



Digital Broadcasting Migration Bhutan

Part 2: Field Mission Findings and Recommendations.

A Report for the ITU and the Ministry of Information
and Communications Bhutan

ITU Asia-Pacific

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“The views in this report are those of the Expert and do not necessarily represent the views of ITU and its membership.”

Table of Contents

Table of Contents.....	3
List of Acronyms and Abbreviations.....	4
Acknowledgement	5
1 Executive Summary	6
2 Purpose and Objective for Mission	8
2.1 Field Mission	8
3 Mission Findings	9
3.1 Overview.....	9
3.2 Role and Structure of the Working Committee	9
3.3 Work Plan and Timetable	11
3.4 Terms of Reference.....	12
3.5 Migration Feasibility.....	12
3.5.1 Why Migration?	13
3.6 Migration Affordability	13
3.7 Readiness for Development of Road Map.....	14
3.7.1 Capability to prepare the Road Map	15
3.7.2 Working Committee Resources	15
4 Development of the Road Map	16
4.1 Stage 1 Issues:.....	16
4.2 Stage 2 Issues.....	18
4.3 Stage 3 Issues.....	21
4.4 Progressing the Work: Working Committee Action Plan.....	21
5 Further Assistance for the Working Committee.....	22
6 Recommendations	23
7 Annexes.....	24
7.1 Annex A: Working Committee Terms of Reference	25
7.2 Annex B: Strategic Policy Considerations.....	26
7.3 Annex C: Working Committee Questions at ITU Digital Migration Workshop (April 2010).....	28
7.4 Annex D: ITU Guidelines on the Transition from Analogue to Digital Broadcasting – Workshop Presentation April 2010	29
7.5 Annex E: Suggested Agenda for Planning Meeting of Working Committee.....	31
7.6 Annex F: Bhutan Responses to ITU DTV Migration Questionnaire.....	32
7.7 Annex G: List of Persons Interviewed by the Expert during the Mission in addition to members attending the Working Committee Meeting	49
7.8 Annex H :Bhutan Digital Migration Plan Working Group Membership March 2010	50
7.9 Annex I : Digital Migration Workshop Expert’s Powerpoint Slides.....	51
7.10 Annex J: Outline for Bhutan DTV Road Map	52
7.11 Annex K: Extract from ITU Report 2140 describing the various DTV systems around the world.....	62

List of Acronyms and Abbreviations

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BBS	The National Broadcasting Service of Bhutan
BICM Act	Bhutan Broadcasting Information Communications and Media Act
BIMA	Bhutan Broadcast Infocomm and Media Authority
DTH	Direct to Home Satellite Television Delivery
DVB	Digital Video Broadcasting
DVB S2	Digital Video Broadcasting Satellite Standard 2 nd Generation
DVB-S	Digital Video Broadcasting Satellite Standard
DVB-T	Digital Video Broadcasting Terrestrial Standard
DVB-T2	Digital Video Broadcasting Terrestrial Standard 2 nd Generation
Dzongkhag	Administrative or Provincial District in Bhutan
Gewog	Administrative sub-district of a Dzongkhag in Bhutan
HDTV	High Definition Television
ITU	International Telecommunications Union
MoIC	Ministry of Information and Communications
MPEG2	Motion Pictures Expert Group Video Compression Standard 2
MPEG4	Motion Pictures Expert Group Video Compression Standard 4
PPD	Planning and Policy Department of MOIC
UHF	Ultra High Frequency
VHF	Very High Frequency

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1 Executive Summary

This report is the second of two reports in response to a request from the Secretary of the Bhutan Ministry of Information and Communication for assistance with the development of a Digital Television Migration Road Map. The first report completed in January 2010, covered general principles, technology, and guidance about digital migration planning. The report had to be prepared without the benefit of firsthand knowledge of the Bhutanese broadcasting landscape and envisaged a future field mission.

This second report has been prepared after the Field Mission to Bhutan which took place in April 2010. The report reflects the findings of the field mission to complete the consultants mandate from the ITU to undertake a feasibility study into the future project for development of a digital migration Road Map. In addition it provides recommendations and guidance on how the Digital Migration Working Committee of Bhutan might commence, structure, and progress its work on the Migration Road Map. A suggested template/outline for the Road Map and the Working Committee Report is included in the Report to assist the Committee structure its work (See Annex I).

The mission found that while resources in Bhutan are limited, there is sufficient expertise and technical knowledge to allow the Working Committee to undertake the task with some ongoing external guidance. Digital Migration raises important policy and development questions. The final solutions must be developed by Bhutan to fit Bhutan's national needs and at best an external expert can provide guidance on options, planning, and the experience of others who have undertaken the journey.

The Secretary's Working Committee has representation from all relevant stakeholder groups and has an in depth knowledge of local arrangements and needs. The working committee has been waiting for a final recommendation from the ITU expert on Terms of Reference and working arrangements. Draft Terms of Reference were provided in the first Report. Those have been refined in the light of the findings of the field mission.

The report makes recommendations on the operation of the Working Committee, and suggests a proposed timetable for its work as well as providing elements of the working agenda on policy questions and options.

During the mission, and ITU Workshop, attended by members of the Working Committee was conducted by the Expert and the Senior Advisor from the ITU Regional office. This workshop covered ITU initiatives in the region, ITU guidelines on Digital Migration, and a workshop covering many aspects of digital migration.

The report recommends:

- a. Adoption of the Terms of Reference set out at Annex A to this report.
- b. Constitution of the Working Committee with the Secretary MoIC as Sponsor, day-to-day leadership of Head Telecommunications BIMA with Director Planning and Policy Department (PPD) MoIC direct participation as the focal point for MoIC coordination and input from the Secretary as discussed in Section 3.2 of this Report.

- c. An initial, long, off-site meeting of the Working Committee should be held soon to consider this mission report and the First Report and to establish the work plan for the Committee. A suggested agenda for this meeting has been provided at Annex E to this report.
- d. A work timetable be adopted along the lines suggested in Section 3.3 to ensure that the work progresses in a timely manner, and that specific deliverables be defined against a detailed project timeline that breaks down the task into small manageable units. The Working Committee should regularly report progress against this schedule and take action to resolve any impediments to progress.
- e. The Working Committee considers what further assistance is needed from ITU to achieve the agreed work plan and deliverables as the work proceeds.

The Consultant presented a draft of this report and a short overview on its findings to a meeting of the Working Committee on 22 April 2010 before he departed Bhutan.

2 Purpose and Objective for Mission

The Ministry of Information and Communication (MoIC) sought assistance of ITU to develop a comprehensive digital broadcasting plan for Bhutan and was seeking assistance of an Expert to assist in the development of terms of reference for the working committee and assistance to guide the committee in its task. The basic role of the Committee is to develop a Road Map for digital migration (which will identify how, when, and why migration should take place in Bhutan). The decisions of Government that flow from this work will then determine a second stage of work to implement the decisions within the agreed timeframe.

In response to the Secretary's request, the ITU engaged Australian broadcasting Consultant, Mr Colin Knowles to undertake a review of the existing Bhutan broadcasting system and to conduct a feasibility study into a future project for developing a Road Map in Bhutan for transition to digital terrestrial broadcasting.

This work would normally have commenced with the consultant visiting to Bhutan to gather information and to conduct a workshop on digital migration. For various reasons this could not occur, and an initial report was prepared working remotely but in close consultation with ITU and designated group of experts by MoIC Bhutan. That report was updated after feedback from Working Committee and the ITU and the final version was delivered in late January 2010. Since then, additional material was provided by Bhutan in response to an ITU Questionnaire on Digital Migration. The response is attached to this report as Annex F. Where appropriate, the commentary has been incorporated into the findings of the current mission.

The first report included:

- guidance on a wide range of digital migration issues,
- draft Terms of Reference for the Working Committee and
- guidance as to how the Committee might address its task.

In summary then, the current ITU project is intended to:

- assist Bhutan to *define the project* for developing a Road Map; and
- *assess what further assistance* may be needed for the working committee to complete its mandate.

2.1 Field Mission

The field mission in support of the project was undertaken over the period 12-23 April 2010. The consultant was in Bhutan for the full period and Sameer Sharma, Senior Advisor ITU Regional Office for Asia and the Pacific participated in the workshop and the first week of the field mission. The purpose of the mission was to enable the Expert to complete the project defined by the ITU brief.

During the mission the Expert: conducted a workshop on DTV technology and migration; interviewed key stakeholders; visited relevant facilities. The Expert has made an assessment of the capacity of the Working Committee to complete its task and recommended an

organizational structure, action plan, and timetable for the work, and suggested possible ways in which the ITU might further assist with completion of the Road Map.

3 Mission Findings

3.1 Overview

The one-day workshop and subsequent discussions with stakeholders showed there was a mixed understanding of what digital migration was meant to achieve. A number wondered why migration was being considered in Bhutan and were not aware that the ITU engagement was in response to a request for assistance by the Secretary of MoIC Bhutan. However, it was good to find that there was a consistency of views about broadcasting issues generally.

The one day workshop combined with a meeting of the DTV Migration Working Committee saw excellent engagement by all participants, and an enthusiasm to start work on the task of the Committee. This workshop was very helpful in demystifying the migration story, and emphasising the point that, DTV is simply a new and more efficient way of delivering content to television viewers, but like all change there are costs and benefits. It opens up new opportunities and at the same time raises new policy questions that form the foundation for any digital migration Road Map.

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A number of stakeholders expressed concern that this initiative might produce a report that would be left to gather dust and result in no decisions being made. This seems in part to be based on some previous history with other initiatives. However, the remarks more than likely arise from the fact that no one was able to identify a champion for the project and a source of leadership. Ways of addressing these concerns are suggested below:

3.2 Role and Structure of the Working Committee

The Mission of the Working Committee is to determine how, when, and on what basis DTV migration should occur in Bhutan, and to produce its findings in the form of a digital migration Road Map. The Road Map should be a document that establishes the how, when, and basis for migration in the wider context of Bhutan's ICT strategy. Once this high level Road Map is endorsed, there will be a need for a series of additional detailed implementation guidelines that define how the migration will be implemented in the subsequent phases, legislation amended, regulations established, and so on, to meet the agreed timetable for migration. Very few of the high level decisions are concerned with technology; they are basic policy, national interest, and economic questions. A general understanding of what the technology can deliver in terms of audience benefit and the new opportunities and options it can provide is all that is needed to shape the policy options. The high level policy decisions then flow through to the design of the technical and administrative details necessary to deliver the agreed outcomes.

Membership of the Working Committee was determined last year, and draft Terms of Reference were provided by the Expert in January. However, the members of the committee appear to have had no further discussions since the December discussions with the Consultant. Thus the workshop conducted during the mission was their first opportunity for a wide ranging discussion. The workshop resulted in a very productive exchange and identified that perhaps two things need to happen to establish the Committee on its journey. Firstly, it needs to have clear leadership, and a working timetable, and secondly to have a work plan for the task.

The Secretary of MoIC is the official Chairman of the Working Committee. However, given the diversity and challenges of his senior position he is unlikely to be able to provide sufficiently regular attendance and attention to manage day-to-day work of the committee. Most countries establish a similar advisory and working committee to explore and recommend the way forward with digital migration. For those committees, the Secretary of the Department is usually the sponsor, and chairmanship of the committee is assigned to someone who has the confidence of the industry, understands the agenda, and who reports to the sponsor. The sponsor receives regular reports, and from time to time may attend the committee to provide guidance. In this way the work is able to proceed with appropriate policy input and direction from the Secretary on priorities and the Secretary able to oversight the work without having to engage in its day-to-day management. When recommendations are being put for final discussion, the Secretary may at times elect to attend the meeting to provide additional input and/or to be satisfied himself that all relevant considerations have been addressed, and assess the level of support within the committee for its proposals.

Another approach is to establish a small Task Force to carry out the detailed work and to prepare recommendations for the industry advisory committee to consider. However, because in Bhutan the membership would inevitably be the same for both the Task Force and the Advisory Committee, so there is little point in creating separate groups.

To effectively set the agenda, develop the work plan and drive the work of the committee, the convenor should have a sound knowledge of the broadcasting and ICT landscape in Bhutan, the policy and the policy and regulatory framework, and a broad understanding of the possibilities and key requirements of the technology platforms.

After meeting with all key stakeholders and the Working Committee members, in the opinion of the Expert, Head Telecommunications in BIMA, Mr Wangay Dorji, is the person who has the appropriate depth and breadth of knowledge, commitment, and capacity to drive the Working Group Agenda to achieve the best outcome.

From a governance viewpoint, the Director PPD would be the more logical choice given his direct responsibilities for coordination of MoIC policy development activities and direct reporting line to the Secretary. The challenge is that neither he nor his department has a good understanding of the issues or possibilities of digital migration, nor of the detailed requirements that will give rise to policy questions. Therefore, he would need to rely on other members of the committee to generate the agenda for the Working Committee. The leader of the Committee must have sufficient understanding to set the Agenda and guide the

Committee in its deliberations otherwise the work of the Committee will progress too slowly and probably halt before its job is finished.

Director PPD MoIC has a very important role in the Committee for coordination and input on policy questions and for carriage of the questions through the MoIC approval processes. These questions will cut across other aspects of the ICT developments and impact on National development questions. Thus his role is piloting these matters through the administration quickly will be vital for the work of the Committee. The Director PPD would also be well placed to keep the Secretary informed on progress and upcoming issues and could bring to the Committee informed views as it debates the policy matters. MoIC, PPD should also provide the secretariat for the Working Committee.

The option of having an external expert available to guide the Working Party through the whole process would be an expensive and impractical alternative. The proper role of an expert is to assist in setting the agenda, providing guidance from time-to-time, and offering critical appraisal of the proposals as they are developed. Working Committee members must contribute fully to the discussion, they must be engaged in the work, and be committed to the outcomes.

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Further expert assistance and support for the convenor and Committee can be arranged with ITU as suggested later in this report. While there may be a perceived conflict of roles having a BIMA officer reporting directly to the Secretary for this activity rather than through the BIMA Board, this is probably unavoidable given the very limited number of people in Bhutan who could lead this activity effectively.

3.3 Work Plan and Timetable

The work plan for the Committee should be fairly short and focused with regular deliverables so that the subject can be resolved quickly and efficiently. If there is an open ended or long timeframe for the work, it could quickly lose momentum and loose direction. If the necessary policy guidance is given quickly, the primary work of the committee could easily be completed before the end of 2010, and even in a period as short as three months if the members and support resources can give adequate time to the topic within that time period.

