relevant paragraphs/ entries in Legislation/Policies, ASO plans, National Spectrum Plan,
2.	Analyse market conditions and assess 'level-playing-field' requirements/provisions
3.	Determine DTTB/MTV licence Terms and Conditions and align with local Building permit policies and Media permits/authorizations and their planning
4.	Update National Spectrum Plan (and possibly ASO plans)

Table 6.1.15: Main activities related to drafting policies for local permits

2.7 Drafting policies for local permits	
1.	Check relevant paragraphs/ entries in Legislation/policies and Licensing Framework for DTTB and MTV service introductions
2.	Determine and align Building permit policies with intended DTTB/MTV licence Terms and Conditions
3.	Publish policies for DTTB/MTV planning and building permits (may include waivers)
4.	Possibly conduct local hearings and/or expert investigations which may result in changes in permitted spectrum usage/transmitter site parameters (and delays)
5.	Monitor actual transmitter site operations and check/test emitted radiation
6.	Possibly update National Spectrum Plan

Table 6.1.16 Main activities related to drafting of media permits and authorizations

2.8 Drafting of media permits and authorizations	
1.	Check existing media Legislation, Policies and Licensing Framework
2.	Check Technology and Standards Regulation (receiver regulations) and include in media permits policies
3.	Determine Media permits/authorizations and procedures and align with DTTB/MTV licence Terms and Conditions and planning
4.	Publish policies for media permits and authorizations (may include waivers)

Assignment procedures

After having defined the licence conditions, the assignment procedures will be formulated by carrying out the activities related to functional block 2.5, Assignment procedures (see Table 6.1.17).

Table 6.1.17: Main activities related to the formulation of assignment procedures

2.5 Formulation of assignment procedures	
1.	Consult market (industry players and consumers) on assignment methods and licence Terms and Conditions
2.	Evaluate results and select assignment method and procedures
3.	Draft detailed plans and planning for DTTB and MTV assignment procedures
4.	Publish assignment planning and procedures and update National Spectrum Plan (and possibly Legislation)

Determining business models and public financing

The last functional block deals with business models and public financing. The related activities are shown in Table 6.1.18.

Table 6.1.18: Main activities related to determining business models and public financing

2.9 Determining business models and public financing	
1.	Check existing media Legislation, policies and Licensing Framework
2.	Consult Public Broadcaster(s) on current/future analogue television, DTTB and MTV transmissions
3.	Analyze market situation and assess possible market distortions
4.	Define or complete required public service offering on DTTB and MTV platform (if not defined in Legislation yet)
5.	Align defined public service offering with other DTTB/MTV licence terms and conditions and media permits, and their planning
6.	Determine and establish budget for public broadcast service offering and/or subsidizing consumer equipment

Consultation with market parties

The series of activities to establish administrative licence regulations is finalized with consultation of market parties. The purpose of this consultation is to inform the market parties about the licence

regulations and to receive feedback from the market parties about the practical implementation. As far as necessary the regulations will be modified taking into account the comments from the market parties.

License assignment procedure

The licensing procedure phase ends with the licence assignment procedure at the announced date.

It is not necessary and often not possible, because of the restrictions to DTTB or MTV stations during transition, to license all DTTB and MTV networks at the same time.

6.1.2.4 License administration

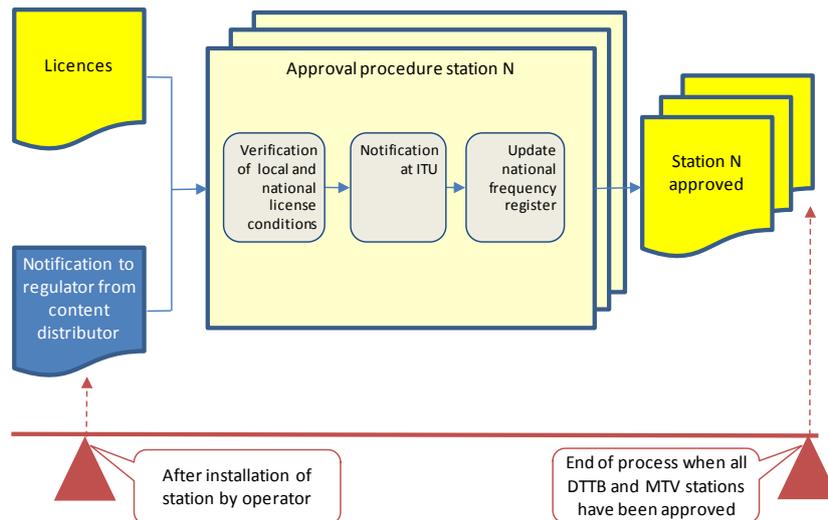


Figure 6.1.7: Phase 4 of the roadmap; licence administration

Verification of licence conditions

After licences have been granted and the operator has informed the regulator that a station is in operation, the regulator should verify if the station operates in accordance with the licence conditions, including:

- Station characteristics;
- Roll-out obligations;
- Media permits;
- Local permits.

Notification to ITU

Subsequently the station will be notified to ITU, taking into account that ITU-BR will check the provisions given in Article 5 of the Geneva Agreement of 2006, such as:

- Conformity check (see section 4.3.4);
- Power density check (if appropriate; see section 4.3.4).

Update of national frequency register

The licence administration phase ends with the formal approval of the licensed stations and an update of the national frequency register, with the operational characteristics of the station.

The process ends when:

- All analogue TV is switched-off;
- All DTTB and MTV stations are in operation without restrictions that were necessary to protect analogue TV;
- National frequency register has been up dated with the operational characteristics of all DTTB and MTV stations.

6.1.3 Implementation guidelines

The roadmap for transition to DTTB and introduction of MTV depends very much on the national situation.

The regulator should address the functional building blocks that are within its responsibility. This could include some of the functions described in Part 4 and 5 of these guidelines. The regulator should also consider the functional building blocks that are within the responsibility of other players of the value chain in order determine the interfaces.

Furthermore it has to be estimated to what extent key topics and choices of the selected building blocks have to be considered and consequently the activities that have to be carried out, taking into account:

- The actual status on DTTB and MTV regulation and licensing;
- The market situation;
- Responsibilities of regulator and licence holder regarding technology choices and network planning.

Finally a realistic time schedule for the whole process needs to be adopted, taking into account:

- International recommendations or agreements related to analogue switch-off;
- Time schedules in neighbouring countries;
- Preparation and installation time for market parties;
- Time needed for the receiver industry (manufactures, retail) to supply digital TV consumer equipment.

It should be noted that in Europe the period between DTTB launch and completed analogue TV switch-off ranges from 3 to 14 years.

An enquiry in the first phase of the ITU project on the digital broadcasting transition roadmap in Africa, gave among others the following indications on introduction of DTTB and MTV services and analogue switch-off:

Table 6.1.19: Indicated of number of African countries regarding DTTB and MTV introduction and end of transition

Timing	Number of countries		
	DTTB introduction	MTV Introduction	End of transition
Until 2010	9	6	1
Until 2015	1	0	8
Until 2020	1	1	9

These time schedules reflect high ambitions in transition to DTTB and introduction to MTV in many African countries. Those countries that have not started yet to prepare DTTB and MTV introduction are advised to do so, sooner rather than later, taking into account that:

- The analogue switch-off dates indicated by the African countries range from 2010 to 2020;
- A number of African countries are in an advanced stage of DTTB and MTV implementation, which likely leads to pressure from broadcasters to start DTTB and MTV services in other countries.
- In the Asia-Pacific region analogue switch-off dates indicated range from 2013 to beyond 2020.
- While a number of countries in the Asia-Pacific region understand the need for migration the smaller countries lack the knowledge and resources to pursue migration at this time. Most of the larger countries are more active in planning and migration.

6.2 Roadmap for transition to DTTB by a network operator

Chapter 6.2 provides background information and guidelines on key topics and choices regarding the preparation of a roadmap for transition to DTTB by a network operator. The chapter consists of three sections:

- 6.2.1 Construction of a roadmap;
- 6.2.2 Generic roadmap for transition to DTTB by a network operator;
- 6.2.3 Implementation guidelines.

6.2.1 Construction of a roadmap

The roadmap for transition to DTTB by a network operator consists of four phases:

1. Preparation
The preparatory phase starts when the regulator is preparing the licensing policy and regulation (See phase 1, 2 and 3 of the regulator's roadmap in chapter 6.1). The aim of the preparations is to apply successfully for a DTTB licence.
2. Planning
The planning phase starts at the date of issue of the licence and ends with the adoption of the network implementation plan. This plan describes station characteristics and a time schedule for implementation.
3. Implementation
The implementation phase is the follow-up of the planning phase and ends when all DTTB transmitters are operational.
4. Analogue TV switch-off
The time schedule of the analogue switch-off phase is given by the ASO plan of the regulator. Engineering work on DTTB sites is likely to continue after analogue switch-off.

In each phase a number of functional blocks (see Figure 1.2.1. of chapter 1.2) has to be addressed. Guidelines regarding key topics and choices of these functional blocks are described in the corresponding chapters.

For each of the functional blocks, the main activities for carrying out the function have to be identified together with the entity that is responsible for the activities. These main activities may be supplemented by main activities that are not specific for DTTB, but are nevertheless needed for a successful transition to DTTB. Examples of such non-specific DTTB activities are:

- Service provisioning and contracting content providers;
- Project and resource planning
- Site acquisition;

- Equipment installation.

The roadmap is constructed by placing the relevant functional blocks in each phase in a logical order and in a time frame. It is important that the order of activities in each phase by the different players, including the regulator, fits with each other. Hence for determining the order of the functional blocks, information exchange and negotiations between market parties and the regulator is essential.

A graphical illustration of the process described above is shown in Figure 6.2.1.

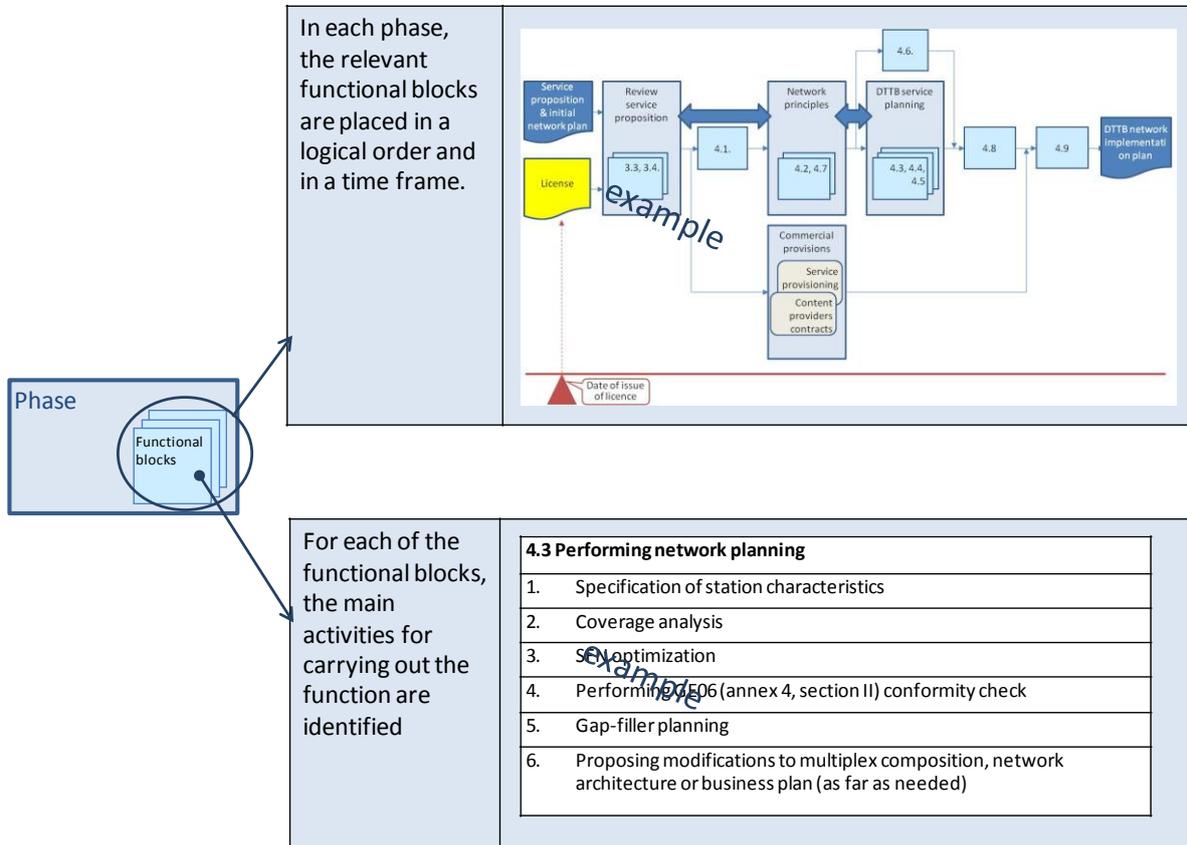


Figure 6.2.1: The process is described by phases and main activities

The functional blocks connected to each of the four phases of the roadmap are shown in Figure 6.2.2.

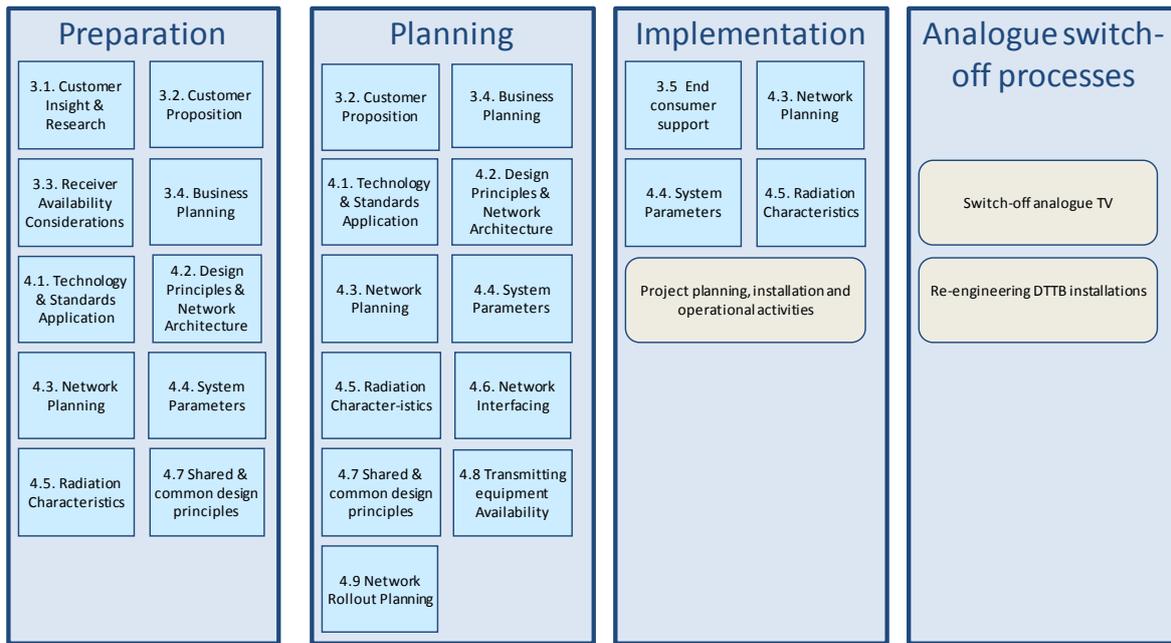


Figure 6.2.2: Functional blocks connected to each of the four phases of the network operator's roadmap for transition to DTTB

It should be noted that Figure 6.2.2 represents a generic case. The actual selection of functional blocks may differ from country to country.

Phases 1, 2 and 3 are carried out sequentially and phase 4 is carried out partly in parallel to phase 3 with regular checks to verify if the results of these parts are still in line. The sequence of the four parts of the roadmap is illustrated in Figure 6.2.3.

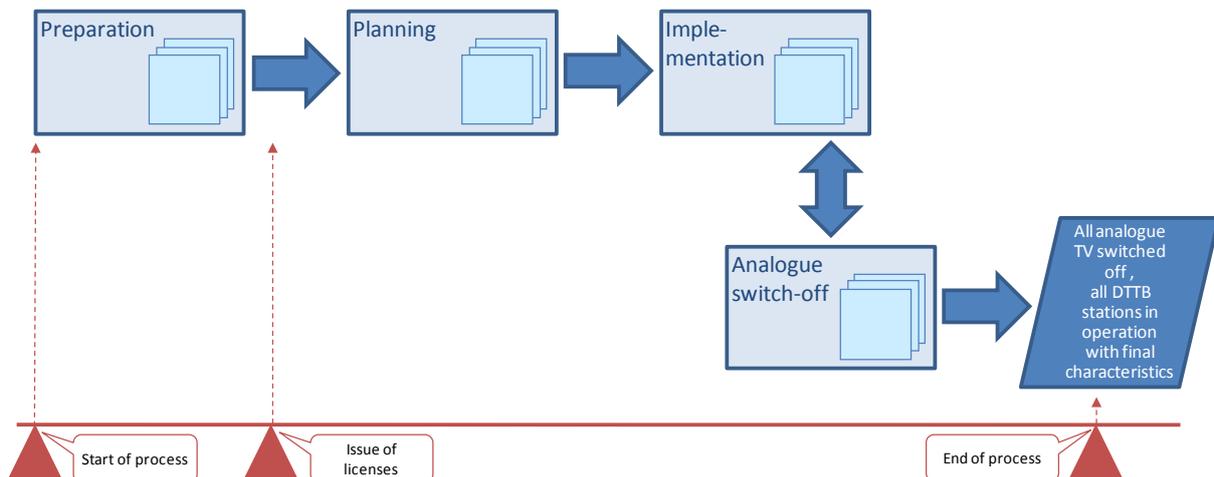


Figure 6.2.3: Interrelation between the four phases of the roadmap

The process ends when all analogue TV is switched-off and all DTTB stations are in operation without any restrictions that were necessary to protect analogue TV. However, further evolution of the network is likely to take place resulting from the introduction of new services, regulatory obligations or technology changes.²

6.2.2 Generic roadmap for transition to DTTB by a network operator

In the roadmap shown in this section, the following assumptions have been made:

- No existing DTTB services;
- One DTTB network operator, acting as multiplex operator, service provider and content distributor;
- Multiplexes contain also the TV services that are transmitted via analogue TV networks;
- DTTB network operator is also responsible for the analogue TV transmissions.

