Final Report

ITU-D
Study Group 1

Question 8/1

Examination of strategies and methods of migration from analogue to digital terrestrial broadcasting and implementation of new services

6th Study Period
2014-2017

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Question 8/1: Examination of strategies and methods of migration from analogue to digital terrestrial broadcasting and implementation of new services

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Preface

ITU Telecommunication Development Sector (ITU-D) study groups provide a neutral contribution-driven platform where experts from governments, industry and academia gather to produce practical tools, useful guidelines and resources to address development issues. Through the work of the ITU-D study groups, ITU-D members study and analyse specific task-oriented telecommunication/ICT questions with an aim to accelerate progress on national development priorities.

Study groups provide an opportunity for all ITU-D members to share experiences, present ideas, exchange views and achieve consensus on appropriate strategies to address telecommunication/ICT priorities. ITU-D study groups are responsible for developing reports, guidelines and recommendations based on inputs or contributions received from the membership. Information, which is gathered through surveys, contributions and case studies, is made available for easy access by the membership using content-management and web-publication tools. Their work is linked to the various ITU-D programmes and initiatives to create synergies that benefit the membership in terms of resources and expertise. Collaboration with other groups and organizations conducting work on related topics is essential.

The topics for study by the ITU-D study groups are decided every four years at the World Telecommunication Development Conferences (WTDCs), which establish work programmes and guidelines for defining telecommunication/ICT development questions and priorities for the next four years.

The scope of work for **ITU-D Study Group 1** is to study "**Enabling environment for the development of telecommunications/ICTs**", and of **ITU-D Study Group 2** to study **"ICT applications, cybersecurity, emergency telecommunications and climate-change adaptation"**.

During the 2014-2017 study period **ITU-D Study Group 1** was led by the Chairman, Roxanne McElvane Webber (United States of America), and Vice-Chairmen representing the six regions: Regina Fleur Assoumou-Bessou (Côte d'Ivoire), Peter Ngwan Mbengie (Cameroon), Claymir Carozza Rodriguez (Venezuela), Victor Martinez (Paraguay), Wesam Al-Ramadeen (Jordan), Ahmed Abdel Aziz Gad (Egypt), Yasuhiko Kawasumi (Japan), Nguyen Quy Quyen (Viet Nam), Vadym Kaptur (Ukraine), Almaz Tilenbaev (Kyrgyz Republic), and Blanca Gonzalez (Spain).

Final report

This final report in response to **Question 8/1: "Examination of strategies and methods of migration from analogue to digital terrestrial broadcasting and implementation of new services"** and its Guidelines on communication strategies have been under the leadership of its Rapporteur: Roberto Hirayama (Brazil); and six Vice Rapporteurs: Mamadou Pathé Barry (Guinea), Fabrice Djoumessi Dontsa (Cameroon), Peter Martin Ikumilu (Kenya), Jinane Karam (Telecommunications Regulatory Authority (TRA), Lebanon), Jean-Marie Maignan (Haiti) and Arseny Plossky (Russian Federation). They have also been assisted by ITU-D focal points and the ITU-D Study Groups Secretariat.

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Executive Summary

i. Introduction

The migration from analogue to digital broadcasting technologies has already been completed in some countries and is underway in several other countries and regions. In the transition process to digital television, important decisions have to be made and actions need to be thoroughly planned and implemented. Along with that, the use of the "Digital Dividend" is an important issue, and continues to be widely debated by broadcasters and operators of telecommunication and other services operating in the same frequency bands. In this regard it is crucial for regulatory authorities to balance the interests of users with the demands of growth in all branches of the industry.

There is also a need to study the impact of the Digital Dividend (definition of Digital Dividend[1]) on all parties and to review best practices in this regard, in order to reap the maximum benefit from the frequencies concerned. The Digital Dividend spectrum can be used for new, innovative services, ranging from interactive television to mobile communications and wireless broadband Internet services.

In this context, the present report discusses best practices for the transition from analogue to digital television, communication strategies to accelerate the process of public awareness about digital broadcasting, spectrum issues related to the Analogue Switch-Off (ASO), and the use of the released spectrum (Digital Dividend) to implement new services and applications.

ii. Previous work on the transition from analogue to digital broadcasting television

The ITU has been working for the past three study periods on the important issue of transitioning from analogue to digital broadcasting. During this time, several important outputs where developed that are still relevant to the work of ITU-D Question 8/1. First, the Report of ITU-D Question 11-3/2 for the study period 2010-2014 is an important reference about the public policies that need to be in place so that countries can start the digital switchover and the implementation itself. Additionally, the report provides relevant information on the funding required for implementation and the receiver base, among other topics. The Report can be found at: http://www.itu.int/pub/D-STG-SG02.11.3-2014.

Another important reference database for the transition to digital broadcasting is the Digital Terrestrial Television Broadcasting Switchover Database (DSO), which can be found at http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Summary.aspx. This database contains information on relevant events (e.g. workshops, frequency coordination meetings, and seminars), publications (e.g. ITU-R and ITU-D documents, roadmaps, and workshop presentations), websites (e.g. ITU-R and ITU-D, broadcasting organizations, GE-06), contacts, and information sources (list of relevant surveys, questionnaires of the ITU-D and ITU-R and other sources). An important task for the DSO database is to gather key information from the countries regarding the digital switchover, such as year of the launch of the digital television, DTT technology, status of the transition (ongoing, completed), among other information.

iii. Statement of the situation

As stated above, through the DSO database, ITU-D compiles information on the digital transition process around the world, presenting interesting figures to illustrate the current status of countries' implementation of digital television implementation, the status of the Analogue Switch-Off (ASO), and other information.

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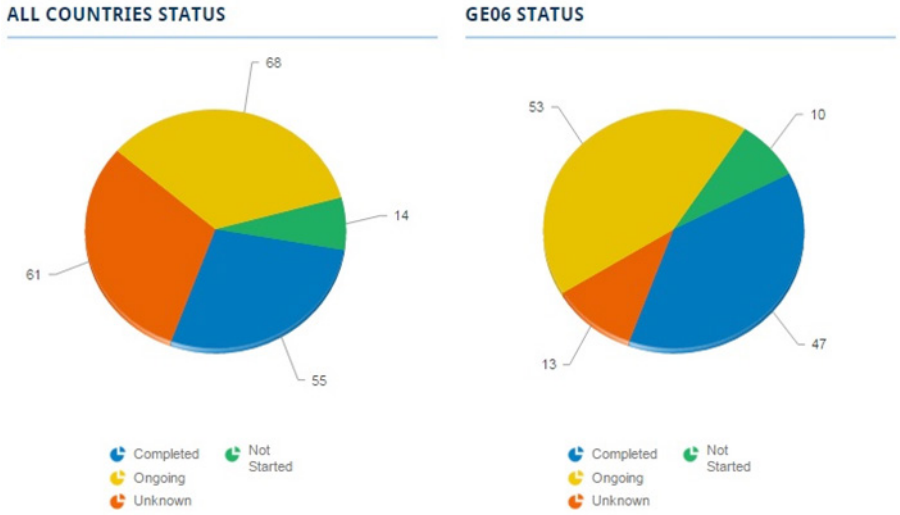
[1] Digital Dividend is defined in the ITU Terminology Database as "the improved efficiency in the use of the spectrum, consequential to the digital switchover. NOTE: This term is merely and specifically relevant to broadcasting". The latest updated version of related terms can be found at: https://www.itu.int/md/R15-CCV-C-0024/.

Below, some statistics collected using the DSO database are presented to state the current situation regarding the transition from analogue to digital television.

Figure 1: Current status of the transition around the world and in the GE06 plan countries

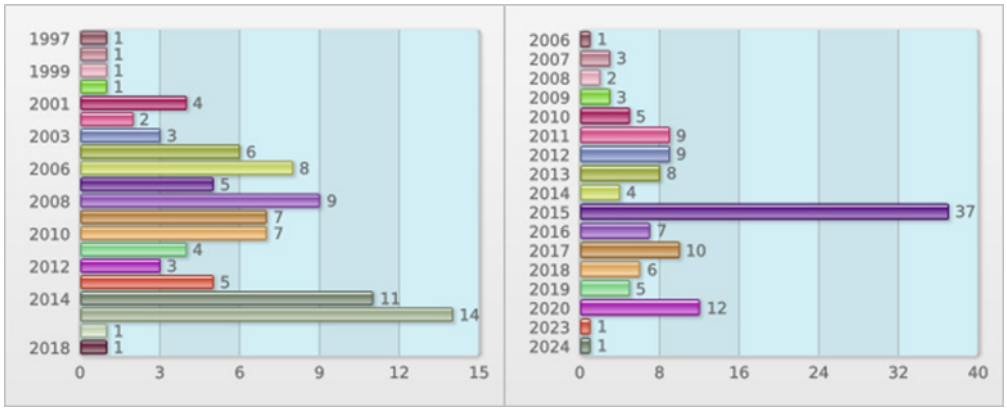


Source: DSO database, August 2016

It is noteworthy that the majority of the respondents are currently in the middle of an ongoing transition, both from the perspective of all countries and in the subset of the countries that adopted the GE06 plan.

Figure 2 shares additional aggregated statistics from all the respondents, showing the year digital television transmissions were launched and the year that countries either plan or performed the ASO.

Figure 2: Year of launch (a) and analogue switch-off (b)



(a) (b)

Source: DSO database, August 2016

From **Figure 2** it can be noted that a significant number of countries have completed their transition and therefore may be using or allocated the released spectrum a.k.a. Digital Dividend to new services. The best practice and experiences from countries regarding both the transition and the usage of the Digital Dividend are detailed and discussed throughout this report.

iv. Summary of the milestones for the transition

In the past study period certain milestones for the transition were identified and listed in **Chapter 2** of the Report of Question 11-3/2. In summary, the recommended steps to consider in changing the national telecommunications and broadcasting regulatory frameworks were the following:

- Analyze the social and economic environment to clearly state objectives and goals to be accomplished with digital broadcasting;
- Wide discussion with all the stakeholders on a national plan for digital broadcasting and telecommunication services, including the discussion of social goals and objectives;
- Reflect accordingly in the national regulatory framework (laws, decrees and other lower level regulations) the consensus reached in the discussion referred in item above;
- Adopt a digital broadcasting standard bearing in mind the objectives stated in the updated regulatory framework;
- Plan and grant the needed spectrum for the transition period which will allow simulcast transmissions of analogue and digital broadcasting;
- Fine tune public policies, including financial aid for broadcasters and telecom providers to deploy the infrastructure needed to accomplish the social goals stated in the regulatory framework.

These steps are fundamental, but do not account for important final steps that are necessary to conclude the digital switchover, and that are especially relevant in the scope of Question 8/1, namely, the actions that need to be undertaken to switch off analogue transmissions and to plan for the future use of the spectrum that could be released (Digital Dividend). These steps include the following tasks:

- Plan the Analogue Switch-Off (ASO) and define the best strategy to implement the ASO ("one shot", "regional/phased approach", pilot cities) in each country;
- Establish a communications strategy to reach consumers and stimulate their actions to fulfil the necessary steps to receive the digital television signals properly;
- Establish a clear method to determine whether to switch off analogue transmissions bearing in mind the availability of receivers, implementation of receiving and transmitting infrastructure, and consumer's household readiness for DTV;
- Plan for the future use of the Digital Dividend so that public policies applicable to the related frequency bands can be clear to all stakeholders;
- Plan for interference mitigation that can arise from the implementation of new services in the Digital Dividend.

These tasks are the main focus of the current Report for Question 8/1, which deals not only with the transition from analogue to digital broadcasting, with special attention to the ASO, but also with implementation of new services in the frequency bands that will be released after the conclusion of the transition process.

1 CHAPTER 1 – Best practices to accelerate the transition from analogue to digital television broadcasting and bridge the Digital Divide with the deployment of new services

This chapter analyzes best practices among countries that have already performed the Analogue Switch-Off (ASO) or that are planning to do so. Strategies related to planning and implementing the ASO are detailed. As previously stated, thorough planning of this fundamental step is crucial for its success.

This chapter also presents criteria that can be used by decision makers to assess whether a certain region is ready for the ASO or not. The recommendation is to use research methods based on specific criteria previously defined by each country, consulting the involved parties and stakeholders, to decide if the ASO can be performed in a specific region. A specific research methodology is proposed to assess the number of TV households that are "ready" for digital terrestrial television broadcasting (DTTB). This metric can be used as a key element in determining whether to perform the ASO in a specific region.

1.1 Analogue Switch-Off strategies

The Analogue Switch-Off (ASO) refers to the shutdown of the transmissions of analogue television signals when the digital television signals become widespread and receivers are largely available to the public and deployed in households. There are different aspects to be considered, including but not limited to:

- Migration phases;
- Technical preparations;
- End-user equipment;
- End-user communication strategy;
- Broadcasting Services/Programs;
- Digital Dividend;
- Benefits of transition.

There are several challenges to a successful ASO, which include coordination and communication efforts, a well- developed receiver supply chain to assure a sufficient quantity of affordable receivers to all users, funding for the part of the population that will not be able to purchase a receiver, among other tasks.

1.1.1 The different Analogue Switch-Off strategies

Different countries planned and executed the Analogue Switch-Off (ASO) in a variety of ways. The strategies for switching off analogue television transmissions have pros and cons.

The ASO strategies can be basically grouped in two categories:

- National/countrywide ASO ("One shot");
- Regional/phased ASO ("Phased ASO").

Other related strategies are also employed, such as performing the ASO in pilot cities to test certain procedures and assess public awareness and engagement in the process. Pilot testing can be particularly useful to test the supply chain for receivers in the retail market, communication/marketing strategies and information campaigns, and to test technical procedures.

1.1.2 Key success factors for Analogue Switch-Off based on best practices

In order to plan for the Analogue Switch-Off (ASO), the Study Group suggests that each country analyze the particularities of the broadcast market, the socioeconomic environment involving the deployment of digital television and also assess methods for consumer outreach so that necessary actions are performed by the public, which include purchasing and setting up infrastructure to receive digital television signals without interference of eventual new services deployed in the neighboring frequency bands.

One of the best practices that can be pointed out is to use specific objective criteria to decide whether to switch off analogue transmission in a specific region of the country. These criteria need to assess whether the region is ready for the ASO or not, based on the availability of infrastructure to both transmit and receive digital television signals. Some options for defining these criteria follow.

1.1.1.1 Research and assessment criteria of the ASO condition

This section presents criteria, based on specific research methodology, which can be used in the decision-making process to determine whether a certain region is ready for the ASO. The recommendation is to use research methods based in specific criteria previously defined by each country, consulting the involved parties and stakeholders, to decide if the ASO can be performed in a specific region or in the whole country.

Criteria for research and assessment of the Analogue Switch-Off condition:

1) Research should be able to provide data to assess:
   a) The number of households that have access to free-to-air terrestrial television broadcasting, either by analogue reception or by digital reception; and
   b) The number of households that do not have access to free-to-air terrestrial television broadcasting.
2) The research needs to measure the percentage of free-to-air digital terrestrial television broadcasting reception in the universe that consists solely of households that access free-to-air terrestrial television broadcasting.
3) In order to determine the analogue switch off condition[1], all the households that access free-to-air terrestrial television broadcasting should be considered, although these households may also have, simultaneously, another type of reception of TV programming (i.e., satellite and pay TV).
4) Households in which access to TV programming is provided exclusively by satellite or cable TV (pay television), or which do not access free-to-air terrestrial television broadcasting, should not be taken into account.
5) For purposes of assessing the achievement of the ASO condition, being “ready to receive digital terrestrial television broadcasting” means having installed equipment suitable for receiving the digital terrestrial television broadcasting signal, in other words a household that has:
   a) Suitable antenna to receive the digital signal; and
   b) TV with an integrated converter box or analogue television set with external digital converter box.
6) There shall not be any assumption about the user´s fitness to access free-to-air digital terrestrial television broadcasting. The results from at least one research study to assess the achievement

[1] For example, in Brazil the ASO condition is that at least 93 per cent of TV households be ready to receive digital terrestrial television broadcasting.

of the analogue switch off condition should be available before the countdown period, for those countries implementing that provision[2].

7) The research shall follow the same assumptions to ensure reliability in comparing the evolution of the percentage of digital terrestrial television reception readiness in each region.

8) The research needs to be performed by interviews that are personal, by household, by means of a statistically representative sampling of the region, using a questionnaire that allows for the identification of the household digital terrestrial television broadcasting readiness.

Guidelines for the research methodology:

1) The research interviews will be conducted personally, face to face, per household, using a statistically relevant sampling.[3]

2) The confidence interval (confidence level) to be considered in the sample design of the survey should be at least 95 per cent.

3) The error margin to be used to measure the ASO condition should be a maximum of 3 percentage points (three percentage points).

4) Guidelines for sample planning:

   a) The research to assess the ASO condition should follow the Analogue Switch-Off Schedule in place, or one that supersedes it.

   b) The sampling of the research should be carried out by location, understanding location as a capital, a municipality or set of similar municipalities, considering the recommendation of a research and statistics analysis technical team.

   c) The Municipalities for each ASO phase should be grouped into locations based on the following municipality's profile:

      i. Geographic characteristics;

      ii. Socioeconomic characteristics;

      iii. Population;

      iv. Cultural similarities;

      v. Other criteria to be defined, if necessary.

   d) The final ASO phase, which can be comprised of multiple municipalities, should receive the same methodological treatment for assessing the ASO condition applied to municipalities in other phases, in terms of household approach and personal interviews, confidence level of ninety five percent and an error margin of three percent. To define the sample universe, this group should include a specific analysis for sample planning, considering the lessons learned from the research in the previous phases.

5) The sample should be representative of the surveyed location based on households´ quotas by Municipality, proportionate to the universe and based on data from population assessment researches[4], such as a periodic Census, with random selection, as defined by the research institute.

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[2] In Brazil, for example, the countdown begins 60 days to the end of analog broadcasting, as provided for in Decree No. 3205/2014.

[3] For Brazil, as an example, the criteria are provided the Brazilian Institute of Geography and Statistics – IBGE, on its methodology for the National Sample Survey – PNAD.

[4] In Brazil, for example, there is an annual National Household Survey – PNAD and the Census every 10 years.

6) The data collection instrument should be a structured questionnaire with a set of questions designed especially for assessing the ASO condition, with the aid of stimuli[5], if necessary, to meet the research measuring goals, considering the previous experience of the research institute.

7) The team of interviewers should be properly trained and questionnaires from data collection must undergo quality checks and process consistency whose responsibility will be that of the research institute.

8) The result of the first assessment research should be published before the countdown period begins.

1.2 Analogue Switch-Off implementation

The implementation of the ASO requires prior planning and coordination between the several involved parties. The success of this task is directly related to how the stakeholders (broadcasters, regulators, the government, financing institutions, retailers, logistic operators, among others) and the public are included in the discussions and engaged in the process, and also whether and how they take the required actions as requested under the country's communication strategies.

Several countries have already performed the ASO and many other are planning to do so in the near future. The present section intends to collect some experiences and best practice on the ASO implementation and also on coping with the myriad of challenges that involve shutting down analogue television.

1.2.1 Case study from Brazil

As an example, we first analyze the case of Brazil. The Brazilian case is of particular interest because of its strategy to tackle both the digital switchover and the use of the Digital Dividend[6] processes at the same time through coordination between broadcasters and mobile service providers.

1.2.1.1 Simulcast

At the end of 2012, ANATEL, the telecommunications regulator and the agency responsible for planning radiofrequency spectrum use in Brazil, concluded a planning effort to allocate digital television channels, which ensured that broadcasters could perform simulcast transmissions for all primary analogue stations in the country until the end of the digital switchover, which was originally scheduled for June 2016. To achieve this goal, the VHF (174-216 MHz) and UHF (470-806 MHz) bands were used. Considering that each analogue channel must have its digital correspondent and that the abovementioned planning effort included approximately 6200 digital channels in the Digital Television Channels Assignment Plan, more than 12,200 channels, including analogue and digital, were available during the "simulcast" period.

For Brazil and other big countries in area and/or population, assuring that there are enough channels to guarantee simulcast transmissions for all primary television stations is an important step toward digital broadcasting. After that step, in the Brazilian case, the implementation of digital broadcast stations went smoothly.

[5] Stimuli can be pictures, models or other tools that help the respondents reaching an accurate answer for a certain question. In Brazil, evidence shows, for example, that some people mix up flat screen televisions with digital ready televisions, which is not necessarily true for some markets. Brazil, for instance, mandated a schedule to electronics industry so to have an integrated converter box embedded in all flat screen televisions. This schedule ended in 2014, however, before that some of the flat screen televisions sold in the market did not have an integrated converter.

[6] The use of Digital Dividend is being addressed in this report in **Chapter 4**.

1.2.1.2 Planning the Analogue Switch-Off

Brazil initiated, in 2013, the planning process to accelerate the transition and to properly plan the actions that would have to be undertaken by all stakeholders to switch-off analogue television transmissions.

The first step was the publication by the Ministry of Communications, the governmental body that licenses broadcasting services in Brazil, of Ordinance No. 14/2013[7] establishing some guidelines: (i) improve access of the population to Digital Broadcast Television; (ii) provide spectrum to improve the mobile broadband with high speeds; (iii) expand the optical fiber networks in the whole country; and (iv) improve national technology development and national industry. In other words, both sectors, telecommunications and broadcasting, would have to be involved in the transition process, because both digital broadcasting and mobile services were set as priorities.

The second decision, in the same year, was to change the Analogue Switch-Off (ASO) strategy. The main concern was to align two tasks: (i) reforming the 700MHz band and freeing the Digital Dividend for mobile services, and at the same time (ii) switching-off the analogue television transmissions.

Consequently, Decree No. 8,061/2013[8] was issued, stating that the digital switchover would be changed and would begin in 2015 and end in 2018, instead of June 2016 for all the country, following a schedule that would be outlined by the Ministry of Communications. Subsequently, the Ministry of Communications, after discussions with ANATEL and experts of the sector, published a new ASO Plan[9], starting in 2015 and gradually being implemented until November 2018 in the major markets, instead of a "one shot" approach, as planned before. The logic was to anticipate the switch-off for major markets and postpone it for smaller ones, bearing in mind the interest of the telecommunication service providers in using the Digital Dividend for mobile services. The regions and the specific timeframe in which they will be switched-off can be found in the Brazilian case study in **Chapter 5**.

The idea was also to perform tests to verify several procedures, such as communication with the population, logistics to make available digital receptors and to implement digital transmissions, etc., a task that was planned to be performed by a Pilot Test in 2015. Following testing, the actual switch-off of the most populated areas (state capitals and some other major cities) was planned to occur from 2016 to 2018, and finally the smaller municipalities were planned to be switched-off after 2018. Along with that, it was decided that the Pilot Test of the ASO would take place in Rio Verde, a small city in the state of Goiás, in November 2015. Following the schedule established, in 2016, Brasilia, the country´s capital, was to be the first big city to have the ASO. After that, the process would be implemented in all metropolitan areas in Brazil's state capitals until 2018.

1.2.1.3 Analogue Switch-Off monitoring indicators

Several parameters will be monitored throughout the transition process to trigger decision-making, among them key parameters will be: (i) the coverage with digital transmissions in any certain area and (ii) the number of households ready to receive digital transmissions. These indicators will guide authorities and the third-party entity responsible for the migration of television channels and the transition to digital television in some markets.

The number of households ready to receive digital transmissions will trigger some important actions in the transition process, such as anticipating or postponing the ASO in a specific area. After discussions with interested parties, it was mandated that 93 per cent of the population with access

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7 Ordinance n. 14, February 6th 2013, available at: http://www2.mcti.gov.br/index.php?option=com_mtree&task=att_download&link_id=686&cf_id=24.

8 Available at http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2013/Decreto/D8061.htm#art1.

9 Ordinance n. 477, June 20th 2014, available at http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?jornal=1&pagina=42&data=23/06/2014, that was replaced by Ordinances no. 378, January 22nd 2016, available at http://www2.mcti.gov.br/documentos/documentos/portaria-mc-n-378.pdf, and further detailed by Ordinance no. 1714, April 25th 2016, available at http://www2.mcti.gov.br/documentos/documentos/portaria-mc-n-1714.pdf.

to terrestrial television services should be able to receive the digital signal before the analogue shut-down is allowed.[10]

In November 2014, the Ministry of Communications defined the conditions by which viewers should be warned of the analogue switch-off, by broadcasters, on the analogue channels. The Ministry determined that communication of the analogue switch-off date and the respective digital channel number that would replace it should start 360 days before the switch-off, and the countdown would begin 60 days prior to that date. More details can be found in **Chapter 2** and in **Chapter 5**.

1.2.2 Case study from Russian Federation

1.2.2.1 Introduction

The transition to digital terrestrial television in the Russian Federation is carried out by a Federal Target Program named "Development of TV and radio broadcasting in the Russian Federation in 2009-2018" (hereafter the Program), in accordance with the Government Decree of the Russian Federation no. 911, from 08/29/2015, "On Amending Resolution of the Government of the Russian Federation dated December 3, 2009 no. 85".

1.2.2.2 Activities of the Russian program

The framework of the program includes the following measures and is carried out through the following activities:

1) Construction of terrestrial networks for digital television broadcasting
   - 1.1 The development of system projects for the digital television broadcasting networks of Russian regions (2009-2012);
   - 1.2 The development of the first multiplex of the TV broadcasting network (expansion and construction of the first multiplex of TV broadcasting network) (2009-2016);
   - 1.3 Construction and modernization of the centers of multiplexes formation (2010-2015);
   - 1.4 Ensuring the control equipment (2009-2014);
   - 1.5 Creation of the second multiplex of the TV broadcasting network (2013-2018);
   - 1.6 Organizing the required amount of time-doubles for TV and radio channels (2013-2014);
   - 1.7 Creation of the additional multiplexes (2018);
   - 1.8 Creation of the integrated automated control system of the digital broadcasting network (2015-2018).
2) Creation of the multi-functional satellites for different purposes, including broadcasting
   - 2.1 Measures to create satellites "Express-AM5" and "Express-AM6" (2010-2017) and satellites "Express AM7" and "Express AM8" (2011-2018);
   - 2.2 Creation of the multi-functional satellite "Yamal-601" for different purposes, including broadcasting (2015-2018).
3) Creation of the Control Center for archival depository for the accounting, restoration and digitalization of materials (2012-2015)
4) Public awareness campaign (2010-2015)

[10] Ordinance n. 378, January 22nd 2016, available at: http://www2.mcti.gov.br/documentos/documentos/portaria-mc-n-378.pdf.

5) Provision of subsidies for the public telecom operators from the federal budget

   5.1 Provision of subsidies for the public service provider for services (works), ensuring the implementation of urgent measures for the preparation of digital broadcasting;

   5.2 Provision of subsidies for the public service provider for cost recovery (part of the cost) related to the implementation of terrestrial digital broadcasting terrestrial TV and radio channels required in 2011 in settlements with a population of less than 100 thousand people, in the 2012-2018 in all settlements of the Russian Federation.

6) Management of the implementation of the program (2010-2015)

More details on the Russian case study can be found in **Chapter 5** of this report, including information on the implementation of the terrestrial and satellite networks mentioned in items 1 and 2 above, and also the target indicators used in the management of the Russian program by Radio Research & Development Institute (NIIR), Russian Federation.

1.2.2.3 Implementation of the program

Construction of digital terrestrial television broadcasting networks

By the performing of the measures of the Program, it was planned to construct 4984 radio television transmitting stations (RTS), which would contain 2 transmitters each. This RTS network will cover 98,4 per cent of inhabitants of the Russian Federation by 20 television programs within 2 federal multiplexes of digital terrestrial television (DTTV). Also it was planned to use regional inserts in federal channels. This feature will be provided by 83 centers of formation of multiplexes (CFM). By 2018, there will be some additional regional-only multiplexes containing television programs with regional and local content.

The construction of DTTV networks is being performed in 4 phases depending on the strategic and social value of television in a certain region of the Russian Federation. Within the network of each region, construction is also performed by a stage system. Basically, the stage system is formed by the following principles:

Stage 1: Existing stations of analogue TV with high-power transmitters (more than 1kW), which will be upgraded by DTTV equipment.

Stage 2: New DTTV stations with high-power transmitters (more than 1kW).

Stage 3: Existing analogue TV stations with low-power transmitters, which will be upgraded by DTTV equipment.

Stage 4: New DTTV stations with low-power transmitters.

Besides the construction of DTTV networks, the scope of the Program includes organizing necessary time-doubles for TV signals, because the Russian Federation territory is divided from the East to West by 5 time-zones and certain regions should be covered by time-doubles of DTTV channels.