As set out in draft terms of reference that follow, the work of the Committee needs to be undertaken in several stages:

1. Identify and make recommendations on key policy questions that need to be decided to enable options and recommendations on the migrations question to be developed – say within one month of commencement;

2. Detailed analysis and recommendations about the how and when of Digital Migration through the development of a Migration Road Map - (This could be completed within 3 months of receipt of policy guidance from Stage 1 recommendation because work can continue on a number of aspects of this pending confirmation of the policy direction); and
3. Recommendations on the regulation, planning and other matters necessary to give effect to the migration. This last stage cannot fully advance until the Road Map is endorsed by the Minister and the Road Map may need several refinements and adjustments during the endorsement process. The last stage will put in place detailed planning, regulation etc which must reflect the endorsed direction. Work could commence during the approval of Stage 2. Stage 3 could take 3-6 months taking account of the detailed drafting and planning work that may be necessary, but may be deferred if there were a decision to delay the commencement of migration for some time.
4. Coordinate communications on the migration strategy and actual implementation according to the Road Map (depends on the timing determined by Stages 1-3); including formal definition of system standards.

This schedule suggests that complete work of the committee may take between 7-10 months depending on how long formal consideration of the progressive recommendations takes. Starting from now it should be possible to complete Stage 1 by the end of May 2011, Stage 2 by end of September 2011, and Stage 3 could be completed before the end of 2011. Detailed work by the relevant agencies to produce regulations could be completed within the first quarter of 2012. A schedule of this duration is not too ambitious, and the dates link well with the scheduled completion of the national optical fibre network and other ICT initiatives. As such the Road Map and subsequent regulations and planning and policy will provide a stable and holistic framework for future broadcasting development.

The Road Map will establish when and how migration should occur in Bhutan and how this relates to other ICT initiatives. By completing the Digital Television Migration Road Map early, there will be greater certainty for the Industry and other initiatives can be made from a fully informed position about the future digital television migration.

Bhutan will ultimately have to migrate to digital because manufacturers will stop making analogue receivers. Migration is not a question of if, but when and how migration should occur.

3.4 Terms of Reference

After considering the findings of the missions, the Expert has made minor modifications to the earlier draft Terms of Reference provided in the first report. The proposed Terms of Reference are Annex A to this report.

3.5 Migration Feasibility

The converged ICT Act in Bhutan provides a very sound platform for launching a DTV initiative. Most of the critical policy foundations that will be required for DTV are already

outlined in the Act (eg open access, infrastructure sharing, technology neutrality, and separation of content and carriage). It will need to be supported by appropriate Regulations made under the Act once the Digital Migration Road Map is approved. However, implementation of Digital Broadcasting will touch on other legislation as well and to move forward there should be harmonization of legislation to provide ensure new services can proceed with the least administrative complexity and with administrative certainty. This will be particularly critical if private investment is to be a driver of change.

Throughout the mission, and the workshop, the Expert found there was a high level of enthusiasm, engagement and motivation to address the migration question. In the Working Committee meeting held in conjunction with the Digital Migration Workshop, participants were invited to each list two key questions and concerns they had about digital migration. The questions raised are attached as Annex C because members of the Committee thought that they would form an excellent basis for them to commence their future discussions. These questions and the discussion that followed showed that the members of the Committee have already thought about the issues and are ready to engage in enthusiastic and structured debate and are committed to discovering the answers for Bhutan. This means that the Working Committee has a good start towards addressing its mandate.

This enthusiasm needs to be nurtured. The Expert recommends that the Working Committee be formally constituted, its Terms of Reference agreed, and that it commence work within the next month. It would be useful for the Committee to take at least a full day, and perhaps two full days without interruption working to a defined agenda. In this meeting it should be able to complete Stage 1 of its task and have a good understanding and start on Stage 2.

If the Working Committee is to remain motivated then there must be a commitment from MoIC to quickly address the policy questions raised by the Working Committee. Even if final decisions can't be made quickly, there should be fast "in principle" agreement or advice on potential difficulties so that the work can continue uninterrupted.

3.5.1 Why Migration?

Although Bhutan does not currently use the parts of the Broadcasting Band intended to be cleared by migration to Digital Television, Television Broadcasts in Bhutan will ultimately have to migrate to digital because manufacturers will stop making analogue receivers. While digital receivers today are comparatively more expensive this is rapidly changing. Set-top-box converters which allow digital television to be viewed on existing analogue receivers have become quite cheap in bulk quantity. Furthermore, digital television transmission will provide additional capacity for delivery of additional services at low marginal cost per service. Like other ICT developments it opens new possibilities to improve communication, education, information, and cultural and social development. Therefore it is not a question of should Bhutan migrate, but rather when should it migrate.

3.6 Migration Affordability

Bhutan will require various forms of assistance to implement digital migration. The resources in country limited and the first major obstacle will be the financial cost of the infrastructure. Taking account of the way other like developments occur in Bhutan, the infrastructure would most likely need an external grant and training of staff to maintain the assets once installed. Consumer conversion would also be an issue because even though the

retail cost of consumer set-top-box converters for existing television receivers has now dropped below USD 25 and wholesale perhaps below USD 15, this may still represent a significant outlay for many households in Bhutan.

Some form of subsidy would need to be provided to assist the lowest income households convert. Many in this group may not even have television existing terrestrial coverage is incomplete and detailed information about the reach and take-up of cable in un-served areas is not known, nor is there useful data about the extent of use of unregulated transborder DTH services. However, at the lowest income levels the cost of cable or transborder DTH is likely to be unaffordable and this probably means they do not have television. At best they may have access to some collective viewing such as that established by BBS for the elections and Coronation.

These are factors that the Working Committee will need to determine as it progresses on the development of the Road Map.

3.7 Readiness for Development of Road Map

Current ICT developments such as the installation of fibre optic cable to all Gewogs (smallest subordinate administrative district in Bhutan) may open new opportunities and raise consumer expectations. It may also facilitate the distribution of Digital Television. Because Digital Television needs to be reviewed as an integral part of the ICT revolution, early decisions about DTV and the associated policies will assist *inter alia* resolution of questions about the development and digitization cable, and may assist in resolving the current debate about transborder DTH services.

Unlike most other developing countries, Bhutan is reported to have around 80% of its population having access to cable services. The people that are not connected tend to be people living too far from the villages to be reached economically by cable. Many of these may already have DTH satellite services. This suggests that one option for Bhutan may be to continue to rely on cable and DTH services rather than develop terrestrial DTV. However, this is a complex question, because cable expansion depends on commercial decisions about viability, satellite involves additional cost for consumers. Neither option can be considered a universal access solution unless there were some form of subsidy. This is an issue the Working Party will need to consider.

There is no immediate spectrum urgency for Bhutan to migrate to digital but cable operators are keen to convert so that they can have better control of their product and reduce piracy. This would enable them to offer a range of services from basic(essentially the free-to-air services as may be determined appropriate), and added value packages for other programming. Because TV uses only Band III and a few channels at the bottom of Band IV there is no demand pressure for clearance. However, because of the need to resolve matters such as DTH, and to establish a stable platform for commercial investment in broadcasting etc, the formulation of a Digital Migration Road Map is important now so that all developments can be seen in an overall context.

Even though questions of financial affordability remain, now is the time when Bhutan should establish its Road Map for digital migration. Without this Road Map, the practical aspects of funding etc cannot start to be addressed. Unless there is a migration the Road Map,

television will become an orphan in the aggressive expansion of ICT in Bhutan and opportunities for true convergence may be missed.

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3.7.1 Capability to prepare the Road Map

There is sufficient depth of knowledge and expertise on DTV and technology and policy issues for the Working Committee to address its mandate. The key work of the Committee relates to the policy arrangements necessary to support a new multi-channel delivery vehicle for television, and because it involves a technology change for viewers to benefit, how should this be managed over time. These questions are no more complex or difficult than those that Government faces every day in balancing budget, national interest, and public policy. The knowledge of the general capabilities of the technology is sufficient, and assisted by the documentation already provided, to allow formulation of options around the hard questions.

Digital migration must reflect the overall needs of Bhutan, and be solution developed by Bhutanese for Bhutan.

A readymade solution cannot be provided externally, but the Working Committee has ITU assurance that it will receive essential guidance, mentoring and review as may be needed to complete the task.

3.7.2 Working Committee Resources

The membership of the Working Committee covers all key stakeholders, those not represented such as the Bhutan Telecom, appear to have been invited but have concluded they had little to contribute to the deliberations of the Committee at this stage. Given the limited number of people in the key agencies represented and supporting the Working Committee, resources could be stretched unless the Working Committee mandate is executed as a high priority over a short duration. Subsequent implementation work could be spread over a longer period commensurate with the availability of resources and the agreed timetable.

Because there are a limited number of people who are available to do detailed work that will flow on from the Road Map, Bhutan may need further assistance with implementation development. The Working Committee would be best supported by an arrangement that provided ongoing email exchange with the Expert, and perhaps should it be necessary, further short in-country visit to workshop the developed Road Map and future implementation strategies.

4 Development of the Road Map

During the Bhutan Digital Migration Workshop, Sameer Sharma, Senior Advisor ITU Regional Office for Asia and the Pacific, presented a session entitled “Guidelines on the transition from Analogue to Digital Broadcasting” a copy of which is Annex D to this Report. The first task of the Working Committee is to outline the Road Map and to determine what information and decisions are needed for each step on the map. A work plan to address these in an appropriate time sequence then should be made and serve as the guiding activity plan for the Committee. The major components of the Road Map are set out in the ITU Guidelines

1. Policy and Regulation Framework
2. Market and Business Development
3. System and Network Standards
4. Analogue Switch-off Arrangements

Each of these has broadly been outlined earlier in the three stage program for the Working Committee.

4.1 Stage 1 Issues:

Given that digital migration must occur at some time, in principle decisions are needed on the foundational policy questions:

- a. How are digital services to be delivered and what will be the relative roles of terrestrial, cable, and satellite in the mix, and what initiatives may be necessary to encourage public private partnership in the venture?
- b. When will private television broadcasters enter the market and should they be permitted to commence on analogue and later convert to digital or should they commence with digital only?
- c. Will there be further extensions of BBS service: should these be digital so as to avoid future need for migration, if so should there be any incentive or subsidy for converters in the digital only areas which are likely to be in areas where affordability may be an issue?
- d. Will the digital transmission multiplex be shared so that current and future services can share a single transmitter or will there be a separate multiplexer and transmitters for each operator?
- e. How many different programs will a single broadcaster be permitted to provide on a multiplex? Will any of these be HDTV? Will other data services be permitted or will data be limited to program associated data like EPG or sub-titles?
- f. Should Emergency/Disaster broadcast to be incorporate to the extent possible into digital television implementation?

These will provide the basis for development of the Policy and Regulatory Road Map and define the overall system parameters for market and business development and system and network standards.

The Expert's commentary and guidance on the above three issues are:

- a. **Role of the Different Platforms.** Perhaps the first question that needs to be addressed is the relative role of cable satellite, and terrestrial delivery of television. Cable is an important delivery vehicle in Bhutan and may also benefit from its own digital conversion. Depending on what industry arrangements are put in place to manage this service and potential upgrade, it could accelerate the introduction of Digital Television. DTH satellite services are external to Bhutan and the subject of current discussions on how to provide services that are relevant to Bhutan, do not seriously erode existing licensed cable services. This question needs to be addressed in the overall model for future television. It would be difficult to envisage a comprehensive television service in Bhutan which did not at least deliver a core package of Bhutanese services via satellite because this is the only way that remote and isolated people could receive a service. Such a service may also serve to feed DTV transmitters across the country, and also supply cable operators with a core package of services. Terrestrial services are currently limited in coverage and are only the BBS service. With some potential for optical fibre distribution in the next year or so, an argument might be made that this may be a cheaper and more efficient way to deliver services to transmitters and cable operators. This may be a good option for the first few years of establishing DTV services; however, at some point some form of DTH service will be needed to reach the remote households. The wide acceptance of cable seems to suggest that viewers are unlikely to give up the choice from a large number of channels to switch to DTV, yet those who do not subscribe should have access to core broadcast services free to air. These factors will need careful consideration in determining the appropriate mix of delivery options for Bhutan as it moves into the digital age.
- b. **Competition:** The InfoCom Act and the published draft broadcasting policy support the introduction of competition in broadcasting so the remaining question to be answered is when and how it will be introduced. If digital services are to commence early then it would make sense to start with the largest population centres and commence all new services on digital. Additional services would be an incentive for consumers to take up digital, provided new and the existing service were delivered on the platform.
- c. **BBS Extension.** BBS is currently completing the installation of analogue television transmitters in the 20 Dzongkhag. These transmitters are able to be upgraded to digital transmission but over the next year, there will be a growing audience using the analogue service. If further extensions are planned and there is a decision to migrate to digital, then there is an argument that the new services be digital. However, before this can occur, there needs to be a digital signal distribution from BBS, because while the current satellite feed could be used, it would require the installation of encoding and multiplexing equipment at the new transmitter sites. The cost of this would be prohibitive. However, after the optical fibre is completed, if BBS has access to the fibre for its signal distribution, then it could establish a digital service to feed the new transmitters from a common encoder and multiplex in Thimphu. This equipment would be able to serve the complete network either by satellite or optical fibre. The working group will need to assess the difficulty and cost of linking any new

transmitters to the cable before reaching a conclusion on this subject. Satellite delivery would require a new transponder channel, which would be hard to justify as a parallel to the current analogue satellite feed, if there were only a handful of transmitters serving a small population. Later in the conversion process, it could be practical to switch the satellite distribution to digital and install digital receivers at the analogue transmitter locations which rely on satellite. However, this would at the same time create difficulties for viewers who rely on the satellite for service. The Working Committee will need to research these matters. It may be that there are no immediate plans for expansion of BBS coverage in which case there may be no need for an immediate answer.