When multiplex operator, service provider, content distributor and analogue TV operator are different organizations, the order of the functions will not be different. However the interfaces between the respective parts of transmission chain need to be clearly defined and service agreements should cover a smooth hand-over of responsibilities.

The roadmap described in this chapter is for the case where the operator takes the technical decisions and performs the network planning. In some countries, the regulator has a broader role than in others. In the case where some of the technical choices e.g. standard and system choices or (part of) network planning is a responsibility of the regulator, the roadmap is not basically different. The network operator will still make his own assessments about service quality, coverage quality and radiation characteristics. Normally the network operator wishes to make these assessments with higher accuracy and in more detail than the regulator.

The four phases of the roadmap are described below.

6.2.2.1 Preparations

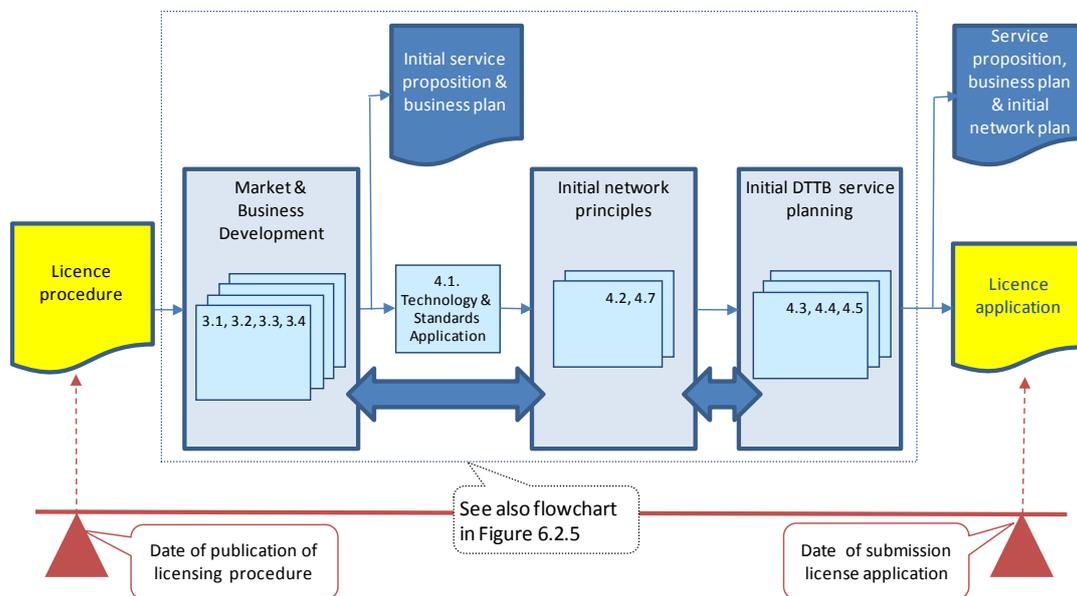


Figure 6.2.4: Phase 1 of the roadmap; preparations

² See also Networks in evolution, making changes to the digital terrestrial television platform. DigiTAG, May 2008.

Input data

In the roadmap shown above, the preparatory phase starts when the licence procedure has been published. This is the latest moment for the start. A start during first three phases of the regulator's roadmap (see chapter 6.1) has the advantage that well informed reactions can be given to proposals from government or regulator in consultation with market parties during:

1. DTTB/MTV policy development;
2. Analogue switch-off planning;
3. Licensing policy and regulation.

Market and business development

In the preparatory phase, the network operator will first address market and business development by carrying out the activities related to functional blocks:

- 3.1 Customer insight and research (see Table 6.2.1);
- 3.2 Customer proposition (see Table 6.2.2);
- 3.3 Receiver availability considerations (see Table 6.2.3);
- 3.4 Business planning (see Table 6.2.4).

Table 6.2.1: Main activities related to investigate customer insight and carrying out market research

3.1 Investigation of customer insight and carrying out market research	
1.	Determine need, timing and scope for market research
2.	Analyse competitive offerings, substitutes and technology developments
3.	Design and develop preliminary DTTB and MTV service propositions
4.	Draft market research plan, staff and budget market research project
5.	Carry out market research and analyse results, translate into DTTB/MTV service propositions, if necessary carry out additional market research

Table 6.2.2: Main activities related to defining customer proposition

3.2 Defining customer proposition	
1.	Analyse earlier DTTB and MTV service launches and compare with customer research results/local market conditions
2.	Define DTTB/MTV service propositions and check feasibility/cost levels with key suppliers, i.e. Distributor (broadcast network operator) and Content Aggregators, Content Creators
3.	Possibly redefine DTTB/MTV service propositions and test in market again, i.e. additional market research

Table 6.2.3 Main activities related to carrying out receiver availability considerations

3.3 Carrying out receiver availability considerations	
1.	Analyse earlier DTTB and MTV service launches, assess local substitutes and technology developments
2.	Check any prescribed Technologies and Standards, Receiver regulations and analyse market research results
3.	Assess and make inventory of availability and roadmaps of various receiver types/attributes
4.	Check network compatibility and interoperability (radio interfaces and API/applications)
5.	Assess and detail ex-factory and retail pricing for various receivers
6.	Decide key receivers and their attributes, draft receiver/service roadmap

Table 6.2.4 Main activities related to performing business planning

3.4 Performing business planning	
1.	Analyse legal/regulatory framework (may include prescribed Technologies and Standards, Assignment Procedure, License Terms and Conditions, Business Models and Public Financing), determine impact and opportunities
2.	Assess market take-up and project revenue streams, based on customer research and proposition
3.	Assess and calculate associated costs (considering concepts of ‘total cost of ownership’), project costs ahead
4.	Carry out profitability and sensitivity analysis, draft business plan scenarios
5.	Quantify total investments and their associated risks, assess financing and public funding possibilities, consider co-operation/joint venture/vendor financing/revenue sharing

The functional blocks 3.1 to 3.4 include some iterations as shown on the left hand side of the flowchart in Figure 6.2.5. The activities indicated above result in an initial customer proposition and business plan.

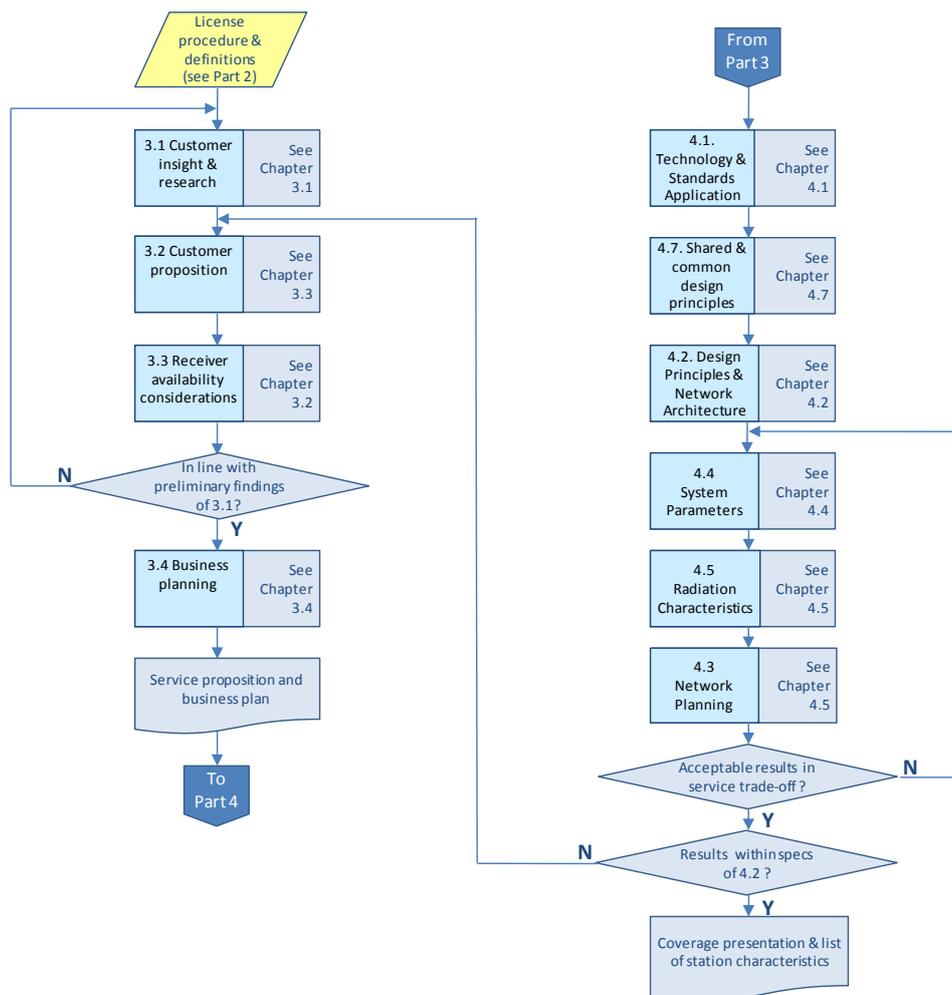


Figure 6.2.5: Flowchart for developing the service proposition and initial network plan

Technology and standards application and initial network principles

After the initial customer proposition and business plan have been approved, the activities related to the following functional block are carried out:

- 4.1 Technology and standards application (see Table 6.2.5);
- 4.2 Design principles and network architecture (see Table 6.2.6);
- 4.7 Shared and common design principles (see Table 6.2.7).

Table 6.2.5: Main activities related to technology and standards application

4.1 Technology and standards application	
1.	Describing tests
2.	Evaluation of SDTV and HDTV specifications (including sound channels) and estimation of required bit rate
3.	Evaluation of standards characteristics with GE06 provisions, business plan and receiver availability
4.	Evaluation of characteristics of compression systems
5.	Evaluation of conditional access systems
6.	Evaluation of additional systems (including access systems if needed) and estimation of required bit rate

Table 6.2.6: Main activities related to developing design principles and network architecture

4.2 Developing design principles and network architecture	
1.	Education and training of technical staff
2.	Evaluation of roll-out options
3.	Evaluation of type of distribution network
4.	Evaluation of network topology
5.	Drafting multiplex composition plan
6.	Establishing frequency plan per multiplex/network
7.	Drafting transmitting station lay out

Table 6.2.7: Main activities related to deciding shared and common design principles

4.7 Deciding shared and common design principles	
1.	Investigate national regulations regarding site sharing
2.	Determine in principle shared use of DTTB and MTV networks and which elements (sites, antennas, multiplex)
3.	Determine in principle on common design and planning of DTTB and MTV networks
4.	Prepare site sharing agreements

Initial DTTB service planning

In the next series of activities an initial DTTB network plan is developed, which includes several iterative steps and possibly a review of the service proposition and business plan, technology choices and network principles (see in Figure 6.2.5).

For drafting the initial network plan the activities related to the following functional blocks are carried out:

- 4.3 Network planning (see Table 6.2.8);
- 4.4 System parameters (see Table 6.2.9);
- 4.5 Radiation characteristics (see Table 6.2.10).

Table 6.2.8: Main activities related to performing network planning

4.3 Performing network planning	
1.	Specification of station characteristics
2.	Coverage analysis
3.	SFN optimization
4.	Performing GE06 (annex 4, section II) conformity check
5.	Gap-filler planning
6.	Proposing modifications to multiplex composition, network architecture or business plan (as far as necessary)

Table 6.2.9: Main activities related to determining system parameters

4.4 Determining system parameters	
1.	Evaluation of FFT size (2k or 8k)
2.	Evaluation of carrier modulation
3.	Evaluation of code rate
4.	Evaluation of guard interval

Table 6.2.10: Main activities related to assessing radiation characteristics

4.5 Assessing radiation characteristics	
1.	Evaluation of transmitter power, antenna gain and polarization
2.	Evaluation and optimizing antenna diagram
3.	Calculation of antenna power budget

In the preparatory phase not all station characteristics are known in detail, nor is it necessary to achieve a detailed initial network plan. The purpose is:

- To verify business plan and customer proposition;
- To be able to react to proposals from government or regulator in consultation with market parties (see phase 1, 2 and 3 of the regulator’s flowchart in chapter 6.1), in the case where the preparatory phase has been started before the licence procedure has been published;
- To have sufficient information for a successful licence application.

The preparatory phase ends with a set of documents describing the service proposition, business plan and an initial network plan. This should be finalized in time for the licence application.

6.2.2.2 Planning

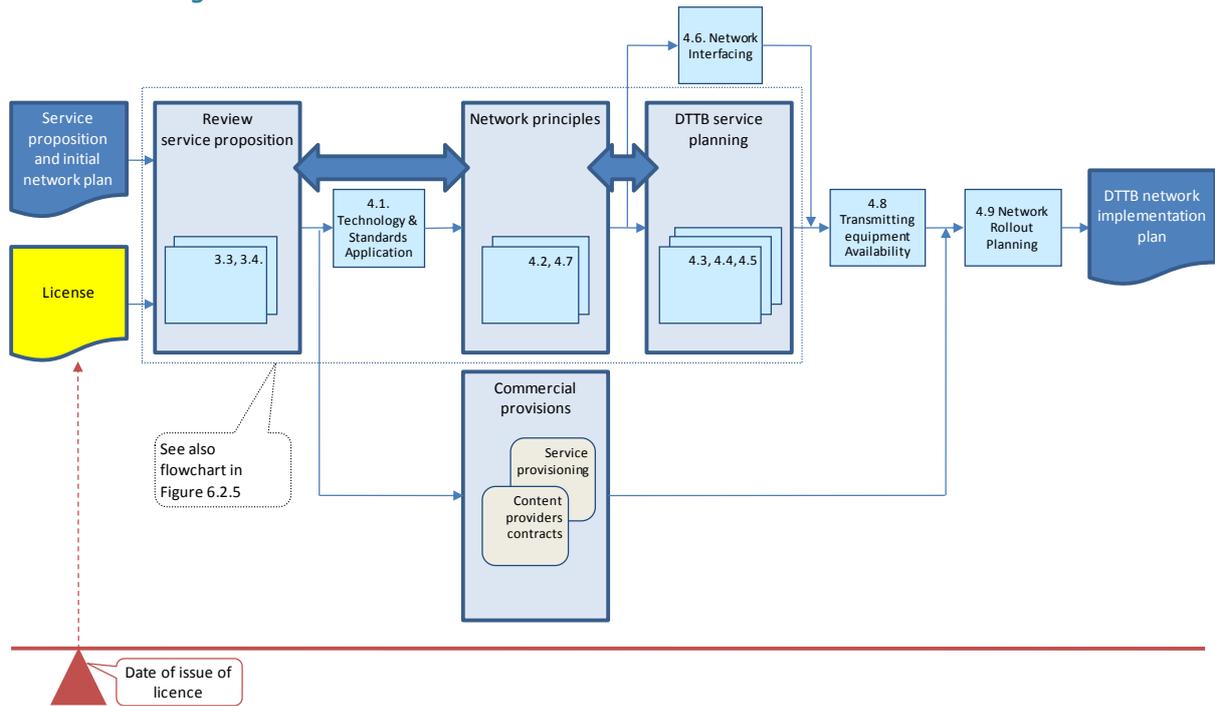


Figure 6.2.6: Phase 2 of the roadmap; planning

Input data

The planning phase starts when the licence has been issued. License conditions and the service proposition, business plan and initial network plan, resulting from phase 1, are the input data for phase 2.

Review service proposition

Depending on the licence conditions, customer proposition and business plan (functional block 3.2 and 3.4 respectively) may need to be reviewed, by carrying out appropriate activities from Tables 6.2.2 and 6.2.4 (see in section 6.2.3.1).

Commercial provisions

After review of customer proposition and business plan, the network operator will start the following commercial activities:

- Service provisioning;
- Contracting content providers.

Technology and standards application and initial network principles

In parallel with the commercial activities, the initial technical choices will be reviewed and defined in more detail by carrying out appropriate activities related to functional blocks:

- 4.1 Technology and standards application (see Table 6.2.5 in section 6.2.2.1);
- 4.2 Design principles and network architecture (see Table 6.2.6 in section 6.2.2.1);
- 4.7 Shared and common design principles (Table 6.2.7 in section 6.2.2.1).

