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PARTICULARITIES OF THE IMPLEMENTATION OF TERRESTRIAL DIGITAL TELEVISION IN THE REPUBLIC OF MOLDOVA

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Abstract. This article provides a brief overview of stages of digital terrestrial broadcasting implementation in the Republic of Moldova. In 2015 Î.S. "Radiocommunications" built the first national multiplex MUX-A, which later in 2016 was put into operation. The mentioned multiplex provides with the DVB-T2 signal 6 national coverage areas located throughout the country. For the broadcasting of digital terrestrial television signals in the Republic of Moldova, there have been allocated the channels previously intended for analog terrestrial television, with a bandwidth of 8 MHz. Currently, television broadcasting is in Simulcast mode, when both analog and digital transmitters are working at the same time. As of September 1, 2019, 98% of the country's population has access to the DVB-T2 signal.

Keywords: *DVB, DVB-T2, Digital dividend, digital terrestrial network, SFN, Head End, T2 Gateway, multiplex.*

Introduction

The contemporary period is characterized by the advanced development of digital technologies for signal processing and transmission, their integration with communication and multimedia technologies. This phenomenon is caused by the emergence of new technological systems and new services that become increasingly intelligent. Globally, the end of the last millennium was marked by the beginning of transition to the digital television with the set standards adoption for different TV transmission systems. The implementation of digital technologies has significantly reduced the number of TV programs in analog format, and will lead to their disappearance in the near future.

The advantages of digital television systems over analog television are undeniable:

- The radio frequency spectrum is much more efficiently managed, because many audiovisual services can be transmitted in the frequency band of a single channel;
- Digital image quality is better, because the signal is resistant to interference and noise.

- The viewer can receive additional information - such as the EPG table (Electronic Program Guide);
- There is an opportunity to receive additional facilities like support and titles in different languages, etc.

Currently in the world, several digital television systems are put into operation, such as:

- DVB (Digital Video Broadcasting) [1], – is a system implemented in the countries of the European Union, Russia, Australia, Ukraine, the Republic of Moldova, in most African countries;
- ATSC (Advanced Television Systems Committee) [2] – is a system implemented in the United States, Canada, Mexico, Argentina, Taiwan and South Korea;
- ISDB (Integrated Services Digital Broadcasting) [3] – is a system implemented in Japan, South America and other countries of the world;
- DMB (Digital Multimedia Broadcasting) [4] – is a system implemented in China, Cuba, Hong Kong and other countries.

DVB - is a set of standards in digital television, developed by an international consortium operating under the name DVB Project, today, consisting of about 300 companies from 35 countries. These standards are known as:

- DVB-T, DVB-T2 - terrestrial broadcast;
- DVB-H, DVB-SH, DVB-H2 - for portable devices;
- DVB-S, DVB-S2, DVB-S2X - satellite transmission;
- DVB-C, DVB-C2 - cable transmission.

DVB-T [5, 6] and DVB-T2 [7, 8] (Digital Video Broadcasting - Terrestrial) systems, offer technical solutions for various applications in the field of digital terrestrial television. The implementation of these technologies has allowed the reorganization of the radio spectrum previously intended for analog terrestrial television, releasing the top of the spectrum (694-790MHz and 790-862 MHz) for other new telecommunications services. According to statistics on the distribution of digital terrestrial television standards, DVB-T and DVB-T2 are prevailing in the world, see Figure 1.