Creation of the multi-functional satellites Express AM5-AM8 and Yamal-601

To deliver the federal multiplexes signals to regional CFMs and RTSs, a satellite transport network was created on the base of multi-functional satellites Express AM5-AM8 and Yamal-601**.** Two hops are projected: the first hop from federal CFM in Moscow to regional CFMs, and the second from regional CFMs to RTSs. In some cases, the second hop can be substituted by a regional radio relay network. The scheme showing the interaction of the ground and satellite network elements is presented in **Annex 2** of this report.

Managing the implementation of the Program

To manage implementation, the Russian Federation implemented an additional measure named "Performing the monitoring of the implementation of the measures of the Federal Target Program '*Development of TV and radio broadcasting in the Russian Federation in 2009-2018 years*' and the achievement of target indicators of the Program's effectiveness". **Annex 2** of the report presents the target indicators of the Program and a Plan for their achievement. In the process of implementing the Program, special software RAKURS was used to solve spectrum management tasks in the interests of national broadcasting service. **Annex 9** of the Report presents the detailed description and the fields of exploitation of RAKURS. **Annex 10** of this report presents the experience in the use of software tools for migration to digital TV in the Russian Federation.

1.2.3 Case Study from Thailand

Thailand also brings some important lessons learned and recommendations for the transition process listed below.

Digital TV communication plan

- Mass communication to the public about the transition from traditional Analogue TV (ATV) to Digital TV (DTV) broadcasting is considered as a critical activity to allow for a successful transition process.
- The public relations (PR) messages should be simplified and contained information regarding key activities of the DTV transition process as well as impacts and benefits of DTV to the audiences. These messages should be delivered through both traditional platforms such as TV, radio, and billboard, and online platforms such as Facebook, YouTube, Twitter, and Line.
- Engagement from government agencies and relevant parties in both national and local levels are key success factors for digital TV communication.

Digital TV subsidy program

- DTV subsidy program needs to be funded sufficiently. In Thailand, DTV coupon was selected for DTV subsidy program. It was funded by the Broadcasting and Telecommunications Research and Development Fund for the Public Interest (BTFP), which received money from DTV auction revenue.
- The DTV coupon value should be sufficient to redeem a qualified set-top box with necessary accessories (receiving antennas and installation kits) and should be distributed to every household across country. Redeemable DTV coupons should be distributed in areas, where the DTV signal is available.
- Collaboration among relevant agencies is required to facilitate the distribution of coupons to people. For example, in Thailand, there was a collaboration between Postal Office, Ministry of Interior, and NBTC.

Receivers

- The receiver specifications should be developed based on international standards and align with other countries' specifications to achieve economy of scale production cost, for example ASEAN[11] countries developed a common specification.
- DTV accessibility for person with disabilities should be taken into consideration when developing specification such as Audio Description (AD) for the blind and Closed Caption (CC) for the hearing-impaired.

[11] ASEAN – Association of Southeast Asian Nations.

- It is necessary to develop applications or tools to assist people to install and point the antenna correctly. In Thailand, NBTC developed the 'DTV Service Area' application to provide information at a distance to the station, antenna direction, and frequency channel.
- In order to increase the accessibility of DTV, a variety of receiver types (STB, iDTV, and portable/mobile receiver) should be available.
- Proper training for the STB distributors, retailers, and installers is a key process to assist people to access to DTV.

Digital TV network rollout

- Prior to actual network rollout, DTV field trial should be conducted to determine suitable DTV parameters and to collect feedbacks from broadcasters and consumers.
- Infrastructure sharing for DTV network can significantly reduce network investment cost. This is also beneficial to the people in terms of receiving antenna installation by pointing to one direction and receiving DTV signal from all networks.
- The network operators have to strictly follow the network rollout schedule to ensure that the DTV signal is available as indicated in the rollout plan.
- In order to facilitate the DTV network rollout, the existing analogue TV sites and facilities including antenna system should be used in DTV network, when applicable.
- To ensure the network coverage and quality, it is important to monitor the DTV signal.
- To ensure the service availability and fast recovery, SLA (Service Level Agreement) needs to be determined. The redundant equipment/systems needs to be prepared in the critical part of the network.

1.2.4 Case study from United States of America

The analogue to digital transition was a technological event unprecedented in scale in the United States broadcast television industry, touching nearly every American household directly or indirectly. The Federal Communications Commission (FCC) had two primary goals: to provide existing broadcasters with DTV channel and power assignments that would replicate the quality and geographic area covered by their existing analogue license, and to reallocate some broadcast spectrum for other uses. [12]

June 12, 2009 was the date the last full-power television station in the U.S. ceased over-the-air transmission of analogue programming, and was the culmination of more than twenty years of technical collaboration and ten years of complex regulatory decisions. Today, all full-power stations in the United States transmit only DTV. [13]

Noteworthy in the American case study is the transition and ASO strategy, which performed the ASO in 2009 implementing a large-scale program to ensure both public awareness and that low income users had access to receiving equipment. Below we present some lessons learned from United States' experience.

[12] *See, The Broadcaster's Transition Date Roulette: Strategic Aspects of the DTV Transition*, James Miller & James Prieger, (*Broadcaster's Transition Date Roulette*) 9 J. on Telecomm & High Tech L. (2011) at 437, 460-61. As required by the Budget Act of 1997, the FCC allocated some of the spectrum for public safety radio services and other parts for commercial use (fixed and mobile telecommunications and broadcast, with the licenses to be assigned by competitive bidding). *Id.* at 461.

[13] The digital conversion deadline for low Power, Class A translator stations is September 1, 2015. *See, e.g.,* DTV and LPTV Class A Translator Stations, http://www.fcc.gov/guides/dtv-transition-and-lptv-class-translator-stations.

1.2.4.1 DTV transition milestones

In 1982, diverse broadcast industry interests came together to form the Advanced Television Systems Committee (ATSC) and develop a voluntary standard for an advanced television system (ATS) to replace the aging North American NTSC television standard. In July 1987, the FCC issued its *First Notice of Inquiry* on ATS and formed the Advisory Committee on Advanced Television Service (ACATS) to review the technical issues and provide a recommendation for a new ATS standard. In 1990, the FCC declared that the new standard would have to support a genuine HDTV signal, and ACATS and ATSC began collaborating on a recommendation for a technical standard. Former analogue television competitors formed a "Grand Alliance" in May 1983 to work on a single standard, and in 1996 the FCC adopted the ATSC standard for DTV.

Subsequently, a number of steps were taken to facilitate the transition. In 1997, the FCC adopted a DTV Table of Allotments and related service rules. In addition, Congress granted each full-power broadcaster a second 6 MHz channel and temporary license that allowed them to build a digital station while maintaining their analogue TV operations. The broadcasters were allowed to transmit via analogue signals over one channel and via digital signals over the other channel; when the transition was complete, they were required to relinquish one of the channels.[14]

The FCC issued the appropriate licenses and adopted mandatory dates by which broadcasters would have to complete the transition to DTV. The conversion was planned to occur on a phased-in basis according to market size and network. Stations in the top 10 markets were required to complete the transition first, followed by the United States markets ranked 11-30, followed by all other full-power commercial stations, and then finally non-commercial stations.[15] Transition deadlines ranged from 1999-2003, and were later relaxed by the United States Congress based on circumstances in a given market. The United States Congress also codified the FCC-determined deadline of 2006 for the full digital switch – at which time stations would have to relinquish one of the channels and cease analogue broadcasting.[16] Congress subsequently extended this deadline to February 18, 2009 and then finally fixed the deadline at June 12, 2009.[17]

In the meantime, as the transition to digital proceeded through the nation, the FCC in 2002 required manufacturers to include a digital receiver tuner in new TV sets. Later, analogue television sets that continued to be sold were required to have a warning label indicating that it would require an analogue-to-digital converter box. All converter boxes were required to comply with standards set by the FCC.

To gain experience in a complete switch to digital in advance of the 2009 statutory deadline, the FCC conducted a trial in a local market. The first test market to cease analogue transmission and switch to a digital signal was performed in 2008 in Wilmington, North Carolina, at that time the United States' 135th largest market.[18] The test provided the FCC with insight on ways to address and correct transition and reception problems in advance of the full nationwide switch to digital. Wilmington was one of the few cities in the United States that was technically able to make the full digital switch ahead of the transition deadline, and with its flat terrain and all TV stations using UHF channels, proved to be a good place for early testing. Only 7 per cent of the viewers were affected by the loss of analogue broadcasts, and to address this problem, on November 7, 2008 the FCC permitted those digital TV stations with coverage gaps or that needed to extend their coverage to use a distributed transmission system (DTS).

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14 See: *Broadcaster's Transition Date Roulette* at 460.

15 *Id.* at 463.

16 *Id.*

17 The FCC extended the Feb 17, 2009 deadline for an additional 30 days to permit "night lighting." During this period, analogue stations could continue to broadcast and inform unprepared viewers about the DTV transition and to broadcast during emergency situations such as severe weather. Approximately 120 full service stations briefly maintained their analogue "night light" service.

18 See: *FCC to Test Transition to Digital TV in NC*, The Washington Post, (K. Hart, May 8, 2008) http://www.washingtonpost.com/wp-dyn/content/article/2008/05/07/AR2008050703661.html.

1.2.4.2 The switch to digital broadcasting

On June 12, 2009, 1,800 full power television stations broadcasting in analogue made the transition to a digital signal. Only 4 stations did not complete the transition; these ceased broadcasting. As a whole, broadcasters spent approximately $10 billion dollars on the technical changes needed to make the transition. Individually, TV stations spent roughly $1 to 2 million to construct new digital transmission and broadcasting facilities, including equipment and studios for high definition production.

At that time, nearly 115 million United States' households had one or more televisions. Eleven percent or 12.5 million households relied exclusively on free, over-the-air broadcasting for their access to television; they did not subscribe to cable, satellite or any other pay service. An estimated 40 million households had at least one TV set that relied on free, over-the-air broadcasting, even though they had other TV sets in the household that were connected to a subscription service. By June 12, 2009, 97.8 per cent of households were ready for the transition because they had a DTV set, a converter box, or subscribed to cable, satellite, or another pay service.

In addition, the United States coordinated with Canada and Mexico on their DTV band and Digital Dividend plans to avoid potential incompatibility with the U.S. plan and interference to U.S. broadcast stations. Canada and Mexico had transition time schedules that were different both from each other and from the United States. Negotiated arrangements with both countries allowed DTV service to be successfully introduced along the United States' borders.

Most of the spectrum vacated by broadcasters as they moved to DTV was auctioned to companies that are providing consumers with advanced wireless services, such as wireless broadband. In addition, an important benefit of the switch to all-digital broadcasting in the United States is that parts of the valuable broadcast spectrum has been freed for public safety communications by groups such as police, fire departments and rescue squads.

1.2.4.3 Post transition

The DTV transition had relatively few problems on and after the June 12, 2009 transition deadline[19]. UHF reception was good or better than expected, and VHF signals generally reached viewers further out than UHF, as expected. Consumers resolved many post-transition reception problems by performing a "double rescan" on their converter box.[20] Other problems were resolved by consumer's "trial and error" relocation of indoor antennas or upgrading their antennas.

1.2.4.4 Lessons learned: what worked well

- FCC collaboration with industry and federal, state and local government was very important to the success of the DTV transition.
- Industry coordination (voluntary and mandatory) with broadcasters, manufacturers, and retailers – early and ongoing at the national and local level – was a key factor in the success.
- Requiring manufacturers to include a digital receiver tuner in new TV sets by a specific date meant that consumers did not continue to buy TVs that would be obsolete in the near future.
- Coordination between the agency distributing the set-top-box coupons and other federal agencies that have regular contact with consumers helped the outreach campaign.

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19 A table indicating spectrum allocation before and after the DTV transition can be found in **Chapter 4** in the case studies from the United States.

20 To perform a "double rescan" the consumer manually caused the equipment to scan for all existing DTV signals in a given DTV frequency range. The equipment would then update and store all of the DTV stations found. See also: http://www.fcc.gov/guides/rescan-digital-tv-channels.

- Local governments establishing relationships with local business and organizations, particularly those focusing on elderly, low income, non-English-speaking populations was important to consumer outreach.
- Early transition of a few trial markets was important.
- Consumer outreach efforts began in 2007 and by January 2009 awareness of the DTV transition was very high. Having local walk-in centers, including retailers and local stations available to train consumers on how to set up digital antennas and converter boxes, worked well.
- Having well-trained staff in call centers available 24 hours a day, 7 days a week on toll-free numbers with up-to-date referral information to answer consumer questions was also very important. Having workshops and demonstrations on how to set up the converter box equipment was helpful. In special situations, contractors were also sent to help some consumers in their homes.
- Post-transition work with industry partners to develop new antenna guides based on the post-transition experience were developed and posted on a single website[21] to provide consumers with the updated information.
- Identifying those who would be impacted by the change, such as the elderly, low income and non-English speaking consumers, was important in developing the outreach message and educational material.
- Creating and delivering a consistent outreach message was important; the message needs to be clear, simple, and concise.
- Establishing partnerships with broadcasters associations, industry, manufacturers, and television operators to coordinate the outreach campaign as early as possible was critical to educating consumers.

1.2.4.5 Lessons learned: what could have worked better

- Significant propagation problems were identified with VHF channels 2-6; they were subject to more reception problems than originally anticipated.
- VHF channels 7-13 also experienced problems with propagation (Rayleigh fading).
- Simplified installations and antenna adjustments would have eased the burden on the elderly and those uncomfortable with technology.
- More attention could have been paid to ensuring consumers had the appropriate antennas for their TV set.[22]
- Some viewers that were located at the edge of previous analogue coverage lost total reception from their TV stations because the new digital TV stations were constructed at a different location that post transition had no digital reception.
- Managing expectations of viewers at the edge of analogue service as well as those with poor analogue service, and working to quickly provide alternatives that would restore service would have been helpful.
- Earlier and more transition test markets might have helped in the final transition planning.

1.2.4.6 Other considerations

- Funding for consumer outreach and contracts (e.g., call center and in-person assistance) should be anticipated and budgeted early in the process;

[21] http://www.dtv.gov.
[22] See: *What Kind of Antenna do I need to Receive DTV Signals*? http://www.fcc.gov/guides/antennas-and-digital-television.

- Educational material and training should be developed well in advance and updated as test market experience identifies the need for revisions;
- "Soft" tests that are coordinated across all the stations in a market combined with a local call-in center are recommended;
- Pay close attention to receiving antennas;
- Setting a mandatory date to switch to digital is important, but it can be changed if necessary;
- Permitting "night light" service on a temporary basis after a mandatory switch date can be useful to the public;[23]
- Coordinate with neighboring countries and obtain bilateral agreements early in the process to address technical issues and identify mutual sharing solutions;
- Consider using sport events, schools, churches, parks, community centers, libraries, and festivals as venues for consumer outreach and information sharing;
- Social media can help publish and distribute information on the transition (Facebook, twitter, Instagram, YouTube, etc.).

1.2.5 Best practices on Analogue Switch-Off implementation

This section presents some conclusions based on the case studies analyzed and some best practices that can be used to conclude or speed up the transition.

- The main point of ASO implementation is that – with the exception of the detailed design of the technical network parameters – none of the decisions in the transition process are of a purely technical nature. Instead, planning decisions have to be made beforehand. And these planning decisions imply a whole set of features which need to be scrutinized carefully in advance. The final decisions always are also of political relevance.
- There is no single ready-to implement concept for the transition process. Instead, every country had to define its own goals and procedures and adapt to changes in the process. Countries considering the transition can profit from these experiences and build their own strategies based on existing experiences.
- Assuring that channels are available for simulcast transmissions can be beneficial for the implementation of digital terrestrial television transmissions.
- Planning the use of spectrum, for example, assigning channels properly to the DTV Allotment Table can be beneficial to the process.
- Pilot cities can be a good way to test several critical procedures, including communication to the population, logistics for receiver availability, interaction between stakeholders, population engagement, and other tasks.
- A centralized entity responsible for the transition process either within the government or a third party, can help to speed up the process due to gains in coordination between interested parties.
- Engaging receiver manufacturers and other industry stakeholders can help in several steps of the process, including communication strategies, e.g., labels in TV sets informing that the equipment is DTV ready.
- Coordination between neighboring countries, is very important to assure a smooth transition.
- Receiver antennas need special attention because of the possible impact on the consumer´s experience or lack thereof.

[23] See note 728 above, which defines "night light" service.

– Verification of network after planning and deployment shall be done early in migration phase throughout field measurements and surveys, the purpose is to verify the planning process and to fine-tune the network.

1.3 Public policies related to receiver availability

To receive digital terrestrial television, the consumer needs a set-top box that converts analog signals to digital ones or a TV-set with an integrated DTV decoder. This section presents a public policy option that can be used to speed up the transition from analogue to digital broadcasting by distributing a DTTB household readiness kit for low income population.

1.3.1 Guidelines for the Digital Terrestrial Television Broadcasting (DTTB) household readiness kit to be delivered to low-income families according to the Analogue Switch-Off schedule

Some low income families will not have sufficient resources to buy this equipment. Because of that and in order to speed up the transition process, the government can implement policies to allow this part of the population to have access to digital terrestrial television broadcasting, including also the needs of the persons with disabilities. One of those policy options is described in this section.

1.3.1.1 DTTB readiness kit

Being "ready" to receive digital terrestrial television broadcasting (DTTB) means a household that has:

– A suitable antenna to receive the digital signal; and

– A TV with an integrated converter box or analogue television set with an external digital converter box.

One of the policy options that can be implemented to make sure that low income families have the reception equipment available is to purchase and distribute it. This policy is being used in Brazil and Argentina, and other countries.

The kit to be distributed to low income families according to the analogue switch off schedule should consist of the equipment listed in **Annex 11**.

1.3.1.2 Community centers

The transition to digital television raises many hopes by the diversity and the quality of reception of audiovisual services due to technological innovation and the introduction of competition in the market. After the ASO, the introduction of innovative services through the use of the Digital Dividend is also expected. The success of the ASO depends on a range of measures, among them, one of the most important is the wide availability of DTT receivers (television set and set top boxes).

In developed countries, the assurance of availability and access of DTT receivers has been implemented by several models including some based on assistance to low-income populations. Based on a Government subsidy, this model provides DTT receivers via a coupon or specific equipment.

This model finds its essence in the accepted definition of "low-income population" and reliable statistical data able to identify this population, which remains marginal compared to the total population. This is not the case in developing countries, especially the countries of sub-Saharan Africa, where the low-income population represents a higher percentage of the population.

Developing countries have to find another model to allow access to DTT receivers by a large majority of the population. Among the models, there is a realistic and attainable model that is based on the creation of community centers in rural and / or isolated areas.

The community center is based on the principle of one-time installation of a DTT receiver, powered by solar energy. Where possible, this community center could eventually offer Internet services to improve its economic viability.

This model was adopted by Niger in its national transition strategy and is particularly useful for countries that lack sufficient resources to finance the transition to digital television. The Governments that adopt this approach must provide the resources and create conditions so that they function independently and permanently. These resources focus on the acquisition of equipment (DTT receivers and solar energy) and the structural organization for the operation and management of the community center.

The main advantages of this innovative strategy are:

- It promotes equal access to DTT services;
- It helps to reduce the digital divide rural-urban area and;
- It reduces the costs of Government subsidy.

1.3.2 Guidelines for the logistics of the distribution of DTTB readiness kits for low-income population

1.3.2.1 Introduction

The following guidelines apply to models that distribute kits containing antenna, cables, set top box and any other reception equipment necessary to receive digital television transmissions.

The logistics process assumes that the contact information from the families eligible to receive equipment for their households will be provided to the operators, broadcasters and other stakeholders to be used to distribute the equipment. The availability of the contact information is important to begin the logistics planning phase and to assess the distribution method for each region.

Some decisions need to be done in order to assess the best way to deliver the equipment. The equipment can be sent directly to the household or eligible families could go to a Local Distribution Walk-in Center to retrieve them. Pros and cons can be pointed out for each of these options.

Direct delivery to a household can be simpler, however the opportunity for the population go to a Walk-in Center, be trained to install the reception equipment and resolve doubts or questions about the transition process can be very useful for a smooth transition. Each country needs to assess what is the best option for their specific case.

1.3.2.2 The distribution process

The distribution process considers five (5) main steps, with possibly different suppliers, as shown in **Table 1**. Step 4 can be the more complex in the whole distribution logistics process. This step consists in delivering to the final beneficiary the equipment, to which can be considered (3) three options, not mutually exclusive and possibly concurrent or sequential to the cities whose analogue transmissions are switched off, namely:

1) Household Direct Delivery;
2) Withdrawal from Outsourced Receptors Distribution Points (RDPs); and,
3) Withdrawal from Receptors Distribution Points (RDPs) owned by broadcasters and/or telecom operators, whichever are involved in the switch-off process.

The Receptor Distribution Points (RDPs) are local sites in the cities which are undergoing the Analogue Switch off in a specific timeframe used by the equipment providers to deliver DTTB readiness kits in

the municipality and to allow the population to retrieve their kits from. The RDPs can be also used as walk-in centers for training on installing the equipment and to resolve doubts about the transition process.

Table 1: Steps of the distribution process and potential suppliers by step.

Steps of the Process	Possible Suppliers
0 – Antennas and STBs Manufacturing	STBs/Antennas Manufacturers
1 – Transport to Distribution Centers (DC) in the Country	Antennas/STBs Manufacturers Logistics Operators**
2 – Storage in the DCs	Logistics Operators**
3 – Transport to the final distribution point locally*	Logistics Operators**
4 – Delivery directly to the households and/or delivery to Receptors Distribution Points (RDPs)	Household Direct Delivery: Logistics Operators RDPs: Logistics Operators, Retailers or the Local Broadcaster/Telecom Operator
5 – Reverse Logistics (returns)	Logistics Operators**
* May include local/regional intermediate warehouses. ** Including local post and other logistics operators.	

If it is difficult to supply contact information to the logistics operators because they are either unavailable or privacy restrictions imposed by the government on sharing with third parties this information, (for example, if the government cannot share the addresses of the beneficiaries of minimum income programs with the logistics partners) it is recommended that the distribution be done through Receptors Distribution Points (RDPs).

For this reason, it is important that at least one walk-in center (RDP) be available for each location involved in an Analogue Switch-Off (ASO). It is also recommended that these walk-in centers are active for at least three weeks after the ASO date to provide the equipment for all those that are eligible and did not have the chance to do it before the ASO. This initiative can avoid complaints from low income families that are eligible to receive the equipment.

Additionally, if the equipment does not work or is defective it is recommended that they be replaced or rectified in service points available at each location, according to the Consumer Protection Laws in force in each country.

Another important matter to consider are the communication strategies to inform the families eligible to receive the DTTB readiness kits about the process to undergo to withdraw the kits. Communication strategies are discussed in **Chapter 2** of this report. However, important decisions need to be made about the communication process which directly affects the distribution logistics. One of them is the RDPs access policy, for example, and whether it will be possible to provide customer care for all walk-in customers or if an appointment is necessary. The communication channels need to inform the population of the process and its specifics.

Along with that the criteria for eligibility of receiving a DTTB readiness kit needs also to be considered and carefully thought about by the NRT (National Roadmap Team) and informed to all stakeholders of the distribution logistics process, including the entities running the RDPs, for example, logistics operators, broadcasters, etc., which will need to carefully check if the family that is either being provided the equipment or withdrawing it from a RDP is really the target public of this policy.

1.3.3 Monitoring the distribution of the DTTB readiness kits for low-income population

During the distribution process it is recommended that reports be produced and forwarded to the National Roadmap Team (NRT), including, among other information, indicators to assess the progress of the logistics and distribution activities, such as the number of kits delivered and/or kits with outstanding delivery, to monitor the evolution of process.

2 CHAPTER 2 – Communication strategies to accelerate the process of public awareness about digital broadcasting

Because of the scarcity of frequencies, a long simulcast phase may not be possible in all countries. Thus, viewers have to get ready for the digital television switchover on relatively short notice. The switch-off therefore has to be accompanied by comprehensive communication strategies supported by all involved actors.

This chapter aims at analyzing communication strategies to accelerate the process of public awareness about digital broadcasting and the whole process involved in the switch-on of digital transmissions and the switch-off of analogue ones. Strategies on issues related to communication channels used in the communication strategy and also a summary of the guidelines of a successful Analogue Switch-Off (ASO) communication plan are addressed.

2.1 Analogue-Switch-Off communication strategies and messages

The communication strategies are extremely important for a successful Analogue Switch-Off (ASO). Bearing that in mind, the present section presents some useful experiences of communicating the ASO process to the public, which include among other tasks structuring marketing strategies, communication campaigns (mass communication ads and other relevant means), and other means to inform the public, such as call centers and websites.

2.1.1 Case studies from Brazil

In regards to communicating to the public the redistribution of TV channels and the Analogue Switch-Off (ASO) in Brazil, it was established that the stakeholders, including third party entities constituted to manage all or parts of the process (the EAD[24] in the case of Brazil), the broadcasters and others, would perform several tasks listed below:

- Provide a Call Center to resolve doubts, answer questions and to assist the population in the installation of TV reception filters and Digital TV Converters, among others.
- Provide information regarding the redistribution and digitalization of the TV channels by means of an internet website;
- Warn viewers, on the analogue channels, of the analogue switch-off date and the respective digital channel number that will replace it, 360 days before the switch-off, starting a countdown 60 days prior to that date, with the help of broadcasters and bearing in mind the conditions set forth by the Ministry of Communications;
- Insert a standard logo and message in analogue television channels to be used for the countdown alert to the shutdown of analogue signals in accordance with the criteria established by the Ministry of Communications;
- Provide information on the internet and by means of an advertising campaign, which should include broadcast television, to inform the population about the process of redistribution of channels and shutdown of analogue TV signals, and also on ways to mitigate potential harmful interference when the mobile networks in the 700 MHz band are implemented.

To promote consumer awareness and action regarding the Analogue Switch-off (ASO) two main groups of communication strategies are being implemented: (i) a mandatory minimum consumer information campaign and (ii) a massive media campaign. The first one is aimed at informing the public through the analogue channels by insertions in the programming of specific material that both inform the user and motivate the consumer to migrate to digital reception, and also by providing a call center and a

[24] EAD – Managing Entity of the Process of Redistribution and Digitalization of Television and Retransmission of Television Channels. For more information see **Chapter 3** and **Chapter 4**.

web site to inform users. The second one has the objective of engaging the public in the process by means of several communication channels orchestrated as a coherent Media Campaign based on a Communication Plan. More information on both Campaigns can be found in **Annex 4** of this report.

2.1.2 Case study from Russian Federation

The implementation of digital terrestrial television in the Russian Federation was a governmental level task, and the transition from analogue television to the digital one was provided by a federal target program named "Development of tele-radio broadcasting in the Russian Federation for the period 2009-2015". This program included actions for ensuring successful and balanced implementation of digital television in the Russian Federation. These actions included an informational-explanatory campaign and informal-analytical system.

2.1.2.1 Informational-explanatory campaign in the Russian Federation

Tasks of informational-explanatory campaign

The main tasks of the informational-explanatory campaign within the framework of federal target program were as follows:

- Notification of transition on digital broadcasting, explaining the need to implement digital television, including its advantages;
- Informing on procedures and terms of transition from analogue to digital television, providing information on structure of digital television multiplexes, emphasizing the free-of-charge basis to view digital television multiplexes;
- Forming the loyal attitude to transition to digital television and switching-off the analogue one, adjustment of possible negative public sense of digitalization program;
- Public motivation to acquire digital television receivers;
- Informing on options of receiving digital television signal and features of connection and use of receiving equipment, providing information about the last stage of implementation of digital terrestrial broadcasting – switching-off the analogue service;
- Notification of inhabitants of some regions which already implemented DVB-T about implementation of DVB-T2, pointing out the need to change DVB-T equipment for DVB-T2 receivers.

Actions of informational-explanatory campaign

The informational-explanatory campaign began in late 2013. It contained the following actions:

- Creating the concept and advertisement materials for informal support for the transition to the digital television;
- Providing the advertising campaign on television, radio and by the outdoor advertisement;
- Creation and promotion of Internet-portal about digital television;
- Organization of digital terrestrial television hotline;
- Cooperation with mass-media, media-community and Internet-community;
- Monitoring of publications in mass-media and Internet;
- Holding the sociological research;
- Informational-methodological maintenance of consultative support centers.

Implementation informational-explanatory campaign actions

Within the framework of the program, an Internet-portal was created. During 2014 banners and informational material for the portal were produced. Moreover, in the middle of 2014 special videos about digital terrestrial television have been created and launched in the Internet. As of December 2014, 76 consultative support centers were working in the Russian Federation. Additionally, a hotline was operating. By that hotline inhabitants could obtain the information about digital terrestrial television. See the main results of the hotline work in **Annex 3** of this report. In June and November 2014 sociological surveys among inhabitants of Russian Federation were held. The results of public awareness about digital television are presented in **Annex 3** of this report. By 2015, actions provided within the framework of informational-explanatory campaign allowed for high level of public awareness about the implementation of digital terrestrial television in Russian Federation and serious interest in digital television.