DTTB service planning

Following the review of technical choices the DTTB service planning will be reviewed and defined in more detail by carrying out the activities related to functional blocks:

- 4.3 Network planning (see Table 6.2.8 in section 6.2.2.1);
- 4.4 System parameters (see Table 6.2.9 in section 6.2.2.1);
- 4.5 Radiation characteristics (see Table 6.2.10 in section 6.2.2.1).

As in the preparatory phase, this includes several iterative steps and possibly a review of the service proposition. The order of steps is similar as in Figure 6.2.5 in section 6.2.2.1).

Network interfacing

In parallel to service planning, the activities related to functional block 4.6 (Network interfacing) will be carried out (see Table 6.2.11).

Table 6.2.11: Main activities related to specifying network interfaces

4.6 Specifying network interfaces	
1.	Drafting interface specifications between studio and multiplex head end
2.	Drafting interface specifications between network monitoring system and transmitting equipment
3.	Describing the radio interface

Transmitting equipment availability

When the optimum network plan has been achieved and network interfaces have been specified, transmitting equipment availability will be considered and network roll out be planned by carrying out the activities related to functional blocks:

- 4.8 Transmitting equipment availability (see Table 6.2.12);
- 4.9 Network roll out planning (see Table 6.2.13).

Table 6.2.12: Main activities related to considering equipment availability

4.8 Considering equipment availability	
1.	Carrying out market research
2.	Drafting transmitter specifications
3.	Drafting antenna specifications
4.	Drafting distribution link specifications
5.	Drafting multiplex head end specification
6.	Equipment testing

Table 6.2.13: Main activities related to planning network roll out

4.9 Network roll out planning	
1.	Describing pilot tests
2.	Roll out planning (e.g. main cities, provincial cities, rural areas), before and after ASO
3.	Agreement with receiver manufacturers to deliver receivers in sufficient quantities, in time
4.	Coverage assessment at each stage of implementation
5.	Setting up communication plan and related provisions (e.g. helpdesk, website)

The planning phase ends with a set of documents describing the DTTB network implementation plan.

6.2.2.3 Implementation

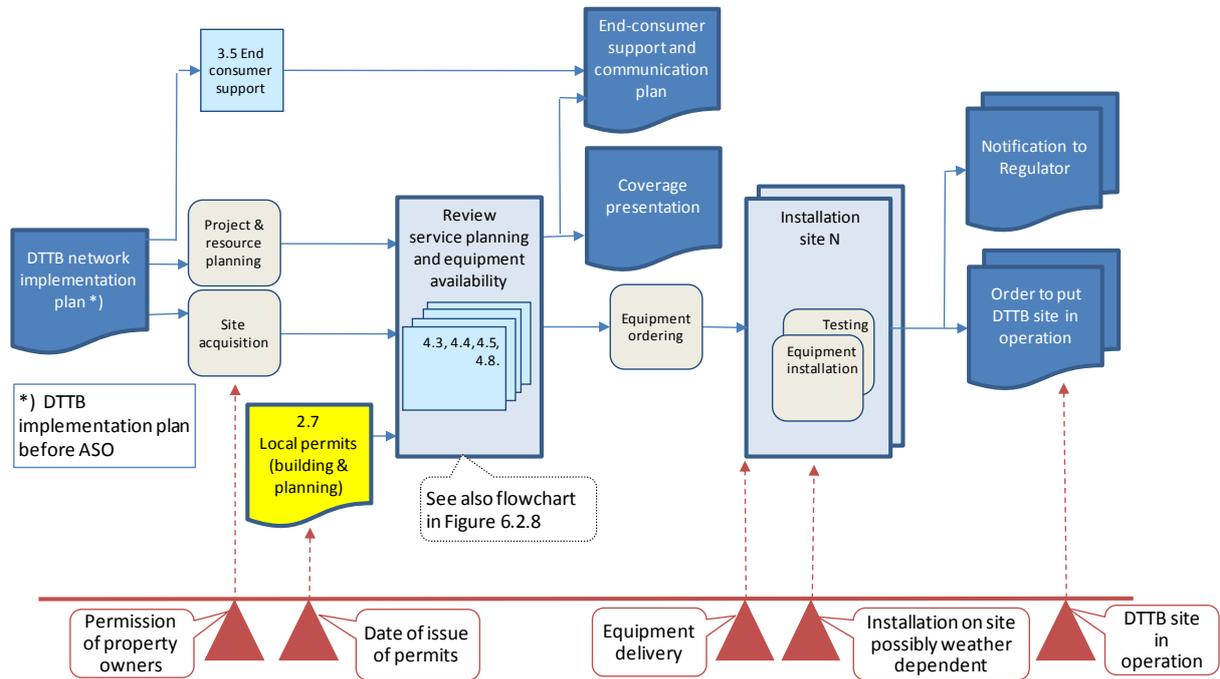


Figure 6.2.7: Phase 3 of the roadmap; Implementation

Input data

The implementation phase of the DTTB network starts when the network implementation plan, resulting from phase 2 of the roadmap has been adopted. A number of DTTB stations contained in this plan probably have temporal restrictions, necessary to protect analogue TV during transition.

Project- and resource planning and site acquisition

On the basis of the DTTB network implementation plan, project and resources planning and site acquisition will start and local building and planning permits need to be acquired.

Review of service planning and transmission equipment availability

In carrying out the above mentioned activities, modifications to the network implementation plan may have to be accepted. For instance site acquisition may not be successful; or a new site may be realized at a different location than assumed in the DTTB network implementation plan. It may also happen that in the detailed project planning antenna heights or diagrams are specified differently than originally assumed. In such cases, service planning and equipment availability needs to be reviewed by carrying out the appropriate activities relating to the following functional blocks:

- 4.3 Network planning (see Table 6.2.7 in section 6.2.2.1);
- 4.4 System parameters (see Table 6.2.8 in section 6.2.2.1);
- 4.5 Radiation characteristics (see Table 6.2.9 in section 6.2.2.1);
- 4.8 Transmitting equipment availability (see Table 6.2.12 in section 6.2.2.2).

This includes several iterative steps as shown in Figure 6.2.8.

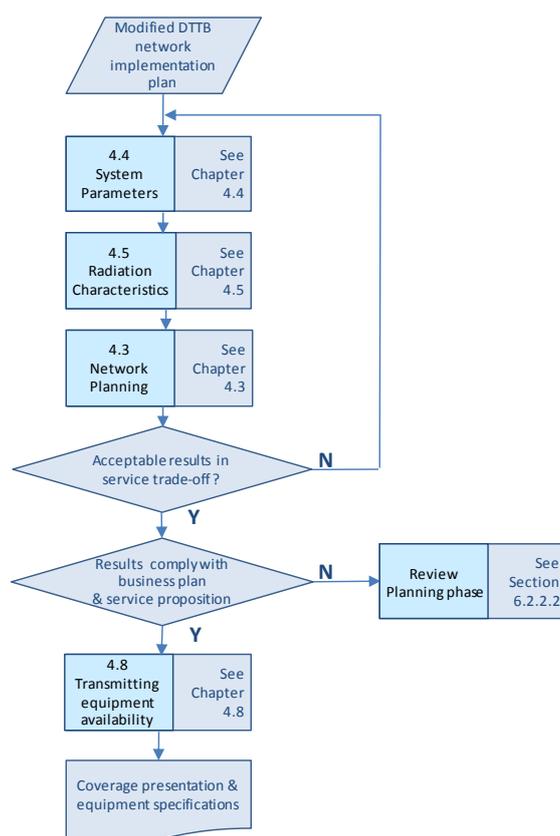


Figure 6.2.8: Flowchart for reviewing service planning and transmitting equipment availability

If the results of the review of the service planning do not comply anymore with the customer proposition or business plan, the planning phase should be reviewed.

When the optimum set of station characteristics has been obtained, the equipment specifications will be reviewed and detailed coverage presentations will be made. The latter will be used for communication to public and content providers to show reception possibilities in the various implementation stages.

Equipment ordering

On the basis of the equipment specifications, equipment tender procedures will be initiated. After comparing several offers, suppliers will be selected and equipment ordered.

Consumer support

Before a site is brought into use, the end-consumers in the related coverage area should be informed about the new digital services and the necessary receiving equipment by addressing functional block 3.5 (End consumer support). The main activities are listed in Table 6.2.14.

Table 6.2.14: Main activities related to defining end consumer support

3.5 Defining end consumer support	
1.	Check relationships with ASO plan and communication and determine impact
2.	Consult and carry out 'Road shows' for Device Creators (i.e. manufacturers and retailers), Content Aggregators, and for MTV also mobile operators
3.	Draft end-consumer support and communication plan and determine means and budget, possibly align business planning

Installation

When the equipment has been delivered, installation of transmitting equipment starts, followed by site acceptance tests.

During the installation stage it could happen that, for unexpected reasons, stations cannot be installed as planned. In that case, the DTTB implementation plan may need to be reviewed in order to provide information on the consequences of the changes and to prepare amended coverage presentations.

The installation work should be planned in such a way that the transmitters can be put into operation at the agreed date, taking into account that some sites may be inaccessible during certain periods of the year.

When installation of a station has been completed, the regulator will be notified that the station will be put into operation in accordance with the licence terms and conditions.

6.2.2.4 Analogue switch-off

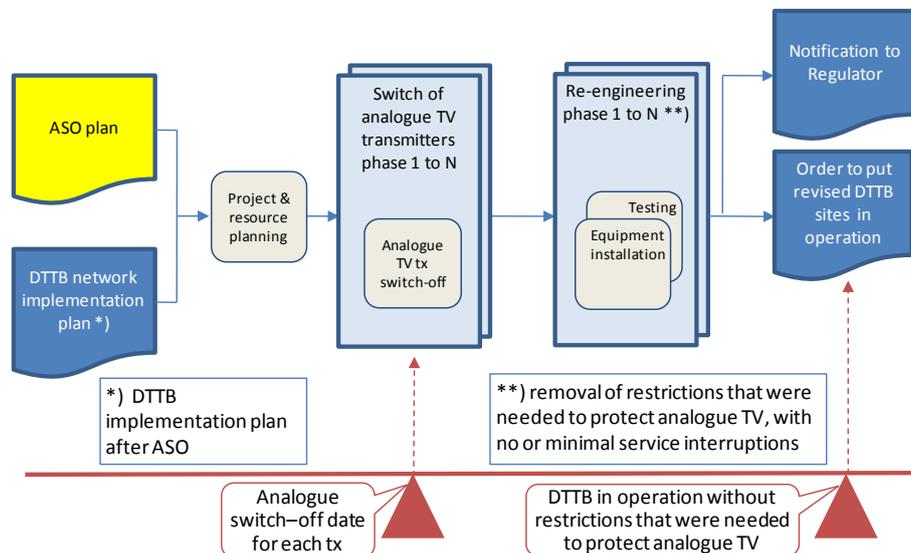


Figure 6.2.9: Phase 4 of the roadmap; Analogue switch-off

Input data

The analogue switch-off phase starts during the transition period in accordance with the ASO planning and milestones documents. The DTTB station characteristics during and after simulcasting are contained in the DTTB network implementation plan resulting from phase 2 of the roadmap.

Project and resource planning and analogue switch-off

Switching-off analogue TV transmitters will be carried out in accordance with the ASO planning provided by the Regulator.

Re-engineering

After switch-off, re-engineering of the sites begins. These activities may consist of three parts:

- Removal of superfluous analogue TV equipment;
- Modification of radiation characteristics in order to remove restrictions that were needed to protect analogue TV;

- Installation of additional DTTB or MTV transmitters that are licensed after analogue switch-off.

Normally it is required to carry out these activities with minimal interruptions of the DTTB services.

When the re-engineering work has been completed, the regulator will be notified that the station has been modified in accordance with the licence terms and condition specified for the situation after analogue switch-off.

6.2.3 Implementation guideline

Each player in the value chain (see Figure 1.2.3 in chapter 1.2) should select for each of the four phases of DTTB network operator's roadmap:

- the functional building blocks that are within the operational responsibility of the organization;
- the functional building blocks that are within the operational responsibility of other players of the value chain in order determine where interfaces and service agreements are needed;
- the functional building blocks, within the responsibility of government and/or regulator, that are inputs to a).

Furthermore, it has to be estimated to what extent key topics and choices of the selected building blocks have to be considered and the activities that have to be carried out, taking into account:

- The status of implementation of the regulator's roadmap;
- Market situation, including already licensed DTTB transmissions and competing offers by satellite, cable or IPTV;
- Existing transmitter network infrastructure;
- Responsibilities of regulator and licence holder regarding technology choices and network planning.

A realistic time schedule for the whole process needs to be established, taking into account that a number of mile stones in the process is not or not entirely in the control of the network operator such as:

- Publication of the licence procedure, describing the way licences are assigned and may include applicable standards and site sharing regulations;
- Issue of the licence, with terms and conditions prescribing, among others, service roll out obligations and permitted frequency use;
- Analogue switch-off planning and mile stones prescribing start of simulcast and analogue switch-off dates;
- Building and planning permits from local authorities for setting up new sites or changing existing sites;
- Permission of property owners to use property for setting up new sites or changing existing sites;
- Equipment delivery times;
- Installation periods, seasonal weather conditions may restrict access to some sites.

The starting point should preferably be in an early stage of implementation of the regulator's roadmap (see chapter 6.1) in order to be able to react to proposals from government or regulator in consultation with market parties. Latest moment for start is when the licence procedure has been published and a licence application can be submitted.

6.3 Roadmap for introduction MTV by a network operator

Chapter 6.3 provides background information and guidelines on key topics and choices regarding the preparation of a roadmap for introduction of MTV a network operator. The chapter consists of three sections:

- 6.3.1 Construction of a roadmap;
- 6.3.2 Generic roadmap for introduction of MTV by a network operator;
- 6.3.3 Implementation guidelines.

6.3.1 Construction of a roadmap

The roadmap for introduction of MTV by a network operator consists of three phases:

1. Preparation
The preparatory phase starts when the regulator is preparing the licensing policy and regulation (See phase 1, 2 and 3 of the regulator's roadmap in chapter 6.1). The aim of the preparations is to apply successfully for a MTV licence.
2. Planning
The planning phase starts at the date of issue of the licence and ends with the adoption of the network implementation plan. This plan describes station characteristics and a time schedule for implementation.
3. Implementation
The implementation phase is the follow-up of the planning phase and ends when all MTV transmitters are operational.

Contrary to the roadmap for transition to DTTB by a network operator (see chapter 6.2), analogue switch-off (ASO) is not an integral part of the MTV introduction process. Consequently, the MTV roadmap has no phase regarding ASO. However, MTV frequencies may only be licensed when ASO is in an advanced stage, or completed.

In each phase, a number of functional blocks (see Figure 1.2.1. of chapter 1.2) has to be addressed. Guidelines regarding key topics and choices of these functional blocks are described in the corresponding chapters.

For each of the functional blocks, the main activities for carrying out the function have to be identified together with the entity that is responsible for the activities. These main activities may be supplemented by main activities that are not specific for MTV, but are, nevertheless, necessary for a successful introduction of MTV. Examples of such non-specific MTV activities are:

- Service provisioning and contracting content providers;
- Project and resource planning;
- Site acquisition;
- Equipment installation.

The roadmap is constructed by placing, the relevant functional blocks in each phase in a logical order and in a time frame. It is important that the order of activities in each phase by the different players, including the regulator, fits with each other. Hence, for determining the order of the functional blocks, information exchange and negotiations between market parties and the regulator is essential.

A graphical illustration of the process described above is shown in Figure 6.3.1.

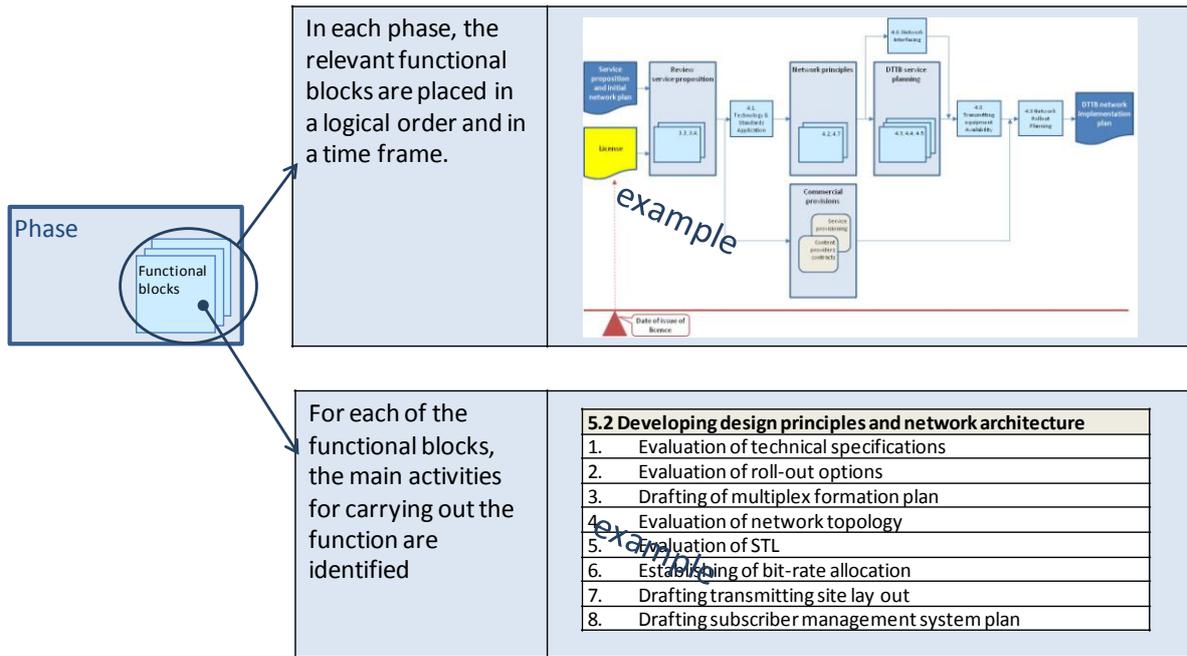


Figure 6.3.1: The process is described by phases and main activities

The functional blocks connected to each of the three phases of the roadmap are shown in Figure 6.3.2.