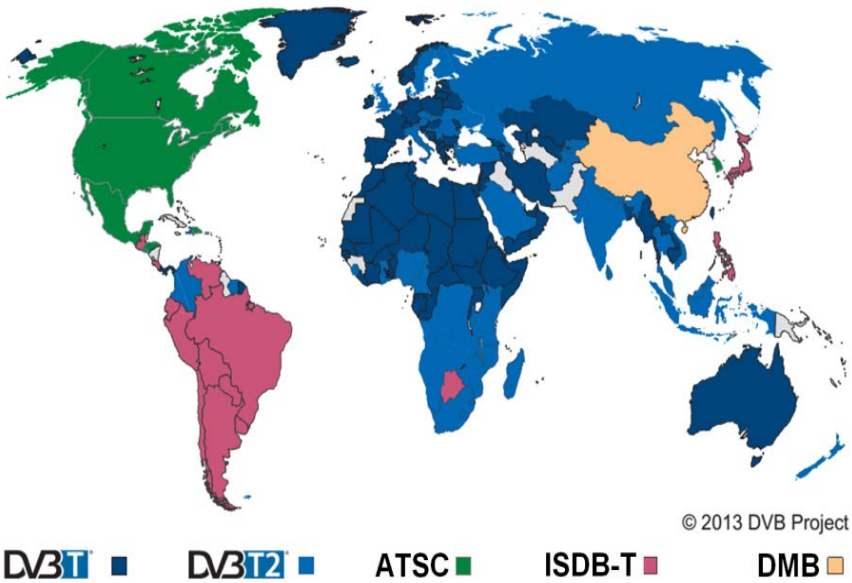

Figure 1. Distribution of digital terrestrial standards in the world.

Due to geographical location of the Republic of Moldova, currently are used DVB-T and DVB-T2 standards. In the near future, will be used only the DVB-T2 system.

Distribution of the radio spectrum

In 2006 in Geneva, under the auspices of ITU (International Telecommunication Union), was held the Regional Radiocommunication Conference (RRC-06) on the digital terrestrial broadcasting service planning. According to the provisions of the Regional Agreement, signed under RRC-06, since June 17, 2015, the Republic of Moldova has assumed responsibility for the implementation of digital terrestrial television. Also, in RRC-06 it was adopted a new frequency plan, which defined the use of bands III (VHF - 174-230 MHz) and IV / V (UHF - 470-862 MHz) for digital terrestrial transmission. According to the final documents RRC-06, the territory of the Republic of Moldova was divided into 6 national areas, see Figure 2.

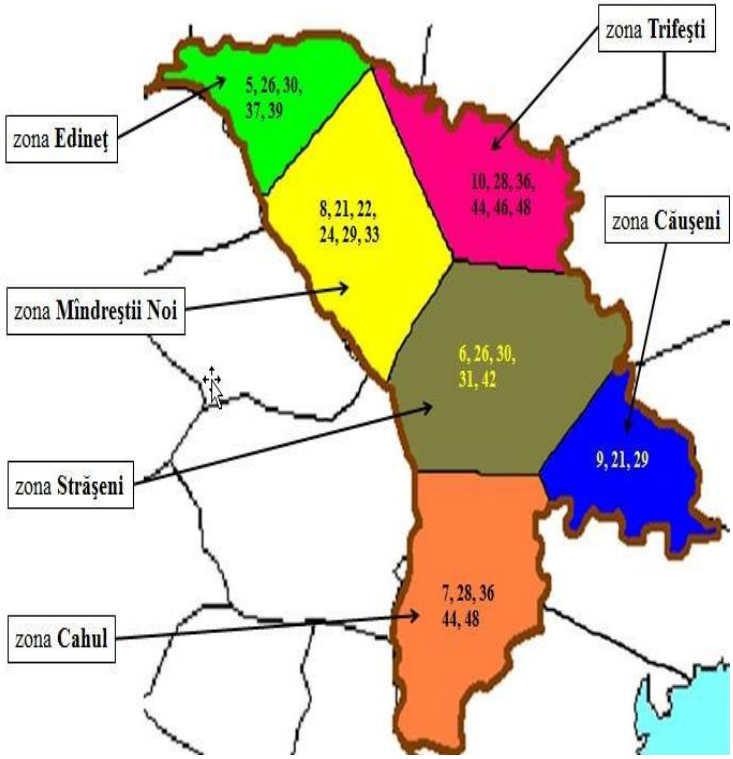

Figure 2. Location of national digital terrestrial television areas in the Republic of Moldova.

Initially, for each national area there were allocated 6 channels (by total 36 channels / frequencies). Also, the territory of the Republic of Moldova was divided into 12 regions to which were allocated 26 channels / frequencies.

By the Decision of the Republic of Moldova Government no. 116 of 11 February 2013 the spectrum 790-862 MHz (channels 61-69), also called the "Digital dividend-1", was transmitted to the management of mobile operators. At the World Radio Conference, held in Geneva in 2012, it was recommended to examine the possibility of using the band 694-790 MHz (channels 49-60), the so-called "Digital dividend-2", for mobile electronic communications services.

Taking into account the "Digital Dividend-1" and the "Digital Dividend-2", in the Republic of Moldova 3 digital terrestrial multiplexes with national coverage can be built (2

multiplexes in UHF band and 1 multiplex in VHF band), as well as 21 regional digital terrestrial multiplexes.