2.1.2.2 Informal-analytical system for efficiency exhibition and analysis about the transition process to digital television in Russian Federation

For efficiency exhibition and analysis of the transition process to digital television in Russian Federation, NIIR developed a special informal-analytical system. Access to that system is provided through the Internet.

Tasks of informal-analytical system

The main tasks of informal-analytical system in the framework of realization of the program are:

- Exhibition of graphical data on the process of realization of program;
- Showing the combined data on the process of realization of program;
- Access to the toolset for analysis about reaching the values of key indicators and indexes of Program implementation efficiency;
- Providing the news and regulatory data relative to realization of program and digital TV as a whole.

The informal-analytical system developed allows control of the transition from the analogue television to the digital one and also can be a tool for estimating the deadlines for Digital Switchover for certain parts or regions of the country.

Besides the fact that the system was developed for the transition process in the Russian Federation, the informal-analytical system can be updated to be used by other countries interested and that are currently implementing digital TV. Details on the structure of the system and the look-and-feel of the system can be found in **Annex 1** of this report.

2.1.3 Case study from United States of America

Outreach to consumers began in 2007 and targeted all TV viewers who relied on over-the-air (terrestrial) signals and did not subscribe to a pay service. Concentrated efforts were made to reach and assist those who were likely to need the most help, e.g., senior citizens, minorities, non-English speakers, those with disabilities, low income consumers, and those living in rural areas or on tribal lands. The FCC worked with businesses to provide in-home installation services and walk-in help centers throughout the United States, and a team of 200 FCC staff travelled the country to provide direct outreach to consumers and develop partnerships with local government and non-governmental organizations. Written publications that included frequently asked questions, explanatory charts describing how to install converter boxes, troubleshooting guides, antenna information, and mapping tools were made available in English and Spanish. Key publications were translated into 29 languages. The FCC also used

its existing toll-free call center to reach the public, and created an interactive DTV website to help consumers obtain the latest information[25]. The FCC spent nearly $130 million on consumer outreach.

TV broadcasters were required to educate consumers about the DTV transition, and therefore conducted their own outreach activities, including on-air announcements, consumer publications, and public appearances. Roughly $1.2 billion was spent by broadcasters on these activities.

The U.S. Congress created a subsidy program for DTV converter boxes. In 2008, the National Telecommunications and Information Administration (NTIA) began distributing coupons to consumers and spent roughly $1.4 billion subsidizing the purchase of digital-to-analogue converters. Every U.S. household, no matter what the income level, was entitled to up to 2 coupons, each worth $40 towards the purchase of a digital-to-analogue converter box. 35 million coupons were redeemed.

2.1.4 Other case studies

It is important to point out that **Chapter 5** presents several other case studies, among them the case of Thailand which brings another interesting perspective on informing the public of the transition process, especially on their Receiver Subsidy Program.[26] For more details please refer to the Guidelines on Communication Strategies.

2.2 Guidelines for communication campaigns, provisioning of call centers and websites, and other forms of informing the population about the Analogue Switch-Off

This section addresses some specific guidelines that governmental authorities, together with broadcasters and telecom service providers, can undertake to guide all the stakeholders on how to better reach consumers to inform, resolve doubts, actively informing people on the necessity of replacing their television sets or buying converter boxes, and also on how to install that equipment, and finally to inform about the necessity of mitigating interference from telecommunication services using the Digital Dividend. The mechanisms that are being used include Call Centers, Web Sites and a Communication Plan that includes media campaigns and other actions.

2.2.1 Guidelines for the online communication

An Internet-portal which centralizes all information about the DTV transition is highly recommended, alongside other online communication tools. Below some guidelines for the usage of such tools are presented.

1) The web site should contain information on: (a) the National Roadmap Team (NRT)[27] and its mission; (b) user rights and duties; (c) the process of digitalization of broadcast television and the Analogue Switch-Off (ASO), including maps showing the progress for each region; (d) the need for determined measures on the part of the viewer, so it will continue watching broadcast TV with quality from a certain date on; and (e) ways to mitigate possible harmful interference when mobile networks in the Digital Dividend bands[28] are implemented.

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25 http://www.dtv.gov.

26 For additional information see section 5 of document SG1RGQ/227(Rev.1), of broadcasting frequency allocations (Thailand).

27 In Brazil, for example, the NRT (named GIRED in Brazil) is constituted of members from the government, telecom regulator, broadcasters, telecom service providers and an entity that will implement the actions decided by the NRT. This entity is called EAD (Managing Entity of the Process of Redistribution and Digitalization of Television and Retransmission of Television Channels), and it carries out actions for both the transition to digital broadcasting, and the reframing of the Digital Dividend bands and eventual mitigation of interference.

28 In Brazil, for example, the first Digital Dividend band assigned was the 700MHz band.

2) The address of the website (electronic site) should be easily remembered by the population and visible in the informative campaigns.[29]

3) Subject to availability, electronic addresses (web) similar to the one that will be used must be preemptively registered to mitigate any confusion that may harm society and the transition.

4) The web site should allow interaction (real-time or not) with the user to resolve doubts.

5) The web page should follow web standards that allow access to content and use of functionalities through different browsers and Internet access devices (computers, tablets, smartphones, etc.).

6) The web site should be accessible to people with disabilities, using best practices and protocols to provide this content and features to this public.

7) The web site should be clearly organized, emphasizing the content channels, the accessibility bar, the internal search engine and the relationship channels (telephone, "contact us" information and/or chat on- line).

8) The content should be written in simple language, avoiding technical terms difficult to understand by the public.

9) The web site must provide audiovisual content, guides and tutorials that make clear the specific changes that will be necessary to implement Digital TV, as the exchange of analogue TV set for digital ones, the converter box installation on analogue TVs and the installation of appropriate antennas, and measures in case of interference.

10) The analogue TV switch-off (ASO) schedule should be highlighted.

11) In countries that decide to support low income population in the transition, the web page must clearly state that these families[30] are entitled to equipment necessary to access digital television, such as a Digital TV converter box and an antenna, and there will be free distribution of such equipment at any given time.

12) The Page Access Data of the internet page should indicate the most sought after information and the most common questions in order to guide the production of new content and better use of existing ones.

13) The presentation of content can be scaled and adapted due to the relocation schedule of the channels and of the switch off of analog television channels, and also the beginning of operations of mobile networks in Digital Dividend bands, subject to the NRT guidelines.

2.2.2 Guidelines for telephone call centers

1) The call center number must be easy to remember (800 number or preferably, a three-digit access code).

2) The call center should provide anyone information about appropriate measures to receive Digital TV with quality as well as on the analog TV switch off schedule, as well as measures in the event of interference, according to the schedule of activities.

3) The call center should have IVR (Interactive Voice Response) functionality as brief as possible so that to allow the user to choose to be attended by a real person.

4) The telephone call center should explain that the reception of free to air Digital TV may require replacement of the television set or the installation of a converter box and, in both cases, may require the installation of suitable antenna, and resolve doubts and assist all population in the installation of TV reception filters and Digital TV Converter Boxes, among others.

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[29] In Brazil, for example, the NRT decided to include in the analogue channels a logo and informative stripes shown in the television screen, as required by Ordinance No. 3205 of November 28, 2014, by the Ministry of Communications, which need to present the call center and web site information.

[30] For example, families registered in the Bolsa Família Program of the Brazilian Federal Government.

5) In countries that decide to support low income population in the transition, the call center must inform that these families are entitled to equipment necessary to digital television, which will be distributed free at any given time.

6) The call center should make clear the information that low income families must provide, at its own expense, the antenna installation.

7) The language used in the telephone call center should be simple.

8) The telephone call center data should enable the improvement of the service, identifying development opportunities of scripts best suited to people's needs.

9) The call center should be able to explain to society the purposes of the digitalization process, such as improving the quality of free to air broadcast television transmissions and the expansion of broadband service.

10) The call center needs to be open 24 hours a day, seven days a week.

11) The call center must be able to provide personal care to the residents of the affected localities, pursuant to disclosure schedule of the analog signal switch off process. The population of other regions, that will have the ASO further in time, can be answered via IVR, which should provide basic information and direct them to the website.

2.2.3 Guidelines for other communication channels

2.2.3.1 Case studies from Niger

The Republic of Niger, located in Sub-Saharan Africa is a vast landlocked country that faces all kinds of structural challenges. The main issue in the transition to digital television is the need for funding. Yet, the analysis of other sectors of the economy, including telecommunications, shows that it is marked by rapid development of mobile telephony, which is the main communication platform with coverage of 30 per cent of the territory and 50 per cent of the population. Due to its very high penetration, the mobile is not only seen as a phone but also as a transaction device. It is also an identity landmark for hundreds of people as it is common in rural areas, to have a phone shared by several people.

The situation in Niger described above is similar to most countries in Sub-Saharan Africa. The scarcity of sources to finance the transition incentivizes these countries to develop strategies for its completion; strategies in which communication is a key success factor. Under these conditions, the mobile, through SMS services, is an effective communication tool, which optimizes the chances of being heard and understood.

The use of SMS has been an approach taken in Niger for SIM registration. Because of its immediacy of sending and receiving, its deferred consultation, the simplicity of its implementation and its very affordable cost, SMS messages were used to alert citizens about issues and procedures related to SIM registration. SMS can be used as part of the outreach and communication plans of A-D Transition. Messages will be sent to the public regarding progress, the outlets of set top boxes, the procedure for verifying set top boxes compliance, etc.

2.2.4 Guidelines for the ASO communication plan

1) The communication plan should aim to reach the digital conversion goal established by the NRT.[31]

2) The communication plan should state the benefits of free to air TV (quality and gratuity, for example).

[31] For example, in Brazil the digital conversion goal established by Ordinance No. 481/2014, of the Ministry of Communications, is to have 93 per cent of TV households digital TV "ready" at the time of the ASO.

3) There is a need for research to guide the communication actions, identifying the main difficulties to be overcome and allow the measurement of the effectiveness of outreach efforts.

4) Research to assess the fulfilment of the digital conversion goal can assist in obtaining grants for communication initiatives.

5) The disclosure of actions should clearly state the concrete steps that viewers should adopt to continue watching broadcast TV in digital format (TV replacement or converter box acquisition, as well as proper antenna installation), in addition to the measures to be followed in the event of any interference with telecommunication services.

6) The dissemination actions should make clear that there is a schedule in progress that will result in the gradual shutdown of the analogue signal throughout the country, indicating, when possible, the digital channels.

7) The disclosure of actions should point out that there is an entity responsible for providing information / guidance on the measures necessary to continue watching broadcast TV in the digital format and provide support for the mitigation of any interference.

8) The disclosure of actions should highlight the ways people can contact that entity (call center, web site or other interaction mechanisms).

9) There is a need for the use of all available means of communication to disseminate information.

10) There is a need for interaction with industry segments and electronic equipment retailers (TVs, converters and antennas) for disseminating information to society by means of communication to reach consumers of these products.

11) Promotional activities are desirable to demonstrate in public places, step by step assembly of a kit of digital TV.

12) There is a need to assess how best to interact with seniors, disabled, illiterate and low-income population in the “step by step” installation of converter boxes, filters and antennas, for example, associations, technical schools, trade unions, local representations, scout groups, municipalities and other civil society organizations in order to “train” volunteers.

13) In countries that decide to support low-income population in the transition, there is a need for specific campaigns for low-income population on the right to receive the digital TV antenna and converter.

14) There is a need for specific actions from a NRT Official Press Office to keep the digitalization agenda in the media whenever there is a major milestone in the process.

15) There is a need for the designation of a spokesperson able to address media outlets throughout the country.

3 CHAPTER 3 – Spectrum issues related to the Analogue Switch-Off process

3.1 Spectrum planning issues

3.1.1 Background

In 2006, ITU developed the Geneva 2006 (GE-06) Agreement for planning the digital terrestrial broadcasting service in Region 1 (parts of Region 1 situated to the west of meridian 170° E and to the north of parallel 40° S, except the territory of Mongolia) and in the Islamic Republic of Iran, in the frequency bands 174–230 MHz and 470–862 MHz. Under this agreement, all of the frequency bands used for analogue television broadcasting would be used for digital broadcasting containers (multiplexes).

In order to respond to the increasing need for network capacity, the 2007 World Radiocommunication Conference (WRC-07) made an allocation in the upper part of the UHF broadcast band for the mobile service, to accommodate international mobile telecommunications (IMT) in Region 1 in the range 790 to 862 MHz, and in Region 2 in the range 698-862 MHz.

In 2012, the World Radiocommunication Conference (WRC-12) decided on a new allocation for mobile service in Region 1 in the frequency band 694-790 MHz, to be effective immediately after WRC-15, and approved Resolution 232 on the "Use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service in Region 1 and the related study" and ITU has started the appropriate study in response to this Resolution, including the impact of this new allocation in terms of cross border coordination.

In 2015, The World Radiocommunication Conference (WRC-15) took a key decision that will provide enhanced capacity for mobile broadband in the 694-790 MHz frequency band in **ITU Region-1** (Europe, Africa, the Middle East and Central Asia)[32] and a globally harmonized solution to implement the Digital Dividend. The decision allocated this band to the mobile service and identified it for International Mobile Telecommunications (IMT) in ITU Region-1, similarly to what was decided by the World Radiocommunication Conference in 2007 (WRC-07) for ITU Region-2 (Americas) and Region-3 (Asia-Pacific).

3.1.2 Spectrum planning challenges

3.1.2.1 Re-planning of broadcasting frequency allocations

At the time the decision was made at WRC-07, the process of switching from analogue to digital terrestrial television transmission was well under way in many countries, and had been completed in some. The decisions of WRC-07 and WRC-12 to allocate the upper part of the UHF band to the mobile service have somewhat complicated the situation.

A consequence of these decisions is that any country wishing to use this allocation needs to vacate the corresponding band from existing uses, whether broadcasting, military or wireless microphones. More precisely, if the target plan for digital switchover already included channels falling in the bands in question, it has to be modified, hence re-planned and re-negotiated in cooperation with neighboring countries.

The WRC-07 decision prompted government action in many countries around the world to re-farm UHF frequencies (previously planned for digital terrestrial television use) for mobile services. A total or partial re-planning of broadcasting frequency allocations is needed to compensate for the loss of accessible spectrum.

[32] http://www.itu.int/ITU-R/index.asp?category=information&rlink=emergency-bands&lang=en.

3.1.2.2 Reconstituting the spectrum rights for broadcasting below the 700 MHz band

WRC-15 agreed that UHF spectrum (470 MHz to 690 MHz) will remain exclusively allocated to terrestrial TV services in Region 1, for at least a decade. Any review of this allocation shall be in the WRC-23 meeting.

In addition, GE-06 Plan had generally provided to each country the rights enabling the deployment of about six to eight layers for broadcasting (i.e., equivalent to 6 to 8 channels available in each area of a country). The concept of layers provides an easy picture of the deployment situation and it has to be used cautiously in the context of equitable access.

The reallocation of the 800 MHz band had different impacts in various countries depending on their number of GE-06 assignment/allotment rights in the band 790-862 MHz and therefore the number of affected layers. For countries having other primary services operating in all or part of the 800 MHz band, the impact on broadcasting service was correspondingly reduced.

In comparison with the 800 MHz band, the reallocation of the frequency band 694-790 MHz to mobile service would be significantly more disruptive for broadcasting service since it would correspond to a loss of 30 per cent of the band 470-790 MHz (96 MHz from a total of 320 MHz). This means approximately the loss of 2 layers in addition to those lost in the 790-862 MHz band. In some countries, layers can be affected very badly. The reconstitution would have to ensure equitable access amongst countries and would require significant planning and coordination activities. This process is a significant challenge, which should not be underestimated.

Reconstituting the spectrum rights for broadcasting below the 700 MHz/800 MHz must:

- Satisfy the objective of each country;
- Take into consideration different elements such as the quality of the coverage, the extent of use of the single frequency networks, and/or the type of reception; and,
- Consider the equitable access principle.

3.1.2.3 Impact of the technology evolution on GE-06 Plan

Since RRC06, important developments were made providing a significant increase in the transmission capacity on the terrestrial platform. These relate to improvements in the standards used for coding (compressing) information (MPEG4 vs MPEG2) and in transmission systems (DVB-T2 vs DVB-T).

The introduction of these two technologies, if combined, can increase the capacity of a multiplex by up to 160 per cent for fixed reception. It is also assumed that the capacity gain in the case of portable or mobile reception will be similar to that of fixed reception. However, implementation of new DTT systems such as DVB-T2 may have an impact on the frequency planning. In particular, if GE-06 Plan entries are to be used for DVB-T2 instead of DVB-T the conditions for such substitution need to be determined and the implications in terms of interference, protection requirements and coverage parameters have to be investigated.

3.2 Applicability of the GE-06 Plan

3.2.1 General considerations for the application of the GE-06 Plan

In determining the application and implications of the GE-06 Plan, three steps must be considered regarding the spectrum availability:

Step 1: assessing the usability of the acquired administrative rights

The spectrum rights included in the GE-06 Plan are of an administrative nature and they are the results of international negotiations. A proper analysis is necessary to determine the applicability of these rights. Different sources could provide input to make a comprehensive inventory of the spectrum rights:

- GE-06 Plan includes important restrictions and conditions that should be taken into consideration, for example, spectrum rights that can only be assigned or taken into operation after bi-lateral negotiations or discussions with neighboring member States.
- Next to the GE-06 Plan, various bi-lateral and multi-lateral agreements between member states can be present. These bi-lateral agreements are not known to the ITU and hence not included in the GE-06 Plan.
- Also, some provisions in the RR for other services (i.e. other than broadcasting services) could be applied to protect defined services in the broadcast bands. For example, Radio Astronomy might have the status of primary use and is protected from interference from broadcast services (band V channel 38). This protection could apply in the country itself as well as abroad. It is important to determine in which geographical area this protection applies; this could be a limited area. Outside this area a broadcast service can operate, possibly without restrictions.
- An assessment of the WRC decisions should especially be considered such as WRC-07 and WRC-12 decisions in relation with new allocations in the UHF band.

Step 2: determining the application of these acquired rights

In this step, the administrative rights should be translated into assignable packages of spectrum rights (e.g. several multiplexes per package or specific assignments for each transmitter location) depending on the Regulator's objectives. Different parameters should be considered:

- Realization of a DTTB Universal service;
- Roll-out speed;
- Service package composition;
- Type of service.

Step 3: assessing the service coverage of the frequencies to be assigned

A detailed network planning to predict the network coverage requires considerable resources and knowledge. For a detailed network planning some minimal resources are required:

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

For more details, refer to the ITU Handbook "Guidelines for the transition from analogue to digital broadcasting".

3.2.2 DVB-T2 in GE-06

3.2.2.1 General overview

The RRC-06 adopted DVB-T and T-DAB as the two transmission systems for which the GE-06 Plan was developed. Furthermore, the Plan modification procedures of Article 4 have been developed

specifically in terms of these two transmission systems. This means that only these two transmission systems can be used for modifying the Plan and their Plan entries. If a Contracting Member of the GE-06 Agreement wants to implement assignments using DVB-T2 or any other transmission system, these assignments must first be submitted as Plan modifications using suitable technical characteristics and either indicating T-DAB or DVB-T as the transmission system.

When the Plan entry is brought into operation the administration can notify the actual transmission system (e.g. DVB-T2, DVB-H or any other suitable system) under the Article 5 provision 5.1.3 of the agreement. Under this provision such an implementation should consider these conditions:

– Not to cause more interference or require a higher level of protection than the original Plan entry.

– The peak power density over any 4 kHz of such an implementation should not exceed the peak power density in the same 4 kHz of the corresponding digital broadcasting Plan entry.

The ITU-R has prepared the notice form GB1 [CR262] for the notification of a DVB-T2 assignment.

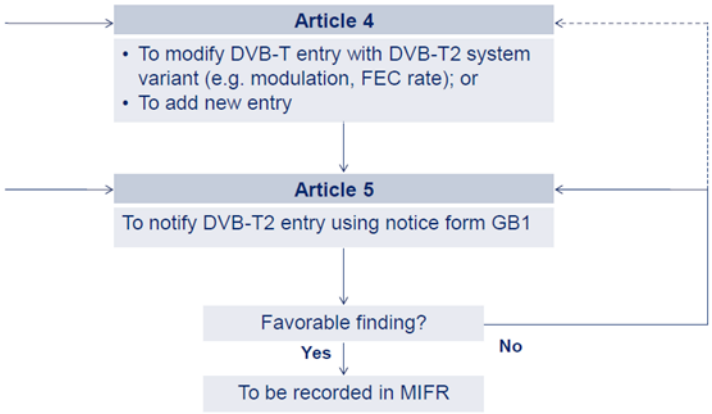
3.2.2.2 Implementation of DVB-T2 in the GE-06 Plan

In order to avoid re-planning activities and therefore adding complexity to the introduction of DVB-T2, it is essential that DVB-T2 implementation should be able to use DVB-T assignments and allotments of the GE-06 Plan.

In addition, the DVB-T2 implementation will have to conform to the spectrum mask of the corresponding GE-06 Plan entry as given in the GE-06 Agreement.

Furthermore, the technical characteristics of the DVB-T2 implementation should be such, that it would receive a favorable finding when examining it under Section II of Annex 4 to the GE-06 Agreement, along with Rule of Procedure Part A10/GE-06 5.1.3, decisions 1 to 3 for conformity with respect to the corresponding Plan entry. DVB-T2 implementations that are in conformity with the relevant digital Plan entry and that have received a favorable finding will be recorded in the MIFR.

Figure 3: Submission of DVB-T2 assignments



Source: EBU-UER.

DVB-T2 offers sufficient flexibility in terms of the number of suitable equivalent variants that would maintain the same service area and would permit the operation of an assignment(s) within the limitations of Provision 5.1.3 of the GE-06 Agreement and a corresponding digital broadcasting Plan entry. Based on these considerations, **Annex 4** lists the DVB-T2 variants which are directly compatible with GE-06.

However, there are some DVB-T2 variants which are not directly compatible with DVB-T variants in GE-06 such as:

- Extended carrier mode for certain FFT sizes and certain bandwidths;
- 1k FFT for 7 and 8 MHz bandwidths;
- Certain FFT sizes for 1.7 MHz bandwidth.

They may have the same interference potential but the GE-06 DVB-T mask would not be respected. DVB-T2 variants for 5 and 6 MHz channel arrangements may also be considered for the implementation of a GE-06 Plan entry if suitable filtering is applied, however variants for these channel arrangements do not yet have defined spectrum shaping limits in the ETSI specification [EN 302 755] or in ITU-R Rec. BT.1877 [BT1877].[33]

3.3 ITU assistance related to GE-06 spectrum re-planning

3.3.1 Re-planning GE-06 for Sub-Saharan African countries

Figure 4: Sub Sahara African GE-06 region

The African Telecommunication Union (ATU), with the assistance of the ITU, concluded an 18-month negotiation and coordination process to complete the GE-06 modification activities to satisfy all or most of each nation's broadcasting frequency requirements.[34] These activities have been very successful with a target number of four coverage layers (multiplexes) per site largely attained, showing that the broadcasting spectrum needs of these administrations can be covered in the UHF frequency band 470-694 MHz. These administrations have completed the process of formal submission of official GE-06 Plan modification notice files to the ITU BR in order that the modifications could officially take effect and be reflected in the GE-06 Plan.

Africa becomes the first region in a position to allocate the Digital Dividend to the mobile service for both the 700 MHz and 800 MHz bands as soon as the WRC-12 decisions on the 700 MHz allocation to the mobile service became effective after World Radiocommunication Conference in 2015 (WRC-15).

[33] For more information, see https://tech.ebu.ch/docs/tech/tech3348.pdf.
[34] For more information, see http://www.itu.int/ITU-R/terrestrial/broadcast/ATU/.

3.3.2 Re-planning GE-06 for Arab countries

Figure 5: ASMG GE-06 planning area

In accordance with the recommendation of the 35th meeting of the Permanent Arab Committee for Communications and Information (Cairo, 4-5/3/2014) and based on contributions of the Technical Secretariat of the Council of Arab Ministers for Communications and Information, the ASMG with the assistance of the ITU concluded an 11-month negotiation and coordination process to ensure sufficient spectrum for broadcasting in the 470-694 MHz and be able to free the 700/800 MHz. A target of four layers per Administration was set for this coordination period, knowing that this number can be increased in the future according to the needs of the Arab states and based on GE-06 Article 4 Procedures. Three planning and coordination meetings were held in Dubai (UAE), Hammamet (Tunisia) and Marrakech (Morocco). 27 iterations were completed for the compatibility analysis based on the requirements submitted by administrations.

3.3.3 Using GE-06 tools for other regions

In other regions the software tools developed for GE-06 and the re-planning methodology can also be used. Re-planning activities also took place in Latin-America. In some cases, countries had the direct assistance of ITU and/or used ITU spectrum planning software tools available.

3.3.4 Re-planning GE-06 in European region 1 (WEDDIP experience)

Following the finalization of the first CEPT Digital Dividend study, a group of Administrations decided that they wanted to discuss the consequences of the implementation of the Digital Dividend from a strategic perspective. In 2009 they founded the Western European Digital Divided Implementation Platform (WEDDIP).

This group (containing 8 nations: Belgium, Germany, France, Ireland, Luxembourg, the Netherlands, Switzerland and the United Kingdom) conceived Terms of Reference in which they agreed to coordinate the frequency coordination activities carried out by its member countries in order to implement the Digital Dividend, with a view to:

- Achieving mutual compatibility of the spectrum resources to be used in the VHF and UHF-band following the implementation of the Digital Dividend, for both broadcasting and/or mobile services;
- Facilitating any consequential modifications to the GE-06 Plan; and,
- Continuing to respect the principle of equitable access to spectrum resources in the spirit of GE-06, while taking into account relevant future developments.

The Group committed its members work on the basis of consensus.

3.3.5 Spectrum planning activities in Asian countries

One interesting case from the region is Thailand. NBTC (Thailand´s regulator) was in collaboration with International Telecommunications Union (ITU) to conduct a frequency planning for DTT. This project completed in February 2015. The DTT frequency plan was developed based on the outcome of this project and was officially published in August 2015. However, the frequency planning activity is still ongoing due to the modifications in the technical characteristics.

The following planning targets were defined:

1) FX rooftop coverage for 95 per cent of the Thai households;
2) Regional FX rooftop coverage in 39 regions for providing Community services;
3) Portable Indoor (PI) coverage in target municipalities; and
4) Protection of operational ATV services in the UHF band.

Planning targets 1 to 3 are defined in the regulatory framework, i.e. NBTC Notifications. It should be noted however that the PI target was not clearly defined at the beginning of the planning process. Thus, the first step was to design the DTTB networks for FX rooftop reception and then calculate what the resulting PI coverage would be. At the time that the FX network would be deployed the policy makers would have reached a conclusion on the PI target and additional PI sites could be planned at a later stage. This approach would also allow the regulator to monitor the uptake of the DTTB services and how well the service providers would do in earning advertising income on the DTTB platform.

The operational ATV networks had to be protected from DTTB interfering with these networks (and hence the ATV viewers) and conversely the DTTB network needed to be made compatible with these ATV networks. Also, the network topology should be kept as much as possible, the same when transitioning from the simulcast period (in which ATV service had to be protected) to the all-digital situation (after television ASO in the UHF band).

The adopted approach was to first plan for the all-digital situation, in which the network would be optimized to reach the planning targets and to minimize spectrum usage. This planning scenario was labelled scenario C. For protecting ATV services either some interference on the ATV networks had to be accepted (i.e. acceptable interference) or temporarily frequency had to be applied. The number of frequency changes should be kept to a minimum as this would increase network costs as well as complicate the network deployment. An overview of this planning approach is provided in **Figure 6**.