- d. **Multiplex Sharing:** The Digital TV Multiplexer is a device that allows multiple services to be delivered over a single transmitter. Depending on the system and operational configurations chosen, a single DTV transmitter can deliver around standard definition channels or various mixtures of standard definition and high definition television and other data and audio services. For the early introduction of DTV in Bhutan, there would be little point in trying to establish High Definition this can be changed later when there is a need. Six channels represent an enormous increase in the potential service delivery (although still small comparatively to cable) and it opens the way for a private broadcaster to potentially share this capacity to deliver a new service. There may be other options for educational or other government information services to be delivered on one of the channels. BBS has indicated to the Expert that it would need additional resource to establish an additional television service and that its current priority is to improve its radio services. It may be possible to use some channels to rebroadcast other services from elsewhere that can be made available free to provide more diversity. In any event, with an initial small audience, and significant costs to establish a transmitter per service, the Expert suggests that the system be planned around a shared multiplex. This can be changed in the future if there was sufficient demand for additional channels. Appropriate access policies, decisions on multiplexer “ownership” etc will need to be made if this option is taken up. The current proposed arrangement for management of the Optical Fibre network may be a useful guide as to how the multiplexer could be managed.

4.2 Stage 2 Issues

Stage 2 is concerned about analysing and making recommendation on a number of factors that will lead to different options for migration:

- a. What are the implications of including mobile television in the mix? Does this make sense in Bhutan?
- b. System transmission standards?
- c. Spectrum to be used?
- d. Total costs for all stakeholders against various time lines?
- e. Consumer Impacts?
- f. Implications for business and business development?

- g. Implications for national development such as cultural development, education, information?
- h. Ways in which emergency warning can be incorporated and what provisions need to be made to guarantee such service are incorporated in the networks?
- i. Content and whether there should be specific guidelines such as programming in the national languages? Children's content etc?
- j. Types of licence and associated regulatory framework?
- k. Any further policy issues that arise from the above including the development of a formal competition policy or guideline?
- l. Detailed consideration of access regimes for infrastructure?
- m. Possible incentives and their cost?
- n. When and how should migration commence?
- o. A practical timetable for migration? and
- p. Possible arrangements for communicating to consumers and industry, and managing the eventual change over process?

At this point it would be inappropriate for the Expert to comment on more than standards, spectrum and options for commencement. The other issues need much more input from Working Party members. The commentary is provided as a guide to the issues the Working Party must consider and are not formed recommendations.

- a. **Standards.** The secretary's letter to the ITU indicated that Bhutan was leaning towards the DVB-T standards for Bhutan. The Expert understand that India has already decided to use DVB which is already established or adopted by many countries in South-East Asia, Europe, Australia. If India does proceed with this, then there is a strong chance that it will establish manufacturing or supply of consumer equipment at low cost. Given the reliance on India for assistance, and its close proximity adoption of an identical standard would be sensible. Whether Bhutan should adopt the most recent evolution of the DVB-T standard to DVB-T2 is an open question. If the T2/MPEG4 standard gains wide acceptance globally then there may eventually be a need for a further migration in time. However, this would be an easier migration because equipment to this standard is expected to be fully backwards compatible. At present there is virtually no consumer equipment to deliver the T2 standard, and the first implementation will be in the UK. If India were to adopt the T2 standard then there may be a compelling argument in favour of the later standard. From a spectrum perspective Bhutan's relatively light use of spectrum and limited demand in the foreseeable future, suggests that the only argument for T2 would be because it was the latest standard. In other countries considering T2, spectrum congestion is a driver to gain the spectrum productivity and improved service carrying capacity offered by T2 compared with the original DVB-T standard. The other standard consideration is the use of MPEG4 coding for compression over MPEG 2 which is used by most existing digital broadcasters. MPEG2 was the only system available to the early adopters, MPEG4 cost have now fallen and new consumer equipment will soon have both MPEG4 and MPEG2 capability with little

or no cost differential. Because MPEG4 allows more services to be accommodated in the channel, it provides better flexibility for the future. Most countries would choose to adopt MPEG4 in future. Those using MPEG2 cannot convert easily because of the MPEG2 legacy. The UK and other countries in Europe plan to use MPEG4 in conjunction with DVB-T2 because they are establishing new services and consumer reception of existing services will not be affected because the DVB-T2/MPEG4 receivers will also receive DVB-T/MPEG2. The reverse is not true. The alternative standards are those of China, Japan, and the USA. Details of these were contained in the first report and the Working Committee may wish to conduct further appraisal of them. The main arguments against adopting these standards is that the global support for them outside of their countries of origin is far more limited than for the DVB family. The Expert could provide further detailed arguments for and against each of the options if required, but this goes beyond the scope of the current ITU assignment brief.

There are advantages in commencing migration earlier as a more graduated approach can be taken and new possibilities can start to be explored.

- b. **Spectrum.** Bhutan does not currently use any of the Broadcasting Band Spectrum that has been earmarked by the ITU for early analogue clearance, or for sharing or allocation to new types of services. Currently VHF-Band III is used extensively with a few low power services in the bottom part of UHF-Band IV. Bhutan should look to maintain the current ITU Band III and UHF broadcast spectrum in its National Plan because these frequencies are harmonized internationally so consumer equipment supply is cheaper. Unlike some developed countries where spectrum demand is putting pressure on Broadcast Spectrum, this is not likely to be the case in Bhutan in the foreseeable future. Bhutan's terrain means that frequency coordination with neighbours is necessary only for high power FM and HF services, or maybe some television services near the borders. It would be sensible to establish digital television in the VHF Band where ever possible and ideally two channels removed from the existing service. This will reduce the cost of combining equipment necessary for the transmitters to share the existing transmit antenna. Adjacent channels can be used where necessary but the combining equipment will be more expensive. VHF will also provide better coverage; existing consumer antennas can be used.
- c. **Options for Commencement.** There are advantages in commencing migration earlier rather than later. In starting earlier then a more graduated approach can be taken and at the same time the opportunities can start to be explored. A possible approach would be to commence service in Thimphu to match the current Analogue coverage. This would provide the experience to the largest and potentially the most affluent city. At the same time this could be an opportunity to introduce a private broadcasting service to the available program mix. The Thimphu market would appear large enough to support a new broadcaster and it would allow this to become established before seeing digital expansion elsewhere. In the next stage digital might move to the 20 Dzongkhag using the optical fibre to carry the program to the

transmitters. The rest would naturally follow from there. This graduated approach has been used in all countries which have adopted Digital Television. Simulcast of analogue and digital would be needed until the audience had been substantially converted which would perhaps take several years. Analogue switch off could also be phased to take place progressively an appropriate period after digital commencement. A progressive extension and switchover would also provide the opportunity to redeploy and convert the relatively new analogue transmitters to digital as they were withdrawn from service. The timing and appropriateness of such a strategy will need more detailed financial and consumer analysis. By starting in Thimphu and delaying further extension for a year or so, there would be better opportunity to obtain real data on consumer interest, and about how to communicate the change to consumers and the industry. Taking a realistic view, commencement of a pilot digital transmission by the end of 2012 would be possible subject to the availability of funds to purchase a transmitter and the associated multiplexing and encoding equipment. This suggested schedule assumes that the preparation of the Road Map proceeds in accordance with the timetable set in Section 3.3

4.3 Stage 3 Issues

Stage 3 is concerned with the mechanics of implementation once a decision is made on migration as such the Working Committee need prepare only a broad Road Map of the tasks involved and some ideas about how they will be undertaken and by whom. Hence, detailed consideration of Stage 3 beyond this broad level can be left for the time being, and revisited after Stage 2 and possible timing of digital commencement and migration is established. It will involve careful review of all legislation and regulation that may impact on the establishment and operation of infrastructure and services that eventually make up the complete package of broadcast and broadcast like services for Bhutan.

4.4 Progressing the Work: Working Committee Action Plan

The Expert presented the report and conclusions to a special meeting of the Working Committee before he departed Bhutan. The immediate next steps for the Working Committee should be:

1. Meet to discuss the recommendations and suggestions contained in both Consultant Reports.
2. Discuss the Draft Terms of Reference set out in Section 3.4 and Annex A and agree a final version.
3. Agree the working arrangements and organization of the Working Committee
4. Hold first full working meeting of the Committee to develop a work plan based on Annex I as discussed below, determination of priorities, a provisional allocation of work and timetable for deliverables. This meeting should also agree a forward schedule of meetings. In general deliverables (discussion papers on the topic as draft sections of the report, should be circulated in advance and become the topic for the next meeting).

All four items could be addressed in a first comprehensive meeting of the Committee. To assist this action, the Expert has prepared a draft Agenda for the first meeting which is shown at Annex E. In addition the Expert has prepared a suggested outline for a completed Road

Map. This is provided at Annex I. This outline could form a logical work plan for the Committee as described in the introduction to the document.

The document could initially become a comprehensive report on the recommendations and deliberations of the Committee, and record the underlying assumptions and policy objectives/decision. After DTV Migration Recommendations have been adopted the document should be updated to reflect decisions agreed and thus become the Road Map for Digital Migration. At that time it may be appropriate to expand the sections on implementation and to update other parts as may be necessary in the lapse of time. In any event, the task of moving from a Working Committee Report to Road Map will be fairly simple using this approach.

5 Further Assistance for the Working Committee

The nominated Working Committee should be fully competent to address Stage 1 and the majority of the Stage 2 questions. The suggested format and headings for the Road Map and Report should provide strong guidance to the work and should enable the Working Committee to substantially complete its task without much additional assistance.

If further assistance is required it may be in the following areas:

- a. Critical Review of draft reports and recommendations that support the Road Map and its development;
- b. Assisting the Committee and Secretary at important stages of the work if discussion gets bogged down in deliberation of options;
- c. Development of the future implementation strategy for Road Map; and

The ITU Senior advisor has indicated that ITU will consider the provision of further assistance as may be necessary if Bhutan so requests. Bhutan is one of the pilot countries for preparation of a developing country Road Map so work here will assist the process for other countries covered by the recently constituted ITU Project.

Ways of delivering further assistance will depend on the defined needs after the Working Committee reviews its agenda and work plan.

The Expert believes that the reports provided and other available documentation, referenced in the First Report, will enable Bhutan to make considerable progress with the task using occasional expert input by email or web based exchange. Assistance beyond that would need to be established on its merits as the Working Group proceeds with its mission. Such assistance would need to be arranged by ITU in consultation with the Expert.

Beyond the formulation of the Road Map, Bhutan may need assistance with detailed review of legislation and regulation and other things to support the decisions arising from the Road Map, as the task may stretch the limited resources available in Bhutan. Likewise further input may be required at the point actual migration and communication strategies are being planned.

If the suggestions contained in this report about the organization and work and Agenda of the Working Committee are adopted, then Bhutan should be able to move a considerable distance towards defining its Migration Road Map from within its own resources. Until the work is underway and the challenges and any knowledge gaps emerge no useful assessment of the need for and type of assistance that may be required can be made beyond the above suggestions.

6 Recommendations

From the findings of the mission material provided in this report and analysis and guidance reflected in the first report the following approach to development of the Digital Television Migration Road Map for Bhutan is recommended:

- a. Adoption of the Terms of Reference set out at Annex A to this report
- b. Constitution of the Working Committee with the Secretary MoIC as Sponsor, day-to-day leadership of Head Telecommunications BIMA with PPD MoIC direct participation as the focal point for MoIC coordination and input from the Secretary as discussed in Section 3.2 of this Report.
- c. An initial long off-site meeting of the Working Committee should be held soon to consider this mission report and the guidance contained herein and that contained in the First Report. (A draft Agenda for this meeting is contained in Annex E).
- d. A working timetable be adopted along the lines suggested in Section 3.3 to ensure that the work progresses in a timely manner, and that specific deliverables defined by the draft Road Map topics in Annex I be mapped a more detailed timeline that breaks down the task into small manageable units. The Working Committee should regularly report progress against this schedule and take action to resolve any impediments to progress.
- e. The Working Committee considers what further assistance is needed from ITU to achieve the agreed work plan and deliverables as the work proceeds.

7 Annexes

- A. Working Committee Terms of Reference
- B. Strategic Policy Considerations
- C. Working Committee Questions at ITU Digital Migration Workshop (April 2010)
- D. ITU Guidelines on the Transition from Analogue to Digital Broadcasting – Workshop Presentation April 2010
- E. Suggested Agenda for Planning Meeting of Working Committee
- F. Bhutan Response to ITU Questionnaire on Digital Migration Feb 2010
- G. List of People Interviewed during the Mission
- H. Bhutan Digital Migration Plan Working Committee Membership Mar 2010
- I. Expert's Presentation from Digital Migration Workshop April 2010
- J. Outline for Bhutan Digital Migration Road Map
- K. Extract from ITU Report 2140 describing the various DTV systems around the world.

7.1 Annex A: Working Committee Terms of Reference

Digital Migration Working Committee Recommended Terms of Reference

The Working Committee is appointed by the Secretary MoIC who is the sponsor of the project. The Committee is required to make recommendations to the Secretary MoIC on all aspects of the introduction of digital television to Bhutan as described in these Terms of Reference.

The Working Committee should undertake its task in several stages:

5. Identify and make recommendations on key policy questions that need to be decided to enable options and recommendations on the migrations question to be developed;
6. Detailed analysis and recommendations about the how and when of Digital Migration; and
7. Recommendations on the regulation, planning and other matters necessary to give effect to the migration.

The Committee should complete the above stages against the following timetable:

- Stage 1: Report by [1 month after commencement]
- Stage 2: Report [3 months] after receipt of policy direction from Stage 1
- Stage 3: [6 months after receiving Government response to Stage 2 Recommendations]

In undertaking its task the Working Committee should recommend:

1. How when and why digital television should be introduced into Bhutan;
2. The preferred approach to the strategic policy questions set out in Section 3.1 of the ITU Digital Broadcasting Migration Bhutan Report (*Copied as Annex B to the April 2010 ITU field mission report*);
3. The system standards to be adopted in Bhutan for digital television;
4. How cable television, and potential DTH services should be structured to complement and integrate the digital television solutions;
5. How and when competitive services should be introduced into Bhutan, including ways in which such services might be introduced in an equitable manner;
6. The number and type of television services that may be required/practical in Bhutan over the next 5-10 year time period including multi-channel, HDTV, and other services using this technology;
7. Whether digital television should be introduced using a multi-service per transmitter channel basis or as a simple multi-program single licence per transmitter solution;
8. Changes to existing legislation and regulations are needed to implement the proposals;
9. Arrangements for equitable access to transmission infrastructure
10. A practical timetable for implementation of digital television in Bhutan;
11. Forms and duration of any assistance which might be needed to facilitate digital migration
12. Arrangements for assisting viewers understand digital migration including factors that might determine when analogue switch-off might occur

In making these recommendations, the Committee should:

- Assess the costs of digital conversion for all stakeholders (Government, Broadcasters, Infrastructure, Consumers) including both capital and ongoing operating costs;
- Develop detailed spectrum and channel plans for implementation of digital television including recommendations on the channel plans to apply post analogue switch-off;
- Determine arrangements for establishing the necessary standards in Bhutan to implement the recommended approach (eg technical standards, and associated service specifications);
- Consider Programming aspects for digital television in relation to the advancement of the National communications and information goals and whether any particular prescriptions should be made in the allocation of capacity;

The Working Committee may establish a Task Groups to assist in the detailed development of its positions on the above questions.