For the broadcasting of digital terrestrial television signals in the Republic of Moldova, there have been allocated the channels previously intended for analog terrestrial television, with a bandwidth of 8 MHz.

Currently, Republic of Moldova is going through a transition period in which coexist both TV networks broadcasting signals, analog and digital. Since June 17, 2015, analog television channels have no protection in case of disturbances caused by digital television channels.

Coding and multiplexing of audiovisual content from the input of digital television system

The final destination of DVB-T, DVB-T2 digital television systems is to transmit more services in the frequency band to a TV channel (TV programs, RD programs, teletext, EPG table, etc.). To achieve this purpose it is necessary to perform the procedure of encoding (compressing) the audiovisual content at the input of the system and its subsequent multiplexing. The functional scheme of the coding and multiplexing station of digital television signals is demonstrated in Figure 3. In the first stage it is performed the encoding of the digitized audiovisual content, then are made two levels of multiplexing. At the first level the component parts of a service are multiplexed (Program multiplexer). The second level of multiplexing involves the multiplexing of components that refer to different services (Transport multiplexer).

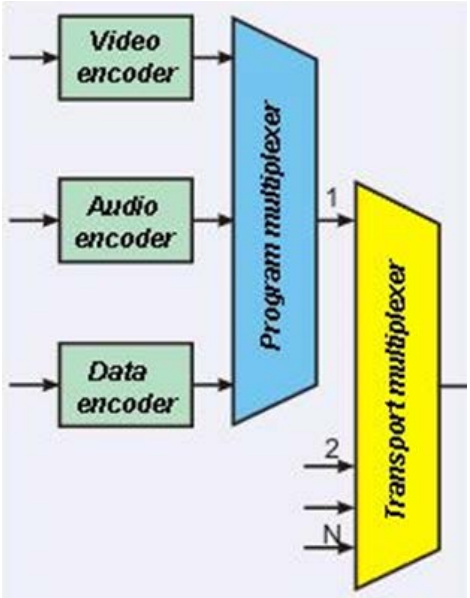

Figure 3. Functional diagram of the encoding and multiplexing station of digital signals.

The coding and multiplexing station is defined by the name "Head End" and is the central part of any digital television system. At the output of the "Head End" station, is obtained the packaged digital stream, which is transmitted to the inputs of the DVB-T2 transmitters of the digital terrestrial network (according to the system specifications).

The implementation of digital television systems is possible only with using in conjunction technologies for encoding (compressing) of digitized audiovisual content [9].

The string of digital signal encoding standards is known as MPEG (Moving Pictures Experts Group). Currently in the world there are two standards of digital video compression that are widely used: H.262 / MPEG-2 [10] and H.264 AVC / MPEG-4 [11]. The H.265 HEVC / MPEG-H standard [12] has also recently been developed, which contains some undeniable advantages in terms of system capacity.

This standard is already beginning to be implemented in many countries around the world. It should also be noted that the Audio signal in DVB-T, DVB-T2 systems is encoded according to the MPEG-1 Audio Layer II [13].

In 2003 S.E. «Radiocommunications» (the national operator in the field of terrestrial broadcasting) put into operation the first "Head End" station of H.262 type, which with the DVB-T system provided digital terrestrial television services in Chisinau for 8 years. At the beginning of 2011, the H.264 type encoders were put into operation, which today are still in operation, providing with digital signal 2 stations from Chisinau and at the same time the first national digital terrestrial television multiplex. In 2017, the company's specialists performed technical tests of H.265 encoders in order to apply, in the near future. This modern technology stay to the formation of national digital television multiplexes. The real tests, which were carried out in Chisinau on 58 channel, demonstrated the efficiency of the new compression technology. The capacities of the H.264 and H.265 compression systems (for a Video signal), obtained following the tests performed by the S.E. «Radiocommunications» in the years 2016-2017 are presented in Figure 4.