3.3.6 Case study from Brazil

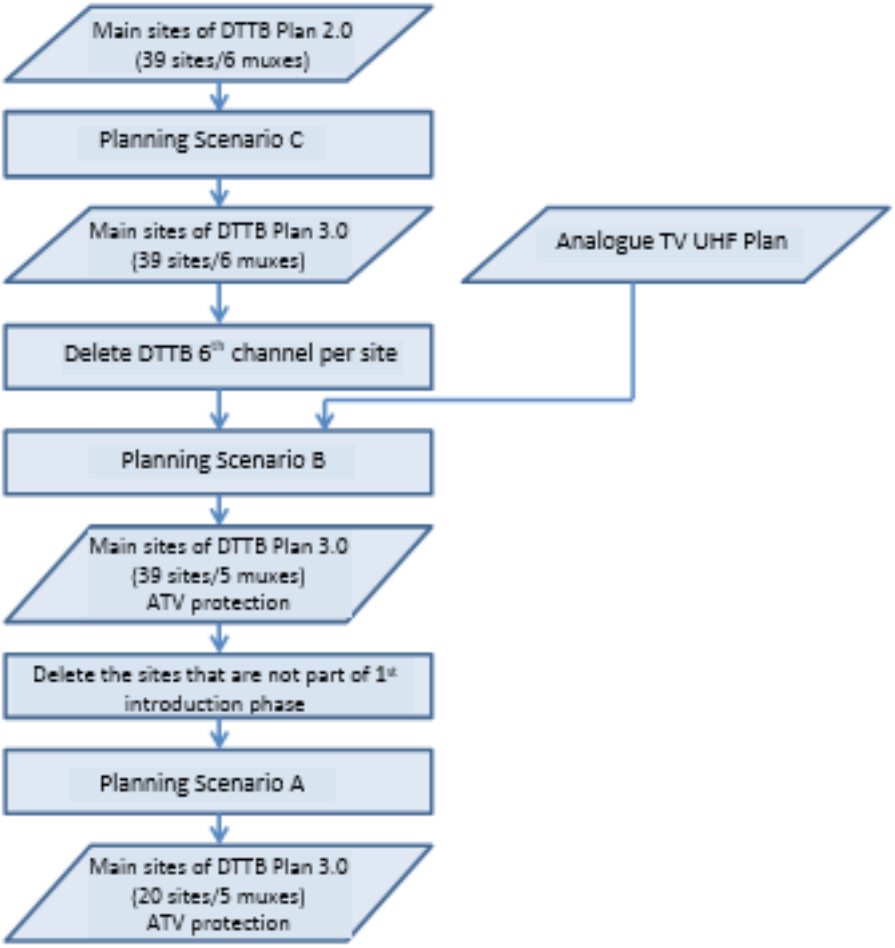
3.3.6.1 Spectrum re-planning

ANATEL is the entity responsible for planning the spectrum usage in Brazil. For television broadcasting services, ANATEL constantly updates the Basic Digital Television Channel Assignment Plan (PBTVD) and Basic Television and Retransmission of Television Channel Assignment Plans (PBTV and PBRTV). These plans contain all channels that can be used in each municipality, and the technical conditions for their usage, for example, maximum power, geographic coordinates, frequency assignment, technology (digital and analogue), among others.

In order to allow for the usage of the 700MHz band after the auction, ANATEL developed studies to reorganize the allocation of television channels in the abovementioned plans to free all the channels residing in the 700 MHz band. After a lot of debate between broadcasters, Ministry of Communications[35]

[35] In Brazil, the Ministry of Communications is the entity responsible for licensing broadcasting services, all other telecommunication services are licensed by ANATEL.

Figure 6: Applied planning approach



Source: Collaboration project between NBTC and ITU

and ANATEL, new channels were defined in the in lower UHF Band for the broadcasters that operate in the 700MHz band.

The planning was an important part of the process and allowed ANATEL to assess the number of channels that would need to be reallocated after the 700MHz auction. A total number of 1050 channels in 1096 municipalities (Brazil has 5565 municipalities in total), which accounts for around 43 per cent of the total population (Brazil has around 203 million people).

In order to guarantee the execution of all the changes necessary to allow for the usage of the 700MHz band, the auction proceedings established that all costs involved in the migration of those 1050 television stations to other frequency channels would be paid by the winners of the 700 MHz band auction. Alongside all those costs, the auction proceedings also established that the costs involved in interference mitigation and the communication of the analogue switch-off to the population would also be covered.

To accomplish this task, the auction proceedings established that the winners would have to constitute a third-party entity, named EAD – Managing Entity of the Process of Redistribution and Digitalization of Television and Retransmission of Television Channels[36]. This company would then manage all the process, which involves planning, acquisition of the necessary equipment and implementation of the entire infrastructure to enable the television broadcasters to operate in the new channels.

[36] Translation from the Portuguese Term: "*Entidade Administradora do Processo de Redistribuição e Digitalização de Canais de TV e RTV* – EAD".

Furthermore, the company would be responsible to undertake actions for interference mitigation between the incomers and the TV broadcasting, and also develop strategies to properly communicate the analogue switch-off to the population.

This third party entity (EAD) is a facilitator of the whole process with the specific responsibility of fulfilling the task of making the spectrum available, which, in some cases and specific municipalities, can involve switching off analogue transmissions to allow the reallocation of channels. For example, at cities like Brasília, São Paulo and Rio de Janeiro, which are surrounded by a multitude of other smaller cities forming dense metropolitan areas, the spectrum is today very crowded in the UHF band with several analogue and digital channels. Those metropolitan areas need to switch-off analogue transmissions prior to the reallocation of channels to free up the 700MHz band.

3.3.6.2 Re-farming of the Digital Dividend band

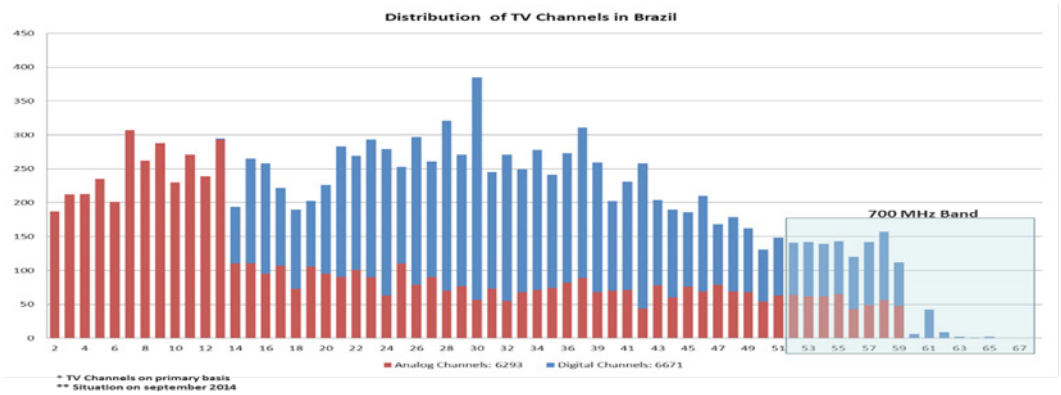
Bearing in mind the public policies for the 700 MHz band and the digital switchover, Brazil began developing studies to re-farm television channels to release the television channels from 52 to 69.

In regions where the UHF spectrum is more densely occupied, it was necessary to consider the situation of the Analogue Switch-Off to succeed in releasing the band. That is the case for 1096 of the 5565 Brazilian municipalities, which represent about 43 per cent of the country´s population. In the remaining municipalities, it was possible to reallocate all analogue and digital channels (restacking all the channels), and ensure the release of 700MHz.

In summary, it will be necessary to change the frequency of about 1050 television stations´ channels. Furthermore, during the process, were included 4300 additional digital channels in the Digital Television Channel Assignment Plan, so as to ensure that the current analogue coverage would be preserved in the digital television transmissions, an important prerequisite for the planning effort.

This process will be carried out during the switchover phase, and the 700 MHz band will be released gradually. **Figure 7** describes the amount of channels that were considered in the re-farming process.

Figure 7: Distribution of TV channels in Brazil



4 CHAPTER 4 – Use of released spectrum to implement new services and applications

One of the major benefits from the transition from analogue terrestrial to digital television is the opportunity to release a significant amount of radiofrequency resources. That released resource is called the Digital Dividend. The size of the dividend will vary from one country to another, owing to national circumstances, such as the geographical position, size, topography and spectrum planning in certain and adjacent countries.

Globally, telecommunication companies, especially mobile telecommunication service providers claim that the Digital Dividend may be used to offer mobile broadband Internet service, especially in rural areas where there are no fixed network alternatives (Digital Divide). On the other hand, broadcasters claim that they will need more spectrum in the future to be able to introduce new innovative services.

Some countries address some spectrum and ICT management issues which can be tackled by rational use of the Digital Dividend. Besides the problem of demand of mobile operators, there is the big social-economic issue of the Digital Divide, which is a major matter in the field of telecommunication. The term Digital Divide refers to the inequality in access to modern information services on different levels. The term Digital Divide includes two issues: the divide between the urban and rural areas, and the divide between different administrative areas within single country.

4.1 Digital Dividend concepts and application

Currently, there are some definitions of the Digital Dividend. In the Report ITU-R SM.2353-0 – The challenges and opportunities for spectrum management resulting from the transition to digital terrestrial television in the UHF bands [37] (published in June 2015) some particular cases of definition of "Digital Dividend" in different ITU Regions and countries are presented. In some cases, Digital Dividend is interpreted as: a released spectrum resource in certain bands in the frequency range of 470-862 MHz which is proposed to allocate for mobile service.

Another definition is more general and states: Digital Dividend is a released radio frequency spectrum in the UHF frequency bands available over requiring resource to transit analogue television programmes in the digital format, which is possible to be used for different needs since the analogue TV broadcasting is switched-off. This definition reveals the essence of the Digital Dividend to the best possible extent, i.e. the availability of additional frequency resource regardless of its further usage.

The Digital Dividend can also be defined as the high end of the UHF band, currently allocated to broadcasting services in most countries, and that will be released as a result of the transition from analogue to digital (Analogue Switch-Off – ASO) and thus can be assigned to provide mobile broadband services, allowing the maximum amount of spectrum that can respond to the growth of data traffic and increase coverage of these services.

Digital Divide is the inequality in the access to digital radiocommunication services between different countries, regions of one country and also various social groups of the population. It arises from differences in the level of social and economic development of the countries and regions, and also from well-being of various groups of the population. In the scope of the issue of Digital Dividend realization, it is appropriate to consider the divide between the urban and rural areas (suburbs, villages and townships) and the divide between different regions within separate countries (regional Digital Divide).

[37] http://www.itu.int/pub/R-REP-SM.2353-2015.

4.2 Principles of rational use of Digital Dividend

There are a variety of ways to use the released radiofrequency resource.[38] Most important of them being expanding broadcasting services[39] and implementing mobile[40] radio services considering spectrum planning principles within the framework of Digital Dividend utilization. These principles are the basis for decision making for rational realization of Digital Dividend. They can be presented as a system of technical, regulatory and social-economic principles.

Technical principles can be regarded as limitations/restrictions, i.e. principles required to plan and use the released spectrum to ensure non-interference between different services.

Social-economic principles can be regarded as matters of choice i.e. these principles should be the basis of choosing how the released radiofrequency resource will be allocated and used to ensure maximum social and economic benefit.

Regulatory principles can be regarded as additions i.e. principles bonding technical and social-economic principles. **Annex 8** presents descriptions of the principles and examples of rational utilization of the Digital Dividend.

Adherence to these principles allows the released frequency resource to be used rationally, to ensure the main goal of spectrum management is achieved: ensuring maximum social-economic benefit while using the radiofrequency spectrum on non-interference basis. Moreover, it can help to bridge the Digital Divide.

4.3 Purposes of the usage of the Digital Dividend: telecommunications issues

4.3.1 Issue of bridging the regional Digital Divide

The issue of Digital Divide between different regions of a country is typical for large countries, and is impacted by:

- Heterogeneous size of regions;
- Heterogeneously distributed population in regions;
- Heterogeneously developed markets of communication services both from penetration point of view and the number and quality of such services;
- Heterogeneous penetration of different services and types of communication.

The above-mentioned issues can be mitigated by the use of the Digital Dividend among other solutions. However, they cannot be addressed in a general way, but need a detailed analysis for each given region to determine the spectrum requirements for different technologies. Otherwise, the use of the Digital Dividend can increase the abovementioned heterogeneities resulting in an increase in the Digital Divide.

4.3.2 Bridging the Digital Divide between urban and rural areas

Radio communication technologies will have the utmost social value in those conditions where the choice is restricted or no acceptable alternatives are available to provide access to the population to global and local data transmission networks. This is why tackling the quality gap between urban

[38] This material have been proposed also to Report ITU-R SM.2353-0. The challenges and opportunities for spectrum management resulting from the transition to digital terrestrial television in the UHF bands.

[39] Report ITU-R BT.2302 Spectrum requirements for terrestrial television broadcasting in the UHF frequency band in Region 1 and the Islamic Republic of Iran. ITU, Geneva, Switzerland, April 2014. http://www.itu.int/pub/R-REP-BT.2302-2014.

[40] Report ITU-R BT.2302 Spectrum requirements for terrestrial television broadcasting in the UHF frequency band in Region 1 and the Islamic Republic of Iran. ITU, Geneva, Switzerland, April 2014. http://www.itu.int/pub/R-REP-BT.2302-2014.

and suburban/rural areas by increasing the penetration of communication services will be of great importance to improve the quality of life for the increased number of economically active people living outside of cities.

Bridging the Digital Divide between the urban and rural population is an important task for many countries. The development of communication networks in rural areas is typically much slower than in urban ones. The complexity of providing up-to-date information services to rural and remote areas primarily resides in the difficulty for operators to make enough profit to cover costs to build and operate broadband communication networks. Attempts to apply the same implementation approaches to rural areas as those used in urban areas commonly result in a too expensive deployment and, hence, typically are not successful. Thus, to successfully bridge the Digital Divide, it is necessary to employ a combination of wide bandwidth and low expenditures for network deployment and operation.

On the other hand, a substantial volume of investment is made to produce HD screens, large, extra-large and 3D screens, video survey and video communication systems. Today the main obstacle to technology improvement to provide higher quality on broadcast TV programs and video telecommunication links is not in the limitations of the end-user equipment capabilities, but primarily in the lack of available channel bandwidth. It is justified to say that the demand for transmitting video images with increased quality via broadcasting and communication links will form the ground for further growth in the communication market for next 20-30 years.

This is a real challenge for all types of systems operating radio frequency spectrum and for regulators as well, because the radio frequency spectrum is limited. In such conditions, it is very important to carefully define the balance between spectrum allocations to completely different types of radiocommunication:

– Broadcast data delivery to many users simultaneously (one-way radiocommunication);
– On-demand data delivery to a particular user (two-way radiocommunication).

Modern radio systems have been developed to address primarily one of the two above-mentioned tasks. In addition, it is often possible to fulfill another task with the same system, but by less optimal means. For example, on demand interactive data can also be transmitted to individual subscribers via digital TV broadcasting transmitters, but the efficiency of the radio link will be low. Or mobile network base stations can be used for digital broadcasting, but the mobile network infrastructure will not be used most efficiently.

Application-specific aspects of different radio technologies show that whole data delivery and wideband access system is impossible to be efficiently constructed based on a one radio service only, such as data broadcasting, wideband fixed/mobile service or other kind.

For example, it is extremely inefficient to transmit data packets for one separate user by means of a high power transmitter, covering a large area. However, this high power transmitter can provide very low cost for transmissions of the same data for many users – for example entertainment and news programs in high definition. This can enable offloading of mobile communication networks, by removing the transmission of large volumes of HD multimedia traffic in the downlink, for example. An attempt to transmit the same HD programs in mobile communication networks will lead to inefficient use of network resources meant to transmit different data packets to different users (bandwidths and levels of transmitter power of numerous base stations). The reason is that wireless data transmission networks, including 4G networks, are two-way packet-switched networks. With the increased network load, the access speed per user will decrease according to the number of connected users, inevitably affecting the quality of received data in order to transmit TV signal (jitter, delays, packet losses). The degraded quality can be expressed in lower quality image, delayed playback, jerked images and loss of video sequence fragments.

The abovementioned Digital Divide issues between the urban and rural areas and between developed and undeveloped regions leads to the consideration of the Digital Dividend realization as a valuable

possibility to improve access to telecommunication services. Depending on how effectively the Digital Dividend is used the Digital Divide on different levels can be reduced or increased.

4.4 Ways to realize the Digital Dividend

In global practices there are some ways of Digital Dividend realization, primary of them being the further development of digital terrestrial television and the implementation of mobile communication in frequency bands 174-230 and 470-862 MHz. These bands possess sufficient communications capacity for transmission voice, video and data, and also provide better propagation characteristics than frequency ranges 900 and 1800 MHz. That makes the Digital Dividend attractive to Mobile operators and TV broadcasters, which have high demand for additional radiofrequency resources to expand the quality and range of services provided.

These problems lead to necessity of strict analysis of potential implementation of next possible options of Digital Dividend realization:

- **Development of digital terrestrial television using Digital Dividend:** This option supposes using released spectrum for future development of digital terrestrial television. This development can be extensive (increasing the number of available TV programs) and intensive (implementation of new television types or services, like 3D-television, UHDTV, etc.);
- **Implementation of mobile communication in UHF frequency range:** This option supposes using released spectrum from broadcasting services for implementation of mobile communication;
- **Combined option:** This option supposes sharing the Digital Dividend between digital terrestrial television and mobile communication.

AHCIET[41], which is an association of telecommunication service providers, also points out some factors to be considered about the use of the Digital Dividend, listed below.

- For the future deployment of mobile broadband systems additional spectrum in the lower frequency bands identified is needed, as recommended by the ITU Radio Regulations and the results of the World Radiocommunication Conference 2007 (WRC-07), which identified the UHF spectrum in Region 1 (including Europe), down from the current 900MHz band, and in Region 2 (Americas) and in several countries in Region 3 (Asia, including China, India, Korea and Japan), down from the current 850MHz band;
- The 700MHz band (one of the Digital Dividend bands) result in a significant spectrum to develop mobile broadband services and thus contribute to reducing the Digital Divide, mainly as a more economical solution to provide greater coverage to rural areas and low density population, and also enhance the development of new services for citizens and BA applications and greater opportunities for innovation and for education, health, etc.;
- Non-discriminatory and neutral in terms of technology and services applied to the Digital Dividend approach could help develop the telecommunications market, because it would ensure a reliable legal framework, facilitate the convergence of services, promote the development of these rural areas, and help reduce the environmental impact and infrastructure investments through increased efficiency in the use of spectrum;
- As an example, currently in most Latin American countries, television is broadcast mainly in the VHF band and the UHF band has a more limited use, and that analog technology itself is used in a very inefficient manner. This implies an important advantage for the countries of the region, since the analogue switch off and the transition to Digital TV is not a priori a determinant of relevance for the allocation of this band to mobile services, especially if one takes into account an estimated 10 years of transition to have all digitized TV services;

[41] Asociación Iberoamericana de Centros de Investigación y Empresas de Telecomunicaciones (AHCIET).

– The distribution of the use of the 700MHz band between broadcasting and mobile services, generates an important social benefit and does not undermine the possibility of providing a large range of digital broadcast television. Effectively allocating 186MHz, i.e. 65 per cent of the 700MHz band, exclusively for broadcasting, and 108MHz to mobile services (UHF channels 698-806Mhz), more than 100 free to air television channels can be transmitted or about 60 High Definition and also substantially increase offering mobile broadband services;

– There is an interesting opportunity for countries to reallocate the 700MHz band to mobile telecommunications services prior to the analogue switch off and so leading the deployment of the latest and most efficient technologies for mobile Internet access and other next-generation services, thereby contributing to the development of the economy as a whole, generating jobs, developing investments and also social welfare and the reduction of the Digital Divide.

More information on the economic benefits of the use of the Digital Dividend can be found in the case study contributed by Asociación Iberoamericana de Centros de Investigación y Empresas de Telecomunicaciones (AHCIET) in **Chapter 5**.

4.5 Status of the use of the Digital Dividend frequency bands

Several countries have already allocated the Digital Dividend to other services. In this section, some examples are presented.

4.5.1 Case study from Brazil

A useful case is the Brazilian 700MHz band allocation for auctioning its first Digital Dividend band.

In 2008, ANATEL, the National Telecommunications Regulator in Brazil, established the regulatory actions planned for the next ten years[42]. These actions aimed to reach some strategic goals: (i) increase the access of the population to broadband services; (ii) improve the quality of the telecommunications services provided to consumers; (iii) provide telecommunication services in the rural areas with accessible prices; and (iv) ensure appropriate levels of competition on telecommunication services.

Along with that, in 2013, the Ministry of Communications established the guidelines for the 700 MHz auction: (i) improve de access of the population to Digital Broadcast Television; (ii) provide spectrum to improve the mobile broadband with high speeds; (iii) expand the optical fibre networks in the whole country; and (iv) improve the national technology development and national industry.

These were the main goals for the whole process that was carried out and resulted in the 700 MHz Auction in Brazil, and which were considered in several decisions regarding the construction of the auction process. Along with the 700MHz Auction process, the transition from analogue to digital television is being carried out by broadcasters in Brazil following the public policies formulated by the government. One of those policy instruments is the Decree no. 5.820/2006[43], which established the year of 2016 as the limit to switch off the analogue transmissions of broadcast TV.

However, with the discussions of the 700MHz Auction, in 2013, the government issued the Decree no. 8061 and changed the logic by which the switch-off would happen in Brazil. First, a single switch-off was planned for the whole country ("one-shot") that would happen in 2016. With the change promoted by the Decree no. 8061/2013[44], the switch-off will now happen from 2015 until 2018.

The main objective of this change was to anticipate the switch-off in some regions, to allow the implementation of 4G services using 700MHz band. This is one of the aspects which was impacted

[42] PGR – Plano de Atualização da Regulamentação de Telecomunicações (Telecommunications Regulations Update Plan), approved by Anatel Resolution nº 516/2008. Available at http://legislacao.anatel.gov.br/resolucoes/2008/11-resolucao-516.

[43] Available at http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Decreto/D5820.htm.

[44] Available at http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2013/Decreto/D8061.htm.

by the 700MHz Auction. The process carried out with the abovementioned auction had important implications for the transition from analogue to digital television in Brazil.

In other words, ANATEL, the Brazilian Telecom Regulator, approved in 2013 the allocation of the 700 MHz band to fixed and mobile services in order to provide voice and data communications[45]. The band allocation was established to comply with Frequency Division Duplexing – FDD, and the band was divided in nine 5 + 5 MHz sub-bands. Along with that, ANATEL could authorize the use of Time Division Duplexing – TDD on these sub-bands if technically feasible. Finally, it was decided that the first 5 + 5 MHz sub-band would not be used for 4G services, so it was consequently allocated for public safety applications. The allocation of the band is detailed in the **Annex 6** of this report. A spectrum cap of 10 + 10 MHz was also established for the first round of the auction. The cap could be increased to 20 + 20 MHz for the second round of the auction, for any remaining spectrum. For small cities, the spectrum cap could be also increased to optimize investments, for example with the usage of shared infrastructure between all companies that bought the rights for the spectrum in those cities.

The auction established three national bands of 10 + 10 MHz and one band of the same size for certain regions. For the second round, the remaining spectrum needed to be sold in smaller chunks of 5 + 5 MHz. **Annex 6** of this report illustrates the auction method used.

4.5.2 Case study from Japan

In Japan, the Digital Dividend is generally understood as the spectrum re-allocation or re-allocated spectrum in the switchover from analogue television broadcasting to other applications. The corresponding frequency bands are from 90 to 108 MHz, 170 to 222 MHz, and 710 to 770 MHz. Japan's experience can be found in Report ITU-R BT.2140.

4.5.3 Case study from Kenya

In Kenya, there has been a great demand from mobile operators to be assigned the 800 MHz band to roll out 4G LTE networks. The Ministry of Information and Communications in Kenya attempted to have all licensed telecommunications service providers form a special purpose vehicle to jointly rollout the LTE network using this spectrum, an initiative that never materialized due to disagreements amongst the operators.

One of the mobile network operators before the WRC-15, had been granted authorization to undertake a trial in 800MHz for a 2 x 15 MHz spectrum block on condition that they share capacity with other players, a move that was opposed by the industry. The operator later found it difficult to share capacity with Network Facilities Providers (NFP)-Tier 1 operators especially the other MNOs who were in competition for the same market.

Arising from WRC-15 the country adopted the full A3 channelling arrangement for 800 MHz that was contained in the updated version of Recommendation ITU-R M.1036-4 as depicted in **Annex 7** of this report. In this frequency arrangement, there are three blocks of 2x10 MHz available for assignment to three Tier 1 operators.

[45] Anatel Resolution no. 625, November 11st, 2013. Available at: http://legislacao.anatel.gov.br/resolucoes/2013/644-resolucao-625.

4.5.4 Case study from United States of America

This case study is from the United States of America[46], which switched-off its analogue transmissions in 2009, and relocated the channels 52 to 69 to advanced wireless services. See **Annex 5** of this report the spectrum allocation after the availability of the Digital Dividend for other services.

4.5.5 Case study from Viet Nam

In Viet Nam, the Digital Dividend is understood as "the amount of spectrum made available by the transition from analogue to digital television broadcasting". The roadmap for TV digitalization in Viet Nam covers the time period 2015 to 2020 and it will release the terrestrial TV broadcasting band 694-806MHz for IMT.

4.6 ITU-R activities related to the Digital Dividend

ITU-R studies concerning Digital Dividend:

- Realization of Digital Dividend (Joint ITU-R/ITU-D Report "Digital Dividend: Insights for spectrum decisions"[47], Report TU-R SM.2353-0 The challenges and opportunities for spectrum management resulting from the transition to digital terrestrial television in the UHF bands);
- Demands of different radio services in additional radiofrequency resource. (Report ITU-R BT.2302 Spectrum requirements for terrestrial television broadcasting in the UHF frequency band in Region 1 and the Islamic Republic of Iran. ITU, Geneva, Switzerland, April 2014.[48] Report ITU-R M.2290 Future spectrum requirements estimate for terrestrial IMT. ITU, Geneva, Switzerland, January 2014.[49]);
- Spectrum redeployment (Recommendation ITU-R SM.1603 Spectrum redeployment as a method of national spectrum management[50]).

4.7 Harmonization and cooperation at the regional level

Case Study for Western European Digital Dividend Implementation Platform (WEDDIP)

800 MHz

WEDDIP provided its members a platform to discuss the exploitation of the 800 MHz band as a part of the Digital Dividend, facilitating the negotiation activities. It also offered its members the possibility to share the results of these negotiations at its meetings. This was done on a voluntary basis as some members had made a decision on the release of the 800 MHz band from DTT. Other Administrations entered the discussion on a theoretical technical basis ("let us assume that…").

At 11 meetings (starting September 2009) WEDDIP members discussed the consequences of the release of the 800 MHz band on the agreed working principles on the release of the 800 MHz band. As this was the first regional attempt to discuss a complex frequency re-farming dossier, members had to learn how to find solutions fitting all the required solutions. In December 2012 WEDDIP held its 11th meeting concluding that the majority of requirements were acceptable. One outstanding topic could not be solved through the WEDDIP-process.

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46 Source: Digital Dividend: Americas Regional Radiocommunication Seminar, A. Greenwald Neplokh (Asunción, Paraguay, 2013): http://www.itu.int/en/ITU-R/workshops/regional/RRS-13-Americas/Documents/Forum/RRS-13-Americas-06-FCC-USA.pdf.

47 http://www.itu.int/ITU-D/tech/digital_broadcasting/Reports/DigitalDividend.pdf.

48 http://www.itu.int/pub/R-REP-BT.2302-2014.

49 http://www.itu.int/pub/R-REP-M.2290-2014.

50 http://www.itu.int/rec/R-REC-SM.1603/en.

WEDDIP meetings related to 800 MHz release: 2009 (3 times), 2010 (4 times) and 2011 (4 times). In 2012 no WEDDIP meetings were held.

700 MHz

When WRC 2012 decided that the part of Digital Dividend so-called 700 MHz band (694 – 790 MHz) would become co-primary for mobile operations too, WEDDIP started to consider how to release the 700 MHz band from DTT.

As for some Administrations, the release of the 700 MHz band was a real issue because on a political level the decision was made to use the band for mobile only. Other Administrations were considering to continue DTT distribution in the band. Nevertheless, WEDDIP acknowledged the fact that a release of the 700 MHz band would be a matter of time. Although the WEDDIP group was working on a voluntary basis, the group decided that the process of releasing the 700 MHz band would need more formal agreements. Time pressure was one of the reasons; some members had to release the 700 MHz on a short notice.

WEDDIP members agreed that each country a reasonable TV-distribution was guaranteed. If for example in a given country 6 multiplexes are being operated to distribute 25 programs, in the new situation the amount of multiplexes available should also be able to distribute the same amount of programs. That license conditions, as they vary per country, have to be respected. It was also acknowledged that, as far as feasible, the distribution infrastructures should stay the same. Although frequency or coverage areas may be different, the site from which they are transmitting should stay the same as far as feasible. That DVB-T2 will be the only planning principle as this allows members to benefit from the advantages DVB-T2 has above the DVB-T planning principle on which the GE06 frequency plan was created.

WEDDIP members also agreed on the coordination zones to be respected. Furthermore, the group agreed to use a database containing all the 700 MHz channels subject to the re-farming process and all channels in the remaining DTT-band (470 – 694 MHz). These channels should be identified as:

- Being in use;
- Being licensed (but not yet in operation);
- Channels under consideration and channels not in use, nor licensed but agreed as a result of (bi-)lateral negotiations.

In the process of releasing the 700 MHz band members agreed to disclose all national plans (as they exist in the coordination zone). While discussing the options, members took into account economic aspects and target objectives as they exist in a given country.