[Approved By, and Date]

7.2 Annex B: Strategic Policy Considerations

(From Section of First Report by ITU Expert with minor improvements highlighted)

A digital migration strategy needs to commence with consideration of some fundamental policy matters including:

- a. Why consider migration to digital?
- b. What are the national and public policy objectives to be advanced through digital migration? What are the major enabling factors (eg content, new types of services, specialist channels such as education and information services...)?
- c. What form of digital television is needed to deliver these objectives (eg. multi-channel, HDTV, mobile television, associated data services...)? How will this change over time? Should provision be made in the migration framework to enable such evolution in the future?
- d. Will new services be considered in the strategy (television, data, and other types of services)?
- e. What technical standards should be adopted that will best serve the needs of Bhutan, be cost effective and sustainable? How will these be mandated for Bhutan?
- f. What is the preferred video display standard? Should this be mandated or can it be left to the broadcasters to decide what best meets their needs?
- g. What particular factors should be considered in reaching a decision on the technical standard?
- h. How will consumer migration to digital be accomplished (simulcast, subsidy, new programmes...)?
- i. What would be considered an appropriate penetration of receivers to consider migration sufficiently advanced to turn off analogue? (eg x% of the current analogue television penetration? One per household? One per village? Multiple receivers per household?).
- j. Should future extension of services to those places without any television be implemented a digital only services? At what point would this be a sensible strategy (assuming 100% coverage in analogue is not achieved by the time migration commences)?
- k. To what extent should broadcasters have freedom to use the data stream (eg can they use the allocated data stream for additional services? Will they be required to hold separate licences for each service? What types of licence would be appropriate?
- l. How would any new broadcasters be accommodated (eg digital only new services, new services commencing on analogue and migrating to digital...)?
- m. What expected future changes in needs or services should be considered in formulation of the strategy so that they can be enabled easily at the appropriate time?
- n. To what extent should IPTV and Internet services (which may be used to rebroadcast or allow replay of broadcast programmes) be considered in the framework?
- o. What is a realistic timeframe for migration given economic capacity of Bhutan, the need to ensure most people can receive services intended for them, the cost of professional and consumer equipment, the resources including technical capacity to implement the migration and to create or acquire any new content needed to assist in the process?
- p. Will assistance be provided to consumers? What form should that take? At what point would it be announced or decided?

- q. How will cable and DTH services be integrated with any new DTV services and how can these be migrated to Digital? What services will they be expected to carry from the DTV mix?
- r. Will any assistance be provided to broadcasters and cable operators to assist them to achieve the roll-out of digital services in a timely manner?
- s. Will any new entrants receive the same assistance as may be contemplated for existing broadcasters (eg BBS)? Would this depend on whether they have to migrate from analogue or commence directly on digital? Would any subsidy apply if they are sharing a common multiplexer and infrastructure?
- t. What is the most appropriate spectrum to use for Digital to minimize cost, maximize service delivery etc against potential competing needs for spectrum by other services including other ICT services such as mobile telephone?.
- u. What factors will determine the end of analogue transmissions and the end of any simulcast period?
- v. What is to happen to the spectrum vacated by analogue transmissions?
- w. What other ICT and other services need to be considered in the spectrum and planning decisions? (eg Mobile TV using say DVB-H technology)
- x. What role should satellite play in achieving universal coverage of Bhutan and what is the optimal way to achieve this from a technical, cost and user perspective?
- g. Assignment of Logical Channel Numbers for Bhutan digital services.

7.3 Annex C: Working Committee Questions at ITU Digital Migration Workshop (April 2010)

Bhutan Digital Migration Working Committee
Areas of Interest and Questions Raised by Working Committee Members in
ITU Digital Migration Workshop 13 April 2010

1. Based on discussions digital migration in Bhutan range of options are in consideration. Analogue extension is still in progress and DTH is in the discussion to achieve coverage of remote areas. SS
2. DTH, ANALOGUE, DTV: what is the most relevant to Bhutan? – could the Malaysian/Indonesian solution to DTH have any application in Bhutan. SS
3. Who is the champion of DTV Migration in Bhutan? Leadership of the program? Who will they be? Who should they be? SS
4. Standards which are most appropriate and affordable to Bhutan?
5. How can DTV be promoted, who should play the lead role, what are the tasks to carry out to do this? What are the responsibilities of the different players and agencies?
6. What framework is needed prior to the transition – BIMA needs to be ready before the migration
7. What incentives can be provided to the service provider et al
8. How should we start? What time frame? What service first?
9. What are the cost benefits to consumer and others for the transition?
10. What spectrum should be used for ITU – International standardization etc. – What freedoms to have National Solutions.
11. Is it necessary at all to have a transition to Digital in a country like Bhutan?
12. No evident clear objective for the Working Committee.
13. Benefits of Digital? Act has broad regulatory framework – need to link Policy – Level Playing Field for service providers to do business
14. Key areas where organizations who are implementer – what is the capacity of the organizations to deliver the program? (eg BIMA Spectrum, capacity planning – efficiency)
15. Where will the content come from? What new content will be needed for Digital?
16. Should there be content policy in support?
17. The initiative came from Bhutan/Minister not ITU
18. Government is planning DTH – is this sensible? Concern about cultural integrity – Bhutanese programming could be swamped if BBS is only one in a field of many?
19. Clarity of policy and regulation for private sector to have clear basis to invest? Needs leadership per earlier question
20. DTH would be a disincentive for private cable and other operators to invest in indigenous technology?? Need a policy to attract investment?
21. How do existing businesses in broadcast and broadband be included in the digitalization initiatives
22. Spectrum – lots of channels need lots of spectrum – DTV more efficient. What incentives to operators in return for the benefit of spectrum saving – how can private sector contribute?
23. WHAT are the implications for broadcasting production of digital v existing analogue?
24. What are the appropriate DRM arrangements?
25. Single BBS service – OS content has lots of adverts. How to protect Bhutan from OS commercial content – other countries have clean feed? (See Q34)

7.4 Annex D: ITU Guidelines on the Transition from Analogue to Digital Broadcasting – Workshop Presentation April 2010



**Guidelines on the transition from Analogue
to Digital Broadcasting**

April 2010

*Sameer Sharma, Senior Advisor
ITU Regional Office for Asia and the Pacific*

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7.5 Annex E: Suggested Agenda for Planning Meeting of Working Committee

Suggested Agenda and Work Plan For the Recommended Initial Long Meeting of the Working Committee 1-2 days

1. Introduction and Purpose
2. Discussion of Consultant's Reports and Recommendations
3. Terms of Reference for Working Committee
4. Future Working Arrangements and Organization including arrangements for circulation of meeting records of decisions, draft documents etc.
5. Review Consultant's Suggested Road Map Outline and Work Plan contained in Field Mission Report
6. Review Consultant's Suggested Timetable for the Work and agree an appropriate timetable taking account of available resources and priorities
7. Allocate tasks for development of draft sections of the road map and establish reporting deadlines for delivery of drafts for Working Group Discussion
8. Establish timetable for future meetings and allocate deliverables tentatively to the agenda for those meetings.
9. Discuss Key Policy Guidance that may be needed – see Consultant's suggestions and associated material.

Reference Material

1. First Report from ITU Consultant (Final Report dated January 2010)
2. Field Mission Report from ITU Consultant (Draft version 1.0 dated April final version to come from consultant and ITU shortly)
3. Draft Terms of Reference for the Committee as Updated by Consultant during the Field Mission\
4. Working Committee Discussion Questions from ITU Digital Migration Workshop
5. Strategic Questions from the Consultant's first Report.

7.6 Annex F: Bhutan Responses to ITU DTV Migration Questionnaire

Questionnaire Part I

Q.1 Ministerial and organisational broadcast responsibilities

Q1.1 Please list each ministry and/or organisations, together with their respective responsibilities, for each of the following sound and television broadcasting issues:

Policy, Broadcaster licensing, Broadcaster Regulation, Spectrum Regulation, International coordination of spectrum use, Technical planning.

(For example, some administrations have separate ministries responsible for broadcasting policy or broadcaster licensing matters and spectrum management or spectrum usage licensing, other administrations have separate organisations for broadcasting and non-broadcasting services and separate ministries organisations from sound and television broadcasting)

	Ministry/Organisation Name	Responsibilities
1	Department of Information & Media, Ministry of Information & Communications	Media (including broadcasting) Policy Media development
2	Bhutan InfoComm & Media Authority	Broadcaster regulation, licensing, spectrum regulation, international coordination spectrum, technical planning
3		
4		
5		

Q1.2 Which of the above ministries or organisations would take overall responsibility for the introduction of digital broadcasting in your country?

MoIC

Q2 Plans for the introduction of digital broadcasting

Q2.1 Does the government or regulator have any plans to introduce digital terrestrial broadcasting services? (Please indicate ONE of the following)

1	No plans at this moment	
2	Currently developing a plan for the introduction of digital broadcasting services	√
3	Finalising a plan for the introduction of digital broadcasting services	
4	Installation stage	
5	Trial service stage	
6	Simulcasting	
7	Other (Please describe)	

Q2.2 If in question 2.1 you have selected option 1, has the government or regulator identified a year when it will start the process of introducing digital broadcasting?

Yes - please indicate the date for the relevant service(s)	Radio	TV	Mobile	Data
No - please explain why your country has no current plans for introducing digital broadcasting and if this relates to a particular difficulty in converting to digital broadcasting, please also describe the problem				

Q2.3 What year has the government or regulator chosen for the end of the transition period?

(noting that

i) Under the GE06 Regional Broadcasting Agreement, the end date for the transition from analogue to digital broadcasting is 17 June 2015 in the band 470-862 MHz. However, in the band 174-230 MHz, while most countries also agreed the 17 June 2015 will be the end date for the transition from analogue to digital broadcasting, some countries chose an end date of 17 June 2020

ii) some countries are planning to convert to digital broadcasting before 17 June 2015)

Q2.4 Which of the following groups is leading the demand for the introduction of digital broadcasting?

a	Government	✓
b	Broadcasters	✓
c	Industry	
d	Consumers	
e	Other	

Q3 Digital broadcast requirements

Q3.1 Which of the following digital services is the government or regulator considering, or intending to introduce? (please indicate ALL relevant services)

1	Digital radio broadcasting	✓
2	Digital terrestrial television broadcasting service	✓
3	Digital terrestrial mobile television broadcasting service	✓
4	Datacasting	✓
5	Interactive service	✓
6	Other (please describe)	✓ (IPTV)

Q3.2 Which of the following requirements does the government or regulator intend to provide in your country (Yes or No)? (please indicate ALL relevant requirements)

Digital terrestrial broadcasting provides the opportunity to introduce new services, as well as change and enhance the provision of existing services

1	Provide additional programme channels	
2	Extend the existing coverage of services in terms of population or territory	Yes
3	Introduce new services like datacasting	
4	Increase the broadcast licence revenue from new broadcasters	
5	Use the digital dividend to introduce other radiocommunication services	
6	Incorporate the terrestrial broadcast infrastructure within a public warning, disaster mitigation and relief system	Yes
7	Other (please describe)	

Q3.3 If the requirements listed in question 3.2 are not the same for digital radio broadcasting, digital television broadcasting or digital mobile television broadcasting, please detail the difference in requirements between these services.

Digital radio broadcasting	
Digital television broadcasting	
Digital mobile television broadcasting	

Q4 ITU assistance

Q4.1 If assistance was provided to your country in the transition from analogue to digital broadcasting, which of the following areas of expertise would be most helpful, marking each item on a scale from 1 to 5 (where 1 equals least important and 5 equals most important):

(Note: ITU resources are limited and will normally be in the form of provision of expert advice and assistance)

1	Adapting the Road Map to the requirements of your country	1
2	Ensuring national legislation is ready for the transition to digital broadcasting	1
3	Identifying potential sources of financing and preparation of budget	2
4	Collection of technical information	2
5	Development of customer awareness	
6	Provision of receivers	1
7	Technical or regulatory expertise	2
8	Other (Please specify)	

Q4.2 Please provide any relevant additional information in relation to the items you have marked as most important, in question 4.1.

Assess the feasibility or readiness of migrating to Digital Broadcasting.

Q4.3 If the ITU chose your country as a pilot for the transition from analogue to digital broadcasting in Asia-Pacific Region, would your government be prepared to participate?

Yes	
No (if no, then indicate date when you could participate)	

Q4.4 Please provide the name and department of the person that can provide the necessary commitment to the project.

Secretary, Ministry of Information & Communications

Q4.5 If the government or regulator has already started to introduce digital terrestrial broadcasting, what are the main problems that have been encountered?

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Q5 Digital broadcasting policy

Q5.1 Has the government or regulator indicated any preference for a particular form of digital broadcast licensing and regulation? (please indicate ALL relevant cases)

a	Only existing analogue services will be allowed to convert to digital broadcasting	
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b	New entrants and existing analogue services will be licensed for digital broadcasting	✓
c	During the transition period only new entrants will be licensed for digital broadcasting	
d	During the transition period only existing broadcasters will be licensed for digital broadcasting	
e	Other (Please specify)	

Q5.2 If the options listed in question 5.1 for digital broadcast licensing and regulation are not the same for digital radio broadcasting, digital television broadcasting or digital mobile television broadcasting, please detail the difference in requirements between these services.

Digital radio broadcasting	
Digital television broadcasting	
Digital mobile television broadcasting	

Q5.3 Has the government or regulator identified how many digital broadcasters it is prepared to grant access?

Yes (please indicate number)	public broadcasters -	independent broadcasters -
No		

Q5.4 How many broadcasters have currently indicated a desire to provide digital services?