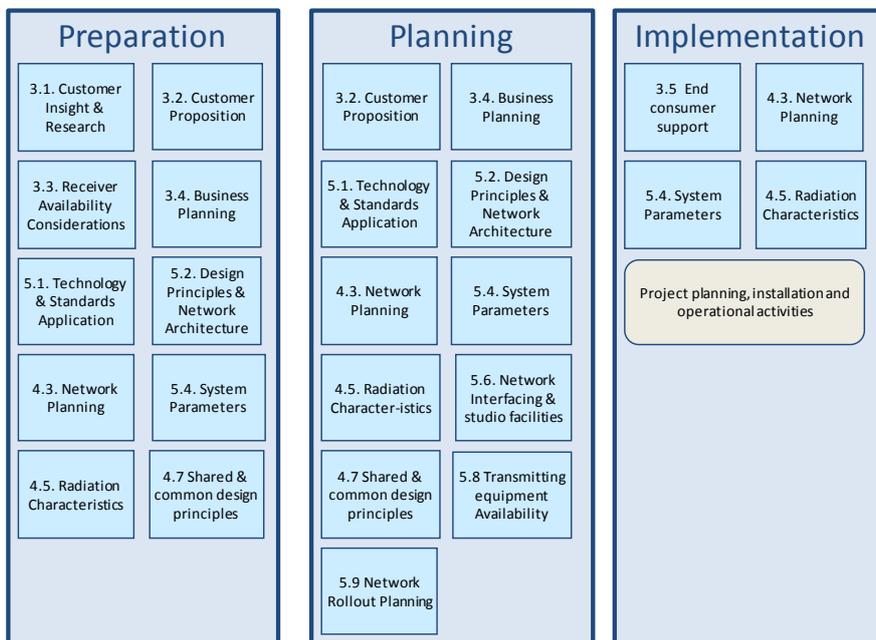


Figure 6.3.2: Functional blocks connected to each of the three phases of the network operator's roadmap for introduction of MTV

It should be noted that Figure 6.3.2 represents a generic case. The actual selection of functional blocks may differ from country to country.

Phases 1, 2 and 3 are carried out sequentially (see Figure 6.3.3).

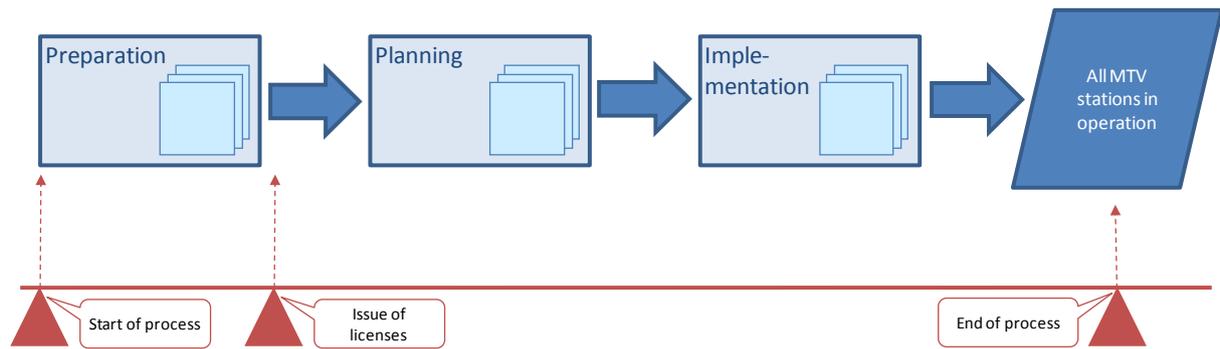


Figure 6.3.3: Interrelation between the three phases of the roadmap

The process ends when all MTV stations are in operation. However further evolution of the network is likely to take place resulting from the introduction of new services, regulatory obligations or technology changes.³

6.3.2 Generic roadmap for introduction of MTV by a network operator

In the roadmap shown in this section it has been assumed that one MTV network operator is involved, acting as multiplex operator, service provider and content distributor.

When multiplex operator, service provider, content distributor are different organizations, the order of the functions will not be different. However the interfaces between the respective parts of transmission chain need to be clearly defined and service agreements should cover a smooth hand-over of responsibilities.

The roadmap described in this chapter is for the case where the operator takes the technical decisions and performs the networks planning. In some countries the regulator has a broader role than in others. In cases where some of the technical choices e.g. standard and system choices or (part of) network planning is a responsibility of the regulator, the roadmap is not basically different. The network operator will still make his own assessments about service quality, coverage quality and radiation characteristics. Normally the network operator wishes to make these assessments with higher accuracy and in more detail than the regulator.

The three phases of the roadmap are described below.

³ See also Networks in evolution, making changes to the digital terrestrial television platform. DigiTAG, May 2008.

6.3.2.1 Preparations

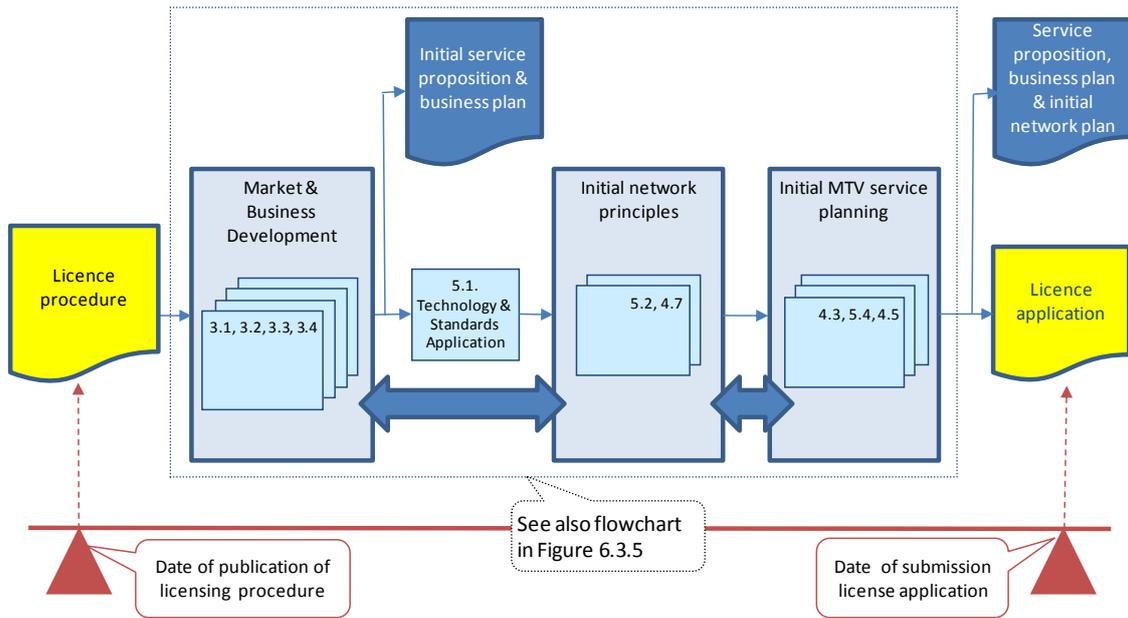


Figure 6.3.4: Phase 1 of the roadmap; preparations

Input data

In the roadmap shown above, the preparatory phase starts when the licence procedure has been published. This is the latest moment for the start. A start during the first three phases of the regulator’s roadmap (see chapter 6.1) has the advantage that well informed reactions can be given to proposals from government or regulator in consultation with market parties during:

1. DTTB/MTV policy development;
2. Analogue switch-off planning;
3. Licensing policy and regulation.

Market and business development

In the preparatory phase the network operator will first address market and business development by carrying out the activities related to functional blocks:

- 3.1 Customer insight and research (see Table 6.3.1);
- 3.2 Customer proposition (see Table 6.3.2);
- 3.3 Receiver availability considerations (see Table 6.3.3);
- 3.4 Business planning (see Table 6.3.4).

Table 6.3.1: Main activities related to investigate customer insight and carrying out market research

3.1 Investigation of customer insight and carrying out market research	
1.	Determine need, timing and scope for market research
2.	Analyse competitive offerings, substitutes and technology developments
3.	Design and develop preliminary DTTB and MTV service propositions
4.	Draft market research plan, staff and budget market research project
5.	Carry out market research and analyse results, translate into DTTB/MTV service propositions, if necessary carry out additional market research

Table 6.3.2: Main activities related to defining customer proposition

3.2 Defining customer proposition	
1.	Analyse earlier DTTB and MTV service launches and compare with customer research results/local market conditions
2.	Define DTTB/MTV service propositions and check feasibility/cost levels with key suppliers, i.e. Distributor (broadcast network operator) and Content Aggregators, Content Creators
3.	Possibly redefine DTTB/MTV service propositions and test in market again, i.e. additional market research

Table 6.3.3: Main activities related to carrying out receiver availability considerations

3.3 Carrying out receiver availability considerations	
1.	Analyse earlier DTTB and MTV service launches, assess local substitutes and technology developments
2.	Check any prescribed Technologies and Standards, Receiver regulations and analyse market research results
3.	Assess and make inventory of availability and roadmaps of various receiver types/attributes
4.	Check network compatibility and interoperability (radio interfaces and API/applications)
5.	Assess and detail ex-factory and retail pricing for various receivers
6.	Decide key receivers and their attributes, draft receiver/service roadmap

Table 6.3.4: Main activities related to performing business planning

3.4 Performing business planning	
1.	Analyse legal/regulatory framework (may include prescribed Technologies & Standards, Assignment Procedure, License Terms & Conditions, Business Models and Public Financing), determine impact and opportunities
2.	Assess market take-up and project revenue streams, based on customer research and proposition
3.	Assess and calculate associated costs (considering concepts of 'total cost of ownership'), project costs ahead
4.	Carry out profitability and sensitivity analysis, draft business plan scenarios
5.	Quantify total investments and their associated risks, assess financing and public funding possibilities, consider co-operation/joint venture/vendor financing/revenue sharing

The functional blocks 3.1 to 3.4 include some iteration as shown on the left hand side of the flowchart in Figure 6.3.5. The activities indicated above result in an initial customer proposition and business plan.

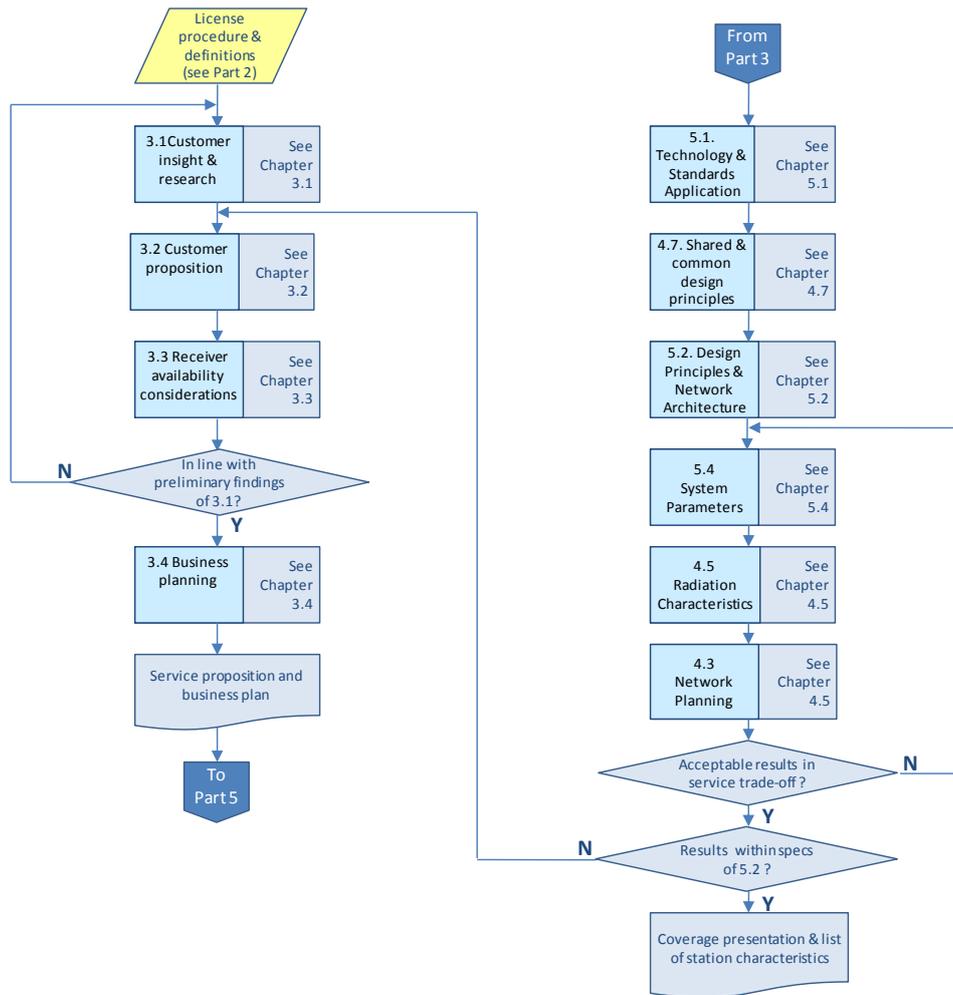


Figure 6.3.5: Flowchart for developing the service proposition and initial network plan

Technology and standards application and initial network principles

After the initial customer proposition and business plan have been approved, the activities related to the following functional block are carried out:

- 5.1 Technology and standards application (see Table 6.3.5);
- 5.2 Design principles and network architecture (see Table 6.3.6);
- 4.7 Shared and common design principles (see Table 6.3.7).

Table 6.3.5: Main activities related to technology and standards application

5.1 Technology and standards application	
1.	Collecting data of MTV standards
2.	Making comparison table of standards
3.	Planning services and channels
4.	Planning interactive services
5.	Evaluation of encryption system
6.	Evaluation of additional system and estimation of required bit-rate for each services
7.	Case studying in the other regions
8.	Selecting a suitable technology of MTV for each cases

Table 6.3.6: Main activities related to developing design principles and network architecture

5.2 Developing design principles and network architecture	
1.	Evaluation of technical specifications
2.	Evaluation of roll-out options
3.	Drafting of multiplex formation plan
4.	Evaluation of network topology
5.	Evaluation of STL
6.	Establishing of bit-rate allocation
7.	Drafting transmitting site lay out
8.	Drafting subscriber management system plan

Table 6.3.7: Main activities related to deciding shared and common design principles

4.7 Deciding shared and common design principles	
1.	Investigate national regulations regarding site sharing
2.	Determine in principle shared use of DTTB and MTV networks and which elements (sites, antennas, multiplex)
3.	Determine in principle on common design and planning of DTTB and MTV networks
4.	Prepare site sharing agreements

Initial MTV service planning

In the next series of activities an initial MTV network plan is developed, which includes several iterative steps and possibly a review of the service proposition and business plan, technology choices and network principles (see in Figure 6.3.5).

For drafting the initial network plan, the activities related to the following functional blocks are carried out:

- 4.3 Network planning (see Table 6.3.8);
- 5.4 System parameters (see Table 6.3.9);
- 4.5 Radiation characteristics (see Table 6.3.10).

Table 6.3.8: Main activities related to performing network planning

4.3 Performing network planning	
1.	Specification of station characteristics
2.	Coverage analysis
3.	SFN optimization
4.	Performing GE06 (annex 4, section II) conformity check
5.	Gap-filler planning
6.	Proposing modifications to multiplex composition, network architecture or business plan (as far as needed)

Table 6.3.9: Main activities related to determining system parameters

5.4 Determining system parameters	
1.	Evaluation of FFT size (4k or 8k)
2.	Evaluation of carrier modulation
3.	Evaluation of code rate
4.	Evaluation of guard interval

Table 6.3.10: Main activities related to assessing radiation characteristics

4.5 Assessing radiation characteristics	
1.	Evaluation of transmitter power, antenna gain and polarization
2.	Evaluation and optimizing antenna diagram
3.	Calculation of antenna power budget

In the preparatory phase not all station characteristics are known in detail, nor is it necessary to achieve a detailed initial network plan. The purpose is:

- To verify business plan and customer proposition;
- To be able to react to proposals from government or regulator in consultation with market parties (see phase 1, 2 and 3 of the regulator’s flowchart in chapter 6.1), in the case where the preparatory phase has been started before the licence procedure has been published;
- To have sufficient information for a successful licence application.