With regard to the interference approaches, usable wanted signal strength in the required coverage area, maximum field strength levels at relevant test points (e.g. at the border of a service area or at a certain distance of a country border); defined service area's; C/I calculations method and calculations margins were agreed. The agreed values could vary per agreement reached between two or more members.

As these activities required many technical planning meetings on bi- or multilateral level, these meetings were also held between the main WEDDIP 'review' meetings. WEDDIP was also used to agree on transition arrangements, although the responsibility was with the Administrations involved.

In order to finalize the creation of a new frequency plan successfully, a timeline and a roadmap was agreed. Timeline/roadmap was covering the exchange of demands/needs for DTT in the band 470-694 MHz; the type of submitted requirements (modification, deletion or addition) and analyses of the compatibility of the submitted requirements.

The timeline also set a sequence of meetings in which members agreed to finalize the frequency plan. Even a 'deadline/end date' was agreed. The release of the 700 MHz band process ended with the signing of an agreement. This agreement summarized the agreed frequency arrangements as well as those issues for which no agreement was available at that moment. WEDDIP meetings related to 700 MHz release: 2013: 2 times; 2014: 3 times, 2015: 5 times, 2016: 2 times.

After successfully finalizing the 700 MHz band release, WEDDIP put its activities on hold. It will call for a meeting if one of its members is requesting it.

4.8 Financing the transition to digital: experiences and best practices

One of the most important questions concerning the digital transition is: **"Who pays for the digitalization of the broadcasting network?"** To exemplify the spectrum of possible options and business models – and to learn from the experiences in different countries – we present the experiences in the following countries:

4.8.1 Case study from Brazil

Avoiding conflicts of interest between telecom service providers and broadcasters

Following the decision to prioritize both the Analogue Switch-Off (ASO) and the availability of the 700MHz band for other services, Brazil auctioned the referred frequency band. It was decided that the auction winners would defray the costs to migrate to digital television in several markets. Thereafter, ANATEL discussed internally methodologies that could be used to accelerate the process and avoid conflicts of interest between the parties. In this regard, ANATEL decided that a specific third party entity, to be established by the auction winners, would manage the amount raised by the auction for restacking digital TV services. The entity would also carry out actions to ensure the switchover to digital TV was completed and would employ methodologies to avoid interference between IMT and broadcasting services in the UHF band.

The reason for this decision was to avoid money transfers between the parties involved, and to standardize the receiving and transmission equipment used in the migration of television channels and transition to digital broadcasting, reducing costs and allowing for coordinated implementation. A centralized entity responsible for acquiring equipment, the logistics and the implementation of the infrastructure can make the process easier and accelerate the transition.

4.8.2 Case study from Germany

The television broadcast network is primarily financed by public fees. Commercial TV providers have to pay a certain amount to be present on the terrestrial platform. All German TV households have to pay an amount per year which is collected by a government agency with the right to impose fees to all households owning a TV set, radio or Internet-Computer. Low income households do not have to pay the fee.

To coordinate the digital transition of the existing broadcasting network, the 15 regional media regulators in Germany set up a coordination group called Joint Group of Media Regulators for Digital Access. The public broadcasters were responsible for implementing the recommendations of this group. In their financial planning the public broadcasters set aside money for the conversion project and implemented the digital upgrading of their network continuously. The result was that at the end of 2008, all TV transmitter stations in Germany had been switched to digital technology.

4.8.3 Case study from United States of America

In the United States, the costs for building the digital television network had to be covered by the broadcasters. By law, the stations were required to buy new transmitters and television antennas. On

the other hand, the American government provided significant incentives to motivate broadcasters and to increase the number of digital-ready households. The FCC allowed for pay-TV services on the digital terrestrial platform if the broadcaster transmitted at least one free-to-view program digitally.

Concerning the set-top boxes, the American government started a coupon program, the DTV Converter Box Coupon Program, which substantially has been subsidized digital transition substantially. Also, the American government, in a law passed in 2007, has required consumer electronics manufacturers to include a digital transmitter in all new TV sets and TV devices many months before the switch-off date so that manufacturers and buyers could prepare. Part of the money being spent for the coupon program has been re-collected from telecom companies, when in 2008 parts of the freed spectrum was auctioned away by the FCC.

Following the release of 108 MHz of spectrum (698 – 806 MHz) resulting from the digital television transition, the United States assigned 74 megahertz for commercial wireless use and 34 MHz for public safety broadband and narrowband use. The commercial wireless spectrum was made available by FCC auction, resulting in US$19.6 billion in net proceeds. Mobile operators were particularly attracted to the excellent propagation characteristics within the UHF band, including favorable penetration through buildings and walls and the ability to cover large geographic areas with less infrastructure. On the public safety side, the United States Congress enacted provisions to create a nationwide interoperable broadband network to help police, firefighters, emergency medical service professionals and other public safety officials stay safe and do their jobs. The law's governing framework for the deployment and operation of this network, which is based on a single, national network architecture, is the new "First Responder Network Authority" or FirstNet.

In addition to the opportunities to provide wireless broadband with the newly available Digital Dividend spectrum, "white spaces" within the remaining UHF spectrum assigned for digital television can be used to provide additional broadband services.

5 CHAPTER 5 – Countries case studies on the transition to digital broadcasting and the use of the Digital Dividend frequency bands

Question 8/1 experts consulted Administrations that produced valuable outputs. Extremely useful contributions on public policies, case studies and best practices were kindly submitted by AHCIET, Brazil, Cameroon, People's Republic of China, Guinea, Hungary, Kenya, Kyrgyz Republic, Paraguay, Russian Federation, Spain and the United States of America.

A short summary of the case studies relevant to this report are included in the table below:

Brazil

SG1RGQ/48	B	This contribution summarizes the activities related to the Auction of the 700 MHz band in Brazil and its implications to the digital terrestrial television broadcasting transition. The results of the auction process include the establishment of a coordination process that will allow the spectrum that now is being used by broadcasters to be freed and the analogue television transmissions to be switched off in several areas, which will open the way for the usage of the band for new services as per the auction.
SG1RGQ/49	B	This contribution summarizes the activities related to the spectrum re-farming and television channels redistribution in Brazil, which are activities necessary for the usage of the 700 MHz band. Among other tasks, the spectrum will need to be freed and the analogue television transmissions be switched-off in several areas, which will open the way for the usage of the band for new services.
SG1RGQ/50	B	This contribution introduces the actions being undertaken to communicate to the public the analogue switch-off dates and all the necessary procedures for a smooth and successful transition. The strategy being carried out by the Brazilian government is to mandate that the 700MHz auction winners constitute a third party entity that will be responsible for all the communication campaigns to inform the public.
SG1/336	B	Recommendations from the Brazilian NRT to improve the transition process in Brazil. This contribution summarizes the reasons for the improvements proposed and adopted and details the changes implemented.

Cameroon

SG1RGQ/39	C	This contribution takes stock of the progress made in the process of migrating from analogue to digital broadcasting in Cameroon.

China (People's Republic of)

SG1/285	C	Re-farming in frequency band 800 MHz so that dividend can be used for VoLTE over LTE. This document aims to: - Introduce technical options for using the frequency band 800 MHz to realize VoLTE over LTE; - Present experiment cases in various areas; - Analyse and forecast the social and economic benefits brought about by deploying VoLTE in 800 MHz.

Guinea (Republic of)

SG1RGQ/23	G	Migration from analogue to digital represents a major change for all countries, developing and developed alike, not only at the technological level, but also at the social and economic levels. The cost of migration may be significant, but migration frees up new frequencies, which are State property. Changeover to digital also implies choices regarding evolution of the regulatory framework to cater for the diversity of information and audiovisual works produced and broadcast, as well as the involvement of all players and public information. For all these reasons, such migration is deemed political in all countries; it is fundamental to the control of their national audiovisual landscape. For this reason, the Government of Guinea has set up a National Committee for Implementation of the Migration Process from Analogue to Digital Radio and Terrestrial TV Broadcasting. This contribution describes the audiovisual landscape in Guinea and the steps taken by the Government to implement migration to digital.
SG1RGQ/153	G	The process of migration from analogue terrestrial to digital terrestrial television (DTTV) in Guinea is being piloted jointly by the Ministry of Posts, Telecommunications and the Digital Economy and the Ministry of Communication. As is generally known, the International Telecommunication Union (ITU), which held its World Telecommunication Development Conference (WTDC) in Dubai, United Arab Emirates, in which Guinea participated, set June 2015 as the date for the switchover to digital terrestrial TV. Taking account of the various constraints associated with this objective, the Republic of Guinea, like other ITU members signatory to the GE-06 Regional Agreement adopted at the Regional Radiocommunication Conference 2006 (RRC-06), committed/keep to the process of ending analogue radio and television broadcasting with a view to full migration to digital broadcasting. As ITU set the goal of ending analogue broadcasting by 17 June 2015, the Government of Guinea with Decree D/2013/023/PRG/SGG of 21 January 2013 set up a National Commission responsible for implementing this process of analogue to digital migration. This was followed on 27 August 2014 by the signing of a concession agreement between the Government of Guinea and the Société Générale d'Afrique, for DTTV in Guinea. For reasons arising mainly from the Ebola outbreak in Guinea, the migration project has not been implemented as planned. New funding is required in order to enable Guinea to enter the digital TV age.

Hungary

SG1RGQ/43	H	This document provides a brief summary of the possibility and operation of the HbbTV service also operating in Hungary. Furthermore, it provides significance of the process of the retuning of the operating transmitters in Hungary.
SG1/27	H	This document presents a short summary of results of analogue switch off in Hungary.
SG1RGQ/198	H	This document provides a brief summary of the switch off in Hungary.

Kenya

SG1/292	K	Implementation of Analogue to Digital Terrestrial Television Migration in Kenya. This contribution provides a brief summary of the switch of in Kenya's experience subsequent to and after the 17th June, 2015, the global deadline for digital migration. It provides information on how this global commitment was carried out in our country, and the various initiatives and processes that were carried out to comply with the requirements set by ITU Member States at the Regional Radio communication Conference held in 2006, known as the GE06 Regional Agreement. It goes on to give an overview of the current status of the continuing process.

Kyrgyz Republic

SG1RGQ/35	K	The document describes the experience of Kyrgyzstan in the migration to digital television broadcasting with due regard to the rights and freedoms of citizens and current broadcasters. It describes the main difficulties encountered in the migration and ways of solving them. It is expected that this migration will preserve the existing balance in obtaining information and eliminate the "Digital Divide" between major cities and remote villages, ensure access to objective information for the population of Kyrgyzstan, and facilitate access to a wide range of high-quality television programmes.

Paraguay

SG1/399	P	This document describes the process of migration to digital terrestrial television in Paraguay, which is still just commencing. Paraguay is slowly but surely making progress in the process of migration to digital terrestrial television. Analogue switch-off is planned for 31 December 2020. Use of the Digital Dividend, however, has already commenced.

Russian Federation

SG1RGQ/92	R	In this contribution the Russian Federation presents working material regarding informational-explanatory campaign for notification about digital television in the Russian Federation to be considered for inclusion in Chapter 3 "Marketing strategies to accelerate the process of public awareness about digital broadcasting" of the future Report on Question 8/1, in accordance with structure which was developed during the SG1 meeting in September 2014.
SG1/221	R	By that contribution AC of Russian Federation presents the developed Informal-analytical system for exhibition and analysis of efficiency of the process of transition to digital television in Russian Federation. That material is proposed to be included in Chapter 3 of the future Report on Question 8/1 in accordance with structure which was developed on SG 1 meeting in September 2014.
SG1RGQ/220	R	This contribution from AC of the Russian Federation presents working material for Chapter 1 "Best Practices for the transition from analogue to digital television broadcasting, especially those to speed up and conclude the transition and aiming on bridging the Digital Divide with the deployment of new services" of the future Report on Question 8/1 in accordance with structure which was developed during the SG1 meeting in September 2015.
SG1/387	R	Experience in the use of software tools for migration to digital TV in the Russian Federation. The Administration of the Russian Federation by this document presents its national experience in the use of software tools for migration to digital TV.

Spain

SG1RGQ/291	S	The successful implementation of the objectives and timetable set out in the Spanish National Plan for DTTV Migration made it possible to complete the switch-off analogue TV transmission in Spain on April 2 2010. The biggest technological change in the country's recent history was completed successfully two years prior to the initially expected date without any major social disruption. Consensus among the agencies involved, the priority given to the public interest over private interests, and the extraordinary and active response by citizens, made it possible to effect an exemplary migration to digital terrestrial television in Spain.

Thailand

SG1RGQ/218	T	In Thailand, the National Broadcasting and Telecommunications Commission (NBTC) is playing an important role in promoting and implementing the transition from analogue to digital terrestrial television. In 2012, the transition roadmap was developed and DVB-T2 was selected as a national standard for digital terrestrial television (DTT). The technical specifications for DTT transmission, DTT receivers, as well as the first frequency plan were then developed. In 2013, NBTC and broadcasters conducted a field trial for DTT in Bangkok area to find tuning suitable parameter set – a key driver to the new frequency plan, aiming for a coverage target as stipulated in the roadmap. Since then, NBTC has been reviewing and updating relevant technical specifications and the frequency plan, as well as developing DTT technical guidelines.
SG1RGQ/227	T	This document provides an overview of Thailand's activities related to transition from analogue to digital broadcasting. The Thailand's Act on Organisation to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services (2010) stipulates that the National Broadcasting and Telecommunications Commission (NBTC) shall have mandates to put in place a master plan for spectrum management and a master plan for broadcasting in Thailand. Pursuant to the First Thailand Broadcasting Master Plan (2012-2016), transition from analogue to digital (terrestrial) broadcasting is one of seven strategies of the NBTC. In this regard, the NBTC has developed a roadmap for transition to digital terrestrial TV broadcasting in Thailand. The roadmap defines 39 service areas nationwide and each has 12 channels for Community Services. The total number of DTTB channel is 48 channels, 24 channels are allocated for national Business broadcasting services and 12 channels are allocated for national Public broadcasting services. 5 DTTB networks have been deployed, all operators agreed to share common infrastructure and facilities, network roll out plan target to reach 95% of household coverage within 4 years (2017). This report consist of background of transition to digital broadcasting, television broadcasting in Thailand, network planning and deployment, service licensing and spectrum auction, receiver and subsidy program, DSO communication, ASO planning and implementation, and lesson learned.

United States of America

SG1RGQ/59	USA	Digital Television (DTV) is an advanced broadcasting technology that has transformed the television viewing experience. DTV enables broadcasters to offer television with better picture and sound quality, and multiple channels of programming. In the United States, most of the spectrum vacated by broadcasters as they moved to DTV was auctioned to companies that are providing consumers with advanced wireless services, such as wireless broadband. In addition, an important benefit of the switch to all-digital broadcasting in the United States is that parts of the valuable broadcast spectrum have been freed for public safety communications by groups such as police, fire departments and rescue squads. The analogue to digital transition was a technological event unprecedented in scale in the U.S. broadcast television industry, touching nearly every American household directly or indirectly. The FCC had two primary goals: to provide existing broadcasters with DTV channel and power assignments that would replicate the quality and geographic area covered by their existing analogue license, and to reallocate some broadcast spectrum for other uses. June 12, 2009 was the date the last full-power television station in the U.S. ceased over-the-air transmission of analogue programming, and was the culmination of more than twenty years of technical collaboration and ten years of complex regulatory decisions. Today, all full-power stations in the United States transmit only DTV.

AHCIET

SG1RGQ/74	C	This contribution is intended as an aid to the debate on the allocation of the Digital Dividend (DD), showing the AHCIET's guidelines in favor of the use of DD for Advanced Mobile Services as well as a reference to the main outcomes of the study carried out by the consortium formed by the GSM Association (GSMA), AHCIET (Ibero-American Association of Research Centers and Telecommunication Companies), Telefónica, América Móvil, TIM Brasil, Qualcomm and Intel; "Economic Benefits of the Digital Dividend for Latin America" whose objective was to provide to the legislators of Latin American countries a qualitative and quantitative assessment of the economic and social benefit that can be generated if the "Digital Dividend" is assigned to Advanced Mobile Services , Primarily to the Mobile Broadband service.

Abbreviations and acronyms

Various abbreviations and acronyms are used through the document, they are provided here.

Abbreviation/acronym	Description
ACATS	United State of America's Advisory Committee on Advanced Television Service
A-D Transition	Analog to Digital Transition
AD	Audio Description
ADEX	Advertising Expense
ANATEL	Brazilian National Telecommunications Agency (Agência Nacional de Telecomunicações)
ASEAN	Association of Southeast Asian Nations
ASMG	Arab Spectrum Management Group
ASO	Analog Switch-Off
ATS	Advanced Television Systems
ATSC	United States of America's Advanced Television Systems Committee
ATU	African Telecommunication Union
ATV	Analog Television
BTFP	Thailand's Broadcasting and Telecommunications Research and Development Fund for the Public Interest
CEPT	European Conference of Postal and Telecommunications (Conférence européenne des administrations des postes et des télécommunications)
DD	Digital Dividend – Spectrum released as a result of the ASO
DSO database	ITU-D's Digital Terrestrial Television Broadcasting Switchover Database), which can be found at http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Summary.aspx
DSO	Digital Switch-Over
DTS	Distributed Transmission System
DTT	Digital Terrestrial Television
DTTB	Digital Terrestrial Television Broadcasting
DTV	Digital Television
DVB-T	Digital Video Broadcast – Terrestrial
DVB-T2	Digital Video Broadcast – Terrestrial 2nd Generation
EAD	Brazilian Managing Entity of the Process of Redistribution and Digitalization of Television and Retransmission of Television Channels (Entidade Administradora do Processo de Redistribuição e Digitalização dos Canais de TV e RTV)
FCC	United States of America's Federal Communications Commission

Abbreviation/acronym	Description
GE-06 Plan	Geneva 2006 Agreement for planning the digital terrestrial broadcasting service in parts of Regions 1 (Africa and Europe) and 3 (Asia and Australasia), in the frequency bands 174–230 MHz and 470–862 MHz
GIRED	Brazilian Digitalization and Redistribution of TV and Retransmission TV Channels Implementation Group (Grupo de Implantação do Processo de Redistribuição e Digitalização dos Canais de TV e RTV)
IBGE	Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística)
IMT	International Mobile Telecommunications
MPEG2 or MPEG4	Standards used for coding (compressing) information
NBTC	Thailand's National Broadcasting and Telecommunications Commission
NIIR	Russian Federation Radio Research & Development Institute
NRT	National Roadmap Team
NTIA	United States of America's National Telecommunications and Information Administration
NTSC	United States of America's National Television System Committee
PBRTV	Brazilian Basic Television and Retransmission of Television Channel Assignment Plans (Plano Básico de Distribuição de Canais de Retransmissão de Televisão em VHF e UHF)
PBTVD	Brazilian Basic Digital Television Channel Assignment Plan (Plano Básico De Distribuição De Canais Digitais)
PNAD	Brazilian National Sample Survey (Pesquisa Nacional Por Amostra de Domicílios)
RDP	Receptors Distribution Point. Thailand's and Brazil's denomination for local sites in the cities which are undergoing the ASO in a specific timeframe used by the equipment providers to deliver DTTB readiness kits in the municipality and to allow the population to retrieve their kits from.
RR	Radio Regulations
RTV	TV Relay Service
Simulcast	Simultaneous broadcasting of both analog and digital TV signals
SMS	Short Message Service
STB	Set Top Box
TVA	Special Television Service Subscription
WEDDIP	Western European Digital Divided Implementation Platform
WRC	World Radiocommunication Conference

Annexes

Annex 1: Russian informal-analytical system

Following data refers to **section 2.1.2.2** of this report.

Structure of informal-analytical system

Informal-analytical system contains 2 units:

- Portal of news and regulatory information on the realization of Programme and Digital TV;
- Geoanalytical portal contained visual exhibition of the information on the realization of Programme, including analytical tools.

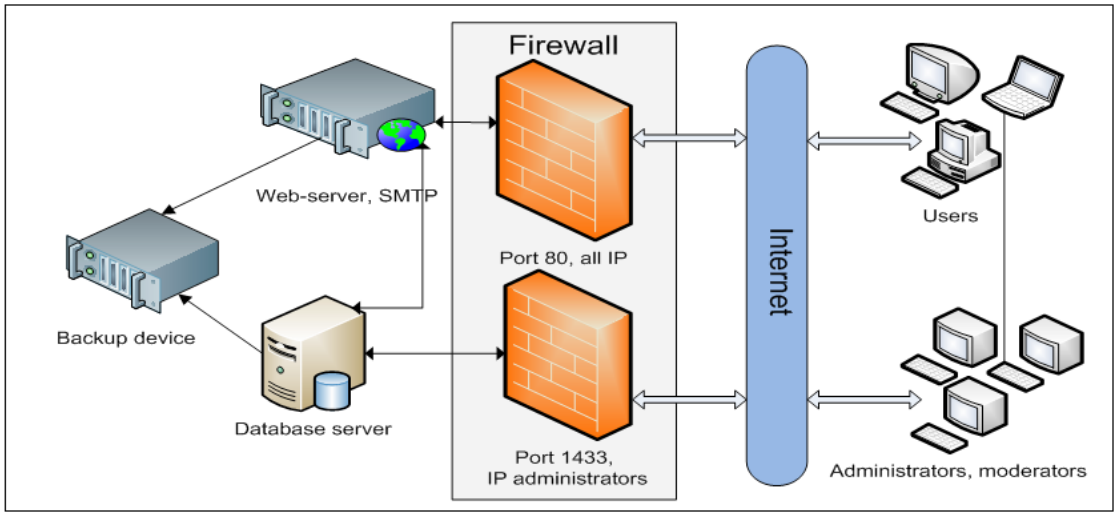
System consists of 2 main subsystems, which have been considered when technical complex had been organized:

- Software part (website) – accessible for users by request;
- Database – accessible only for system administrators.

Technical facilities have been designed with respect to the possibility of increasing of the workload and to ensuring the fault tolerance and workload distribution for exploitation of the system.

Structure of technical facilities is shown in **Figure 1A**.

Figure 1A: Structure of technical facilities for informal-analytical system



News and regulatory information portal on the realization of the Programme and on Digital TV

The News and regulatory information Portal is updated regularly with respect with the monitoring of media and regulatory decisions. The Portal has some tools for improved searching of specific data (news or regulatory decisions). In particular, for the "News" section, there are tools for selecting news for specific regions of Russian Federation. Organization of the Portal of news and regulatory information are shown in **Figure 2A** and **Figure 3A**.

Figure 2A: Structure of news portal

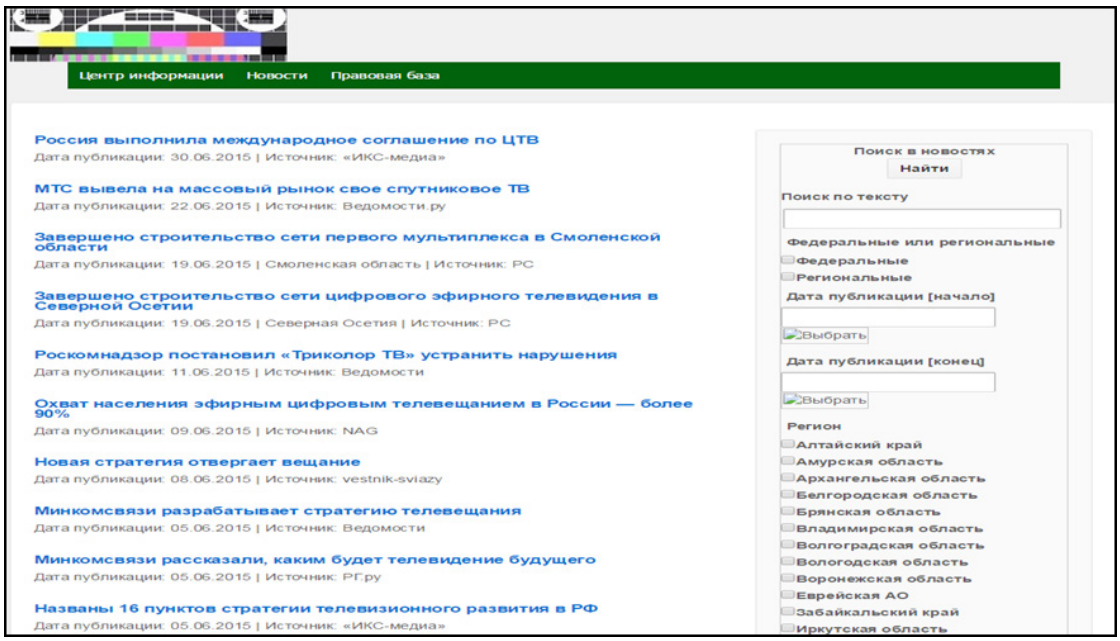
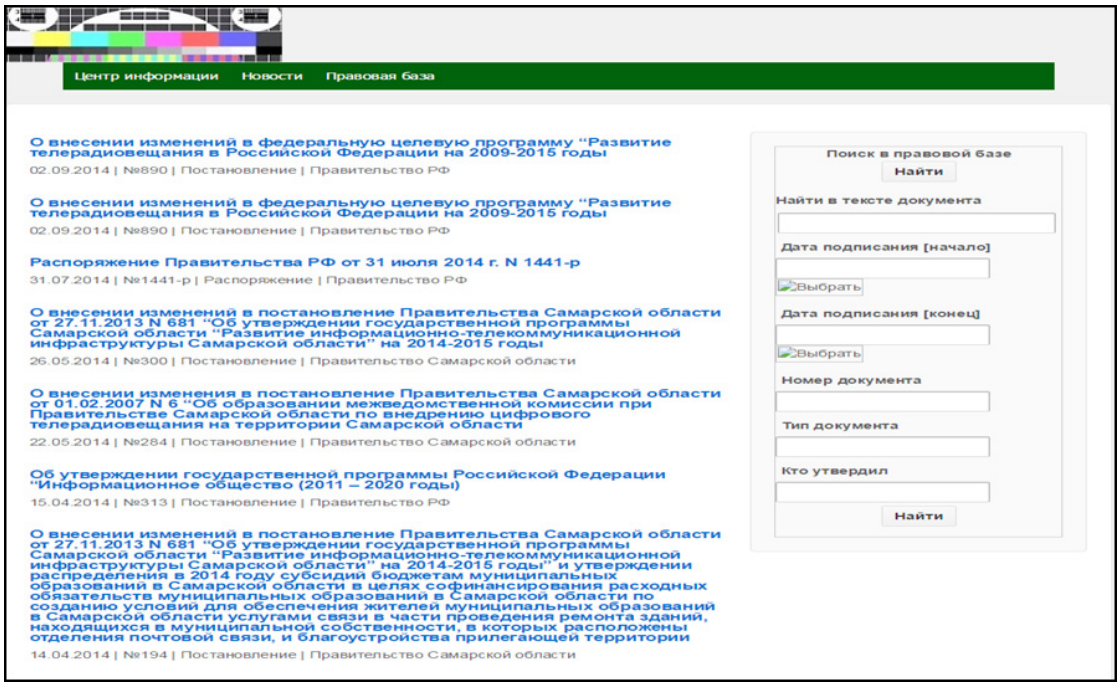


Figure 3A: Structure of regulatory information portal



Geoanalytical portal of the informal-analytical system

The Geoanalytical portal allows realizing the visual control of fulfilment of the Programme and also acquiring the combined data on Digital TV implementation. Combined data can be presented for the whole territory and for the territory of specific regions and parts of country. With the help of map tool, users can download visual information about Digital terrestrial TV (DTTV) stations (with linkage to their geolocation coordinates) from with their respective coverage areas.

Visually the structure of geoanalytical portal is shown in **Figure 4A**. In detail geoanalytical portal contains the following sections:

1) Digital terrestrial television;
   - 1.1 The first multiplex transmitters;
   - 1.2 The second multiplex transmitters;
   - 1.3 Coverage areas of digital terrestrial television;
     - 1.3.1 The first multiplex;
     - 1.3.2 The second multiplex;
2) Satellite direct TV;
   - 2.1 By operators;
   - 2.2 By satellites;
3) Multiplex formation centers;
4) Statistics of implementation of digital terrestrial television.

Figure 5A shows the work of Section "The first multiplex transmitters" for exhibition of realization of Programme on example of specific region with using of special tool for calculation of combined data on coverage areas of DTTV stations with respect with stage of construction.

Figure 6A shows the example of the work of Section "Satellite direct TV by operators" for exhibition of data on coverage of satellite direct TV for the calculation of population coverage by satellite TV services.

Figure 7A shows the example of the work of Section "Coverage areas of digital terrestrial television. The first multiplex" for exhibition of the map of Central European part of Russian Federation covered by DTTV stations being in different stages of construction.

Besides the functions shown on the abovementioned figures, the system has a tool for executing the combined calculation for selected stations (see the example on **Figure 5A**) or regions (Section "Statistics of implementation of digital terrestrial television") and also printing of the presented data.