(please indicate number)	public broadcasters - 1	independent broadcasters -
--------------------------	-------------------------	----------------------------

Q5.5 How will the government or regulator select the successful new broadcasters? (Please indicate the method of selection applicable to public broadcasters and independent broadcasters)

	Method of selection	Public broadcaster	Independent broadcaster
1	Selection of licensee is by "beauty contest"		
2	Selection of licensee is by auction		
3	First come, first served	✓	✓
4	Other (Please specify)		

Q5.6 Will the government or regulator require digital broadcasters to provide specific services?

Yes (please describe the specific services required)	
No	✓

Q5.7 Does the government or regulator impose a requirement on broadcasters to provide coverage to a minimum % of the population or territory (this limit may be based on national coverage, or regional coverage where the broadcaster is only licensed to provide coverage in an area smaller than the whole country) ?

Yes (Please specify)	
----------------------	--

No	✓

Q6 Licensing and regulation issues

Q6.1 If the government or regulator permits independent broadcasters, please indicate which of the following broadcast licence conditions apply? (please select One option)

1	The fee for the broadcast licence is spread over the period of the licence with fee instalments paid annually	✓
2	The fee for the broadcast licence is paid as a lump sum when the licence is awarded	
3	Other (Please specify)	

Q6.2 If the government or regulator permits independent broadcasters, what is the normal time period of the broadcast licence, in years?

Maximum of 15years

Q6.3 If the government or regulator permits independent broadcasters, then does the government or regulator place any limitations on foreign ownership? (please select One option)

1	Foreign ownership is not permitted	✓
2	Foreign ownership is limited to a % of the broadcasting company (please indicate the percentage)	
3	There are no restrictions on foreign ownership	
4	Other (Please specify)	

Q6.4 If the government has decided to introduce digital mobile television, which broadcast standard has it considered or selected to provide this service? (Please indicate which standard would be used for mobile broadcasting)

The GE-06 Regional Broadcasting Agreement is based on T-DAB for radio and DVB-T for digital television broadcasting, different standards would be required for mobile television broadcasting

DVB-H	✓
MediaFLO	
OneSeg	
T-DMB	
Other (please specify)	Depends on the recommendation of the expert

Q6.5 Is the government or regulator considering the introduction of HDTV services?

No	
Yes (please specify)	After the introduction of digital broadcasting yes.

Q7 Digital broadcasting financial issues

Q7.1 Has your government, regulator or broadcasters analysed the cost of introducing digital services, including the costs to the general public?

Yes	
No	✓

Q7.2 Has the government or regulator indicated how the transition by broadcasters to digital terrestrial broadcasting will be funded?

No		√
Yes (If yes, please indicate which of the following approaches apply):		
1	Government to fully fund the process for both state and independent broadcasters	
2	Government to partially fund the process for both state and independent broadcasters (if yes, please indicate either the minimum % of costs or the minimum costs in US \$ millions, the government will fund)	
3	Government to fully fund the process for state broadcasters only	
4	Government to partially fund the process for state broadcasters only (if yes, please indicate either the minimum % of costs or the minimum costs in US \$ millions, the government will fund)	
5	Government to provide grants or loans to the broadcasters (if yes, please indicate the minimum value of these grants or loans in US \$ millions)	
6	Broadcasters expected to fund the process from their own income or resources	
7	Other (please specify)	

Q7.3 If the government or regulator is not funding the transition by broadcasters to digital broadcasting, nor are they providing grants or loans to independent broadcasters, will they provide other incentives to allow independent broadcasters to recover the costs (e.g., extending the broadcast licence period) ?

Yes (please specify)	
No	Possibly, but will depend greatly on the expert's recommendations

Q7.4 Has the government or regulator indicated whether they will subsidise the consumers costs in converting to digital terrestrial broadcasting?

To receive digital broadcasts consumers will need to purchase new or additional equipment. This equipment may be limited to a separate converter, known as a "set-top box." However, in some areas, either due to a change in the frequencies used for transmission, or because of a weak broadcast signal there may be a need to replace the receiving antenna and antenna cable.

No	√
Yes (Please specify)	

Q7.5 Has the government or regulator decided whether to offset the costs of digital conversion by the sale of broadcast licences to new broadcasters or the sale of spectrum released by the digital dividend to new services?

Yes (please specify)	
No	√

Q8 Existing access to digital and mobile services

Q8.1 Can the general public in your country already receive digital broadcast services, if so please indicate which sources of digital broadcast services are available (please indicate ALL sources)

1	digital radio broadcasting from broadcasters within the country	
2	digital television broadcasting from broadcasters within the country	
3	digital services provided by cable operators	
4	digital services accessed over the internet	✓
5	digital services provided by satellite	

Q8.2 Please indicate the extent of mobile phone usage in your country by

Number of mobile phones (1000s)	390
The percentage of the population with access to mobile phone services	57.5 %
The percentage of the total area of the country covered by mobile phone services	64 %

Q8.3 What percentage of the population have access to internet services ?

7 %

Q9 Broadcasting Structure

Q9.1 Which organisation(s) provide terrestrial broadcasting in your country, how are they funded and what type of broadcast service do they provide?

In some countries terrestrial broadcasting is operated solely by the government, in other countries terrestrial broadcasting is operated by government and independent organisations. Both public and independent broadcasters may be funded from a variety of sources, although independent broadcasters are not funded by government.

Please list the relevant broadcasting organisations, whether they are government or non-government, the two principle funding mechanisms and their approximate percentage contribution to the broadcaster's total income and whether they provide both radio or television services using the following codes as indicated in the examples shown on the first three lines. Note: the % of income does not have to equal 100%, as broadcasters have a number of methods for earning income e.g., the sale of programmes to other broadcasters. (Please add additional rows as required).

Funding Mechanism key

Government - the most common are through general taxation, a public subscription, the purchase by the consumer of an annual licence or authority to receive radio or television broadcasts.

Advertising – sale of time for commercials, sponsorship of programmes etc.

Subscription services – limiting provision of some programmes to customers who have paid an additional subscription.

Terrestrial broadcast key

A – Analogue services, D – Digital services, A/D – Analogue and Digital services

	Organisation Name	Public Broadcaster (Yes/No)	Funding Mechanism	% of income	Terrestrial	
					Radio	TV
1	Bhutan Broadcasting Service Corporation	Yes	Government	0.5%	A	A
2	Kuzoo FM	No	Private		A	
3	Radio Valley	No	Private		A	
4	Centennial Radio	No	Private		A	
5						

6						
7						
8						
9						
10						
11						

Q9.2 If terrestrial broadcasting is provided by more than one non-government organisation, then do these non-government broadcasters compete with each other for listeners or viewers within the same geographical area?

Yes	Yes
No	

Q9.3 If the answer to 9.2 is Yes, then is this competition between the broadcasters limited to radio broadcasting or does it apply for both radio and television broadcasting?

Radio only	√
Both radio and television	

Q10 National Frequency Usage

Q10.1 Is the government or regulator satisfied that the digital assignments and allotments your country has in the GE06 Plan will enable digital terrestrial broadcasting to be implemented to the extent and timescales required?

Yes	√
No (Please explain difficulty)	

Q10.2 Were any of your country's digital assignments and allotments obtained at RRC-06 listed with a remark indicating further coordination was required before it can be brought into operation?

At the Regional Radiocommunication Conference in 2006, some digital assignments and allotments were listed in the digital Plan with remarks, indicating that further coordination was required with:

- *existing analogue broadcasting assignments (until the end of the transition period), or*
- *new digital broadcasting assignments/allotments or*
- *existing assignments to other primary terrestrial services)*

Yes	√
No	

Q10.3 If the answer to question 10.2 is Yes, do any of these digital assignments and allotments still require further coordination before they can be brought into operation?

No	√
Yes (Please list the relevant assignments)	

Q10.4 If the answer to question 10.2 is Yes, does the requirement for further coordination inhibit your country's ability to implement digital broadcasting and are there any difficulties in achieving the required coordination. (For example some digital assignments cannot be brought into use until an analogue assignment in a neighbouring country has been switched off)?

No	√
Yes (Please explain)	

Q10.5 What is the highest frequency used in your country for provision of terrestrial analogue broadcasting at:

	MHz
VHF	88-108 for FM Radio 186-192 for TV
UHF	512 – 518 for TV

Q10.6 In the band 790-862 MHz, there is a primary allocation to the fixed service in Region 1. Is this frequency band used in your country for fixed service operation?

Yes	
No	√

Q10.7 In your country, are any existing analogue broadcasting assignments in the band 790-862 MHz used for the fixed service (the GE89 Regional Broadcasting Agreement permitted administrations to use their broadcasting assignments in the frequency band 790 - 862 MHz for the fixed service)?

Yes	
No	√

Q10.8 Is your country currently using or proposing to use any of your GE06 digital broadcasting assignments or allotments in the band 790-862 MHz for the fixed service (the GE06 Regional Broadcasting Agreement, also permits administrations to operate non-broadcasting primary services under the mask of a digital broadcasting entry in the Plan)?

Yes	
No	√

Q10.9 If the answer to question 10.8 is Yes, then please provide a list of the relevant plan entries

No	
Yes (Please list the relevant plan entries)	

Q10.10 Is your government or regulator considering, or has it already decided, to use the digital dividend arising from the transition to digital broadcasting to limit your countries use of the band 790-860 MHz for digital broadcasting services. ?

At WRC-07, a number of countries in Africa entered a new footnote making mobile services, except aeronautical mobile, co-primary with broadcasting and fixed services in the band 790-860 MHz. This footnote is effective until 2015, when a further new footnote comes into force making mobile services, except aeronautical mobile, co-primary with broadcasting and fixed services in the band 790-860 MHz across all of Region 1.

No	
Yes (Please specify)	

Q11 Country statistics

Q11.1 Please indicate the following

Total area of country (in sq km):	38,394 sq.km.
Total population size (in millions)	693,407 (2009)

Q11.2 What % of the population live within the following areas and what area does this cover ?

	% of population	% country area
- City dwellers:	21%	Not known
- Rural location, town dwellers:		

- Remote village/country dwellers:	79%	Not known
------------------------------------	-----	-----------

Q11.3 Please identify any significant trends in population distribution

Rural-urban migration growing annually @ 7%

Q11.4 What are the major languages spoken and the % of the population speaking them?

Languages	spoken by % of population
Dzongkha	Not known
English	Not known
Shar chop-kha	Not known
Lhotsham-kha	Not known

Q11.5 Please list the top 5 cities / population centres and their populations:

	cities / population centres	populations (1,000)
1	Thimphu	98
2	Chukha	74
3	Samtse	60
4	Trashigang	51
5	Sarpang	41

Q11.6 Please explain any significant variations between the total land area of the country and the populated areas of the country

Q11.7 Please provide any information relevant to the planning of radiocommunication services (e.g. the existence of significant bodies of inland water, the country topology - mountainous very flat)

Mountainous terrain

Questionnaire Part II

Section IIa : Current Status Of Terrestrial Broadcasting Services

Q12 Analogue terrestrial television broadcasting service

Q12.1 What TV broadcast standard is currently used for analogue terrestrial broadcasting?

TV Standard	
NTSC	
PAL	PAL
SECAM	

Q12.2 How many analogue terrestrial broadcasting channels are currently available?

1

Q12.3 Please indicate the current number of viewers and average viewing time for each analogue broadcasting channel, as shown in the example for the "Example Broadcasting Company Ltd"

Channel	% of the population within transmission coverage	average number of viewers per week (millions)	average viewing time per week (Hours)
BBSTV	20-T/ 50 with cable	0.05	3hrs
BBS Radio	80	0.3	10hrs

(Please add more lines as appropriate)

Q12.4 What is the current combined coverage by all analogue terrestrial broadcasting services in your country in terms of total population and territory?

Combined coverage from all analogue terrestrial broadcasting	
% of population	% of territory
15	70

Q12.5 Please indicate in the following table the % of the population in your country that currently receive free to air television services by the following means:

	% of viewers
A separate externally mounted VHF/UHF antenna	15
An individual indoor aerial	
Common antenna and distribution system (e.g. Multi-storey buildings or low rise blocks of units)	
Retransmission from the local cable operator	85

Q12.6 Which of the following frequency bands are currently used in your country for analogue terrestrial broadcasting ?

VHF	174-223 MHz	√
	223-230 MHz	
	230-238 MHz	
	246-254 MHz	
UHF	470-790 MHz	Channel 21
	790-862 MHz	
	862-890 MHz	
	Other	

Q12.7 Please indicate the total number of homes in your country (i.e. "TV homes") that have television reception equipment in them?

Appr. 40,000

Q12.8 Please indicate the percentage of "TV homes" for each of the following?

	TV homes with:	% of homes	% of colour TV sets

	1 TV set	15	15
a.	more than 1 TV set	5	5—
b.	A VCR		—
c.	A DVD recorder	2	2—

Q12.9 Are there any existing problems with fm radio reception or analogue television reception?

No	✓
Yes (Interference from neighbouring countries- India in the south, east and west and China in the north)	

Q13 Digital terrestrial broadcasting service (see section 8 for mobile broadcasting)

Q13.1 Is your country providing digital terrestrial broadcasting services?

Yes	
No	✓

Q13.2 Can any part of the population receive digital terrestrial broadcasting from neighbouring countries?

No (If you have also answered No to question 13.1, then please go to question 14.1)	No
Yes	

Q13.3 If the answer to question 13.2 is Yes, please indicate the following

Type of digital terrestrial broadcasting service	Coverage from other countries digital terrestrial broadcasting	
	% of population	% of territory
Radio		
Television		

If you answered No to question 13.1, then please go to question 14.1

Q13.4 In the GE-06 Regional Broadcasting Agreement, radio broadcasting is based on T-DAB and television broadcasting is based on DVB-T, it is therefore assumed that these broadcasting standards are being used for provision of digital broadcasting services in your country, is this assumption correct?

Yes	
No (Please indicate which standards will be used)	

Q13.5 Which of the following digital terrestrial services are currently available in your country?

1	Television	
2	Radio	
3	Data	
4	Interactive	

Q13.6 How many broadcasters are currently providing digital terrestrial broadcasting services in your country?

Q13.7 What is the current combined coverage by all digital terrestrial broadcasting services in your country in terms of total population and territory?

Combined coverage from all digital terrestrial broadcasting	
% of population	% of territory

Q13.8 How many programme or data channels are provided in each digital television multiplex?