The preparatory phase ends with a set of documents describing the service proposition, business plan and an initial network plan. This should be finalized in time for the licence application.

6.3.3.2 Planning

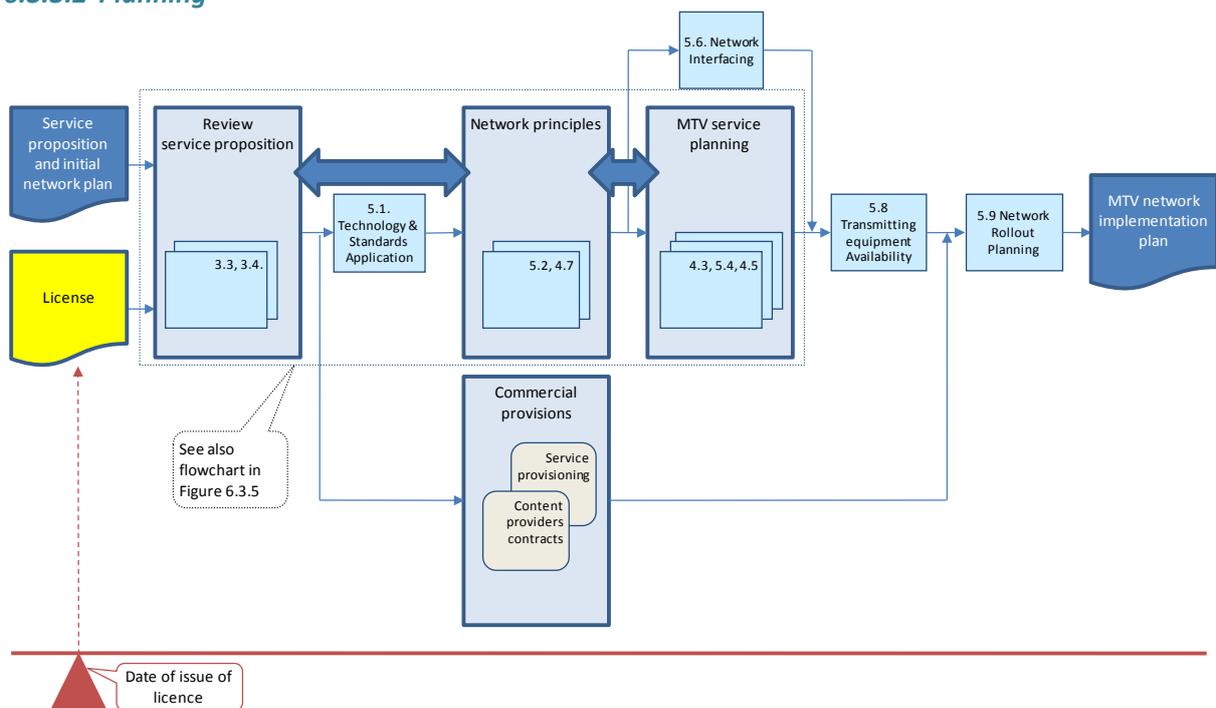


Figure 6.3.6: Phase 2 of the roadmap; planning

Input data

The planning phase starts when the licence has been issued. License conditions and the service proposition, business plan and initial network plan, resulting from phase 1, are the input data for phase 2.

Review service proposition

Depending on the licence conditions, customer proposition and business plan (functional block 3.2 and 3.4, respectively) may need to be reviewed, by carrying out appropriate activities from Tables 6.3.2 and 6.3.4 (see in section 6.3.2.1).

Commercial provisions

After review of customer proposition and business plan, the network operator will start the following commercial activities:

- Service provisioning;
- Contracting content providers.

Technology and standards application and initial network principles

In parallel to the commercial activities, the initial technical choices will be reviewed and defined in more detail by carrying out appropriate activities related to functional blocks:

- 5.1 Technology and standards application (see Table 6.3.5 in section 6.3.2.1);
- 5.2 Design principles and network architecture (see Table 6.3.6 in section 6.3.2.1);
- 4.7 Shared and common design principles (Table 6.3.7 in section 6.3.2.1).

MTV service planning

Following the review of technical choices the MTV service planning will be reviewed and defined in more detail by carrying out the activities related to functional blocks:

- 4.3 Network planning (see Table 6.3.8 in section 6.3.2.1);
- 5.4 System parameters (see Table 6.3.9 in section 6.3.2.1);
- 4.5 Radiation characteristics (see Table 6.3.10 in section 6.3.2.1).

As in the preparatory phase, this includes several iterative steps and possibly a review of the service proposition. The order of steps is similar to Figure 6.3.5 in section 6.3.2.1).

Network interfacing and studio facilities

In parallel to service planning, the activities related to functional block 4.6 (Network interfacing) will be carried out (see Table 6.3.11 below).

Table 6.3.11: Main activities related to specifying network interfaces

4.6 Specifying network interfaces and studio requirements	
1.	Drafting interface specifications between studio and multiplex head end
2.	Drafting interface specifications between network monitoring system and transmitting equipment
3.	Using existing full digital studio or preparing analogue to digital converters
4.	Preparing system and space for additional service

Transmitting equipment availability

When the optimum network plan has been achieved and network interfaces have been specified, transmitting equipment availability will be considered and network roll out be planned by carrying out the activities related to functional blocks:

- 5.8 Transmitting equipment availability (see Table 6.3.12);
- 5.9 Network roll out planning (see Table 6.3.13).

Table 6.3.12: Main activities related to considering equipment availability

5.8 Considering equipment availability	
1.	Drafting transmitter specifications
2.	Drafting antenna specifications
3.	Drafting distribution link specifications
4.	Drafting multiplex head end specification
5.	Equipment testing

Table 6.3.13: Main activities related to planning network roll out

5.9 Network roll out planning	
1.	Describing pilot tests
2.	Roll out planning (e.g. main cities, provincial cities, rural areas)
3.	Agreement with receiver manufacturers to deliver receivers in sufficient quantities, in time
4.	Gap filler implementation planning
5.	Coverage assessment at each stage of implementation
6.	Setting up communication plan and related provisions (e.g. helpdesk, website)

The planning phase ends with a set of documents describing the MTV network implementation plan.

6.3.3.3 Implementation

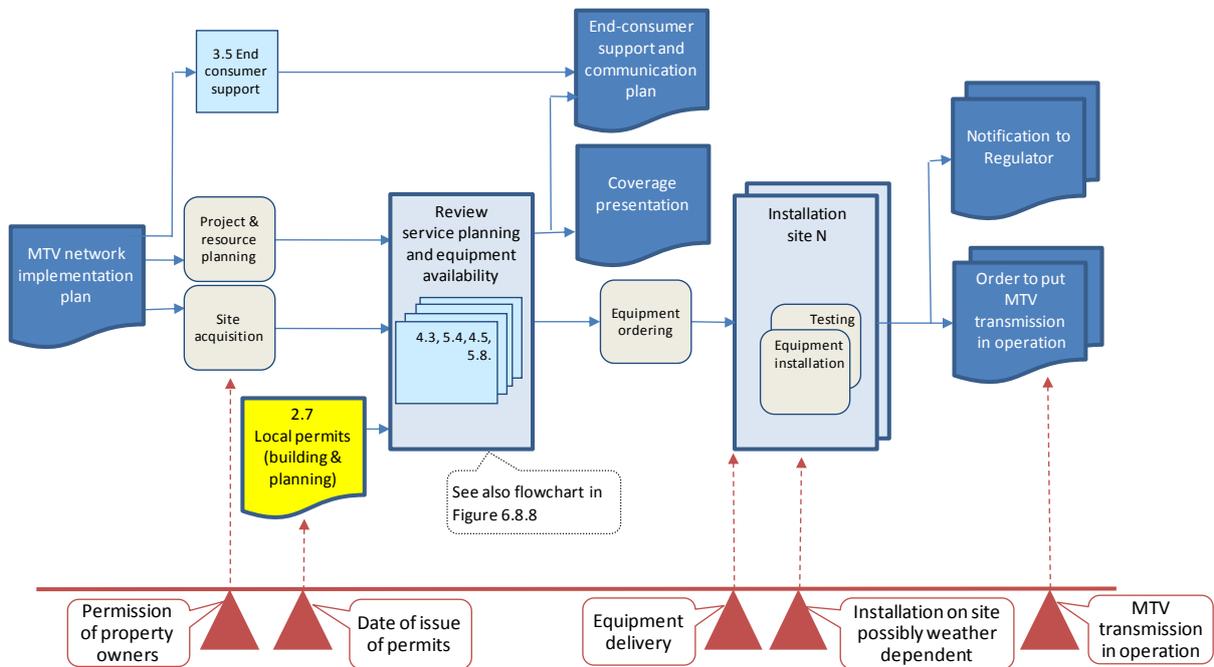


Figure 6.3.7: Phase 3 of the roadmap; Implementation

Input data

The implementation phase of the MTV network starts when the network implementation plan, resulting from phase 2 of the roadmap has been adopted.

Project- and resource planning and site acquisition

On the basis of the MTV network implementation plan, project and resources planning and site acquisition will start and local building and planning permits need to be acquired.

Review of service planning and transmission equipment availability

In carrying out the above mentioned activities, modifications to the network implementation plan may have to be accepted. For instance, site acquisition may not be successful; or a new site may be realized at a different location than assumed in the MTV network implementation plan. It may also happen that, in the detailed project planning, antenna heights or diagrams are specified differently than originally assumed. In such cases service planning and equipment availability needs to be reviewed by carrying out the appropriate activities relating to the following functional blocks:

- 4.3 Network planning (see Table 6.3.7 in section 6.3.2.1);
- 5.4 System parameters (see Table 6.3.8 in section 6.3.2.1);
- 4.5 Radiation characteristics (see Table 6.3.9 in section 6.3.2.1);
- 5.8 Transmitting equipment availability (see Table 6.3.12 in section 6.3.2.2).

This includes several iterative steps as shown in Figure 6.3.8.

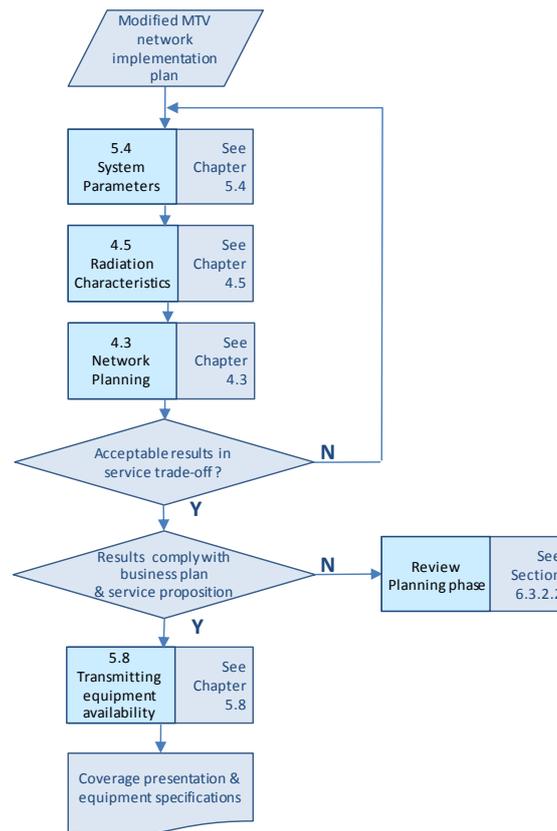


Figure 6.3.8: Flowchart for reviewing service planning and transmitting equipment availability

If the results of the review of the service planning do not comply anymore with the customer proposition or business plan, the planning phase should be reviewed.

When the optimum set of station characteristics has been obtained, the equipment specifications will be reviewed and detailed coverage presentations will be made. The latter will be used for communication to public and content providers to show reception possibilities in the various implementation stages.

Equipment ordering

On the basis of the equipment specifications, equipment tender procedures will be initiated. After comparing several offers, suppliers will be selected and equipment ordered.

Consumer support

Before a site is brought into use the end-consumers in the related coverage area should be informed about the new digital services and the necessary receiving equipment by addressing functional block 3.5 (End consumer support). The main activities are listed in Table 6.3.14.

Table 6.3.14: Main activities related to defining end consumer support

3.5 Defining end consumer support	
1.	Check relationships with ASO plan and communication and determine impact
2.	Consult and carry out 'Road shows' for Device Creators (i.e. manufacturers and retailers), Content Aggregators, and for MTV also mobile operators
3.	Draft end-consumer support and communication plan and determine means and budget, possibly align business planning

Installation

When the equipment has been delivered, installation of transmitting equipment starts, followed by site acceptance tests.

During the installation stage it could happen that, for unexpected reasons, stations cannot be installed as planned. In that case, the MTV implementation plan may need to be reviewed in order to provide information on the consequences of the changes and to prepare amended coverage presentations.

The installation work should be planned in such a way that the transmitters can be put into operation at the agreed date, taking into account that some sites may be inaccessible during certain periods of the year.

When installation of a station has been completed, the regulator will be notified that the station will be put into operation in accordance with the licence terms and conditions.

6.3.3 Implementation guideline

Each player in the value chain (see Figure 1.2.3 in chapter 1.2) should select for each of the four phases of the network operator's roadmap:

- a) the functional building blocks that are within the operational responsibility of the organization;
- b) the functional building blocks that are within the operational responsibility of other players of the value chain in order determine where interfaces and service agreements are needed;
- c) the functional building blocks, within the responsibility of government and/or regulator, that are inputs to a).

Furthermore it has to be estimated to what extent key topics and choices of the selected building blocks have to be considered and consequently the activities that have to be carried out, taking into account:

- The status of implementation of the regulator's roadmap;
- Market situation, including already licensed MTV transmissions, existing or planned DTTB networks and competing offers by mobile operators;
- Existing transmitter network infrastructure;
- Responsibilities of regulator and licence holder regarding technology choices and network planning.

A realistic time schedule for the whole process needs to be established, taking into account that a number of mile stones in the process is not or not entirely in the control of the network operator such as:

- Publication of the licence procedure, describing the way licences are assigned and may include applicable standards and site sharing regulations;
- Issue of the licence, with terms and conditions prescribing among others service roll out obligations and permitted frequency use;
- Building and planning permits from local authorities for setting up new sites or changing existing sites;
- Permission of property owners to use property for setting up new sites or changing existing sites;
- Equipment delivery times;
- Installation periods, seasonal weather conditions may restrict access to some sites.

The starting point should preferably be in an early stage of implementation of the regulator's roadmap (see chapter 6.1) in order to be able to react to proposals from government or regulator in consultation with market parties. Latest moment for start is when the licence procedure has been published and a licence application can be submitted.