Figure 4A: Structure of the geoanalytical portal of the informal-analytical system

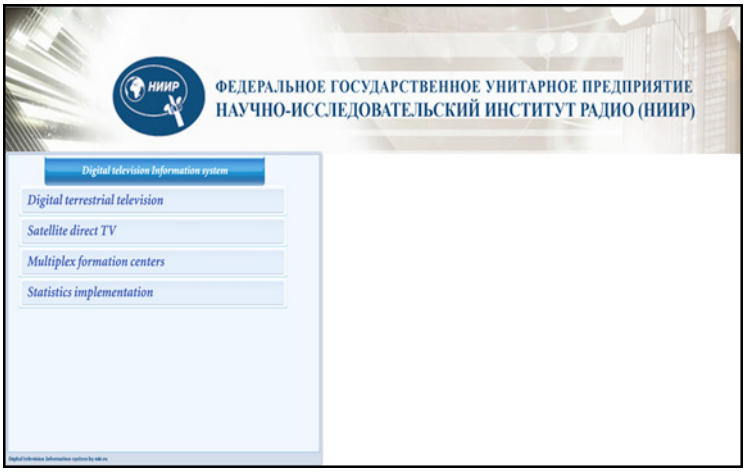


Figure 5A: Work of the geoanalytical portal on the example of one of Russian region

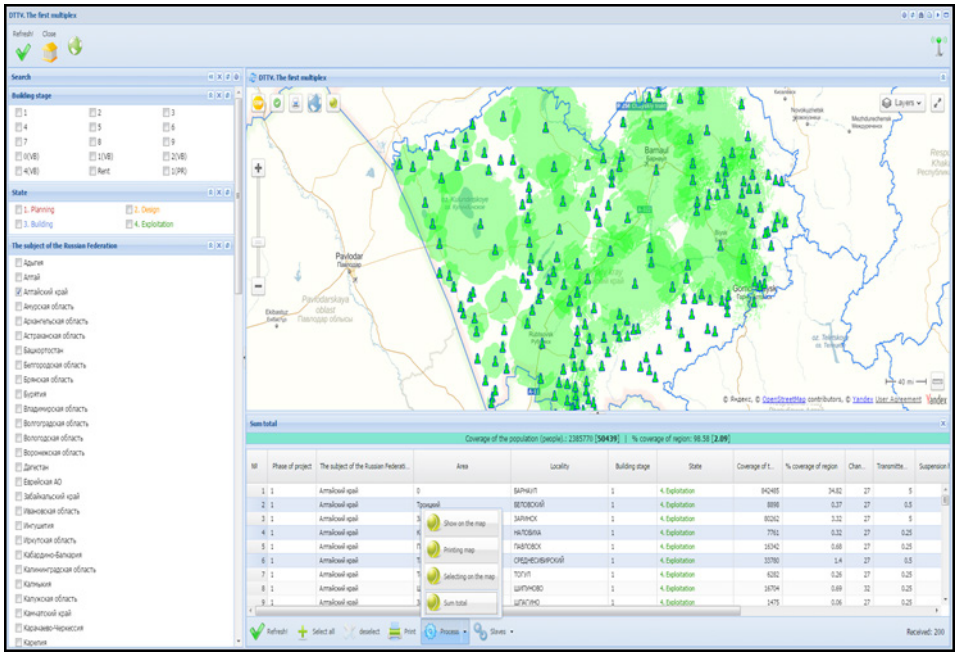


Figure 6A: Work of section “Satellite direct TV by operators”

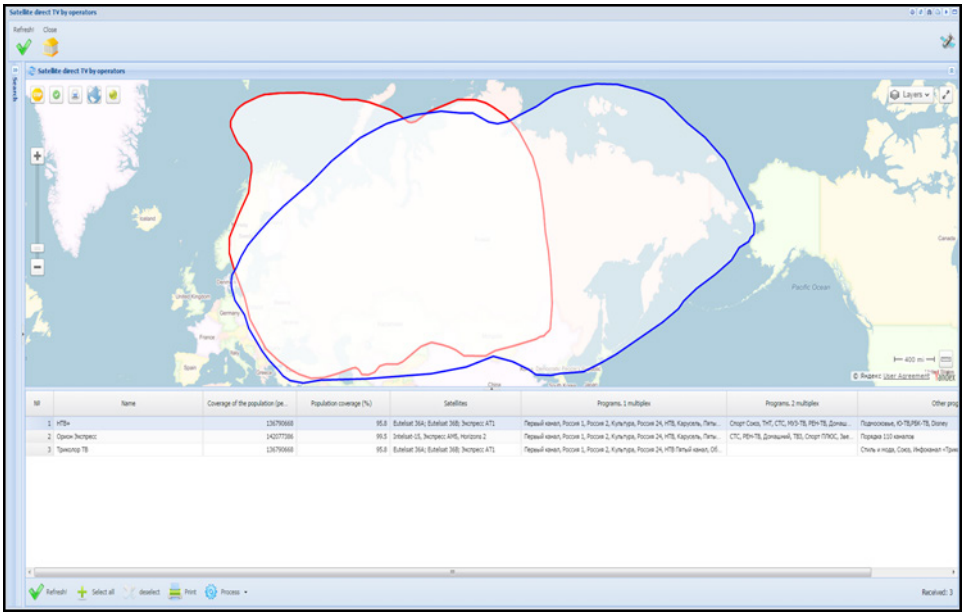
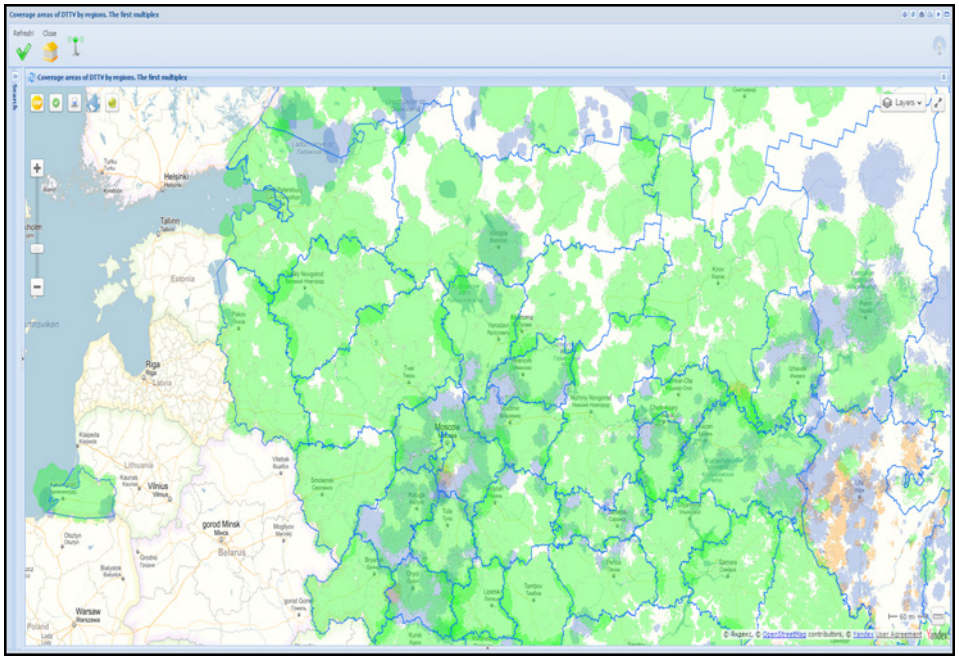


Figure 7A: Work of section “Coverage areas of digital terrestrial television”. The first multiplex on the example of coverage of the Central European part of Russian Federation by the first multiplex of DTTV



Annex 2: Russian digital television and transport network and target indicator for managing the implementation of the program

The following data refers to **section 1.2.2** of this report.

Figure 8A: Scheme of interaction of DTTV network elements in the Russian Federation

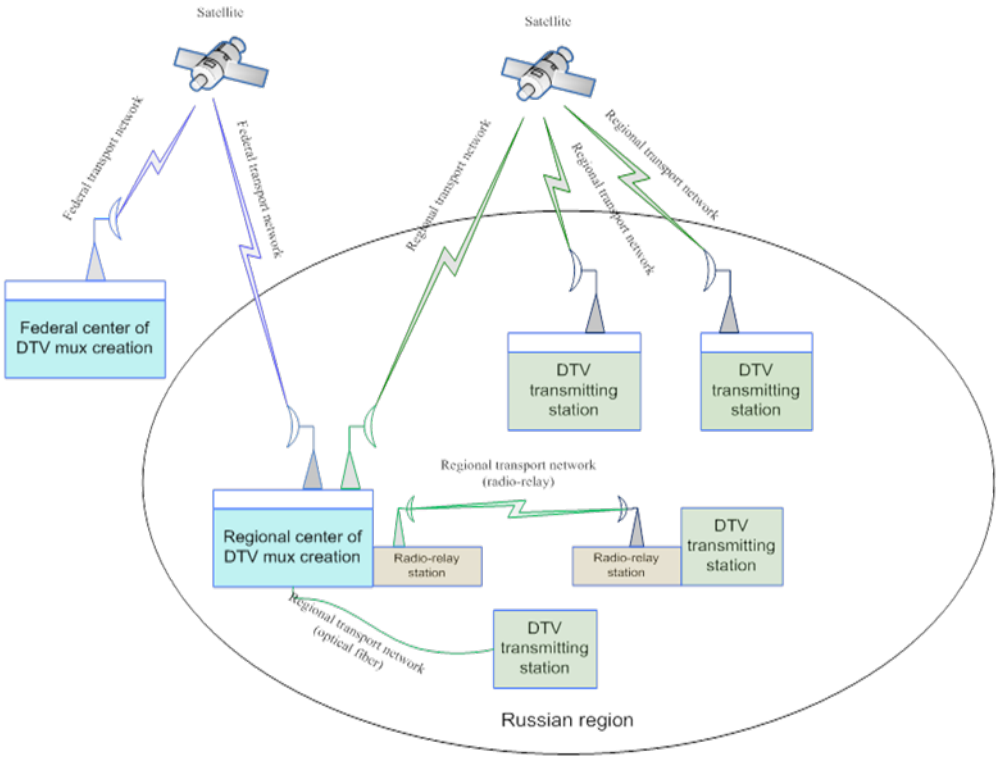


Table 1A: Target indicators for managing the implementation of the program

No.	Indicators	Criterion
1	The population of the Russian Federation not covered by the TV broadcasting	The population of the Russian Federation, not included in any of the service areas: 1. TV stations: - The first multiplex of digital terrestrial TV, - Analogue TV, 2. Satellite Direct TV, broadcasting of the one of the required TV channels.
2	The share of the population of the Russian Federation having the ability to receive nationwide mandatory public TV channels and radio channels, %	The share of the population of the Russian Federation part one of the service areas: 1. TV stations: - The first multiplex of digital terrestrial TV, - Analogue TV, 2. Satellite Direct TV, broadcasting of the one of the required TV channels.

No.	Indicators	Criterion
3	The area of the territory of subjects of the Russian Federation covered by the digital terrestrial broadcasting nationwide mandatory public TV channels and radio channels TV channels (with coverage of not less than 50% of the population of the Russian Federation), thousand km²	The total area of the territory of the Russian Federation subjects in whose coverage areas of stations DTTV terrestrial digital TV broadcasting of the first multiplex includes at least 50% of the population of the Russian Federation.
4	The share of the population of the Russian Federation having the ability to receive 20 free accessed digital channels in the places of permanent residence, %	The share of the population of the Russian Federation, covered by the one of the service: 1. TV stations: - Digital terrestrial TV, - Analogue TV, 2. Satellite Direct TV, broadcasting of at least 20 different TV channels on a free access basis.
5	The share of the population of the Russian Federation having the possibility for receiving of digital broadcasting nationwide mandatory public TV channels and radio channels, and covered by the emergency situations broadcasting in the places of permanent residence, %	The share of the population of the Russian Federation, covered by the stations of the first multiplex of terrestrial digital TV.
6	The number of subjects of the Russian Federation, which started digital terrestrial broadcasting nationwide mandatory public TV channels and radio channels	The number of subjects of the Russian Federation, which have at least one operating DTTV station.
7	The number of subjects of the Russian Federation covered by the digital terrestrial broadcasting nationwide mandatory public TV channels and radio stations (with coverage of not less than 50% of the population of the Russian Federation).	The number of subjects of the Russian Federation, in which the share of the population covered by the stations of the first multiplex of terrestrial digital TV is not less than 50%.
8	The number of subjects of the Russian Federation covered by the digital terrestrial broadcasting nationwide mandatory public TV channels and radio stations (with coverage of not less than 95% of the population of the Russian Federation).	The number of subjects of the Russian Federation, in which the share of the population covered by the stations of the first multiplex of terrestrial digital TV is not less than 95%.

No.	Indicators	Criterion
9	The share of the population of the Russian Federation not covered by the regional television broadcasting in the places of permanent residence, %	The share of the population of the Russian Federation, not covered by the one of the following TV services: 1. Regional terrestrial analogue TV broadcasting, 2. First multiplex of terrestrial digital TV considering the condition of imposing centers of multiplexes formation for delivering the first multiplex by: a) own network of RRL or b) valid contract of lease of a satellite channel or fiber optic line.

Table 2A: Example of results obtained to the referred indicators

№ п/п	Indicators	Program Plan
1	The population of the Russian Federation not covered by the TV broadcasting	-
2	The share of the population of the Russian Federation having the ability to receive nationwide mandatory public TV channels and radio channels, %	100
3	The area of the territory of subjects of the Russian Federation covered by the digital terrestrial broadcasting nationwide mandatory public TV channels and radio channels TV channels (with coverage of not less than 50% of the population of the Russian Federation), thousand km²	17 098 246
4	The share of the population of the Russian Federation having the ability to receive 20 free accessed digital channels in the places of permanent residence, %	98,1
5	The share of the population of the Russian Federation having the possibility for receiving of digital broadcasting nationwide mandatory public TV channels and radio channels, and covered by the emergency situations broadcasting in the places of permanent residence, %	98,4
6	The number of subjects of the Russian Federation, which started digital terrestrial broadcasting nationwide mandatory public TV channels and radio channels	83
7	The number of subjects of the Russian Federation covered by the digital terrestrial broadcasting nationwide mandatory public TV channels and radio stations (with coverage of not less than 50% of the population of the Russian Federation).	83
8	The number of subjects of the Russian Federation covered by the digital terrestrial broadcasting nationwide mandatory public TV channels and radio stations (with coverage of not less than 95% of the population of the Russian Federation).	83
9	The share of the population of the Russian Federation not covered by the regional television broadcasting in the places of permanent residence, %	1,6

№	Indicators	Program plan, total
1	The number of objects of digital broadcasting network of the 1st multiplex put into operation	4984
2	The number of centers of formation of multiplexes put into operation	83
3	The number of objects network of digital broadcasting 2 multiplexes put into operation	4984
4	The number of objects of digital broadcasting networks additional multiplexes put into operation	192

№	Indicators	Program plan, total
5	The number of objects broadcasting the 1st multiplex, on which construction is started (cumulative)	4984

Annex 3a: Results of public awareness on digital television in Russian Federation

Following data refers to **section 2.1.2** of this report.

Data of the awareness of the Russian Federation population regarding the transition from analogue to digital television (June and November 2014 Sociological Surveys):

- Share of inhabitants informed about digital television ~ 82%;
- Share of indifferent inhabitants ~ 3%;
- Share of inhabitants not received any kind of television signal ~ 1%;
- Share of inhabitants informed about realization of federal target program ~ 68%;
- Share of inhabitants informed about free-of-charge digital television programs ~ 31%;
- Share of inhabitants thinking that realization of federal target program is the social responsibility of government ~ 70%;
- Share of inhabitants having equipment for receiving digital terrestrial television ~ 40%;
- Share of inhabitants wanting to acquire equipment for receiving digital terrestrial television ~ 88%.

Data related to the hotline´s work for awareness of the Russian Federation population regarding the transition from analogue to digital television:

- Average rate of incoming calls, which were handled in 20s – 92.67%;
- Rate of lost calls – 2.6%;
- Assessment of quality of service – 4.81 point of 5;
- Customer satisfaction – 95.42%.

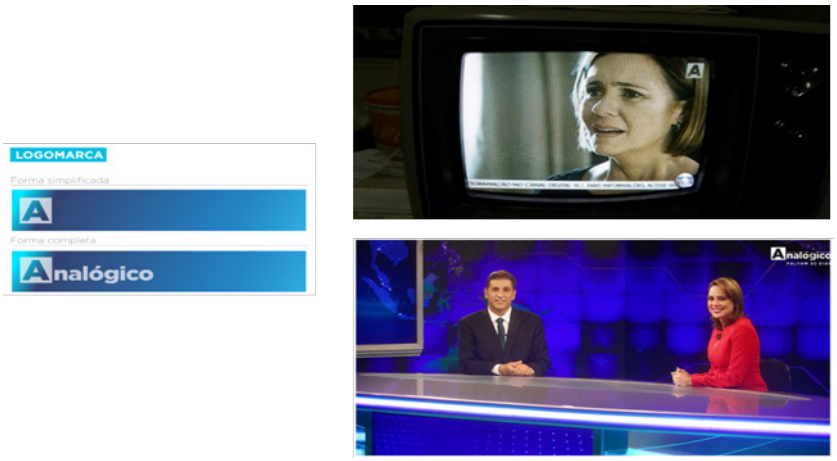
Annex 3b: Brazilian communication campaigns for consumer awareness

Following data refers to **section 2.1.1** of this report.

Mandatory minimum consumer information campaign

Regarding the mandatory consumer information campaign, it was decided that a logo and informative text be inserted from time to time on the screen of analogue channels to inform users that the specific channel is an analogue one. The informative text is used to point out the respective digital channel number and also to inform about the Call Center and the website available to solve doubts and inform about the transition process. **Figure 9A** shows an example of the logo.

Figure 9A: Analogue Switch-Off standard message and logo



The Logo can be seen on the image above, marked by the letter "A" highlighted forming the word "Analogue", and below the channel tuning information for the digital broadcasting simulcast channel.

It was also decided that informative video ads and indicative charts would be aired to the public on the analogue channels also to inform the population about the process and also to constantly catch the audience attention to key information, for example, the ASO date, the digital channel number associated with the current analogue channel, and the call center and web site information.

The standard logo, text messages, informative videos and other means of informing consumers by means of the TV screen of analogue channels follow a standard set forth by the Ministry of Communications[51] that states the minimum number of appearances and duration of each spot. The rule does not establish, however, the specific broadcasting dayparts that the messages need to be aired, but focuses on the minimum number of appearances necessary during the whole day and specifically during the prime time daypart, with the objective of reaching most TV viewers and leaving the compliance to the rules more flexible.

The logo should be displayed preferably in the upper right corner of the screen, being optional to display it in the upper left corner of the screen, in the same format, if it overlaps with a station logo. The initial size should be at least 40x40 pixels, and its size will be gradually increased until the ASO date. The logo's size needs to be increased by 10 per cent (44x44 pixels) 75 days before the ASO date and by 20 per cent (48x48 pixels) 60 days prior to the ASO date. In case of non-achievement of the ASO condition,[52] the logo´s size needs to be increased by 30 per cent (52x52 pixels).

The logo is shown on screen for 30 seconds in each appearance (5 seconds initially in the full form "Analógico", 20 seconds in simplified form "A" and an extra 5 seconds at the end in the full form

[51] Ordinance nº 378, 22/Jan/2016, of the Ministry of Communications.
[52] The ASO condition in Brazil is reached when 93% of the TV households are ready to receive digital signals.

"Analógico") and is constantly on screen when the countdown begins with 60 days to the ASO date. The countdown of the number of days to the ASO is shown right below the logo in the analogue TV channels. Below is presented more details on the number of appearances and duration of each spot of the mandatory communication campaign.

In the context of the mandatory campaign, it was also mandated that analogue channels images would be changed to a widescreen format (16x9 aspect ratio). In other words, the implementation of letterboxing was mandated. This change needs to be implemented 360 days prior to the ASO in any specific city alongside with the insertion of the logo and the informative text. The letterboxing can reduce in 25 per cent the screen area reserved for the television programming, and, as a result, the consumers that have small screen televisions, most of them analogue CRT technology, will have more difficulties for watching the analogue TV channels. The experience of the Pilot City of Rio Verde points out in that direction and this was a motivation for consumers to move to digital reception.

The main reason for this change though is to allow for the insertion of both the informative text and the logo in the black stripes above and below the screen so that the programming is not overlapped by them. This was an important demand from broadcasters that were worried about not having any graphic material overlapping their images.

Finally, informative videos and indicative charts are being aired to inform about the transition process. The first provides general information as a regular TV commercial and the latter is inserted previously to a commercial break blocking the whole image for 15 to 30 seconds with the main objective of having the user full attention to specific information regarding the transition. The information inserted in the indicative chart includes the ASO date, the respective digital channel number and the Call Center and web site information.

The following table summarizes the number of appearances and basic rules of each type of communication tool in the mandatory communication campaign, as presented in **Chapter 2** of this report.

Table 3A: Minimum number of appearances and duration of each spot

Days to the ASO	Indicative chart (pre-break)	Informative Video	Logo	Informative Text (crawl)	Countdown
360	-	-	3 / 30s (1 between 20h and 21h30)	3 / 30s (1 between 20h and 21h30)	-
300	-	-	6 / 30s (1 between 20h and 21h30)	6 / 30s (1 between 20h and 21h30)	-
240	-	-	9 / 30s (2 between 20h and 21h30)	9 / 30s (2 between 20h and 21h30)	-
180	1 / 15s (between 20h and 20h30)	-	12 / 30s (2 between 20h and 21h30)	12 / 30s (2 between 20h and 21h30)	-
120	2 / 15s (1 between 20h and 21h30)	-	15 / 30s (3 between 20h and 21h30)	15 / 30s (3 between 20h and 21h30)	-
90	3 / 15s (1 between 20h and 21h30)	-	15 / 30s (3 between 20h and 21h30)	15 / 30s (3 between 20h and 21h30)	-
75	4 / 15s (1 between 20h and 21h30)	3 / 30s	18 / 30s (10% bigger) (3 between 20h and 21h30)	18 / 30s (3 between 20h and 21h30)	-

Days to the ASO	Indicative chart (pre-break)	Informative Video	Logo	Informative Text (crawl)	Countdown
60	5 / 15s (1 between 20h and 21h30)	3 / 30s	Fixed (20% bigger)	18 / 30s (3 between 20h and 21h30)	Fixed (20% bigger)
30	6 / 15s (1 between 20h and 21h30)	3 / 30s	Fixed (20% bigger)	21 / 30s (3 between 20h and 21h30)	Fixed (20% bigger)
If ASO condition not reached	9 / 30s (3 between 20h and 21h30)	6 / 30s (2 between 20h and 21h30)	Fixed (30% bigger)	40 / 30s (5 between 20h and 21h30)	-

Figure 10A shows an example of the indicative chart format and information.

Figure 10A: Indicative chart (full screen pre-break message)

The indicative chart changes its color depending on how many days left to the ASO. It begins with yellow with 180 days to the ASO and ends with red within 30 days to the ASO, passing by tones of orange for 120, 90, 75 and 60 days to the ASO. The chart´s chromatic variation reflects the urgency in the process and is intended to motivate consumer action.

The chart also reflects the case of not reaching the ASO condition[53] turning its color to dark gray if that situation arises and stating the new ASO data, if the ASO date is postponed, or that "the analogue signal will be turned off at any moment", otherwise. The purpose of this message is to motivate the latecomers, i.e., those that will only act at the final moment of the process.

After the analogue transmissions are switched off the chart is preserved for an extra 30 days covering the whole screen for the whole time and informing that the channel was switched-off and that the programming is available in the respective digital channel. This provision is intended to inform all the population that the analogue channel was really switched-off.

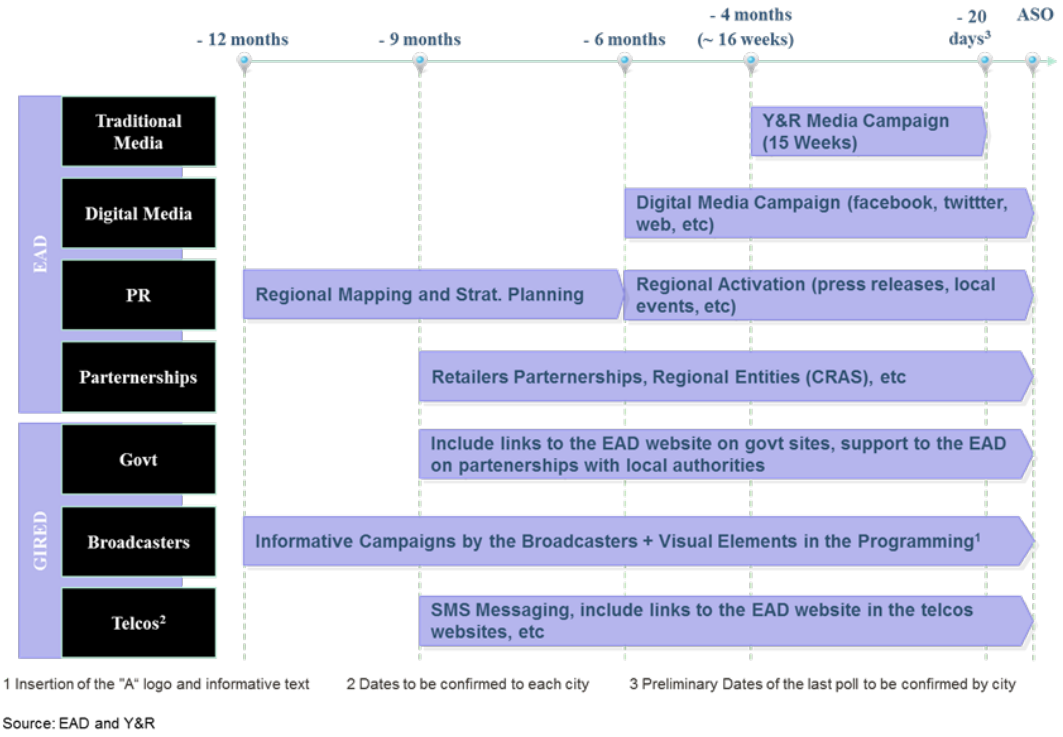
Massive media campaign

Another important part of the communication strategy is the consumer outreach strategies to inform and solve doubts of the public and to motivate action of the population, for example to have the population acquire the necessary reception equipment in order to have the capability of tuning digital signals. These goals are being achieved by a massive media campaign targeting the regions involved

[53] The ASO condition in Brazil is reached when 93 per cent of the TV households are ready to receive digital signals.

in ASO in any specific time. This communication strategy is detailed in a Communication Plan that comprises several means of reaching the consumers. **Figure 11A** summarizes this plan.

Figure 11A: Communication plan outline



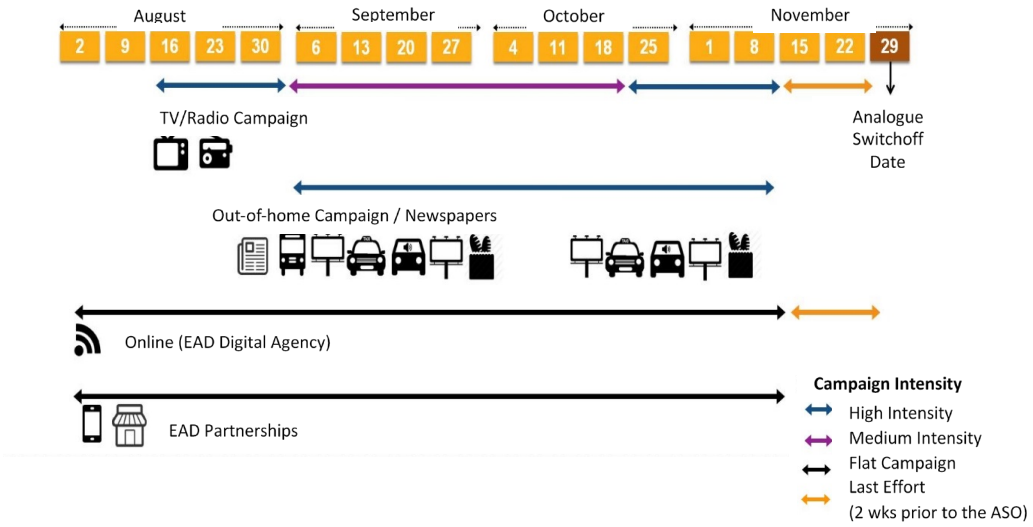
Source: EAD and Y&R

It can be noticed that several different initiatives are used concurrently to maximize the outreach and increase population awareness to the maximum extent possible. Digital Media, Traditional Media, Local partnerships and voluntary informative campaigns by the broadcasters, among other means, are used to inform the consumers and to reach the overall goal of having nearly everybody engaged in the process. It is also a goal to have those that will be impacted by the Analogue Switch-off in a certain region act proactively to assure the reception of the digital signals.