		Number
1	Television	ch
2	Radio	ch
3	Data	ch

Q13.9 How many programme or data channels are provided in each digital radio multiplex?

		Number
1	Radio	ch
2	Data	ch

Q13.10 What was the start year for these digital television multiplex services?

		Start year
1	Digital terrestrial television broadcasting	
2	Digital terrestrial radio broadcasting	
3	Digital terrestrial data services	

Q13.11 What was the start year for these digital radio multiplex services ?

		Start year
1	Digital terrestrial radio broadcasting	
2	Digital terrestrial data services	

Q13.12 Which of the following frequency bands are currently used in your country for digital terrestrial broadcasting?

VHF	174-223 MHz	
	223-230 MHz	
	Other	
UHF	470-790 MHz	
	790-862 MHz	
	Other	

Q13.13 How many of the following items of equipment are distributed in your country?

		Numbers (1000s)
a.	A new DTTB set top box used with a standard TV set	
b.	An integrated digital television set (i.e. one with a DTTB tuner built in, including digital televisions with Plasma or LCD displays)	
c.	A digital TV tuner card and a PC	

Q14 Digital terrestrial mobile broadcasting service

Q14.1 Is your country providing a digital terrestrial mobile television broadcasting services ?

No (Please go to question 15.1)	✓
Yes	

Q14.2 Please indicate the standard adopted for digital terrestrial television mobile broadcasting

	Mobile broadcast standard	Yes/No
--	---------------------------	--------

a	DVB-H	
b	MediaFLO	
c	Oneseg	
d	T-DMB	
	Other (please specify)	

Q14.3 Which of the following digital terrestrial mobile broadcasting services are currently available in your country?

1	Video	
2	Radio	
3	Data	
4	Interactive	

Q14.4 How many broadcasters are currently providing digital terrestrial mobile broadcasting services in your country?

Q14.5 How many programme or data channels are provided in each multiplex?

		Number
1	Video	ch
2	Radio	ch
3	Data	ch

Q14.6 What was the commencement year for these digital terrestrial mobile broadcasting services.

Q 14.7 Which of the following frequency bands are currently used in your country for digital terrestrial broadcasting?

VHF	174-223 MHz	
	223-230 MHz	
	Other	
UHF	470-790 MHz	
	790-862 MHz	
	Other	

Q14.8 Within the bands indicated in question 14.7, please list the channels and bandwidth used for digital terrestrial mobile broadcasting services

	Channels	Bandwidth (MHz)
1		
2.		
3		
4		

Q14.9 How many of the following receivers have been sold in your country for digital terrestrial mobile broadcasting service?

		Numbers (1000s)
a.	Mobile phone	

b.	PMP	
c.	Car navigator	
d.	Other	

Section IIb Current Status of cable TV Services

Q15 Analogue cable TV service

Q15.1 Are analogue cable TV services available in your country?

No (Please go to question 16.1)	
Yes	√

Q15.2 How many cable operators are providing analogue TV services in your country?

Q15.3 How many analogue TV programme channels are available on cable TV services?

40
1-BBS
40,000 approx.

Q15.4 How many homes have access to analogue cable TV services?

Q15.5 What transmission method is used by the cable operator for the subscriber local loop?

		Yes/No
1	Coaxial cable	Yes
2.	Fibre optic cable	Yes
3	Wireless (LMDS or MMDS)	
4.	Both wireless and cable	

Q15.6 If options 3 or 4 are selected in question 15.5, then what range of frequencies are allocated for wireless operation?

From (GHz)	To (GHz)

Q16 Digital cable TV service

Q16.1 Are digital cable TV services available in your country ?

No (Please go to question 17.1)	No
Yes	

Q16.2 How many cable operators are providing digital TV services in your country?

NIL

Q16.3 How many digital TV programme channels are available on cable TV services?

--

Q16.4 How many homes have access to digital cable TV services?

Q16.5 What transmission method is used by the cable operator for the subscriber local loop?

ch
.....(1000s)

		Yes/No
1	Coaxial cable	Yes
2.	Fibre optic cable	Yes
3	Wireless (LMDS or MMDS)	
4.	Both wireless and cable	

Q16.6 If options 3 or 4 are selected in question 16.5, then what range of frequencies are allocated for wireless operation ?

From (GHz)	To (GHz)

Section IIc Current Status of Satellite Broadcast Services

Q17 Analogue satellite TV service

Q17.1 Are analogue satellite TV services available in your country ?

No (Please go to question 18.1)	
Yes	√

Q17.2 How many satellite operators providing analogue TV programmes can be accessed from your country?

Q17.3 How many national broadcasters' analogue programme channels can be accessed from satellite operators?

Q17.4 What is the total number of analogue programme channels that can be accessed from satellite operators (including trans-national direct to home TV services) ?

Q17.5 How many homes have access to analogue TV satellite services ?

Q17.6 What frequencies are allocated to analogue satellite TV services in your country ?

	Type of access	Frequency From(GHz)	Frequency To (GHz)
1	Uplink (only if the uplink to the satellite is from within your country)	6.322	6.328
2	Downlink	4.097	4.103

Q18 Digital satellite TV service

Q18.1 Are digital satellite TV services available in your country ?

No (End of questionnaire)	
Yes	

Q18.2 How many satellite operators providing digital TV programmes can be accessed from your country?

Q18.3 How many national broadcasters' digital programme channels can be accessed from satellite operators?

Q18.4 What is the total number of digital programme channels that can be accessed from satellite operators (including trans-national direct to home TV services)?

Q18.5 How many homes have access to digital TV satellite services?

Q18.6 What frequencies are allocated to digital satellite TV services in your country?

	Type of access	Frequency From(GHz)	Frequency To (GHz)
1	Uplink (only if the uplink to the satellite is from		

	within your country)		
2	Downlink		

7.7 Annex G: List of Persons Interviewed by the Expert during the Mission in addition to members attending the Working Committee Meeting

Name	Position	Organization
Hon Lyonpo Nandalal Rai	Minister	MoIC
Mr Kinley Dorji	Secretary	MoIC
Mr Bhimlal Suberi	Director PPD	MoIC
Mr Kinley T. Wangchuk	Director IM	MoIC
Mr Karma Wangdi	Officiating Director DITT	MoIC
Mr Sonam Phuntsho	Director	BIMA
Mr Thinley Dorji	Managing Director	Bhutan Telecom
Ms Pema Choden	Managing Director	Bhutan Broadcasting Service
Mr Tashi Tshering	Executive Director	TashiCell
Mr Wangay Dorji	Head Telecommunications	BIMA
Mr Jigme Wangdi	Head Radcom & Resource Management	BIMA
Mr Panchaman Rai	Officiating Chief Engineer	BBS
Mr Rinzy Dorgi	Chairman and MD of DrukCom	Cable TV Operators Association Bhutan
Mr Ronrig S Mututsang	CEO	SamdenTech
	Several Staff Reporting to Director General – DG Caught up in SAARC	Dept of School Education
		Working Committee Members

7.8 Annex H :Bhutan Digital Migration Plan Working Group Membership March 2010

WORKING GROUP MEMBERS

#	Name	Designation	Agency	email	mobile#
1	Deo Kumar Bishwa	Manager, Promotion	Bhutan Telecom	deo.biswa@bt.bt	17113027
2	Jigme Wangdhi	Executive Engineer	BIMA	jigme@bicma.gov.bt	77600204
3	Karma Wangdhi	Sr. ICT Officer	DIT	kwangdi@dit.gov.bt	
4	Ngawang Dorji	Satellite Engineer	BBS	ngawangdorji@bbs.com.bt	
5	Panchaman Rai	Offtg. Chief Engineer	BBS	pancha_rai@bbs.com.bt	17602526
6	Rinzin Dorji	Chairman ITAB	Will represent both ITAB and ABCO	rinzy@druknet.bt	17110217
7	Subash Sharma	Engineer	Tashi InfoCom	subash.sharma@tashicell.com	77101010
8	Sonam Dhendup		PPD, MoIC	sdendup@moic.gov.bt	17875525
9	Tshering Dhendup	ICT Officer	DoIM, MoIC	tshering.dhendup@gmail.com	
10	Wangay Dorji	Executive Engineer	BIMA	wangdorji@druknet.bt	17624363
12	Dorji Wangmo	Planning Officer	PPD, MoIC (will attend the meetings on and off)	dwangmo@moic.gov.bt	

7.9 Annex I : Digital Migration Workshop Expert's Powerpoint Slides



Digital Migration Workshop

Thimphu, Bhutan April 2010

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1

7.10 Annex J: Outline for Bhutan DTV Road Map A Guide for the Working Committee

This is an outline of a possible form of a final report of the Working Committee, which could then easily be converted to the Roadmap after decisions are made by simply updating the document to reflect the agreed strategies. It is provided to serve as a guide for the Working Committee and the various sections can be used as the Work Plan and responsibility assigned to various members of the Committee to compile the necessary information in advance of Working Group Discussion which would then be documented into the report as the work progresses. The order of headings can be changed to suit the need and some of the headings may not be relevant. Information to populate some of the headings will be found in the First ITU Consultancy Report delivered in January 2010. Some guidance on other parts is contained in the Second Report (the Consultant's Field Visit Report dated April 2010).

The work of the Committee and its deliberations should generally follow the logical flow given in this outline which will then allow the Committees deliberations, and arguments to be easily captured. The usual way to progress is to take a heading and develop the fact base, such as the Technology or Policy Options, to write up the possible alternative and arguments and then to discuss these in the Working Committee to determine if all of the options have been covered and the pros and cons and then to reach a recommendation on a way forward.

Note that where there is a lot of detail, this should be put into a supporting Appendix to the Report and the headlines mentioned in the body of the report along with any particular observations as to how the facts might assist or hinder the work.

7.10.1 Introduction and Purpose

Explain the reason why Bhutan is considering DTV Migration and the background to creation of the Working Committee, its functions etc. In other words why is this Road Map/Report being written?

7.10.2 Current State of Television Broadcasting Development

This section explains the current situation for Television and sets the framework against which migration must be considered. All aspects should be stated in summary form. The details can go to Annexes but in the ideal this should become a reliable repository of factual information about the infrastructure, costs and ways in which television is currently delivered, the programming and limitations etc and the way it is distributed.

It should include mention of current concerns such as DTH etc as these are things for which solutions might be easier in the wider context of DTV.

7.10.2.1 Free to Air

This will be about BBS Television Delivery, but could include issues about trans-border terrestrial if there is any relevance .

7.10.2.1.1 Transmitter Locations and estimated Coverage and Channel Allocations/Spectrum Used

7.10.2.1.2 Transmitter Input Arrangements

How are the transmitters feed with program (eg satellite, wireless link, optical cable)

7.10.2.1.3 Other Delivery Arrangements

Information about special arrangements for remote villages (such as communal TV viewing, from DTH or cable feed such as those installed for the Election and Coronation in the 176 locations without TV should be mentioned here.

7.10.2.1.4 Transmission Hours

7.10.2.1.5 Program Content

7.10.2.1.6 Costs and possibly current investment and remaining life of the infrastructure

7.10.3 Any Current Developments (service extensions planned or proposed or in train)

7.10.3.1 Cable

As cable is an important means of delivery in Bhutan, it will be important to the DTV delivery as well. This section will document what is known about the cable systems so that the plans can take into account the public dependence on this means of delivery.

7.10.3.1.1 Description of Cable Arrangements Locations and estimated Coverage: Subscriber Numbers

7.10.3.1.2 Cable Technology in Use (eg Fibre, Coaxial, Digital or Analogue)

7.10.3.1.3 Costs and possibly current investment and remaining life of the infrastructure

7.10.3.1.4 *Any Current Developments*

7.10.3.1.5 *Concerns (pirating content??etc)*

7.10.3.2 **DTH**

Given the concerns mentioned to the Consultant, this seems an important question to be considered along with DTV so it should be mentioned in this background data repository of issues.

7.10.3.2.1 *Description of current arrangements including BBS distribution if it is available DTH*

7.10.3.2.2 *Current situation and Developments*

7.10.3.2.3 *Costs (if relevant)*

Could include here the costs incurred in BBS distribution of its program to transmitters.

7.10.4 **Current Concerns and Related Developments**

This section should describe any current matters or concerns that may need to be taken into consideration by the Working Committee during its deliberations and which might shape the recommended outcomes.

7.10.4.1 **Any particular concerns about existing TV arrangements.**

7.10.4.2 **Related ICT Developments**

As DTV is an important component of the ICT landscape, it can be put into context here and any relevant developments mentioned. One of the most important ones is the roll-out of Optical Fibre Cable across the county.

7.10.4.2.1 *Optical Fibre Roll-Out and Capacity*

7.10.5 **Policy Objectives/options relevant to DTV**

Some of the points listed below may already be clear or might need early decisions to allow the DTV Migration strategy to be adequately shaped. Hence as the work progresses these might change from being questions to MoIC to agreed policies that are documented as foundational to the work. As policy confirmation may take some time, the Working Committee should make recommendations and then use the recommendations as the way to

move forward. If there is a change later than the assumption can be changed and the other conclusions adjusted if necessary.

7.10.5.1 DTV Objectives (SDTV/HDTV/Emergency Broadcast....)

What do we want to do with DTV and what types of services should be considered by the Committee in its system and service planning choices. This might include SDTV, possible numbers of channels, future HDTV and so on. It might set out the strategy of moving from one to the other as economic conditions and community needs change.

7.10.5.2 Target Coverage

What do we expect to cover and over what time frame with DTV, and how will the balance be addressed

7.10.5.3 Competition

How and when might competitive private broadcasting services be introduced. Should they be digital only, should any new services be delayed until Digital is in place. etc

7.10.5.4 Access

If infrastructure is shared (and some must be irrespective of the solution) then what arrangements should be in place to ensure level playing field and at the same time appropriate charges for shared facilities.

7.10.5.5 Content

Are there any desired content outcomes for DTV (eg Educational Channel, Government Information Channel, which could use some of the new capacity provided by DTV at very low marginal cost.

7.10.5.6 ??Mobile Television?