Glossary of abbreviations

API	Application Programme Interface
ASO	Analogue Switch-Off
DTTB	Digital Terrestrial Television Broadcasting
EMC	Electro-magnetic compatibility
FFT	Fast Fourier Transform
FTA	Free to air
GE06	Geneva Agreement of 2006
ITU	International Telecommunication Union
ITU-BR	International Telecommunication Union - Radiocommunication Bureau
ITU-R	International Telecommunication Union - Radiocommunication Sector
MTV	Mobile Television
SFN	Single Frequency Network
STL	Studio-Transmitter Link

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		2	3	4	5
EC	Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. EU spectrum policy priorities for the digital switchover in the context of the upcoming ITU Regional Radiocommunication Conference 2006 (RRC-06) COM(2005) 461, Brussels 29.9.2005.	x			
EC	COMMUNICATION FROM THE COMMISSION TO THE COUNCIL, THE EUROPEAN PARLIAMENT, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on the transition from analogue to digital broadcasting (from digital 'switchover' to analogue 'switch-off') COM(2003) 541 final.	x			
EC	Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Reaping the full benefits of the digital dividend in Europe: A common approach to the use of the spectrum released by the digital switchover; COM(2007) 700 final, Brussels, 13.11.2007.	x			
EC	A BIPE consulting study for the European Commission, Digital Switchover in Broadcasting (Final Report, April 2002).	x			
EC	Study on the Regulation of Broadcasting Issues under the New Regulatory Framework, prepared for the EC by Cullen International SA.	x			
EC	European Parliament Mobile TV Study; TNO October 2007.	x			
EC	European Mobile Broadcasting Council; Technical Workstream document. Final version (January 2007).				x
ETSI	ETSI EN 300 401 Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers.				x
ETSI	ETSI EN 300 744 Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television.			x	
ETSI	ETSI EN 300 813 specifies the transmission of MPEG-2 Transport Streams (TS) between two DVB interfaces within Plesiochronous Digital Hierarchy (PDH) networks working in accordance with ITU-T Recommendation G.702.			x	x
ETSI	ETSI EN 301 234: "Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) protocol".				x
ETSI	ETSI EN 302 296 (Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the digital television broadcast service, Terrestrial (DVB-T).			x	
ETSI	ETSI EN 302 304 Digital Video Broadcasting (DVB); Transmission System for Hand held Terminals (DVB-H).				x
ETSI	ETSI ES 201 735 V1.1.1 (2000-09): "Digital Audio Broadcasting (DAB); Internet Protocol (IP) Datagram Tunneling".				x
ETSI	ETSI ETS 300 797: "Digital Audio Broadcasting; Distribution interfaces; Service Transport Interface (STI)".				x
ETSI	ETSI ETS 300 799: "Digital Audio Broadcasting; Distribution interfaces; Ensemble Transport Interface (ETI)".				x
ETSI	ETSI ETS 300 814 specifies the transmission of MPEG2 Transport Streams (TS) between two DVB interfaces within Synchronous Digital Hierarchy (SDH) networks working in accordance with ITU-T Recommendation G.707			x	x
ETSI	ETSI TS 101 759: "Digital Audio Broadcasting (DAB); Data Broadcasting - Transparent Data Channel (TDC)".				x

Source	Title	Related Part			
		2	3	4	5
ETSI	ETSI TS 102 368: "Digital Audio Broadcasting (DAB); DAB - TMC (Traffic Message Channel)".				x
ETSI	ETSI TS 102 371: "Digital Audio Broadcasting (DAB); Transportation and Binary Encoding Specification for DAB Electronic Programme Guide (EPG)".				x
ETSI	ETSI TS 102 428 Digital Audio Broadcasting (DAB); DMB video service; User Application Specification.				x
ETSI	ETSI TS 102 468 V1.1.1 (2007-11); Digital Video Broadcasting (DVB); IP Datacast over DVB-H; Set of Specifications for Phase 1.			x	
ETSI	ETSI TS 102 818: "Digital Audio Broadcasting (DAB); XML Specification for DAB Electronic Programme Guide (EPG)"				x
ETSI	ETSI TR 100 815 Digital Video Broadcasting (DVB); Guidelines for the handling of Asynchronous Transfer Mode (ATM) signals in DVB systems.			x	x
ETSI	ETSI TR 101 89, 1Digital Video Broadcasting (DVB); Professional Interfaces: Guidelines for the implementation and usage of the DVB Asynchronous Serial Interface (ASI).			x	x
ETSI	ETSI TR 101 190 Digital Video Broadcasting (DVB);Implementation guidelines for DVB terrestrial services; Transmission aspects.			x	
ETSI	ETSI TR 101 496-3 V1.1.2 (2001-05) DAB guidelines and rules for implementation and operation part-3 broadcasting network.				x
ETSI	ETSI TR 102 377 V1.4.1 (2009-06) Digital Video Broadcasting (DVB); DVB-H Implementation Guidelines.				x
ETSI	ETSI TR 102 401 V1.1.1 (2005-05) Digital Video Broadcasting (DVB); Transmission to Handheld Terminals (DVB-H); Validation Task Force Report.				x
ITU-D	ITU-D SG2, REPORT on Question 11-1/2 for 2005. Examination of digital broadcasting technologies and systems, including cost/benefit analyses, interoperability of digital terrestrial systems with existing analogue networks, and methods of migration from analogue terrestrial techniques to digital techniques.	x	x	x	x
ITU-D	ITU-D SG2, REPORT on Question 11-2/2 (interim report, 2008). Examination of terrestrial digital sound and television broadcasting technologies and systems, including cost/benefit analyses, interoperability of digital terrestrial systems with existing analogue networks. 22 August 2008	x	x	x	x
ITU-R	Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06).	x		x	x
ITU-R	Recommendation ITU-R BT.419 Directivity and polarization discrimination of antennas in the reception of television broadcasting.			x	
ITU-R	Recommendation ITU-R BT.655 Radio-frequency protection ratios for AM vestigial sideband terrestrial television systems interfered with by unwanted analogue vision signals and their associated sound signals.			x	
ITU-R	Recommendation ITU-R BT.656 Interfaces for digital component video signal in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601 (Part A).			x	
ITU-R	Recommendation ITU-R BT.1306 Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting.			x	
ITU-R	Recommendation ITU-R BT.1368 Planning criteria for digital terrestrial television services in the VHF/UHF bands.			x	

Source	Title	Related Part			
		2	3	4	5
ITU-R	Recommendation ITU-R BT.1833 Broadcasting of multimedia and data applications for mobile reception by handheld receivers.				x
ITU-R	Recommendation ITU-R P.1058 Digital topographic databases for propagation studies.			x	
ITU-R	Recommendation ITU-R P.1546-3; Method for point-to-area predictions for terrestrial services in the frequency range 30MHz to 3000MHz.			x	
ITU-R	Recommendation ITU-R P.1812 A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands.			x	
ITU-R	Report ITU-R BT.2035 Guidelines and techniques for the evaluation of digital terrestrial television broadcasting systems.			x	
ITU-R	Report ITU-R BT.2140 Transition from analogue to digital terrestrial broadcasting.		x	x	
ITU-T	Recommendation ITU-T G.703 Physical/electrical characteristics of hierarchical digital interfaces.			x	x
ITU-T	Recommendation ITU-T G.704 Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels.			x	x

Useful websites

Source	Title	Related Part			
		2	3	4	5
BMCO forum	www.bmco-berlin.com/				x
CEPT	www.ero.dk/	x		x	x
Digitag	www.digitag.org/	x	x	x	x
DMB alliance	http://dmb-alliance.org/				x
DMB portal	http://eng.t-dmb.org/				x
DVB	www.dvb.org/ www.dvb-h.org/	x	x	x	x
EBU	http://tech.ebu.ch/	x	x	x	x
EC	http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/index_en.htm	x	x		
ETSI	www.etsi.org/WebSite/homepage.aspx			x	x
ITU-D	www.itu.int/net/ITU-D/index.aspx	x	x	x	x
ITU-R	www.itu.int/ITU-R/index.asp?category=information&rlink=rhome&lang=en	x	x	x	x
ITU-T	www.itu.int/ITU-T/index.html			x	x
World-DMB	www.worlddab.org/				x

Annex A

Guidelines for Migration of Broadcast Archives from Analogue to Digital

Foreword

These guidelines have been prepared as a supplement to the ITU Guidelines on the Transition from Analogue to Digital Broadcasting. Consistent with the approach taken in the Transition Guidelines, the current supplement on Migration of Broadcast Archives from Analogue to Digital is intended as a basis upon which users can develop a roadmap for the migration of their archives from analogue to digital.

The Transition Guidelines are mostly concerned with the conversion of the radio frequency elements of the broadcast chain, that is the conversion of the means of transmission from analogue to digital and its impact on spectrum, government, broadcasters, the public, and others. They do not address the question of transition of analogue studio equipment to digital technology. This process is already well underway within broadcasting studios and virtually all equipment available today uses digital technology. Studio migration is therefore generally inevitable if not already accomplished; however, broadcasters across the world have many years of programme content stored in their archives in analogue formats. Many of these formats are now obsolete and the equipment to retrieve the content will become increasingly scarce and difficult to maintain. At the same time, the media (tape etc) upon which this content has been recorded deteriorates over time and unless it is kept in ideal environmental conditions, may already be near end of life.

Much of the material contained in these archives may be of significant historical and cultural significance to the countries in which it was created. The ITU and other UN Agencies have long recognized the importance of preservation of this material and the World Telecommunications Development Conference (WTDC 10) identified assistance to broadcasters in the migration of archives from analogue to digital as a broadcasting development priority.

These guidelines were prepared by Australian expert, Mr Colin Knowles, as part of a project to update the digital broadcast migration guidelines prepared for Africa to reflect the different requirements of the Asia Pacific.

These guidelines focus on the broader strategic and operational questions of archives migration, including the benefits that can flow from migration in addition to the basic proposition of preservation of historical programme content. The guidelines, do not attempt to provide the technical solutions to archives migration because those solutions will depend very much on local needs, resources and available funds. Further assistance with identification of technical solutions is widely available from equipment suppliers, broadcasting organizations, and other sources.

List of abbreviations

EBU	European Broadcasting Union
CODEC	Coder Decoder
HDTV	High Definition Television
IT	Information Technology
ITU	International Telecommunications Union
MPEG	Motion Picture Experts Group
MXF	Material Exchange Format
PC	Personal Computer
SDTV	Standard Definition Television

A.1 Introduction

The Oxford English Dictionary defines “archives” as “a place in which public records or other important historic documents are kept”. This tends to suggest that archives are essentially static repositories of historical significance. Broadcast archives are certainly repositories for the storage of old programmes, but this is only one part of the function of the archives. Other functions of the archives include:

- Support of production and postproduction work flows by providing indexes and resources to assist in locating relevant content for use in programmes, and for providing that content in a form suitable for use in the production;
- Providing information about Content including Intellectual Property Rights, and the details of the content of the stored programmes;
- Making the available archives programmes for broadcasting (in a format that is suitable to the prevailing technology of broadcast production and transmission);
- Making available programmes for programme exchange.

Analogue based broadcast archives have long performed these functions for both radio and television but the processes were usually manual labour intensive and involved creating multiple copies of content from the archives master so that it could be previewed by the programme makers to make a selection of the actual content they required. Many of these copies were discarded in the production process.

Broadcast programmes or the content that is used to create them is transitory, and is captured and retained on some form of storage media. During the past 80 years there have many different type of media used for storage of content. This ranges from early gramophone recordings, and movie film, through various different types of magnetic tape storage, with varying formats and different recording and playback devices, through to the more recent digital media of CD, DVD, and solid-state storage.

In the main, the transition from one type of media to another has been driven by significant improvements in technology and capability. This onward march of technology is unlikely to relent, and if anything, the pace of technological advancement in storage media is likely to accelerate. Therefore, the expected operational life of any given media type or format is probably around 10 years. Its actual life when stored well may be very much longer, but unless the technology to recover the content from the media is available the content will be useless.

Some media may, under ideal conditions, have an expected shelf life of up to 100 years, however, even if retention of all of the different playback devices to recover the content were practical, the supported life of these devices (spare parts availability etc), can rarely be guaranteed much longer than 7-10 years after the last production run by the manufacturer of the equipment. Some familiar examples of now obsolete formats include: 2” and 1” and UMATIC© video tape, reel to reel audio tape, MiniDisk© Audio Recorders/Players.

The solution to this complex problem requires regular transfer of content from one format to another. In the analogue domain this process can result in progressive technical degradation of the fidelity of the content from that of the original. However, content in a digital format can in principle be copied serially from one media to another without any degradation. Furthermore, while the conversion from analogue to digital is a difficult, labour intensive task, conversion of digital content from one media type to another can be largely automated.

Digital content does not need to remain as reels of tape held on a shelf in the archives, today it will generally be held in a computer data warehouse on computer disks or computer tape libraries, and can be available on-line, and accessed remotely from the desk top.

Computing technology and data storage has now advanced to the stage where it can provide a suitable storage for broadcast content and thus in the modern broadcast production environment, the only need for proprietary media formats is generally for original capture of the content in field recorders or cameras.

A.2 The concept of digital work flow and archives

The following scenario serves to illustrate the potential change that can be driven through the digital archives:

Bill, a research assistant for a television current affairs programme in an analogue based production centre, has been asked by his producer to find a number of specific pieces of content on a noted person, preferably captured on location in a particular city. Under traditional analogue archives arrangements, he may need to engage assistance from research staff in the archives and also engage in his own research of the various databases and records that contain information about the content stored in the archives. Those records could be both paper-based, computer-based or both. Having identified several potentially useful items, archives staff must access the working copies from the archives and dub the appropriate selections to VHS tape, so that Bill can view them.

Bill receives the VHS tapes and decides that of the ten tapes received from the archives, only three seem to meet the requirement. Those three are passed on to the producer who ends up selecting one segment in one of them. Bill goes back to the archives, to request a broadcast quality copy of the required footage. The archives staff go back and again retrieve the working copy from the shelf and then dubs it to a Digital Betacam tape and provide appropriate clearance of intellectual property rights etc.

The tape arrives, and then is manually loaded into a tape machine in an edit suite to compile the programme, which eventually ends up on another Digital Betacam tape for transmission. A copy of the finished programme must be passed to the archives, together with programme rundowns, scripts etc, for storage and cataloguing. Eventually, the new programme is catalogued and on the shelf available for future programmes.

Consider now, a different technological approach. This time the complete archives database is available electronically through a common on-line interface at Bill's desktop. All archives footage has been converted to a digital file format and is held as broadcast quality content in an automated storage system containing thousands of hours of content. Coupled with this is a compressed copy of the content, available from an on-line server that can be accessed via the intranet. The system is supported by an on-line ordering system.

With access rights as an authorized user, Bill is able to browse the archives footage index from his desktop aided by a powerful search engine he is returned the same ten items identified above. By clicking on the items one at a time, Bill now views the browse footage either as thumbnails marking scene changes or as browse video on his desktop computer. He quickly decides that only three of the items relevant, and emails his producer with brief details and a pointer to the tree items he has identified. (Note the email does not need to carry the video footage, only its identifying references.)

The producer receives the email and clicks on the referenced items and is immediately able to browse them on her desktop PC. She selects one of them and sends an on-line request to the archives to confirm and obtain the necessary rights clearance and to place a broadcast quality copy of the required content on a specific broadcast server on the date editing is to commence. The archives staff then proceeds to clear rights and

schedule the transfer of the content to occur as requested on the nominated date/time. If, for any reason, the transfer cannot occur, the system will automatically notify the producer and archives asking for an alternative destination.

The programme is finished and forwarded electronically to the transmission server and simultaneously, a copy is passed back to archives along with programme rundowns etc., where it is placed in a holding store in the archives digital repository. A job is listed for archives to complete the indexing of the programme. When this is completed, the programme passes to the working store, automatically copies are created for off-site storage, and a browser copy is created and becomes available for further use and retrieval.

Note that in the digital process, no archives handling of media has been necessary. VHS dubs have become unnecessary, there are no tapes to lose, and no dubs have been made by archives in the production stage of the process and the finished programme is automatically archived.

An archives researcher using these same tools may have assisted the search process, but in general the role and contribution of the specialist archivists can move away from custodial activity to direct support of clients to apply their specialist expertise in cataloguing and research.

Because the content and access is managed down to item level by a secure database, access rights can be set for both groups and individual users. Footage for which access rights are limited, or for which even knowledge of its existence must be restricted, can be secured in a way as to be invisible to searches without authorized access. From this high level of security, through to general access, the content in the archives can be secured. For example, one class of client may have rights to search and view footage, but no rights to transfer or copy it to others without authorization.

In a digital production and archives environment, the archives become an integral part of the production work flow and contribute to more efficient production. Furthermore, with the advent of on-line services and the Internet, digitally stored programmes in the archives or other parts of the system may be made available for on-line viewing with limited additional labour involved beyond rights clearances and some formatting for the different media. Transcoding from broadcast to on-line transmission formats can occur automatically and/or different versions of a programme can be held electronically.

A.3 What material is a candidate for conversion

All broadcast content (both contribution and distribution content) held in analogue form on whatever media is a candidate for conversion to digital. Depending on the size of the existing archives (which may reside both in a formal archives location, and in the desk drawers and cupboards of production units), the task of migration could be very large and could take thousands of labour and machine hours for both the physical transfer and quality control of the converted product.

Most analogue media support (tape etc) are now obsolete so a critical part of the planning from migration will be to secure access to well-maintained playback machines that will have sufficient life or spare parts to enable the task to be completed. The availability of spare parts and often technical staff with the ability to maintain these old machines will create a degree of urgency to complete the task (particularly for the oldest formats).

Unfortunately, archives are often held in less than ideal environmental conditions. Often, the material is stored in an office environment with office air-conditioning or no climate control at all. Without appropriate humidity and temperature control, the shelf life of magnetic tape and other media can be considerably reduced. Some of the earliest production of magnetic tape etc did not have the same longevity as more recent production and this life will be much shorter in poor storage.

Commencement of any archives migration project involves a comprehensive inventory and analysis of all existing holdings. In addition to the requirements to store existing archived content, the migration project must also take into account that broadcasting production is continuous, and new content is being generated each day that will add to the archives. To avoid migration becoming a continual catch-up process, capture and archiving of new content as it is created should also become an integral part of a migration and digital archives strategy.

A.4 Archives and content strategies

Considerable work on archives migration and operational strategies have been done by the European Broadcasting Union (EBU), the European Commission and European Broadcasters within the past 10 years which can serve as valuable references to the migration task. Some of these have been listed in the references cited at the end of these guidelines.

Around about the year 2000, relatively cheap digital storage developed for the IT industry started to be adapted to the storage of audio and video media. This opened the way for true digital migration and the elimination of the on-going manual process of manual media conversion process when transfer from one proprietary format was required. An IT centric approach broadcast production and archives is now widely accepted in production, edit and play-out are taken into consideration by appropriate technology solutions. In general, these allow for the storage of content using IT centric storage for both on-line and near-line storage.

In the IT environment data storage solutions for the retention and access to critical records have been in place for over 30 years. In that time the storage platforms themselves have evolved through a number of generations of technology. At the same time, the suppliers of this technology claim that their clients have never lost a single byte of data in the evolution and migration from one storage solution to another. This is actually more than can be said for many analogue archives where older tapes can become unplayable because the media has deteriorated beyond the state of recovery.