All these means of communication are combined to form a coherent Communication Campaign. However, the results can be potentialized if each of these communication tools is used in the right time. Some important decisions for the Campaign include the definition of which timeframe that each media is used and also the Campaign Flighting.[54] To exemplify how this process is done **Figure 12A** shows a way of defining the Campaign Flighting for a specific region before the Analogue Switch off (ASO).

[54] Campaign Flighting is an advertising term for a timing pattern in which commercials are scheduled to run during intervals that are separated by periods in which no advertising messages appear for the advertised item. Any period of time during which the messages are appearing is called a flight, and a period of message inactivity is usually called a "hiatus". The advantage of the flighting technique is that it allows an advertiser who does not have funds for running spots continuously to conserve money and maximize the impact of the commercials by airing them at key strategic times. Advertisers will often employ less costly media such as radio or newspaper during a television flighting hiatus. This method of media planning allows the messages and themes of the advertising campaign to continue to reach consumers while conserving advertising funds.

Figure 12A: Example of Campaign Flighting



In the case of the ASO communication (i) traditional media such as radio and television, (ii) out-of-home media like billboards, transit advertising (buses, taxes, metro, etc), brochure/fliers distribution, etc., (iii) online media (web pages, social media, you tube ads, etc), and (iv) local partnerships with local authorities, retailers and civil society were all used to promote consumer awareness.

The overall Communication Strategy needs also to address specifically the low income population and population with specific needs, especially if they are eligible to receive the reception equipment necessary to receive digital signals, for example, in the model described in **Chapter 1** which a STB and an antenna kit is provided to those not capable of buying the equipment, in order to accelerate the transition by assuring that this part of the population is included.

The Media Campaign needs to address specific information targeted to those families, including awareness of the availability of the DTTB readiness kits, the need to schedule an appointment or to go to a walk-in center to retrieve the kit; how to install the equipment (self-installation) and other information regarding the transition process, for example, the ASO date and Customer Care Centers contact information.

The media campaign main communication channels to promote awareness to this part of the population include social services centers, out-of-home channels (billboards, sound cars, etc.) and television/radio. The Receptors Distribution Centers (PDR), which are locations used to deliver the reception kits to the population (more details in **Chapter 1**), can also be part of the communication strategy, for example, informing consumers, solving doubts, and providing training regarding the installation of the equipment on site.

Annex 4: DVB-T2 variants which are directly compatible with GE-06

The following data refers to **section 3.2.2.2** of this report.

Figure 13A: DVB-T2 variants directly compatible with 7 MHz channel arrangements

Modulation	FFT size	Code rate*	Guard interval
QPSK or 16-QAM or 64-QAM or 256-QAM	2k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/32, 1/16, 1/8, 1/4
	4k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/32, 1/16, 1/8, 1/4
	8k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
	16k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
	32k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128
* For block sizes of 16,200 and 64,800 bits			

Figure 14A: DVB-T2 variants directly compatible with 8 MHz channel arrangements

Modulation	FFT size	Code rate*	Guard interval
QPSK or 16-QAM or 64-QAM or 256-QAM	2k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/32, 1/16, 1/8, 1/4
	4k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/32, 1/16, 1/8, 1/4
	8k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
	16k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
	32k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128
	8k extended	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
	16k extended	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
	32k extended	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128
* For block sizes of 16,200 and 64,800 bits			

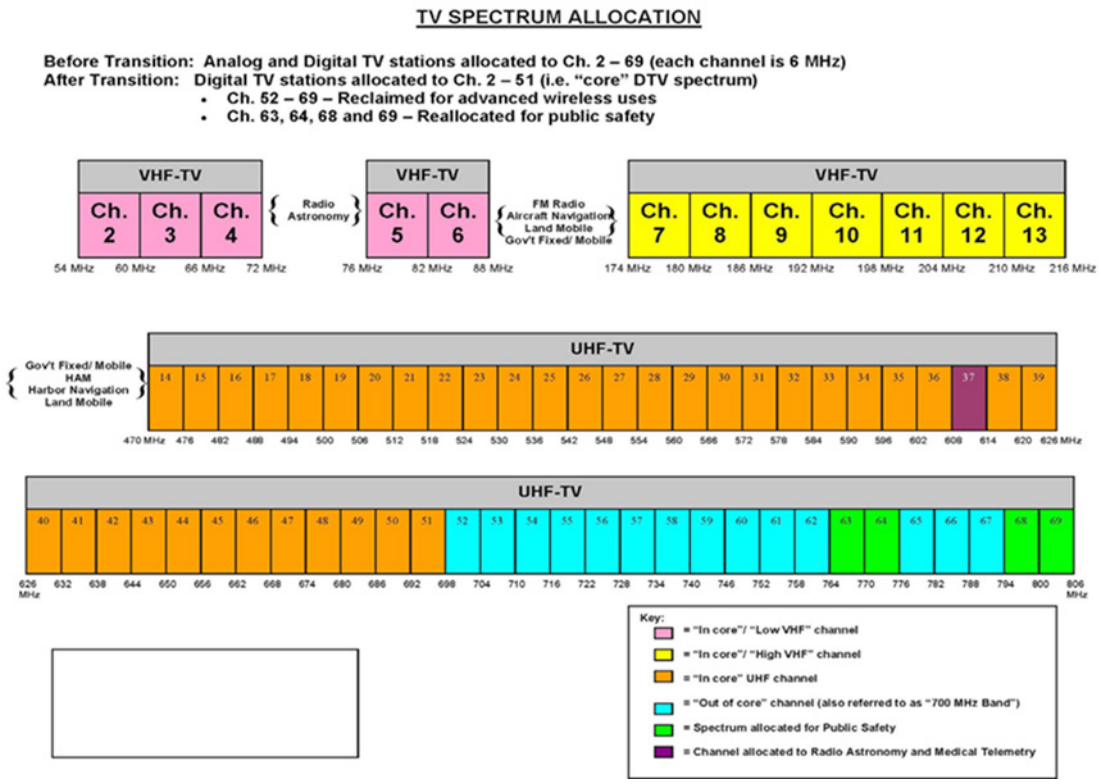
Figure 15A: DVB-T2 variants directly compatible with 1.7 MHz channel arrangements

Modulation	FFT size	Code rate*	Guard interval
QPSK or 16-QAM or 64-QAM or 256-QAM	1k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/16, 1/8, 1/4
	2k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/32, 1/16, 1/8, 1/4
	4k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/32, 1/16, 1/8, 1/4
	8k	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
* For block sizes of 16,200 and 64,800 bits			

Annex 5: Digital television allocation in United States of America

The following data refers to **section 4.5.1** of this report.

Figure 16A: TV allocation in the United States of America



Annex 6: 700MHz band allocation and auction in Brazil

The following data refers to **section 4.5.1** of this report.

Figure 17A: Frequency allocation of 700MHz Band in Brazil

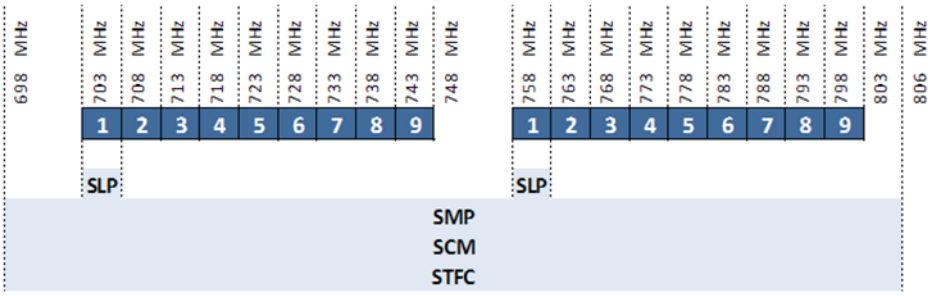
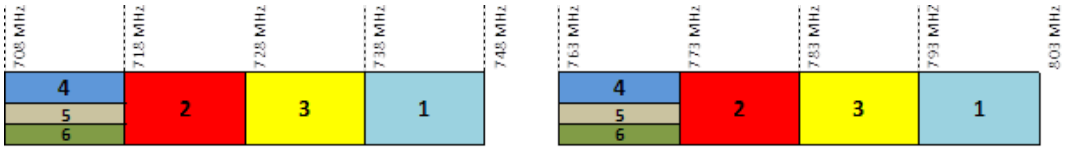


Figure 18A: Brazilian 700MHz band auction rounds

First round



Second round

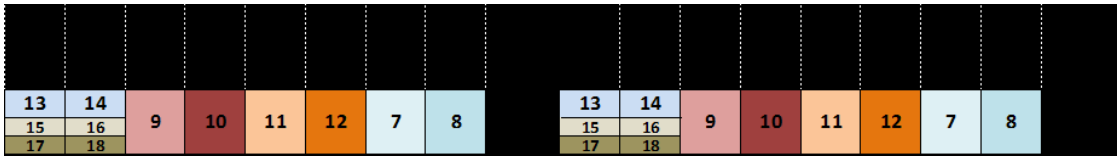
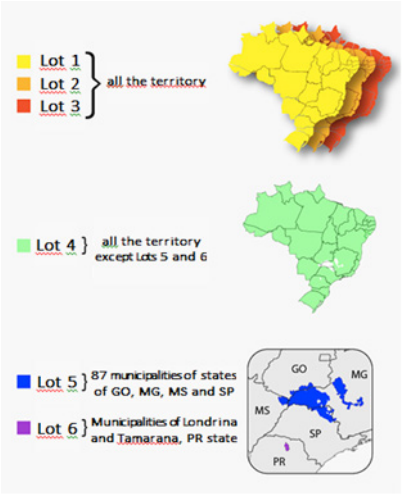


Figure 19A: Brazilian 700MHz Band auction areas



Annex 7: Channeling arrangement for 800 MHz in Kenya

The following data refers to **section 4.5.3** of this report.

Figure 20A: Recommendation ITU–R M.1036-4 (A3 band plan)

790-791 MHz	791 – 821 MHz	821 – 832 MHz	832 – 862 MHz	862-865 MHz
Guard band	Downlink	Duplex Gap	Uplink	Guard band
1 MHz	30 MHz	11 MHz	30 MHz	3 MHz

Annex 8: Principles of rational use of the Digital Dividend

The following data refers to **section 4.2** of this report.

Table 4A: Principles of rational utilization of Digital Dividend

Principles	Groups	Description
Limitation of released frequency resource.	Technical	Radiofrequency spectrum is a limited natural resource with a set of features. It means that in some cases (like Digital Dividend) it is impossible to satisfy all of spectrum demands of telecommunication services market. This fact leads to the requirement of sharing radiofrequency resources between telecommunication services or choosing the more important one for the allocation of released spectrum.
Requirement for ensuring EMC of radio-electronic devices of different telecommunication services.	Technical	Allocation of spectrum to different services leads to the necessity of ensuring EMC between radio-frequency devices of different telecommunication services. Disregarding the EMC principle can cause from lower quality of services to full failure of service rendering.
Requirement for providing coordination of using releasing radiofrequency resource between neighboring countries.	Technical	Radiofrequencies resources of the same frequency range can be utilized for different telecommunication services in different countries. Particularly, the Digital Dividend can be used for DTV and IMT. This fact leads to necessity of providing coordination planning for the utilization of the Digital Dividend in bordering territories of neighboring countries. Disregarding that principles can cause the same problems as disregarding the EMC-principle.
Limitation of terms of the license on using radiofrequency resource.	Regulatory	This principle is a result of the limitation of spectrum resources. This principle should be considered during the allocation of the Digital Dividend and its decision-making process due to the fact that this limitation stimulates a competitive environment in the telecommunication market and also the development and implementation of new telecommunication technologies.
Rights of access to radiofrequency spectrum for all consumers taking into account governmental priorities.	Regulatory	Respect to this principle is key for the provisioning of governmental duties such as national defense, law-and-order and disaster management. Moreover that principle ensures social rights for equal access to telecommunication services.
Necessity of implementation of new prospective radiotechnologies.	Regulatory	Fulfilling governmental policy for the implementation of new radio technologies which use radiofrequency resources more effectively is the key factor of new resources such as the Digital Dividend. Also new technologies can be a bridge for important new services which otherwise could not be provided by current technologies.
Necessity of implementation of new telecommunication services.	Regulatory	A consequence of the previous one. The telecommunication services market is a fast-growing field, which should be filled by new prospective services that stimulate competition and also provide increased spectrum efficiency.

Principles	Groups	Description
Ensuring of a competitive environment on telecommunication services market.	Social-economic	Market competition for the rights for using limited radiofrequency resources, considering governmental priorities and the limitations of the terms of the license, ensure the adherence of the principle of necessity of implementation of new telecommunication services and upgrading the current ones.
Importance of social demands for spectrum.	Social-economic	This principle is a consequence of the principle of governmental priorities and is necessary for providing different telecommunication services in conditions of non-uniformity access and demand for them i.e. non-uniformity of development of different telecommunication services markets.
Non uniformity of development of different telecommunication services markets.	Social-economic	Non-uniformity access to telecommunication services, the so-called Digital Divide, can appear on different levels: cross-country level (countries with better access to services-countries with worse access), inland level (territories inside country with better access to services – territories inside country with worse access) city-rural level. Uncertainty in the use of the Digital Dividend to bridge the Digital Divide either by the DTV and IMT services is possible. Some regions can have high demand for DTV but low for IMT, some other regions inversely. Considering that it is possible to state that the principle of prioritization of social demand leads to necessity of satisfaction of telecommunication services markets demands on different levels such as regions or administrative areas.
Necessity of satisfaction of telecommunication services markets demands on different levels.	Social-economic	This principle is the resulted principle on a base of that Digital Dividend allocation decision should be done to maximize social-economic effect of the utilization of the released frequency resource.

Annex 9: Description of software tool RAKURS

The following data refers to **section 1.2.2** of this report.

Introduction

RAKURS software tool (Calculation and Analysis Applications for Spectrum Management – hereinafter RAKURS) was designed in the Russian Federation by specialists of Electromagnetic Compatibility (EMC) Analysis Center of the Federal State Unitary Enterprise Radio Research and Development Institute (FSUE NIIR CAEMC).[55]

RAKURS is intended for solving spectrum management tasks in the interests of national TV and sound broadcasting service, in particular for automating migration from analogue to digital terrestrial TV.

The software tool is applied to designing transmitting networks for terrestrial broadcasting, modeling electromagnetic environment, calculating coverage areas and optimizing technical parameters of transmitting stations of TV and sound broadcasting networks. In addition RAKURS is widely used for the purposes of bilateral and multilateral coordination of frequency assignments and allotments in border areas and their recording by the International Telecommunication Union (ITU).

With the help of the RAKURS, frequency plans for the Russian Federation, the Regional Commonwealth in the field of communication (RCC) member countries and a number of neighboring countries were developed and coordinated, in particular frequency allotment contours were shaped, and channels were also allocated taking into account their equitable access at Regional Radiocommunication Conference for planning digital terrestrial broadcasting service in parts of Regions 1 and 3 in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06).

Software tool was applied to develop system projects of terrestrial broadcasting networks (designing and optimization of frequency plans for the first and second frequency multiplexes in Russian Federation), and to perform monitoring of implementation measures for Federal target-oriented program “Development of TV and Sound Broadcasting in the Russian Federation in 2009-2018: and achieving target indicators and efficiency of the program implementation.

With the help of RAKURS software tool, a methodology for calculation of DVB-T2 service area for fixed reception in the frequency bands 174-230 and 470-790 MHz was developed (approved by the decision of the State Commission for Radio Frequencies in 2014).

RAKURS software tool was also used to assess technical feasibility and economic efficiency of implementation of cognitive radio in the interests of efficient spectrum use in the frequency band 470-862 MHz.

Additionally, RAKURS software tool helped to study a possibility of using cognitive systems of broadband wireless access in the frequency band 470-686 MHz and to assess possible restrictions on EMC with terrestrial digital TV broadcasting of DVB-T2 standard.

RAKURS software tool is operated during 15 years and is a basic tool of Radio Research & Development Institute (NIIR) to solve the tasks of spectrum management, performing research and development works, calculations on international legal protection of frequency assignments and development of methodologies. Its implementation substantially widened functional capabilities of spectrum management and international legal protection, increased quality of decision-making.

[55] Description of RAKURS software is given in the ITU Handbook “Computer-aided Techniques for Spectrum Management (CAT)” (Edition 2015). http://www.itu.int/pub/R-HDB-01.

Among RAKURS users are some Administrations, particularly Belarus, Armenia, Uzbekistan.

1) RAKURS basic capabilities:

- Mathematical modeling of radio wave propagation of terrestrial broadcasting and radio communication systems in the frequency band from 148 kHz to 3000 MHz;
- Assessment of EMC for radio systems;
- Storage and processing of geophysical and topographical information to be used for radio wave propagation modeling;
- Maintenance of database with technical parameters of frequency allotments and assignments to various systems and standards of terrestrial broadcasting and radio communication systems;
- Expert evaluation of frequency assignment notices, development of recommendations on frequency channel selection for new or modified frequency assignments;
- Selection of channel/frequency and technical characteristics (maximum permissible effective radiated power (ERP) of an assignment, antenna height and radiation pattern, ERP attenuation sector);
- Determination of the need for international coordination of frequency assignments/allotments in accordance with Radio Regulations, international agreements "Geneva-06", "Stockholm-61", and bilateral and multilateral agreements between countries;
- Parity assessment of spectrum use by terrestrial broadcasting systems in border areas of neighboring countries;
- Calculation of service areas for individual stations, multi-frequency and single-frequency broadcasting and radio communication networks;
- Calculation of terrestrial broadcasting and radio communication services penetration based on demographic data referenced to settlements and locations;
- Analysis of electromagnetic environment and calculation of spectrum availability for use by various types of terrestrial broadcasting and radio communication systems;
- Comparative assessment of calculated and measured field strength of useful and interfering radio signals in broadcasting and radio communication networks;
- Mapping installation sites and results of calculation in graphic form suitable for analysis with reference to geographic maps and terrain photos, and forming reports in tabular form;
- Management of distributed computing for effective use of computing powers when modeling electromagnetic environment calculations involving large number of radio systems, performing calculations with high resolution and complexity;
- Estimated cost calculation of components for the designed network;
- Project optimization to decrease network cost and extend the coverage;
- Automated network generation for optimal coverage of the given region.

2) RAKURS structure

The software elements can be grouped into 4 main blocks:

- Database (DB);
- Computing core;
- Project;
- Visualization (geographic information system).

Database

It is a subsystem for collection, storage, search and processing of large volumes of information, being an important part of RAKURS software tool. Database contains information on accounting and technical characteristics of frequency assignments, types and technical features of equipment, synchronous digital broadcasting networks etc. During RAKURS development, there was a task to make it extremely flexible, not requiring software modifications when changing initial frequency planning data such as tabulated propagation curves, distribution of services across frequency bands, standards and frequencies of analogue and digital broadcasting, minimum field strength used, protection ratios and coordination distances. Therefore in addition to records on transmitting stations and analogue and digital frequency assignments and allotments, database contains large number of electronic tables with frequency planning parameters. Data in these tables can easily be modified, if necessary.

Main capabilities of RAKURS database:

– Possibility to arrange both multi-user operation with common server and operation at separate working places (PC/notebook).

– Special formats for data exchange between separate working places.

– Possibility to differentiate access to DB in multi-user mode.

– Automatic data checking when entering and correcting accounting and technical characteristics of systems/stations in DB using various libraries.

Computing core

1) Main categories of calculations

– Calculation of field strength for useful and interfering signals in test points;

– Calculation of noise limited vector coverage area (N azimuthal directions in horizontal plane selected with given step) and interference limited service area taking into account interference from all potential sources. Vector calculation is used to obtain operative assessments;

– Calculation of noise limited raster coverage area (multitude of points corresponding to nodes of imaginary grid consisting of latitude and longitude lines drawn with given step) and interference limited service area taking into account interference from all potential sources. Raster calculation is used to obtain more accurate and detailed results (reasonable calculation step is 80 m or more when using topographic relief data for the Russian Federation's territory; calculation step could be substantially smaller for higher resolution map or 3-D city map);

– Calculation of service area modification taking into account changes in electromagnetic environment (addition/modification of interfering signals) compared to reference situation;

– Calculation of service area reduction due to intra-system interference in synchronous single-frequency networks;

– Calculation of population in service areas for individual stations and single-frequency networks based on the available data such as federal and/or regional population census;

– Instant calculation for any location and given project test points. Mapping and storage of detailed calculation results.

2) Calculation procedures and methods

– Possibility to combine propagation prediction models for terrestrial service paths when calculating useful and interfering signals;

– Possibility to insert results of field tests/measurements, analytical processing and consequent modification of some calculation models;

– Automatic generation of test points within given geometric area with the purpose of calculation for certain territory;

– Accounting urban and suburban build-up areas, woodlands and additional local topographical features (if data on underlying surface is available).

3) Implementation of distributed computing:

– Management of distributed computing using PCs of local area network to calculate large number of data sets;

– Management of distributed computing using remote computing center to perform operative calculation of large volume of data;

– Dispatching distributed computing for sharing load between users.

Project

RAKURS offers the possibility to work, storage and upload working environment according to the project concept (similar to the concept of "document" in MS Office Word). Project interface allows forming mathematical model of electromagnetic environment in operative memory of computer and preliminary calculating attenuations for all paths between loaded into project systems and test points that excludes persistent access to DB and substantially speeds up calculations. The project applies module architecture with flexibility for adapting software to various tasks. Detailed information on radio systems (operational and technical and economic characteristics, data on international legal status and so on), calculation parameters and results are stored in special files, excluding need in access to the database. Use of project interface allows quick transferring calculations between different working places and performing calculations on PCs, not connected to the database.

Visualization (implementation of GIS interface)

– Customized GIS graphic user interface, adapted for frequency planning of terrestrial broadcasting and radio communication systems with the possibility to use both vector maps and raster maps or satellite photos, matrices of terrain relief and geophysical data;

– Management of radio system models and radio networks in the project is carried out directly in GIS with reference to locations and mapped calculations results;

– Adjustable use of geophysical base (hydrography, underlying surface, terrain relief).

– Operative switching between mapping of various subbases;

– Synthesis of raster matrices of terrain relief using vector maps;

– Possibility to form coverage areas, settlements and information on settlements covered by broadcasting, and subsequent uploading the data into website using Yandex.Maps background;

– Possibility to use data from OpenStreetMap, Google.Maps, Yandex.Maps cartographic services. RAKURS allows mapping data and results of calculation (coverage areas of individual stations and single-frequency networks, installation sites, measurement locations and etc.) onto satellite photos and maps of the above mentioned cartographic services. This gives an opportunity to associate results of calculation with actual locations even without exact cartographic data;

– Uploading graphic information into Google Earth 3D visualization software (radio systems, settlements, coverage areas).

Radiocommunication services for which EMC calculation methods were implemented:

– BROADCASTING service (TV) in the frequency bands 48.5-56.5 MHz, 58-66 MHz and 76-100 MHz:

  • Analogue TV broadcasting (D/SECAM, PAL, NTSC).

– BROADCASTING service (TV) in the frequency bands 174-230 MHz and 470-862 MHz:

- Analogue TV broadcasting (D, K/SECAM, PAL, NTSC);
- Digital TV broadcasting (DVB-T, DVB-T2, DVB-H).

– LAND MOBILE service in the frequency band 694-862 MHz:

- Mobile radiocommunication of LTE standard.

EMC methodologies, models and criteria

Main used propagation prediction models are based on current versions of ITU Recommendations: statistic model (ITU-R Recommendation P.1546-2 – corresponds to the methodology adopted by RRC-06, and Recommendation P.1546-5); diffraction model for entire path profile (ITU-R Recommendation P.1812 versions 1, 2, 3); modified model of radio-meteorological parameters of atmosphere for the entire territory of the Russian Federation (average radio-refractive index lapse-rate through the lowest 1 km of the atmosphere, sea-level surface refractivity), developed by FSUE NIIR; ITU-R Recommendation P.1147-4 model for calculation of radio systems for long waves and medium waves; and also Okumura-Hata model for calculations in urban environment, Bullington diffraction model, Free Space model for propagation in free space.

Table 5A: Categories and related ITU Recommendations

Category	ITU Recommendations
Definitions and designations	V.431, V.573, BS.638
Broadcasting standards, broadcasting technical characteristics (including minimum and median field strengths, protection ratios)	BS.412, BS.450, BT.470, BS.599, BS.773, BT.417, BT.419, BT.565, BT.655, BS.707, BS.774, BT.804, P.832, SM.851, BT.1206, BT.1368, BT.1700, BT.1701, BT.2033
Prediction propagation method	P.368, P.525, P.1147, P.1546, P.1812, P.2001, Okumura-Hata, Bullington, Free Space