Is this a concern or aspiration. Different technologies have different ways of delivering this. Some need separate infrastructure. What the committee needs to decide or know is this relevant to Bhutan and how would this sit in relation to future mobile telephony etc. There would be cost for mobile DTV that needs to be factored into the decisions

7.10.5.7 Spectrum

Are there any compelling spectrum issues to be addressed such as Digital Dividend (as Bhutan does not use any of the bands ITU expects to clear by 2015 and there is no pressing demand for alternative use of the spectrum then it may not be a relevant concern. That should be mentioned. At the same time it might be relevant to mention agreements as to long term preservation of particular bands etc.

7.10.5.8 Arrangements for New Services in the Interim?

If there are new services would they be allowed to start on Analogue, and if so what rights would they have to migrate, simulcast etc.

7.10.5.8.1 Requests from Private Operators?

How are requests for private channels going to be handled while the DTV migration work is in train, and before commencement of DTV.

7.10.5.8.2 BBS Extensions

Are further extensions for BBS to continue on Analogue or should new transmitters in areas not currently served go immediately to Digital?

7.10.6 Relationship with Other ICT Policies

The headings are a guide as to possible policy areas of relevance that should be considered by the Committee

7.10.6.1 Access

7.10.6.2 Education

7.10.6.3 National Development

7.10.7 Digital Television Standards

In this section the options should be considered for the Bhutan Standard. It may be useful to list the various world standards and some of their characteristics (see the ITU Report on Digital Migration ITU Rep 2140 for summarized details) (An extract is attached to this outline)

7.10.7.1 Special Considerations (eg following lead of India??)

This may impact on timing and choice and so is a relevant factor

7.10.7.2 Analysis of Options

This depends on how strongly the preference already is for DVB as to whether there needs to be much said about the other systems. It would be pertinent to mention and analyse things like whether to adopt DVB-T or DVB-T2, MPEG2 v MPEG4. Guidance is contained in the Consultants Field Mission Report for Bhutan.

7.10.7.3 Preferred Option

7.10.7.4 Arrangements to formalize the standard in Bhutan

What are the arrangements to make this a National Standard, and how will the nation specific components and tables within the standard be documented (eg through the National Standards Body, By Government Proclamation.....)

7.10.7.4.1 Availability of Equipment

Consumer and Professional production/transmission/distribution equipment.

7.10.7.4.2 Commentary on preferred configuration of the system?

How should the preferred system be set up. Eg service data rates, number of channels in the multiplex, type of sound system to be used, error correction, Electronic Program Guide, allocation of data capacity, preferred data rates for channels, Use of Wide Screen formats and arrangements to accommodate viewing of 4:3 receivers etc.

7.10.8 Spectrum Consideration

What channels should be used and what are the planning concerns if any for implementing the recommended standard. For example are DTV services to be in the same frequency band as existing analogue transmitters, how far away should they be spaced in frequency (eg adjacent channel or one channel removed in VHF, two in UHF) see second consultants report for commentary on this.

7.10.8.1 Proposed Spectrum to be used for DTV

7.10.8.2 Preferred channel assignments and why

7.10.9 Proposed Delivery Model

Shared or stand alone multiplexer

7.10.9.1 Multiplexer Arrangements

How channels on a shared multiplexer will be managed, who should “own” the multiplex, how do others get access, arrangements for access etc.

7.10.9.2 Mix of Terrestrial, Cable, Satellite in delivery of DTV

How do other delivery means fit into the model once the DTV broadcast system is determined

7.10.9.3 Industry implications (cable industry etc and switchover to digital)

How and when should cable start moving to a digital delivery model, how will DTV services appear in the cable channel line up, will the complete multiplex be carried transparently or will it have to be recoded etc.

7.10.9.4 Possible transition and development of DTV reach over time

Clearly it would not be sensible to start everywhere at one time, Therefore there should be a plan that will see DTV start in one or two major centres and then expand over time. Just how far should the plan to reach before it is no longer reasonable to deliver the signal terrestrially

7.10.10 Infrastructure Implications

What does it mean for towers, etc.

7.10.10.1 Transmission Towers and Facilities

7.10.10.2 Electric Power

7.10.10.3 Distribution System for DTV signal

Will this be via the optical fibre cable or via satellite? In some cases it will be a mix.

7.10.10.4 Cable Services

What are the implications for cable operators?

7.10.10.5 Studio/Production Implications

What investment is required for encoding, multiplexing, presentation of new channels if any and so on. Who should be responsible for establishing, operating, maintaining etc.

7.10.10.6 Possible Industry Incentives to support Transition

Discuss possible incentives, such as exemptions from duties on imported equipment, direct financial subsidy, licence fees and any other option and arrangements and suggest what might be needed and the likely costs.

7.10.11 Content Opportunities

Discuss new and current possibilities that DTV might deliver for new content that advances GNH and national development. What might such initiatives cost and how could they be faded over time

7.10.11.1 Education

7.10.11.2 Local Production

7.10.11.3 Information Services

7.10.11.4 Etc?

7.10.12 Regulatory Impacts

What changes or additions are needed to existing rules and regulations to enable the preferred solution.

7.10.12.1 Changes to existing Legislation?

7.10.12.2 New Regulations?

7.10.13 Timing Considerations

When should all of this happen. What makes sense from an economic and practical point of view. This section should discuss options and arrive at a considered solution. It can't be considered in isolation from economic aspects mentioned in the next section so drafting may require a few cycles once the overall cash flow, and options are considered. The arrangements for roll-out over time also impact on this.

7.10.13.1 Options for rolling out DTV and eventual Analogue Switch Off

7.10.13.2 Proposed Roll-Out Timetable

7.10.13.3 Determining appropriate schedule of Analogue Switch Off

What factors might be relevant to switch off. Are there specific targets to be achieved, or should there be a prescribed date to aim for.

7.10.14 Consumer Impacts

Discussion of ways of receiving DTV, (eg integrated receiver, set top box), issues related to 4:3 analogue displays v 16:9 in modern wide screen. Supply of receivers etc.

7.10.14.1 How Consumer can access DTV

7.10.14.2 Receiver Supply

7.10.14.3 Possible Assistance to some viewers?

What assistance may be needed for low income groups, how might this be managed, what would it cost etc.

7.10.14.3.1 FTA options

7.10.14.3.2 Cable?

7.10.14.3.3 Satellite?

7.10.15 Economic Considerations

7.10.15.1 Costs

7.10.15.1.1 Government

All costs for Government, including regulatory costs, incentives etc.

7.10.15.1.2 Broadcaster

7.10.15.1.3 Cable Operators

7.10.15.1.4 Public

7.10.15.2 Benefits

Many of these will be qualitative rather than quantitative or very difficult to assess in hard terms. However, this is not a new problem on public policy and in this section the benefits should be summarized in whatever form is appropriate and might cover things like improved access to information, improved literacy, entertainment choices in Bhutanese languages....etc

7.10.15.3 Estimated cash flow requirement

Against the proposed plan what cash would be needed when. If there are options then these should be set out as alternatives (eg a more or less aggressive roll-out will have significantly different cash flows)

7.10.15.4 Funding Arrangements

Where might the funds come from? What are the possibilities?

7.10.16 Post Switchover Spectrum Considerations

Will any of the spectrum be cleared or earmarked for other uses at the end of the migration (it could perhaps occur earlier where spectrum is vacant)

7.10.16.1 National Band Spectrum Planning Considerations

7.10.17 DTV Implementation

In this section we look at rolling out DTV against the plan. What has to be done? Who will do it? When will they do it? What are the specific tasks to be performed.

7.10.17.1 Responsibilities for Implementation amongst various Stakeholders

7.10.17.2 Switchover Principles and Arrangements

7.10.17.2.1 *Simulcast?*

7.10.17.2.2 *Roll-out of Digital Only Services to Unserved Communities?*

7.10.17.2.3 *Switch Off of Analogue*

7.10.17.2.4 *How will the change be managed*

7.10.17.3 Communications Strategies

How and when will consumers and industry start to be informed of the changes.

7.10.17.3.1 *How will industry and community be informed about the changes*

7.10.17.3.2 *When should communication campaigns start*

7.10.18 DTV Recommendations and Proposed Timetable

7.10.18.1 Summary of Recommendations from Above and Decisions

In the draft stage this section will set out what needs to be done to make it happen, what decisions Government has to take etc. When the decisions are made, the document could be updated to reflect the decisions taken so that it becomes the model against which the developments will occur.

7.11 Annex K: Extract from ITU Report 2140 describing the various DTV systems around the world.

Description of Various DTV Systems from ITU Report 2140 Section 2

2.6.2.1 ATSC

The ATSC Digital Television Standard was designed to maximize the ability to transmit high quality video and audio and ancillary data within a single 6 MHz terrestrial television broadcast channel. This design focus resulted in the advent of digital high definition television (HDTV) and multi channel surround-sound as well as the capability to provide multichannel standard definition and data broadcast and interactive services

The 8-VSB modulation mode for terrestrial broadcasting was designed for spectral efficiency, maximizing the data throughput with a low receiver carrier-to-noise (C/N) threshold requirement, high immunity to both co-channel and adjacent channel interference and a high robustness to transmission errors. The characteristics of 8-VSB allow the use of DTV channels in a crowded spectrum environment that contains both analogue and digital television signals. Lower power requirements of 8-VSB allow ATSC DTV stations to exist on channels where analogue stations cannot due to interference constraints. The spectral efficiency and power requirement characteristics of 8-VSB are essential to the conversion of terrestrial broadcast transmission from analogue to digital since new spectrum is not allotted during the transition phase.

The ATSC system uses the MPEG-2 transport stream syntax for the packetization and multiplexing of video, audio, and data signals for digital broadcasting systems. The Program and System Information Protocol (PSIP) defined in ATSC standard A/65, is a small collection of tables designed to operate within every Transport Stream (TS) for terrestrial broadcast of digital television. Its purpose is to describe the information at the system and event levels for all virtual channels (channel numbers are not tied directly to the actual RF channel frequency) carried in a particular TS. Additionally, information for analogue channels as well as digital channels from other Transport Streams may be incorporated.

ATSC utilizes the MPEG-2 video stream syntax (Main Profile at High Level) for the coding of video. Table 1 lists the compression formats allowed in the ATSC Digital Television Standard. Note that both 60.00 Hz and 59.94 (60x1000/1001) Hz picture rates are allowed. Dual rates are allowed also at the picture rates of 30 Hz and 24 Hz.

TABLE 1
Compression formats

Vertical lines	Pixels	Aspect ratio	Picture rate
1080	1920	16:9	60I, 30P, 24P
720	1280	16:9	60P, 30P, 24P
480	704	16:9 and 4:3	60P, 60I, 30P, 24P
480	640	4:3	60P, 60I, 30P, 24P

The ATSC Standard - Digital Audio Compression (AC-3) as defined in the ATSC A/52B is used for the coding of audio. Enhanced AC-3 (E-AC-3) which provides additional coding tools and capabilities is also defined by the A/52B Standard.

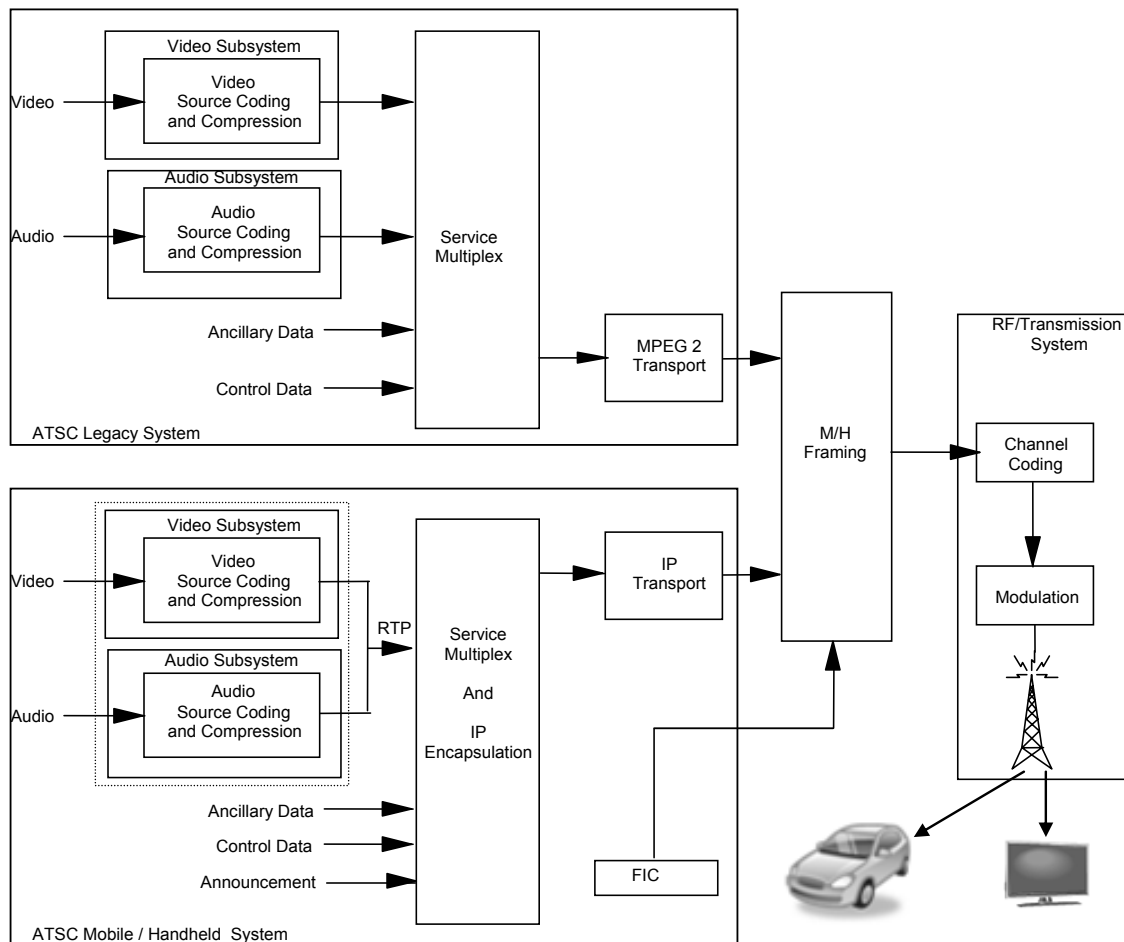
ATSC has developed a suite of data broadcast standards and the ACAP standard for interactive television services.