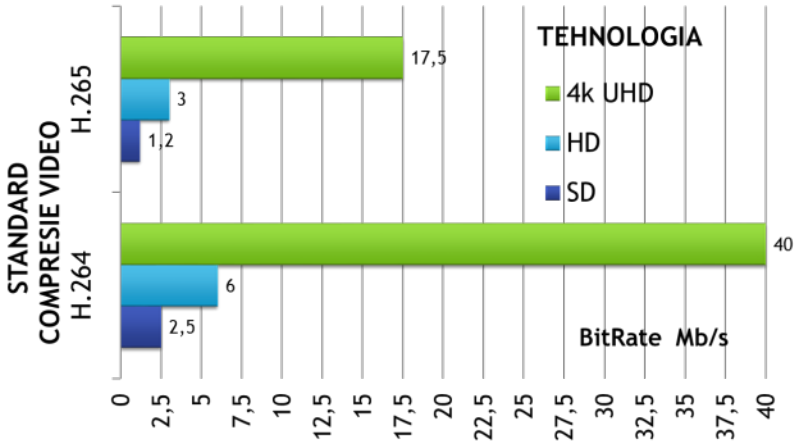

Figure 4. Compression capabilities of H.264 and H.265 systems.

Based on the arguments presented to the Ministry of Information Technology and Communications, by Government Decision no. 52 of 01.02.2017, [18] H.264 and H.265 technologies were approved as national compression standards. In order to make optimal use of the radio spectrum, in a perspective for the Republic of Moldova is provided the migration from the H.264 coding system to the H.265.

DVB-T2 digital terrestrial broadcasting system

The DVB-T2 system can work in the composition of traditional terrestrial networks MFN (Multi Frequency Network) and also in the composition of synchronous networks SFN (Single Frequency Network). At the same time, the flexibility of the DVB-T2 standard [1]

allows the implementation of digital terrestrial networks on the existing infrastructure of terrestrial networks.

A terrestrial broadcasting network with a single SFN frequency consists of a group of transmitters that simultaneously transmit the same signal, on the same carrier frequency, without essentially interfering with each other and at the same time forming the same service area. The important advantages of SFN networks, compared to traditional MFN broadcasting networks, are the following:

- Efficient use of radio frequency spectrum;
- Significant reduction of the shadow areas in the service area;
- More uniform distribution of field strength within the service area, etc.

The implementation of SFN technology is facilitated by the method of modulation with orthogonal frequency division, the so-called COFDM (Coded Orthogonal Frequency Division Multiplexing), which, under certain conditions, ensures signal decoding when several useful radio signals arrive at the receiving point.

The DVB-T2 system provides two modes of operation [14]. The first is called "System A." In this mode, the transport stream from the output of the coding and multiplexing station is fed directly to the input of the modulator. This mode does not provide for the deployment of SFNs.

The second operating mode - "System B", is intended for the deployment of single-frequency networks and provides for the separation processing of input streams between the "T2 Gatway" gateway and the network modulators, see Figure 5. In this case, the logical streams from the output of the coding and multiplexing station are preliminarily fed to the inputs of the physical channels of the the "T2 Gatway" station.

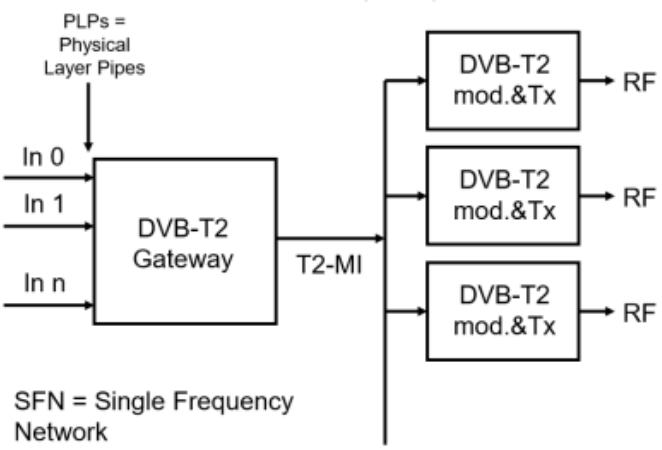

Figure 5. Structure of SFN DVB-T2 cluster.

Thus, the transmitting part of the DVB-T2 SFN network consists of 3 basic elements: an audio-visual content encoding and multiplexing station; gateway "T2 Gateway"; and a group of DVB-T2 transmitters. The first two elements form the so-called “Head End” central station.

At the design stage of terrestrial digital broadcasting networks in the Republic of Moldova, it was decided that during the construction of multiplexes with national coverage, to provide coverage with a DVB-T2 signal to each of the national zones by deploying single-frequency clusters. In this case, 6 channels are needed for the implementation of multiplex with national coverage, see Figure 1.