A successful migration strategy requires an assessment of what the archives is required to do. A primary concern of archivists is that they can retrieve from the archives what they put in and that they can use what they get back. This implies a transparent archiving process, and one which allows the content retrieved from the archives to be formatted in a way that meets the current requirements of the day (perhaps some future technology or format).

As a top-down design all elements of the archived strategy flow from a clear definition of the services the archives is expected to perform (now and in the future). All other elements flow from this as depicted in Figure 1¹.

¹ Adapted from Wright, R, EBU Technical Review October 2006, What Archives Want – the requirements for digital technology, EBU Geneva October 2006

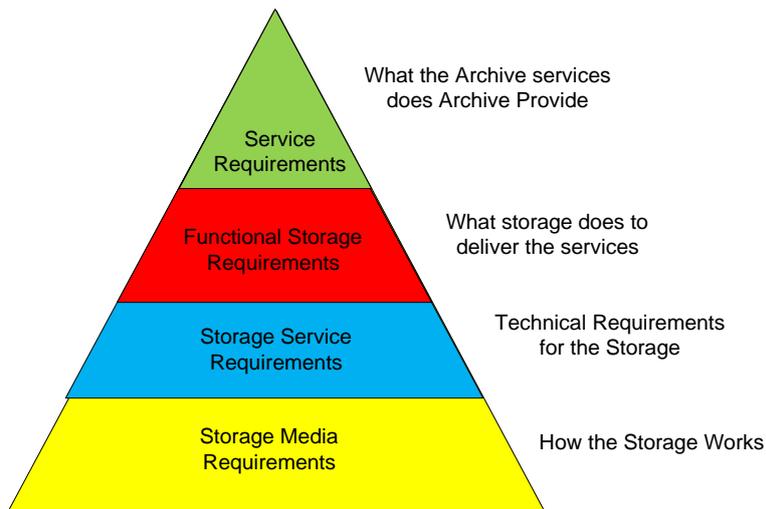


Figure 1 Hierarchy of archive requirements

A forward looking strategy will provide greater assurance that the archives will endure the test of time and require less resources to maintain than one which simply takes today's functions and attempts to replicate them in the digital domain. Functions that the archives need to perform other than to act as a repository for content include:²

- Ingesting new programme elements (such as original field recordings that may serve as content for a number of productions).
- Input for new final programmes from production
- Documentation (rights, content logging, contracts, etc)
- Programme exchange (import/export of programmes from/to external sources)
- Digitization of the legacy archives.

The present guidelines focus on the primary concern of migration of archives from analogue to digital with the principle focus on preserving existing archives and capturing new content in an appropriate digital form. They are not concerned with subject of the integration of the digital archives into the production work flow. This is a much more complex question which generally needs to be tailored to individual broadcaster's capabilities, resources and needs. Some of the workflow functions are integral to modern news room and other systems and for many these may be the kernel of a future integrated solution.

The archives migration roadmap will need to take account of possible future strategic directions for the development of an integrated system. However, this may prove to be economically difficult for many of the countries for which these guidelines have been prepared. The guidelines are therefore structured around priorities for migration that will allow migration to digital to proceed in a staged way with the emphasis being preservation of analogue content, while at the same time putting it into a form where it can be exploited more easily by both basic or comprehensive integrated workflow arrangements as the capability and affordability evolve over time.

A.4.1. Access and repurposing content

In modern digital archives, the content will most likely be stored either on computer disk arrays or as deep archives data tapes held off-line on shelves. It may even be held at the premises of a secure

² EBU Technical Report 003, Radio Archives Conception & Practice, EBU, Geneva July 2009

data storage provider. Thus like the files on a personal computer, a good indexing system is essential if the items are to be relocated quickly in the future.

- This information about the content is very important for its eventual retrieval for reuse and may include items such as:
- Name of the programme or programme element (content which is a building block for a complete programme);
- A locator reference for the content (e.g. file number, shelf number, item number)
- A description of the content of the package of content (programme or programme element)
- Information about personalities, events, shot lists etc within the content.
- Information about the time, date and place it was created.
- Information about the format of the content or the storage media including information about any transformations that it may have undergone in the past. (Migration to a different media, conversion from one format to another.)
- Related content (such as different versions, different language versions, or compressed versions for internet viewing, etc.) which may exist.
- Information about intellectual property rights
- Possibly information about its acquisition (contract documents)
- Information about its permissible use (governed by the rights), such as number of runs permitted, numbers of runs used, etc.

This and similar information is called metadata (information about the content). It is information that can be indexed and searched and which can point to the location of the actual content container itself.

Modern digital cameras and recorders start capturing elements of metadata at the source (e.g. location, time, job number); and further information is usually added along the steps of the production chain, e.g. ingest, edit, post production, presentation, etc. Some of this may be added automatically, other elements must be added by production staff. Finally, relevant archival references are added by archivists before the indexing and metadata file is complete.

Widely used metadata models include the Dublin, Metadata Model³ and the SMPTE model⁴. These models cannot simply be taken and applied directly to a broadcaster's content. They are comprehensive descriptive models from which the most appropriate elements should be selected to the needs of the individual broadcaster or production unit. The model can be augmented over time if the original data model proves too restrictive. It is generally better to start with a basic model and to enhance it over time, rather than to waste storage, complicate searches, and increase the documentation work load by trying to include data items that have no immediate value or for which accurate records do not currently exist.

³ Dublin Core Metadata Initiative: The Dublin Core Metadata Initiative, or "DCMI", is an open organization engaged in the development of interoperable metadata standards that support a broad range of purposes and business models. DCMI's activities include work on architecture and modelling, discussions and collaborative work in DCMI Communities and DCMI Task Groups, annual conferences and workshops, standards liaison, and educational efforts to promote widespread acceptance of metadata standards and practices. <http://dublincore.org/>

⁴ Society of Motion Picture and Television Engineers, www.smpte.org

A.4.2 Content metadata

Hopefully, many elements of the required metadata will already be held in existing archives or production records. Some of the information is probably scattered through production area files, and the archives record may contain only basic identification and catalogue information, some items may have been lost or never recorded.

Planning the metadata model, identification of the sources of data, and defining the required data format must be part of the planning process. The metadata is frequently stored in separate databases or paper records which point to the actual content file and or browse quality copies of the content. In a modern system all metadata would be stored electronically, and ideally along with the content using approaches like Materials Exchange Format (MXF) discussed later. The metadata should be loaded at the time the analogue to digital conversion takes place because it is an integral part of the content record.

A.5 Storage and preservation of content

The introduction to these guidelines discussed some of the reasons why migration of archives from analogue to digital is necessary, and some of the potential benefits. This section further expands on that discussion.

A.5.1 Need for and benefits of migration

All types of storage media upon which sound, moving and still images are recorded have a finite life. The actual life depends very much on the conditions under which the media are stored, and to some extent the care that was taken and the quality of the media used in the original recording. Often life expectancy projections made when a storage medium is first introduced are over time found to be optimistic, particularly when over time unforeseen chemical or physical deterioration occurs.

Some movie films created almost 100 years ago and kept in ideal conditions may still be completely retrievable, yet colour film masters on more modern stable stock have been found to require extensive restoration after around 20 years. Many early films that have not been well stored have been found to have disintegrated to a pile of dust through a range of possible chemical and physical reactions that impacted on much of the film stock of the day. For many countries the earliest television images and news events were captured on film, because video recording technology did not exist. Television programmes, other than film had to be presented live and if a copy was needed for the future it was captured on film.

Magnetic tape made recording dramatically changed the way radio and television programmes could be captured, produced, and presented. It also allowed easy capture of a copy of the programme for future use. The earliest video tape format in common use was 2" video tape. While some broadcasters and archives still hold such tapes and some playback machines, the machines are frequently very difficult to maintain (they generally predate solid state technology, have complex electro-mechanical control and transport systems) and unless the tape stock has been kept in ideal conditions it has probably deteriorated to the point where extensive restoration work would be needed to retrieve a reasonable quality copy. The same is true for the earliest cassette video tapes formats.

1" tape formats followed 2" and as the technology had matured somewhat by that time, it has enjoyed a longer life. Large archives of 1" tape exist around the world. However, the tape stock again is aging and machines have not been manufactured for a number of years. While it remains possible to find spare parts and technicians able to keep these machines running, time is fast running out.

Even the more recent digital video-tape formats are becoming obsolete, for more recent formats, manufacturers have built tape machines that are able to playback several different tape formats

including legacy formats. So while the tape stock remains in reasonable condition urgency for transfer to a modern format will be a lower priority than for the older analogue formats.

A.5.2 Machine availability

Irrespective of how well preserved the storage media may be, there needs to be a playback device for the format otherwise it will be irretrievable. Movie film is an example where the playback device is relatively simple and it would be fairly easy to manufacture a movie film projector 100 years from now. The same is perhaps true for gramophone records. As technology has progressed, the playback devices have become more complex. Miniaturization of these devices and pressures to reduce cost has meant that they rely heavily on special integrated circuits, which would be very difficult and costly to reproduce once the existing stock of manufactures and other spares are exhausted.

Most of the archives formats “at risk” continue to rely on complex electro mechanical playback devices that now have a relatively short future life. Any migration project needs to ensure that there will be sufficient life in the available machines to complete the necessary playback for conversion.

While more modern digital and solid-state storage may have a longer life than older formats, many rely on proprietary encoder/decoder CODECS which tend to be replaced rather rapidly by technology improvements that allow more information to be stored in less space, and or provide improved quality. Such CODECS often rely on proprietary integrated circuitry and software and would inevitably be difficult to obtain much beyond 10 years after last manufacture, and perhaps earlier. Archives, migration therefore needs to select storage formats that can be converted from one to another format in the future with the least possible, and ideally with no loss or degradation of the content. Storage media is developing at such a rate that projections beyond five years are highly unreliable, and archival storage in the future will involve a quasi-continuous upgrade path where storage will become cheaper, and old formats will need to migrate to new in under 10 years.

A.5.3 Digital archives options

While proprietary digital television and audio recording technologies using storage on removable media continue to be available, adoption of one of these formats for future archives migration would not be sensible because they:

- Will have a finite life;
- Provide no opportunity to change the archives paradigm;
- Cannot extract benefits from archives migration (e.g. on-line access)
- Will generally be far more expensive than alternatives.

Some archives adopted recordable CD formats or DVD for digital storage of audio and video however, these carriers were a useful stop-gap while IT type solutions evolved, they suffer from many of the difficulties of older formats. Playback often must be done in real time; most devices suited for handling multiple CDs are slow to retrieve items. DVD is not of sufficient quality for broadcast contribution but may be suitable for some lower quality play-out applications. But once again, players for multiple DVDs generally have operational problems.

By contrast, hard disk based storage (and solid state capture devices) have now matured, digital tape formats such as LTO are highly reliable, have high storage density (many items per tape) can be automated, and when copies are required they can be made accurately at several times real time. Likewise copy from tape to disk occurs at high speed. These observations are now valid for both Audio and Video content.

Guideline 1: *When Migrating Analogue archives to Digital use IT Type storage solutions adapted for audio and video content, in preference to proprietary Audio and/or Video recording formats and media*

Many new storage solutions currently available use the Material Exchange Format (MXF) which provides a “container” or “wrapper”. MXF supports a number of different streams of coded “essence” or content, encoded with any of a variety of CODECS. MXF wrappers also include metadata so that content and metadata are carried in the same “container”. This is an effective interchange format because it is increasingly supported by a number of manufacturers and allows easy transfer between systems, archives, and for programme exchange.

Archives storage solutions do not need to meet the demands of broadcast production or play-out servers, which must for video be frame accurate. Rather the storage can be straight forward disk and tape storage (depending on whether the need is on-line or near-line). On-line storage (disk) provides virtually immediate access to current in-use or high-demand content, while content in near-line storage (usually held in an automated robot storage unit) can be automatically retrieved and brought forward to on-line on demand. Near-line storage generally relies on digital data tape and for content that is accessed only occasionally, this saves both cost and energy compared with on-line. For very large archives, there may also be off-line storage where the digital data tapes containing content that is rarely accessed can be removed from the robot and stored in suitable physical storage and reloaded if required.

Guideline 2: *There must be stringent quality control and supervision of the transfer from analogue to digital and comprehensive checking of the quality of the transfer and the accuracy of the linked meta-data at the time of transfer and while (hopefully) the analogue copy is still available to make a further copy if there are problems with the transfer.*

A.5.4 Analogue – digital

The conversion of analogue formats to digital is the most time-consuming and risky operation archives can undertake. It is time consuming because it requires an enormous amount of manual effort to retrieve, load, playback and monitor each conversion to ensure that the converted content is a close to perfect reproduction of the original as the state of the original will allow.

If there is not stringent quality control and assessment of the conversion process, the converted content may be useless. Tools for electronic monitoring of the conversion quality are very limited and at best can detect major problems such as loss of audio or video, head clogs, etc. Quality control of the conversion must be given high priority, to ensure the content is preserved optimally, and to ensure that the correct and accurate metadata is attached to the content. If the incorrect metadata is attached then searches will turn up the wrong material, and finding it in a large archives at some time in the future will prove very difficult. The material could become lost.

However, in order to ensure that the content can be retrieved and converted to different needs later, there may be a need to transcode original material to a more universal format (e.g. audio Broadcast Wave; MPEG Video) which will ensure that later migration to future technology platform is provided for.

A.5.5 Digital - digital

Transfers from proprietary (traditional broadcast) digital formats to a digital archives format are much easier to carry out than analogue. Firstly, the playback machines usually have extensive error checking and alarms which can relieve the tedium of visual/aural monitoring of the transfer. However, the need to ensure correct meta-data association and quality checking of the finish master digital recording is still important. One advantage of the MXF approach is that the metadata travels and is stored with the content.

Once the digital copy has been confirmed, modern IT type storage can reliably create additional copies for off-line, on line or security storage. Copies can be made at several times real time with full error and validity checking and error correction within the limits of the hardware.

Once the content exists in the digital domain (preferably with lossless compression), then in principle it will be relatively easy to transfer to any future format, be easy to transcode to meet the needs of world wide web (www), Internet display on mobile devices etc.

A.5.6. Preservation of quality, a critical decision

An essential consideration in the migration of archives from analogue to digital is to maintain the best possible quality of transfer to the digital domain. This implies that the conversion should occur from the highest quality source material available if there are multiple versions or copies in the archives. Many old analogue recordings contain artefacts such as noise, poor audio or image quality etc. that could possibly be improved in the conversion process. However, most archives conclude that the digital conversion should as far as possible preserve the analogue content as close as possible to its original form. Then as enhancement software and hardware improves in the future it can, if necessary, be used to make improved copies. For some programmes, the characteristic poor quality of the original may be important to creating the vintage look or sound of the programme. So every effort should be made to avoid coloration of the content during conversion so that the future options are maximized.

A similar question arises about the digital conversion process. Digital Compression, achieve a reduction in the amount of storage needed by discarding information that should not be noticed by listeners or viewers. The highest amounts of compression in the broadcast chain generally take place in the final transmission link, where no further operations are required on the content. Within the production studio, the lowest levels of compression (ideally lossless) are used to ensure that in the subsequent production or transcoding processes the content is not degraded. Likewise, a similar practice should be applied to the archives.

That said, there is little point in up converting a format to a higher one (e.g. SDTV to HDTV) for archiving. Up-conversion cannot transparently replace information that does not exist in the original and the up conversion would introduce unwanted artefacts.

A.6 Establishing priorities for migration

The starting point for archives migration is an inventory of what material must be converted and to establish priorities for its conversion. Most broadcasters find that valuable content is contained not only in the archives, but in production centres, news rooms, and other places and there may be many copies of the same content. Unfortunately, the names and records associated with these copies are often inconsistent and even the names on the packages with the same content may be different. There may also be different versions of the same content that have similar names (e.g. different language versions).

Identification of the material may require some viewing or listening to the content, finding the associated metadata content (records about the content), and some preliminary assessment of the quality of the analogue copies (e.g. is it a master copy, sub-master, original recording or programme elements etc). This information and sorting is important to allow the size of the migration task to be scoped, to assess the most urgent needs for migrations, and if migration is to be done as an integrated part of a larger content management and production workflow strategy, then priorities may be influenced by the content that is in highest demand and which could assist in activating the new workflow.

Some broadcasters have reported that by starting from the material in high demand, digitization of 20 per cent of the archives has enabled more than 80 per cent of their programme needs to be satisfied. This then freed up archives staff to address other issues including continuation of the migration work.

A.6.1 At risk

Once the inventory and risk profile of the inventory has been established then the number of hours of content in each category for migration must be estimated. Suitable machines for transfer must be identified and assessed for capacity to provide sufficient hours and maintenance to allow the transfers to be completed. In addition to the challenge of securing sufficient machines and the maintenance support for them, the single largest dimension of the migration task is the amount of labour hours needed to load, supervise, conduct the transfer, and to carry out quality assurance on the final converted copy and then to make additional digital copies both for backup and as possibly secondary masters depending on the workflow requirements.

For large archives, the time required could run to years of effort, this is a major concern where obsolete hardware must be operated for many hours and fully supported during the period of transfer. Strategies for securing suitable machines can range from stockpiling machines as they are replaced from the operating inventory, sourcing critical consumables (e.g. recording heads, or head drums), or perhaps finding a source from which to purchase machines.