ATSC-M/H

ATSC-M/H (A/153) provides mobile/pedestrian/handheld broadcasting services using a portion of the ~19.39 Mbit/s ATSC 8-VSB payload, while the remainder is still available for HD and/or multiple SD television services. The M/H system is a dual-stream system—the ATSC service multiplex for existing digital television services and the M/H service multiplex for one or more mobile, pedestrian and handheld services.

The ATSC Mobile/Handheld service (M/H) shares the same RF channel as a standard ATSC broadcast service described in ATSC A/53. M/H is enabled by using a portion of the total available 19.4 Mbit/s bandwidth and utilizing delivery over IP transport. The overall M/H system is illustrated in Fig. 4.

FIGURE 4



More detailed information on ATSC can be found in § 1.5, Part 2.

2.6.2.2 ChinaDTV

China DTTB national standard, “Framing structure, channel coding and modulation for digital television terrestrial broadcasting system” was issued on 18th August 2006 by standardization administration of China and was enforced on 1st August 2007. The ChinaDTV system was designed with built-in flexibility, adapt to variety of reception: it is capable of coping not only with fixed reception but also mobile reception, simultaneously supports the application in the adjacent channels to an analogue TV channel, and the framework of single frequency network with the same programme.

The ChinaDTV system had a special design of the PN sequence frame header and symbol guard interval insertion that can achieve rapid and efficient channel estimation and equalization, Low Density Parity Check coding (LDPC), spread spectrum transmission of the system information, etc. The system supports data rates from 4.813 Mbit/s to 32.486 Mbit/s, having application to standard-definition television (SDTV) and high-definition television (HDTV). Also the system was designed for the current 8 MHz TV channel spacing used in China.

It provides service flexibility, with constellation mapping of 64-QAM, 32-QAM, 16-QAM, 4-QAM, 4-QAM-NR, FEC coding LDPC (7488, 3008, (7488, 4512), (7488, 6016), frame header length PN420, PN595, PN945 and two kinds of convolutional interleaving possibility, if desired, of many options. Mobile reception is possible for 4-QAM-NR, 4-QAM even 16-QAM and also for higher modulation orders, proven by extensive laboratory measurements and field trials under different channel conditions.

The system had strong robustness under different environments, against the echoes from terrain or buildings or co-channel signals from distant transmitters or in an SFN. This capability will improve spectrum utilization efficiency when planning digital television services in crowded spectrum conditions as occurs in China.

The ChinaDTV system included randomization for energy dispersal, channel coding, interleaving, constellation mapping, framing structure, processing of frame information, processing of baseband signals and RF signals in every 8MHz digital television band in UHF and VHF spectrum.

Now, a series of relevant digital terrestrial television specifications are under development, and several transmitting stations in Olympic cities are being established, and the HDTV program has been launched in Beijing in October, 2007.

2.6.2.3 DVB-H

The merger of audiovisual and telecommunication services has already been implemented, as most telecommunication actors envisage having TV over xDSL. No doubt the user will soon require the associated service environment to be available on the move. Services can be expected to benefit from a window of opportunity of 8-15 years (eight years is the approximate time frame from now until analogue TV simulcast is turned off in most countries, while 10-15 years is the time before new radio systems, whose requirements are currently being discussed under the label "4G", are rolled out- assuming it will take ten years for 3G to reach break-even point). The opportunity comes from the fact that cellular associated with DVB-T/H would potentially have some of the expected 4G capabilities.

At the basis for the commercial provision of convergent services in mobility, particularly use is made of the DVB-T/DVB-H standard and the concept of wireless communication networks (GSM/GPRS, UMTS) combined with terrestrial DVB broadcast networks.

In the new business and regulatory environment, the longer-term activities of various international work-groups such as DVB and 3GPP have slowed down as industry searches for a shorter-term return on investment. The project will bridge this recent trend with the latest technological developments, allowing DVB in particular to keep its worldwide domination as a broadcasting standard toolbox by supporting the design and testing of the DVB-H standard that is necessary because DVB-T is presently being challenged by ISDB-T in mobility and power consumption issues.

A study on mobile TV (October 2007) was made by the Policy Department of the Economic and Scientific Policy Directorate of the European Parliament.

More detailed information on DVB-H can be found in Part 2, § 1.7.

2.6.2.4 DVB-T

The Digital Video Broadcasting – Terrestrial (DVB-T) system was essentially designed with built-in flexibility, in order to be able to adapt to all channels: it is capable of coping not only with clear channel but with interleaved planning, i.e. in the adjacent channels to an analogue transmission, and even co-channel operation for the same programme by different transmitters (SFN).

The multi-carrier (DVB-T) system was designed originally for the 8 MHz UHF channel spacing used in Europe and has been adapted to fit 7 and 6 MHz channels. Depending on the choice of coding and modulation parameters, data rates from 20 to 30 Mbit/s can be realized to deliver high quality digital television through the broadcasting channels. Equally, lower data rates can be employed in cases where additional ruggedness is considered to be desirable.

It also permits service flexibility, with the possibility of reception by rooftop antennas and also, if desired, of portable reception. Mobile reception is possible for quadrature phase shift keying (QPSK) and also for higher modulation orders, proven by extensive laboratory measurements and field trials under different channel conditions.

The system was also designed to be robust against interference from delayed signals, either echoes from terrain or buildings or signals from distant transmitters in an SFN. This capability will improve spectrum utilization efficiency when planning digital television services in crowded spectrum conditions as occurs in Europe.

The DVB-T system features a number of selectable parameters, which allows it to accommodate a large range of values for C/N ratio and channel behaviour, allowing fixed, portable, or mobile reception, with a trade-off in the usable bit rate. The range of parameters allows the broadcasters to select an appropriate mode for the foreseen application. For instance, a very robust mode (with correspondingly lower payload) is needed to ensure portable reception. A moderately robust mode with a higher payload could be used where the digital services are interleaved with analogue services (for example in the adjacent channels to analogue). The less robust modes with the highest payloads can be used if a clear channel is available for digital television broadcasting.

More detailed information on DVB-T can be found in Part 1, § 1.6.

2.6.2.5 ISDB-T

The Integrated Services Digital Broadcasting - Terrestrial (ISDB-T) system (used in Japan) is designed to provide reliable high-quality video, sound, and data broadcasting not only for fixed receivers but also for portable/mobile receivers. The system is also provided flexibility, expandability, and commonality/interoperability for multimedia broadcasting. The system is rugged because it uses orthogonal frequency division multiplexing (OFDM) modulation, two-dimensional (time-domain and frequency-domain) interleaving, and concatenated error-correction codes.

The ISDB-T system uses OFDM modulation associated with band segmentation which is called band-segmented transmission OFDM (BST-OFDM). The ISDB-T system consists of 13 OFDM segments. Each segment has a bandwidth $B/14$ MHz (B means the bandwidth of a terrestrial TV channel: 6, 7 or 8 MHz depending the region), so one segment occupies bandwidth $6/14$ MHz (428.57 kHz), $7/14$ MHz (500 kHz) or $8/14$ MHz (571.29 kHz). The system has a wide variety of transmission parameters for choosing the carrier modulation scheme, coding rate of the inner error-correcting code, length of time interleaving, etc. Each segment is assigned to a layer, for which a set of transmission parameters can be selected individually.

The system supports hierarchical transmission of up to three layers (Layers A, B, and C). The transmission parameters can be changed in each of these layers. In particular, the centre segment of this hierarchical transmission can be received by handheld receivers (called “One-Seg”). Owing to the common structure of each OFDM segment, a one-segment receiver can “partially” receive a program transmitted on the centre segment of an ISDB-T signal (partial reception is the name given to the means by which a receiver picks out only part of the transmission bandwidth). The system has three transmission modes (Modes 1, 2, and 3) having different carrier intervals in order to deal with a variety of conditions such as the variable guard-interval length as determined by the network configuration and the Doppler shift occurring in mobile reception.

The system uses MPEG-2 Video coding and MPEG-2 advanced audio coding (AAC). Moreover, it adopts MPEG-2 Systems for encapsulating data streams. Therefore various forms of digital content, such as sound, text, still pictures, and other data, can be transmitted simultaneously. It has commonality and interoperability with other systems using MPEG-2 Systems, such as ISDB-S, ISDB-C, and ISDB-T_{SB}.

More detailed information on ISDB-T can be found in Part 2, § 1.8.

2.6.2.6 T-DMB

For mobile multimedia broadcasting services, the Republic of Korea developed a video standard, Terrestrial Digital Multimedia Broadcasting (T-DMB), which is fully backward compatible with T-DAB. Terrestrial Digital Multimedia Broadcasting (T-DMB) is designed to provide video services for users in mobile environment with the backward compatibility with Digital Sound Broadcasting (DSB) System A. The MPEG-4 AVC is known to have compression efficiency as high as up to twice that of MPEG-4 Part 2 Visual (ISO/IEC 14496-2). The MPEG-4 BSAC is known to have the same compression efficiency as MPEG-4 AAC (Advanced Audio Coding) and is characterized by its additional functionality of fine grain scalability. The Binary Format for Scene (BIFS) provides a flexible composition capability for various multimedia objects in conjunction with MPEG-4 Synchronization Layer (SL) that enables smooth rendering of different types of multimedia objects for interactive services. For audio services, DSB System A in Recommendation ITU-R BS.1114 uses MUSICAM, however T-DMB system does MPEG-4 BSAC or MPEG-4 AAC as well as MUSICAM to provide enriched service supplemented by still pictures and texts.

More detailed information is given the Report ITU-R BT 2049 and in § 1.9.1, Part 2.

2.6.2.7 Forward Link Only (FLO)

Forward link only (FLO) is a mobile digital broadcasting technology designed to provide mobile reception of broadcast multimedia content on handsets to address the physical limitations of the handheld terminal, including power consumption, memory, mobility, and form-factor constraints. Service elements of FLO include reception of real-time broadcast video and audio streams; access to multimedia services, and wide area and localized content in the same carrier. FLO system is designed to support access control, subscription management, and interactive services via IP.

2.6.2.8 ISDB-T_{SB}

ISDB-T_{SB} system is known as Multimedia System “F” of Recommendation ITU-R BT.1833, is designed to provide video, high-quality audio and data services which can be configured flexibly. In addition, support of script interpreter for rich content format provides content and service flexibility in multimedia broadcasting for handheld receivers.

More detailed information is given in § 2.5.1.3.

2.7 Summary

TABLE 2

Standard	Channels	Band	Modulation	Applicable standards
ATSC	6 MHz	UHF/VHF	8-VSB	A/52,A/53, A/65, A/153
ChinaDTV	8 MHz	UHF/VHF	OFDM	GB 20600-2006
DVB-T	6, 7 and 8 MHz	UHF/VHF	OFDM	EN 300 744
DVB-H	5, 6, 7 and 8 MHz	UHF/VHF	OFDM	EN 302 304
ISDB-T	6, 7 and 8 MHz	UHF/VHF	Segmented OFDM	ARIB STD-B31
T-DMB	1.75 MHz	VHF/1.5GHz	OFDM	ETSI TS 102 427 and ETSI TS 102 428
FLO	5, 6, 7 and 8 MHz	UHF/VHF	OFDM	TIA 1099
ISDB-T _{SB}	0.43, 0.50, 0.57 MHz 1.29, 1.50, 1.71 MHz	UHF/VHF	Segmented OFDM	ARIB STD-B29

2.8 Evaluation of potential Digital Sound and TV Broadcasting systems

In recent times, several digital broadcasting systems have been proposed in different areas of the world.

All of the currently implemented systems are based on the availability of a high efficiency encoding system with the capability to compress the bit rate needed to transmit digital contents to values compatible with the characteristics of the available on-air channels.

For TV broadcasting, the MPEG standard is currently almost globally adopted in its various levels, even though newer and possibly even more efficient encoding standards have been recently proposed. The different currently available digital transmission systems have been proposed in different times, and the newer ones are supposed to benefit from the analysis of advantages and disadvantages of the previously proposed ones.

In the search for a real “killer application” for digital broadcasting, of the utmost importance is the capability of the digital standard to adapt to possible advanced broadcasting services. Concerning digital TV broadcasting, this includes interactivity, datacasting, portable and mobile reception.

2.8.1 Evaluation of specific Terrestrial Digital Sound and TV Broadcasting

The available standards for digital TV and sound broadcasting can be roughly divided in two groups:

- Single carrier codes (like 8-VSB, used in the USA standard ATSC-DTT)
 - The 8-VSB system is based on coding the digital information to be transmitted using amplitude only (8 levels). The modulated signal is then processed through a Nyquist filter, in order to reduce the transmission bandwidth.
- Multicarrier (various evolutions of COFDM, on which DVB-T and DAB -adopted in Europe and in Countries involved in the RCC-06-, ISDB-T –adopted in Japan-, and other codes are based.

The COFDM approach is based on splitting the data between a high number of carriers within the operating channel. The digital information associated to each carrier can then be coded using amplitude and phase (e.g. QPSK, 16-QAM, 64-QAM). Together, the digital data simultaneously transmitted and associated to the different carriers constitute an OFDM symbol.

COFDM-based codes allow the transmission through the physical channel of a multiplex, consisting of several contents that can then be selected and extracted by the receiver.

Moreover, the signal spreading over many carriers distributed over the whole channel width, together with the error-recovery systems introduced to safeguard the data integrity, make it possible to consider COFDM-based systems, like DVB-T, also for the implementation of SFN networks, in which the same frequency is used for the transmission over adjacent coverage areas and the implied fading due to co-channel interference between signals originated by transmitters operating on the same frequency is recovered due to the COFDM system characteristics. Commercial SFN networks (in DVB-T) have been rolled out for instance in Australia and in Spain.

The same high immunity to interferences makes COFDM digital broadcasting systems also suitable for mobile reception. Especially suited to this purpose is the recently issued standards for handheld receptions listed under Recommendation ITU-R BT.1833. In this case, special attention has been paid to preserving battery life, error correction mechanism, etc. in order to enhance the system's robustness.

The ATSC has developed the ATSC-M/H system which allows broadcasters to use their existing DTV channel to provide service to mobile and handheld devices while maintaining backwards compatibility with the large population of DTV receivers.

For more details, see Part 2, Chapter 1.

2.8.2 Hybrid systems

Some satellite systems use the terrestrial component to improve the quality of service: XM radio, Sirius. More information is available for Digital System E in the Recommendations ITU-R BO.1130 and ITU-R BS.1547. Other systems may use similar approach.