Implementation of the pilot project

Starting with 2003, in Chisinau, the works were initiated for implementation of the pilot project of digital terrestrial broadcasting.

Currently in Chisinau, under test mode, there are 2 digital transmitters, DVB-T and DVB-T2 that broadcast digital packages with TV and RD programs on 56 and 58 channels. These transmitters operate in "System A" mode and are installed at the Central Signal Processing and Distribution Station (SCPDS) where are located the "Head End" station and the set of equipment (encoders, multiplexers, switches, etc.). The digital packets compressed in MPEG 4 format and later multiplexed, are applied to the input of DVB-T and DVBT2 transmitters, which operate on an antenna through a special adder.

The operation of digital transmitters DVB-T (56 channel) and DVB-T2 (58 channel) ensures a coverage area of Chisinau with the digital television of approx. 30 km. TV programs are broadcast with standard image resolution (SD).

Implementation of the first national Mux-A multiplex

In 2015 S.E. «Radiocommunications» built the first national MUX-A multiplex, which in 2016 was put into operation, based on the H.264 AVC / MPEG-4 encoding system. DVB-T2 technology was adopted in the Republic of Moldova as a standard for the deployment of national digital multiplexes. In order to optimize resources (rational use of the radio spectrum, use of existing infrastructure, reduction of the shadow area zones), it was decided to build single-frequency clusters, within the service areas. To accomplish this task, at the Head End station was installed a T2 Gatway, from the output of which T2-MI interface packets are fed through the ground distribution network to the inputs of 17 transmitters mounted on the technological areas of the existing infrastructure of the enterprise. Service areas were formed by setting carrier frequencies in transmitter modulators. All other configuration parameters of the clusters have been configured in the T2 Gatway device. Thus, using one T2 gateway and 17 high and medium power transmitters, were created 6 single frequency service areas. The configuration of the Mux-A (6 SFN clusters) configuration parameters was done by using the “T2 Gateway” menu options, see Figures 6-9. In general terms, the SFN DVB-T2 network configuration is divided into the following 4 groups: *setting the system operation modes; setting up network operation modes; configuring DVB-T2 frame resources; setting PLP parameters.*

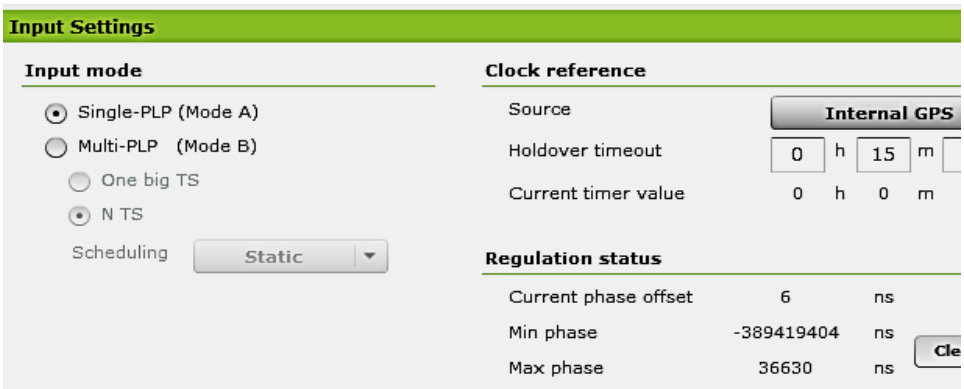

Figure 6. Menu "T2 Gateway": Option - Input Settings.

The coverage map of the first national Mux-A multiplex is shown in Figure 10. Currently, the multiplex has 17 high and medium power transmitters.

This provides access to the DVB-T2 signal for 95% of the country's population.

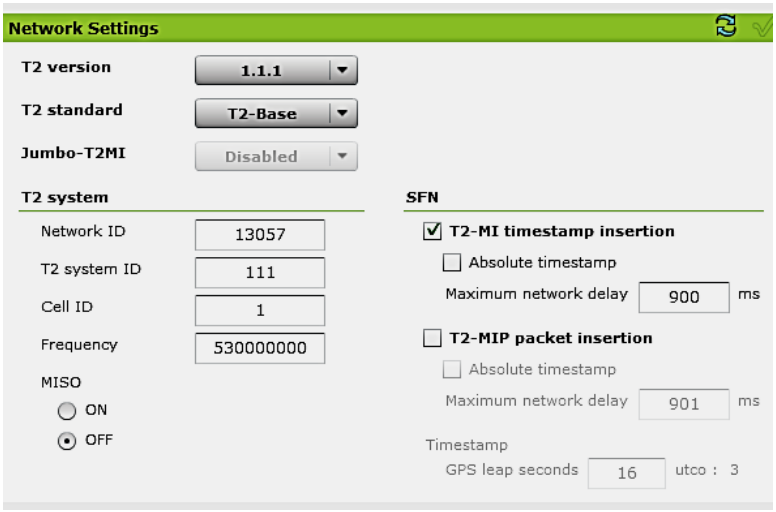

Figure 7. Menu "T2 Gateway": Option - Network Settings.