Figure 21A: Generalized block-diagram of RAKURS software tool

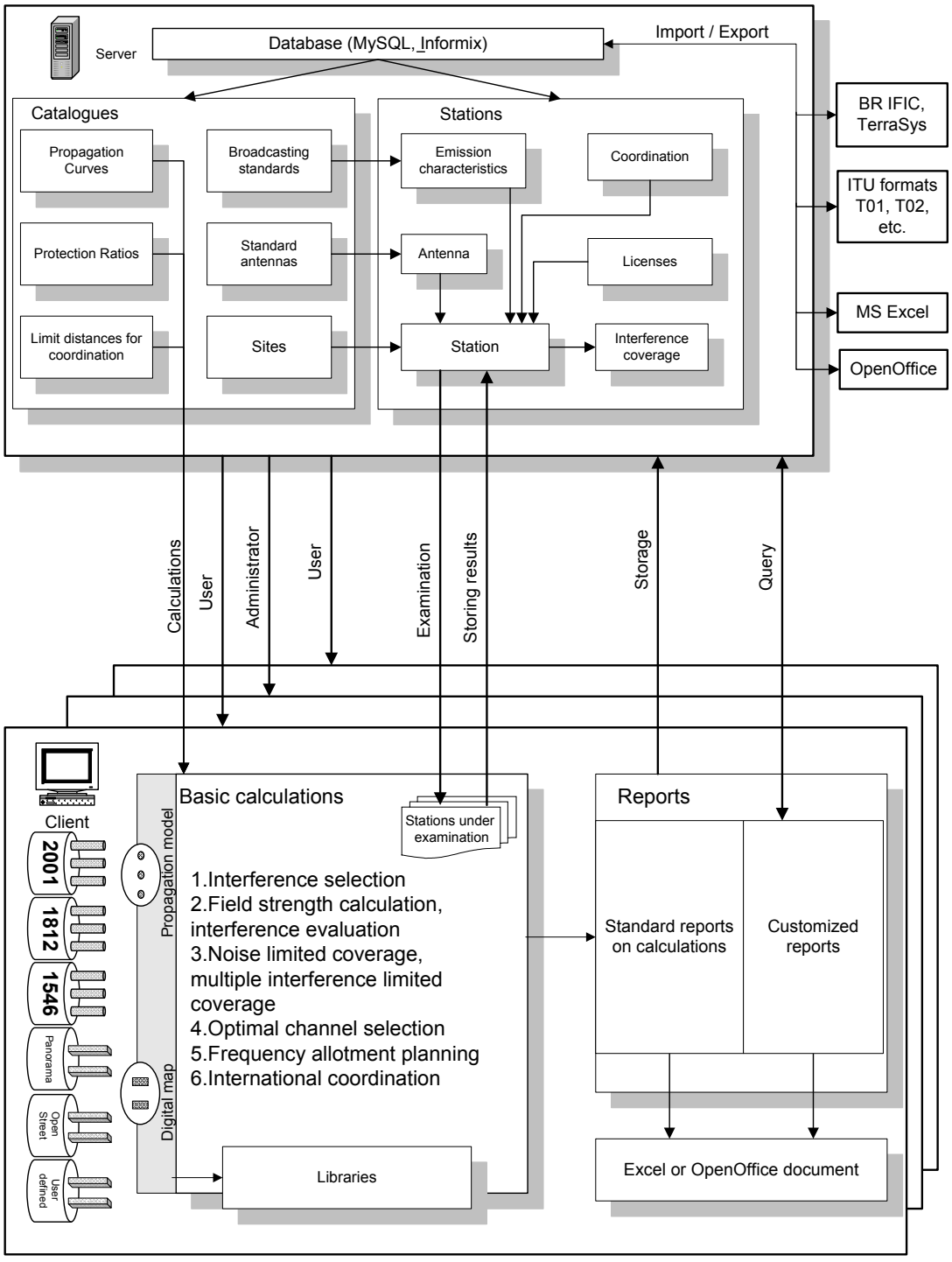


Figure 22A: Frequency situation at border territory of two countries

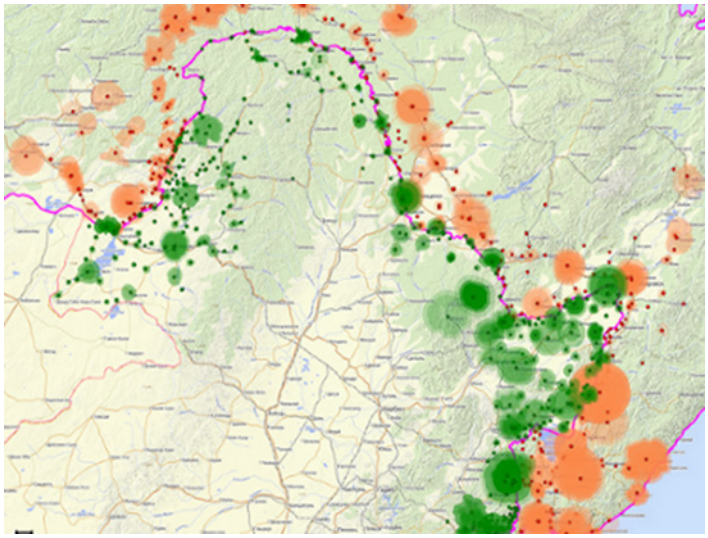


Figure 23A: Coverage of the Russian Federation Region by DTTV programmes

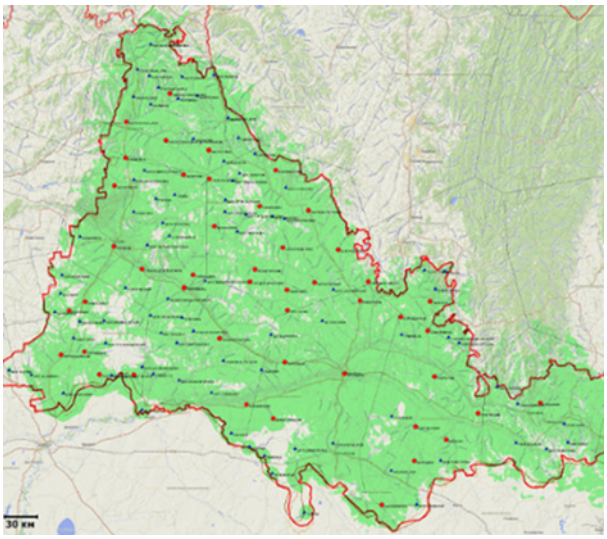


Figure 24A: Calculation of spectrum availability maps

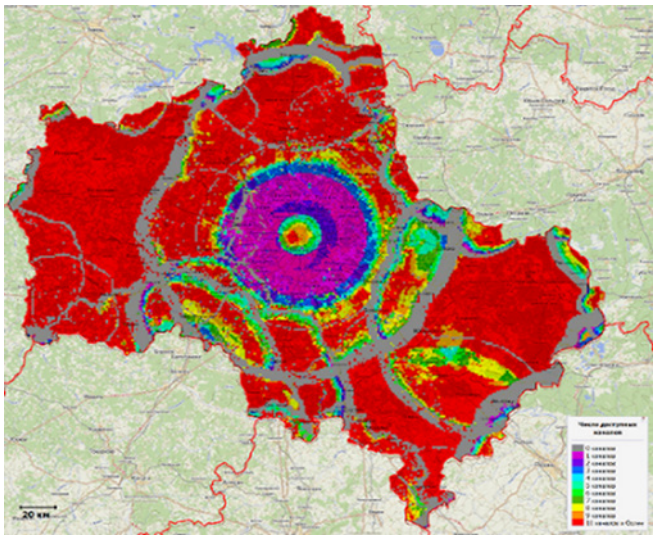


Figure 25A: Service areas of stations with field strength image gradation

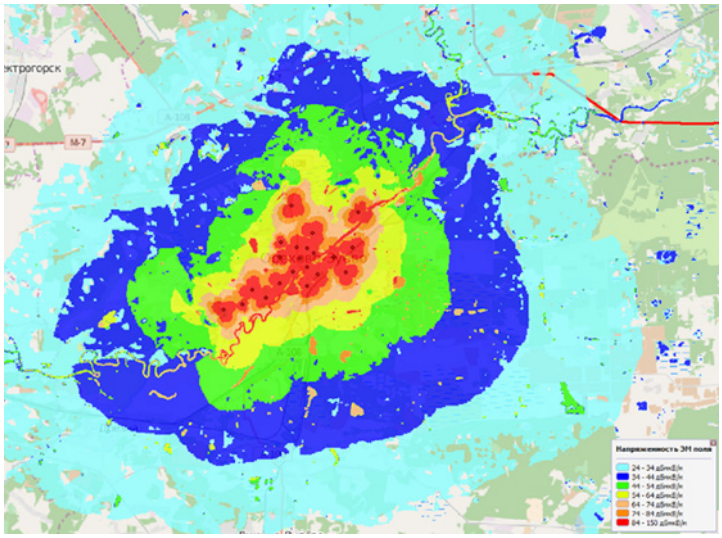


Figure 26A: Virtual LTE network: analysis of the interfering effect on the frequency allotments of neighbouring country

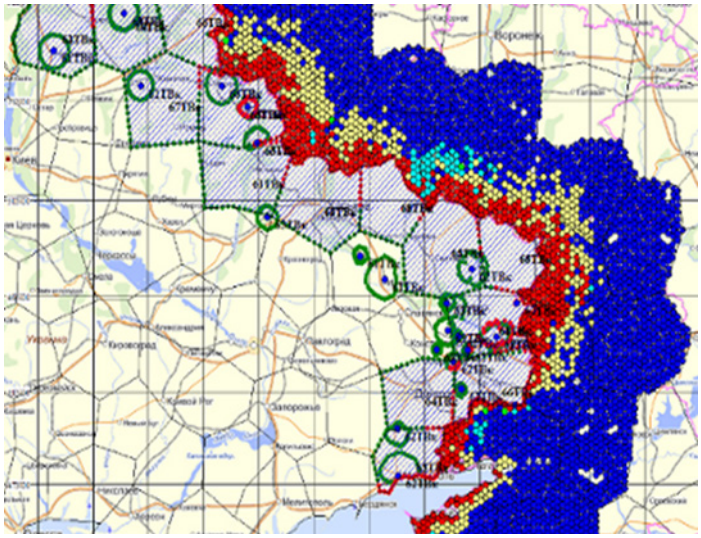


Figure 27A: Calculation of coverage area for DVB-H station in urban environment

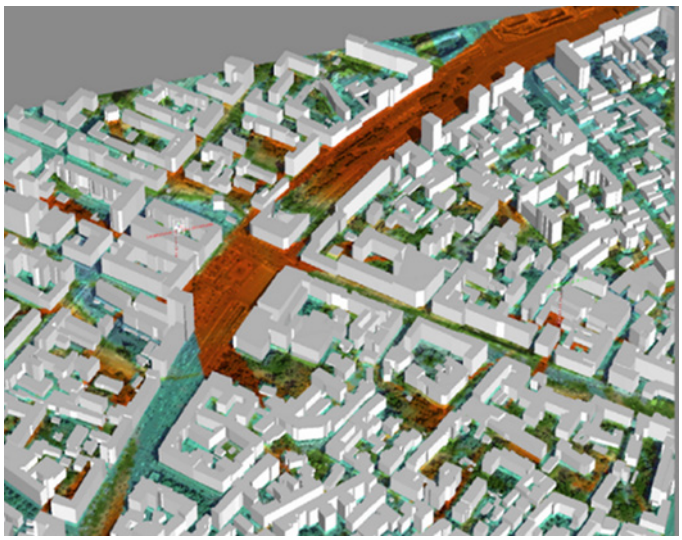


Figure 28A: Coverage areas in best-server mode

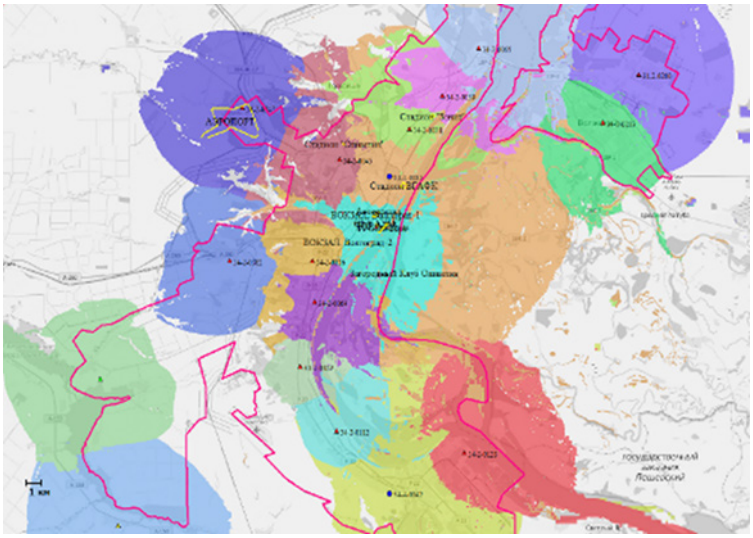


Figure 29A: Calculation of field strength and population in test points, automatically generated within settlement contours

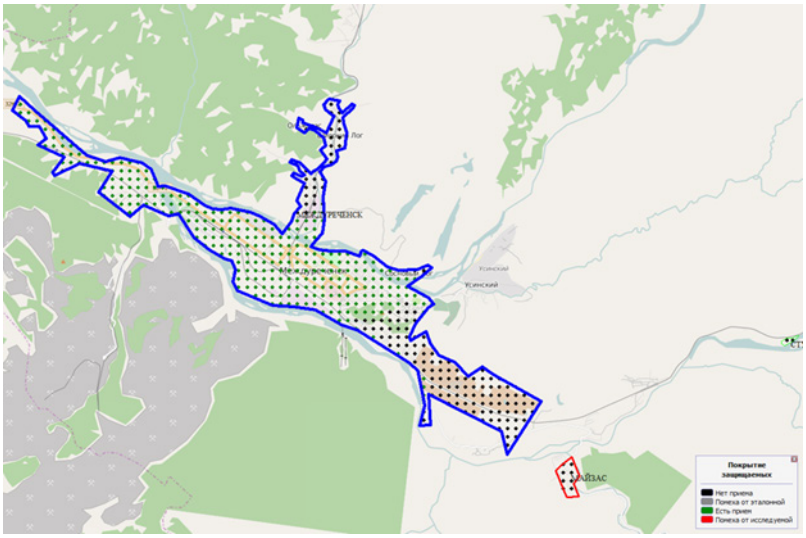


Figure 30A: Snapshot of project

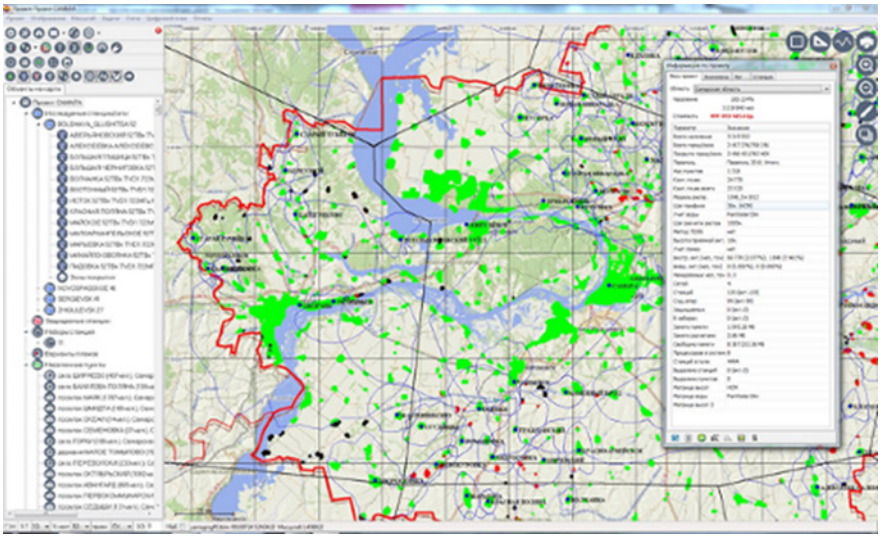
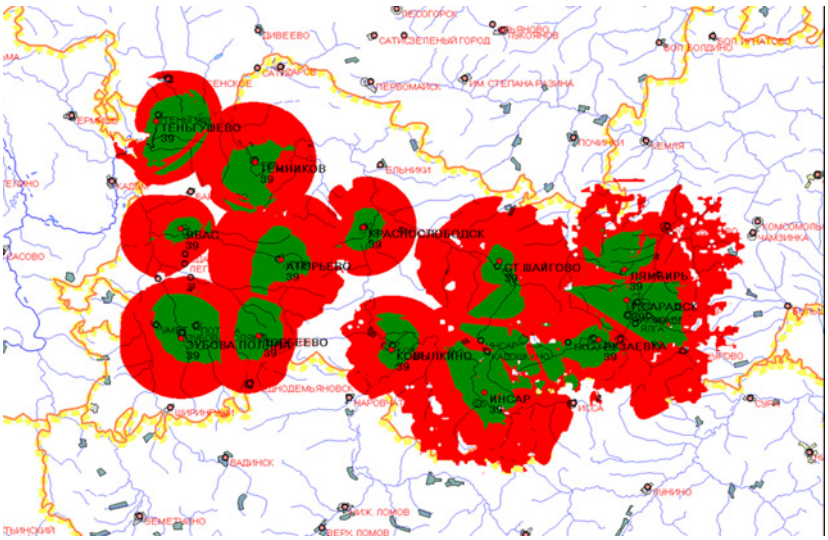


Figure 31A: Calculation of intranet interferences of single-frequency network



Annex 10: Experience in the use of software tools for migration to digital TV in the Russian Federation

The following data refers to **section 1.2.2.3** of this report.

Introduction

Implementation of terrestrial digital TV is the priority governmental task in the Russian Federation. Migration to digital TV in the Russian Federation is carrying out through the Federal Target Program "Development of TV and radio broadcasting in the Russian Federation in 2009-2018", in accordance with the Decree of the Russian Federation Government of 29 August 2015 No 911 "On amending the Decree of the Russian Federation Government No 985 of 3 December, 2009".

The transition to digital TV in the Russian Federation required overcoming a number of challenges that were solved using specialized software tools.

Development of digital frequency allotment plan

Regional Radiocommunication Conference for planning digital terrestrial broadcasting service in parts of Regions 1 and 3 in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06) took place in Geneva, 2006. During the Conference a frequency allotment plan for terrestrial digital TV and sound broadcasting was developed and coordinated between participating countries, which defined the process of migration from analogue to digital television. Development of the frequency plan for a new type of broadcasting service – digital broadcasting, required a long preparation period which proved the need in developing new methodological approaches to frequency planning.

To ensure flexibility of the digital plan implementation, it should be developed based on the new approach – using not only assignments but also using frequency allotments and reference interference sources. Use of frequency allotment contours gave the opportunity to guarantee, in the long term, reception of the given number of multiplex channels in each location of the country, while retaining the flexibility in the selection of the future transmitting network structure.

In addition, development of the digital plan should consider:

- Most rational use of frequency resource which is possible under the given initial conditions.
- Allocation of frequency resource across country's territory according to the strictly specified priority system.
- Flexibility during implementation of the plan in the future for using different types of networks and modes of reception.
- Development of several plan options with different initial conditions for further comparison and selection of the best planning strategy.
- Multiple re-calculation in the case of correction of input data or coordination of the frequency plans during negotiations with neighbouring countries.
- Taking into account all restrictions relating to the incompatibility with analogue TV stations operating during the transition period.
- Taking account of restrictions relating to the incompatibility with assignments of other services.
- Fast development or correction of the plan using minimum computing power, including plan correction directly during the Conference.

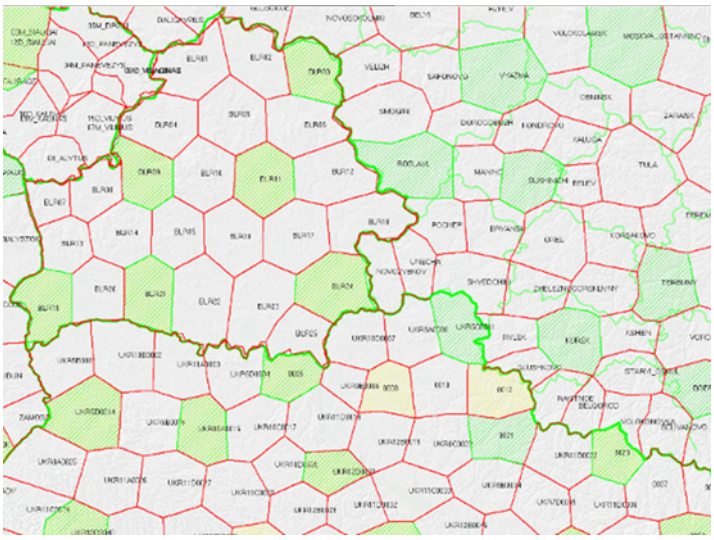
Thus, the task could be resolved only with the help of the profound automation of all preparation processes including consideration of large volume of initial data and criteria for the plan optimization. The RAKURS software tool (Calculation and Analysis Applications for Spectrum Management), designed in

the Russian Federation by specialists of EMC Analysis Center of the Federal State Unitary Enterprise Radio Research and Development Institute (FSUE NIIR CAEMC), become a tool to solve this task.

Using the RAKURS software tool, the whole territory of the Russian Federation and some other countries participating in the planning were divided into regular hexagons. Additionally, a software module was developed allowing arbitrary modification of the allotment contours: add/delete points/edges, create new and delete unnecessary contours, transform allotment shape by dragging polygon vertexes using PC mouse. Frequency allotment contours remain connected and correspond to administrative boundaries and terrain features, and established structure of existing transmitting network.

Special interface was developed to create frequency allotment plans, specifying required channel range, selecting appropriate criterion and starting automatic software for channel selection.

Figure 32A: Interface for frequency allotment planning



The software automatically assessed whether it is possible or not to assign the same channel for two allotments. Additionally during negotiations with the countries in the Regional Commonwealth in the field of communication (RCC) and other neighbouring countries, a huge scope of work was carried out to check and correct data on mutual incompatibility of terrestrial digital broadcasting assignments and allotments. For user convenience, RAKURS software tool contains special interface to announce two allotment contours as “compatible” by clicking them on the screen map. After correcting compatibility data, planning software started again. In some cases, performing only those functions allows taking into account all local conditions of the region and reaching desired number of coverages.

Planning software allows practically on-line re-calculation, observing changes in planning results with the correction of input data. Such approach allowed a great number of successful negotiations, including development of frequency plans for some Administrations in Black Sea Region (Ukraine, Turkey, Bulgaria, Moldova, Georgia and Rumania), coordinated with the frequency plan of Russian Federation.

Using this software tool, frequency plans for RCC countries and a number of neighbouring countries were developed and coordinated. Notices, prepared on the basis of the developed and coordinated plan and submitted by participating countries as input data for the RRC-06, were completely satisfied.

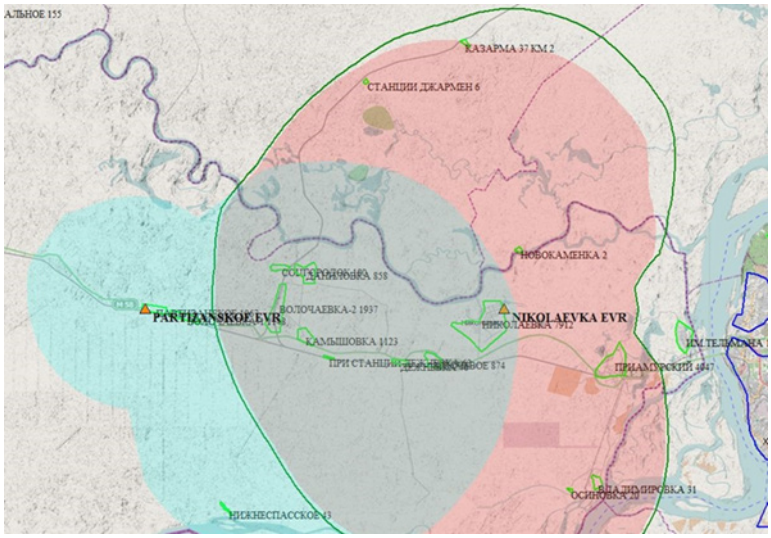
Analysis of compatibility between digital assignments/allotments and analogue TV and other services

When developing the plan for digital frequency allotments, it was necessary to take into account restrictions related to the incompatibility with other services assignments. After analysis of data on

assignments to other primary services, some allotments were “blocked” at certain frequencies, and RAKURS software did not assigned those channels during automatic frequency allocation.

Implementation of GE-06 Plan was gradual and required so-called transition period when analogue and digital broadcasting transmitting stations operate together. During the transition period, the effect of existing and planned stations of terrestrial digital TV broadcasting in neighbouring countries on stations of terrestrial analogue TV broadcasting of the Russian Federation was analysed. RAKURS software tool contains special software allowing calculation of population reduction within service area and service area reduction for existing analogue TV stations in the Russian Federation due to operation of digital TV stations in neighboring countries.

Figure 33A: Service area reduction for analogue TV broadcasting stations



Digital plan implementation

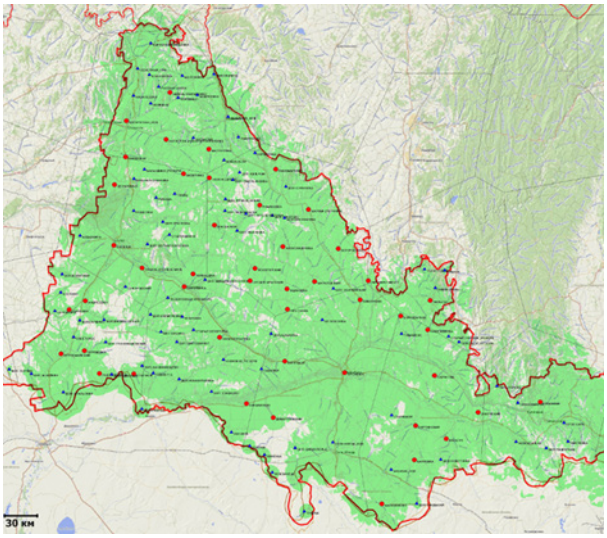
After adoption of Federal Target Program “Development of TV and radio broadcasting in the Russian Federation in 2009-2018”, FSUE NIIR within the Program has completed the whole range of works including Complex Project “Development of Digital Broadcasting in the Russian Federation”, which further became a basis for system projects of regional terrestrial digital TV broadcasting networks. Description of implementation of the Program is in **Chapter 1** of this report.

Within the frames of DTTV network deployment across the territory of the Russian Federation, according to RRC-06 Agreement rules and procedures, the transition from allotment plan to assignment plan (i.e. transition to digital TV stations with specific technical parameters) was implemented.

Optimum selection of TV transmitter sites, specification of their technical parameters, and EMC expert examination both with the existing digital plan and analogue stations in some regions was also implemented using RAKURS software tool.

During the designing stage, the examination was carried out which included identification of parameters for existing and new equipment needed to provide technical support of future DTTV networks under the complex electromagnetic environment and meet requirements on population coverage, quality and availability of broadcasting programs. Networks were designed taking into account specifics of each region: required population coverage (in percent), full or partial influence of existing analogue TV stations.

Figure 34A: Coverage of the Russian Federation region by DTTV programs



In addition, RAKURS software tool contained software module to assess the possibility of converting frequency allotments of GE06 Plan into existing assignments according to provisions of the Agreement without need in coordination, and identification of affected administrations (if any).

Optimization of DTTV broadcasting networks

The basic purpose of the optimization of DTTV system projects is searching for conditions that reduce required capital expenditures for a construction of new transmitting stations and modernization of existing stations while maintaining the population coverage and channel throughput at the required level.

Optimization features:

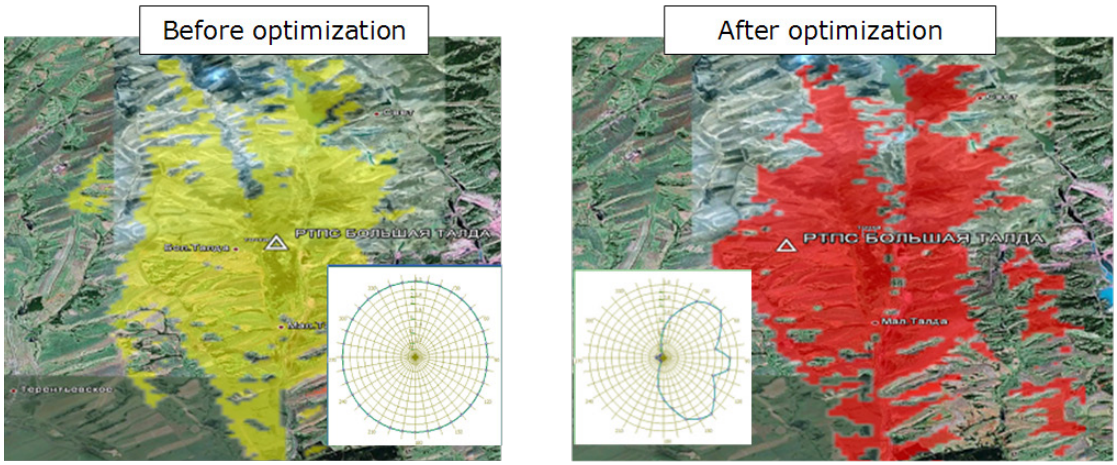
- Large number of stations (up to 500 in one region);
- For many of stations pre-project survey is completed and sites are selected - this limits the opportunity to change their locations;
- Use of detailed information on the population;
- High-accuracy of calculation (calculation step is 300 m);
- Multiple re-calculations due to corrected data from locations;
- Short time for the process.

The optimization is implemented in two modes:

1) Manual mode

RAKURS users could manually modify technical parameters of stations (transmitting power, antenna height, feeder type, antenna radiation pattern), exclude redundant stations from the frequency plan when their coverage areas are entirely covered by a powerful transmitter, correct station locations;

Figure 35A: Effect of optimization procedure



2) Computer-aided mode

Automated selection of station locations and selection of optimum technical parameters of stations. RAKURS software tool generates a list of possible installation sites taking into account infrastructure availability and features of terrain relief, calculates service areas for all the possible installation sites and all possible combinations of heights, powers and antenna systems, and selects the best combination subject to optimum coverage and minimum cost. To perform operative calculations with large volumes of data, RAKURS software tool implemented a procedure for distributed calculations using computing power of local area network or remote computing center.

Implementation of optimization proposals for networks of first multiplex reduced construction costs approximately by 270.4 million rubles.

Use of software tools, particularly RAKURS software tool, provided significant savings in both financial and manpower resources when migrating to digital TV in the Russian Federation. In addition, universal character of the developed software solution facilitated cross-border coordination of frequency planning, and made it possible to use RAKURS software tool by other countries (currently RAKURS software tool is used by Administrations of Republic of Belarus, Republic of Uzbekistan and Republic of Armenia).

Annex 11: DTTV Readiness Kits for low income population in Brazil

The following data refers to **section 1.3.1.1** of this report.

- The Digital TV Converter Box, including accessories, following technical specifications approved by the government or by a group/entity empowered by law/regulations.
- The Digital TV Converter Box specifications should guarantee that the equipment is optimized for coexistence with incoming mobile systems in the Digital Dividend band.
- It is recommended for the Digital TV Converter Box to implement an interactivity middleware and support broadband connectivity either by wireline or wireless networks.
- Receiving System (antenna), including necessary accessories.
- The receiving system can be composed of outside or indoor antenna, with the following remarks:
    - For external antennas, the kit should include a stand that allows the attachment to a wall or the floor (including necessary screws and accessories) and a certified drop cable RG 59 with a minimum length of 15 m, with an F crimp connector on one F threaded end and a connector at the other end. An identification label should also be included to connect the crimped connector on the external antenna;
    - For internal antenna, a coaxial cable should be used with a minimum length of 1.5 m with an F crimp connector.
- To ensure the best reception condition specifically aimed at coexistence with mobile broadband networks (LTE, for example), it is recommended to distribute and install external antennas.
- Distribution of internal antennas should be carefully investigated, since it has a lower cost (due to size) and provides a much simpler installation, however their use is restricted to a limited geographical area in which stable reception of all channels is guaranteed.

The antenna type to be delivered needs to take into account the municipalities involved in each phase of the ASO schedule. The type of antennas can be UHF only (U) or VHF + UHF (V+U). It is recommended to also consider the VHF band for the receiver base when the following situations occur:

- The national spectrum allotment plans indicate that there are planned digital channels in the VHF band.
- There are digital channels operating in the VHF band in the specific region where low income families entitled to receive a DTTB readiness kit reside.

There is no technical feasibility for adding new channels in the UHF band to meet specific provisions of countries' regulations, such as the provision of public/state broadcasting channels.

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