Guideline 3: *The format in which content is stored in the digital archives should where possible result in an accurate reproduction of the original analogue content and be easily transcoded in the future. This implies the use of widely accepted digital content formats such as Broadcast Wave, MPEG etc.*

A further option may be to pool resources with other broadcasters, or archives where they exist in the country so that the costs associated with establishing a migration centre can be shared. The simple fact of providing a clean air, air-conditioned environment for the transfer process can often extend the life of the playback heads many times over compared with a standard office environment.

Some archives have contracted the migration work to commercial companies but this requires careful management to ensure proper quality control by the contractor and the archives to ensure that material is not lost in the conversion and the quality conforms to the specifications. For most countries for which these guidelines have been produced, contracting out of the migration may be prohibitively expensive.

A.6.2 Managing new content

Broadcast organizations create new content almost every day. Much of this will have archival significance; therefore, there will be a continual flow of new material coming into the archives during the transition period. For most organizations, this new material will be in digital formats, but for some there may still be some analogue material arriving.

Coping with this on-going flow of new material must be planned into both the archives workflow and into the migration and storage strategies. In the ideal, the new material will be ingested directly into the digital storage system and archives along with relevant metadata. If this is not possible, a plan needs to be established as to how and when this material will be incorporated into the archives. The best strategy is to start new material going direct to the archives as early as possible; however, as much of this material may be in current use, arrangements need to be made to service this production need in the period between the start of the project and the provision of access systems.

In practice this means that most organizations will need to maintain parallel systems of operation during the early stages of a migration programme. As far as possible the duration of parallel operation should be minimized because it will be costly in staff and other resources.

A.7 The migration roadmap

Similar to the roadmap for migration from analogue to digital broadcasting, an archives migration roadmap is a plan that sets out the key objectives of the project, the projected timetable, key decisions to be made, responsibilities and directions and related projects that may impact on the task. It generally starts from an explicit statement about the current state of the archives, the system and content to be included in the migration task, and defines the desired end state and the steps and decisions needed to achieve that.

The desired end state would include:

- Completion of migration of various classes of content by a projected date
- Urgency of migration for particular types of content and whether any interim arrangements may be necessary to do this pending establishment of the full migration plan.
- A description of the key attributes of the proposed archives system including high level functional requirements and options that may be feasible to allow the project to proceed over an extended time period should funding or other constraints so dictate.
- Discussion of how the archives migration project might integrate with other production workflow projects or decisions.

The roadmap should set out decisions or paths to decisions on issues such as metadata standards, broad systems requirements such as storage objectives and growth over time, determination of priorities for migrations, initial estimates of the volume of material to be migrated and arrangements for refining these estimates in the manner set out earlier in this document. It will also define key milestones including, in principle approval of the project, development of requirements specifications, preparation of funding proposals and options, sourcing strategies for systems and determining systems requirements,

The roadmap should be progressively reviewed and updated as the project proceeds and further decisions which may impact on the strategy and long-term goals are taken. A typical migration project can take years to complete so many things can intervene during that period which might change the direction or approach. For example one large broadcaster established a plan in 1990 to migrate its archives to digital using the best available broadcast tape format of the day. By 2000 that solution was completely superseded by the arrival of mature IT type storage and rapidly developing media management systems. As a consequence, the strategy changed from one of replicating the analogue content onto a digital format with no change in workflow, to one where the workflow solution, and migration was all achievable within the budget previously The main estimated for tape stock alone. Furthermore, had the earlier strategy been followed and implemented, the same broadcaster would now be migrating the digital tapes to a more modern format (again in real time) compared with a fully automated digital to digital transfer to new storage media as that ,media has evolved. Furthermore, the introduction of an integrated archives/production workflow opened up enormous improvements in production efficiency, freed up archives staff to add greater value, and simplified the repurposing of content for new platforms such as the Internet

A flow chart of the decision processes and actions need to develop an archives migration roadmap is shown in Figure 2.

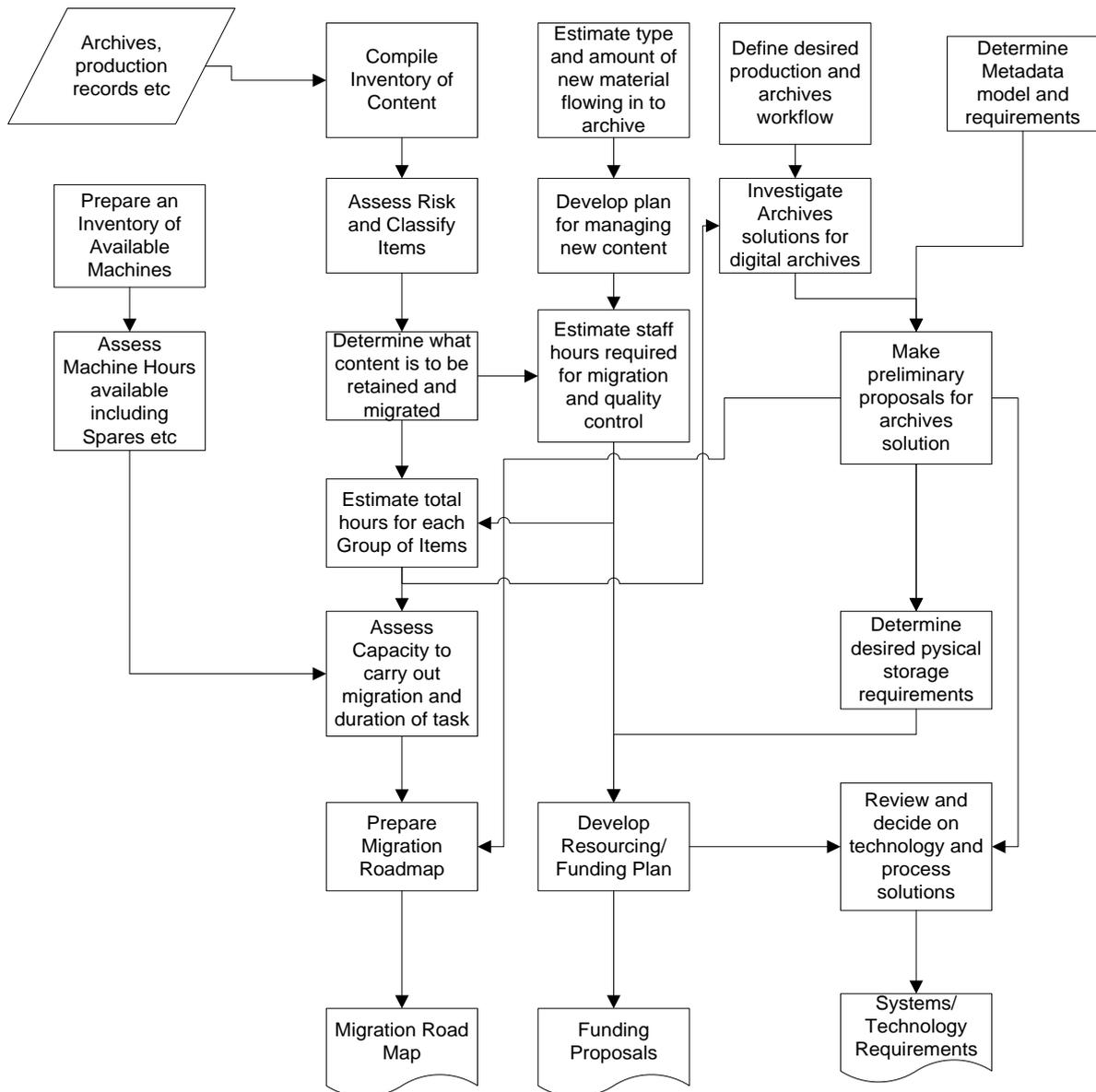


Figure 2: Roadmap development for migration of archives from analogue to digital

Work on the four streams of activity:

- Compiling the inventory;
- Estimating the rate of accumulation of new product to be managed;
- Considering overall workflow and demands for retrieval/access to content in the archives; and
- Establishing the metadata requirements.

These tasks can all commence in parallel. The most complex and time consuming task will be compilation of the inventory.

A.7.1. Compile an inventory of content assets

This step establishes the list of items to be migrated, and should also list those existing assets already in digital formats which will eventually need to be ingested into the new archives storage. During this exercise the length of the item should be documented, as well as reference to any associated metadata records, shelf number, Intellectual Property Rights, Runs available/used etc.

The inventory should incorporate items currently held in the archives, sub-archives, or official or unofficial archives held by production units in whatever form, and should extend to tapes kept in personal lockers and drawers. The long term objective of the migration process, particularly migration to a centralized server based storage solution is to remove duplicate and difficult to track assets, and also to ensure that valuable content that has not found its way to the archives is not lost. If a fully integrated workflow arrangement is achieved then items will always be available for review from the desk top and the need to hold dub copies will be eliminated.

Initial compilation of the list of products is perhaps the easy step. The next is to group the content so that identical items (copies), and programme elements that made up those items are grouped together. This enables decisions to be made on which version is the highest quality candidate for migration, and to identify product which may be identical but have different names.

A.7.2 Assess risk and classify items

Once the products are grouped as above, a critical assessment needs to be made as to the value of the content for archival purposes. How valuable is this content to the organization? Is it unique and will it have significant value to national heritage or the organizations history in time to come? These are questions that competent archives staff are trained to answer in collaboration with content creators. The content can then be ranked in importance to the organization.

Once the products are grouped and ranked, an assessment needs to be made of the state of the copies: Are they master copies? What condition are they in? What is the format? Is it one for which it may be difficult to source a player? How old is the tape or copy?

From this inventory, a priority order for conversion can be established to ensure that highest value, at risk content is given highest priority.

Linder⁵ has suggested a useful and systematic approach to prioritization of video-tape (the logic can also be applied to audio). He suggests that the process commence from determination of the production elements and “Grouping the collection by elements for each project or title to determine which elements were used as intermediate processes in production and which recordings are the complete project in its full length.” He suggests that the organization must then determine the element most useful to the organization (e.g. edited master, camera original etc), but suggests that in general, the highest quality longest length Edited Master should receive the first priority.

Linder offers the following suggestions on priorities:

- Locate the material of most importance from an historical or organizational perspective;
- Amongst these give priority to those with obsolete video formats or have a poor track record of long-term storage performance;
- Tapes that are 10 years or older, have been mistreated or appear to be in an unusual container;
- Any unusual or esoteric formats such as early cartridge, cassette, or reel to reel formats because these obsolete machines are often rare and the tapes often have experienced a difficult life;
- High priority must be given to single copies of a production, because if this tape is lost or damaged the content will be lost.

⁵ Linder, Jim, VidiPax , <http://cool.conservation-us.org/byauth/linder/linder2.html>

Linder⁶ also offers a simple scoring system that can be used to establish priorities amongst material of equal value to the organization. He suggests that Tapes with the highest numerical values from the following scoring system should be restored first. It is assumed that all candidates are of equal value to the organization.

- Does the tape exhibit any symptoms of "sticky shed syndrome" (squealing during playback, frequent head clogging, flaking or sticky surfaces)? *If yes add 5 points.*
- Is the tape a single copy and exhibit any symptoms of "sticky shed syndrome" (squealing during playback, frequent head clogging, flaking or sticky surfaces)? *If yes add 5 points.*
- Is the tape a single copy? *If yes add 5 points.*
- Is the tape an obsolete format? *If yes add 5 points.*
- Is the tape physically damaged? *If yes add 4 points.*
- Is the tape the highest quality element in the production? *If yes add 3 points.*
- Is the tape an early example in a format popular format? *If yes add 3 points.*
- Is the tape 10 years old or younger? *If yes add 2 points.*
- Is the tape between 10 and 15 years old? *If yes add 3 points.*
- Is the tape between 15 and 20 years old? *If yes add 4 points.*
- Is the tape 20 years or older? *If yes add 5 points (older than 25 years add one point per year over 25 (example 30 years old add 10 points)).*
- Has the tape been in a stable environment with proper temperature and humidity control? *If yes deduct 4 points.*

A.7.3 Estimate conversion workload for each group

For each content format (different tape or other carrier formats), estimate the total hours to be converted. Time must be allowed for cleaning, loading, reviewing, as well as actual transfer time. For tapes in poor condition additional time should be allowed for additional preparation of the tape, frequent cleaning of heads etc.

This process will establish the total machine and labour hours needed for each format and hence serve as the basis for identifying how these machine hours will be provided, and what labour is needed for the task. Machine maintenance needs also should be estimated at this stage including the need for critical spares to sustain the machines through the conversion process.

A.7.4 Estimation of labour hours

The source of labour needs to be determined before a full assessment of staff hours can be made. For example, if the task is to be assigned to archives staff in addition to their current duties then the actual available migration throughput may be very low. The archives workload will include receiving and cataloguing new material, locating and retrieving existing archives material, and other duties. If the production units have already migrated to digital formats, then it may be necessary for the archives to transfer analogue content required by production to a digital format outside of the migration project. All of this should be taken into account in the workload estimation.

If the migration task is assigned to a dedicated team or contractor, then the throughput will be higher, but so also will be the demands for quality control of the final product before it is accepted as the new "digital" archives master copy.

⁶ Linder, Op Cit

A.7.5 Ingest of new material

Until there is agreement about the ultimate storage format for the archives, and on the metadata standards, the work of ingesting cataloguing and managing new incoming content will need to continue to use current arrangements. However, for many organizations which generate a considerable amount of new content each day/month/year, this represents an ever-growing backlog of work for the archives. Hence, the earlier the ingestion and management of current content can migrate to the new workflow system the easier the overall migration task will become. For a start, while cataloguing remains an on-going task, retrieval and ingest tasks etc. can be significantly reduced once they become a normal part of the production workflow.

A.7.6 Definition of desired production and archives workflow

The modern digital archives should become an integral part of the production workflow; therefore, decisions on production and archives systems should ensure that the systems will interoperate, capture metadata progressively through the production process, and establish rules and processes that will ensure that content is filtered through the process to determine what items are of enduring archival value, which items are required for the duration of a production. Remember that first and foremost, the issue is about content, its preservation, management, and reuse rather than technology. Technology solutions are easier to design once the true business needs have been codified.

A.7.7 Metadata definition

Modern production equipment (cameras etc.) start to capture metadata from the time of capture of the sound or image (e.g. place, time, project no, image/sound bite number, device upon which the sound or image was captured etc.). Additional metadata is created through the production process.

Metadata is made more useful if there are standards for use within the production facility. In this way duplicate material can be quickly identified, its capture at the point where the data is created reduces the difficult task of trying to reconstruct this from different records later. Metadata is even more useful if global standards are adopted as these facilitate international programme exchange, as well as ensuring that the metadata is more readily incorporated into any new systems which are acquired.

The best starting point is one of the existing general metadata models such as the “Dublin Core” or SMPTE models. These generic models have been created to take account of a wide range of production types extending from film, though video, still images, sound etc. This means that adoption of the complete model would be wasteful in database resources as many items will have no relevance in a particular archives or production context. The best approach is to identify a sub-set of these models to provide a customized model for the archives/broadcaster needs which is harmonized with the global standard. Additional items can be added later if the need evolves.

The metadata model will need to be built into the new archives solution because it will be used for searching and identifying content into the future. It is generally stored in a separate on-line database and suitable search tools are used to interrogate the database. Such tools have been developed by a number of providers, and some are tailored to the needs of specific types of production industry. Most of the larger storage solution providers have arrangements and or partnerships with content management systems providers and can offer a complete service for the definition and establishment of a media asset management system that includes these tools, as well as storage solutions. Many also provide tools to assist in repurposing content for different platforms.

A.7.8 Physical storage

The most appropriate type of physical storage for migrated content will be computer data store, using both hard-disk, and background digital tape management systems. The optimal storage solution and hardware solutions will depend on the total volume of content to be archived, and the

retrieval demands. For example, there is little point in investing in an automated tape retrieval system if there is very low turnover of content because it may be more economical to hold the low use material on shelf and load it as required. One benefit that comes from an automated store is that it can be programmed to review, and copy content from time to time based on time or condition assessment. Rules can also be established that determine when and what content moves from more expensive on-line storage to background near line storage with minimal operator intervention.

Storage decisions include where the storage will be located (will it be located in the IT department, in the archives, or on the premises of a third party storage provider). Along with decisions about the primary storage location/characteristics, decisions need to be made about how back-up copies will be created and stored. Back-up copies should be stored in a separate physical location, be secure, and be regularly reviewed. Backup storage may involve anything from physically storing a copy of the main store on data tape and holding it on shelving with appropriate environmental control, through to completely automate off-site storage that replicates the main storage solution.

Consideration of these options must be done in conjunction with determination of overall systems requirements. As for all elements of the system, the final solutions for any given organization will depend on the cost and availability of funds.

Storage solutions should be planned to grow over time. The preferred approach to storage is to purchase no more than one or two years storage capacity at a time because the technology will evolve, probably become cheaper, and certainly store more content per dollar. Any media asset management system should be able to accommodate this evolution and questions about it should be contained in any request for tender.

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Society of Motion Picture and Television Engineers, www.smpete.org



International Telecommunication Union
Telecommunication Development Bureau
Place des Nations
CH-1211 Geneva 20
Switzerland
www.itu.int