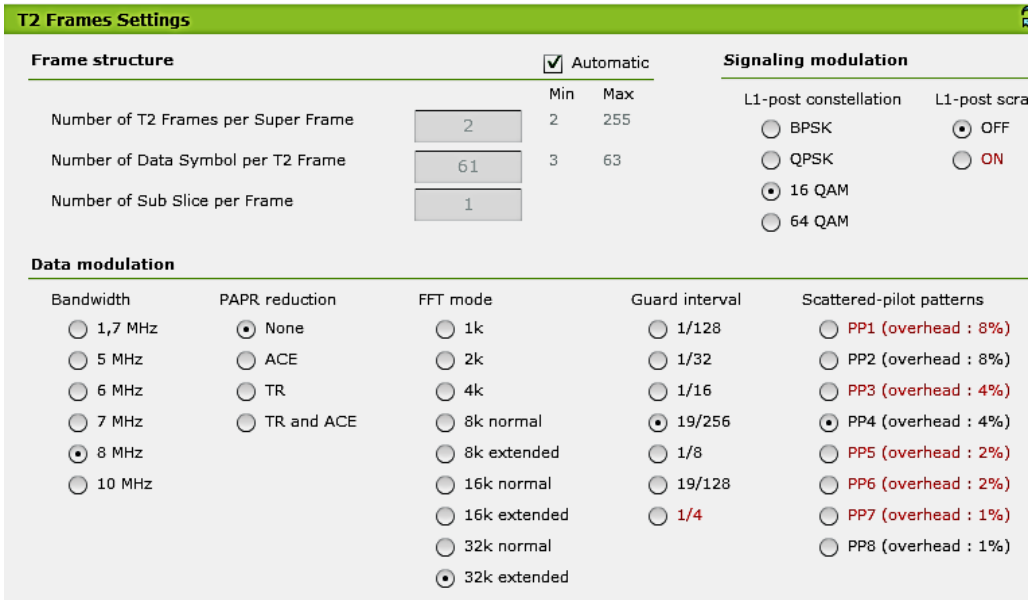

Figure 8. Menu "T2 Gateway": Option - T2 Frames Settings.

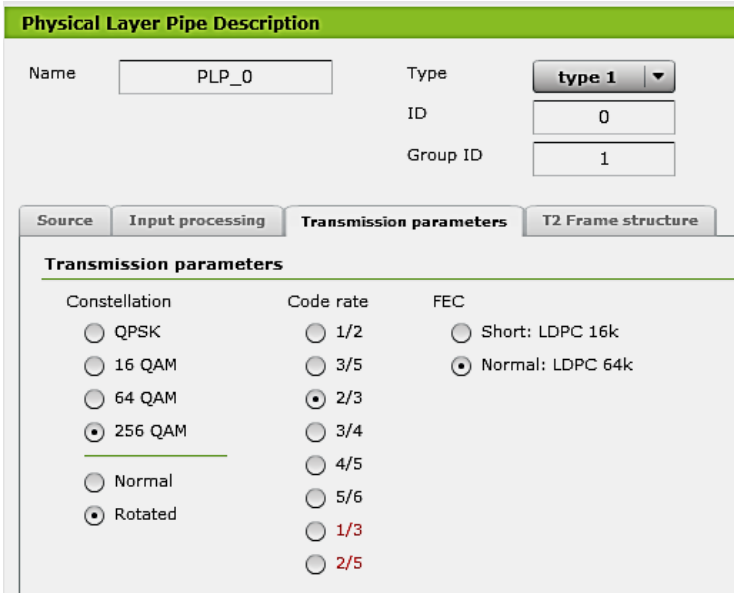

Figure 9. Menu "T2 Gateway": Option - Physical Layer Pipe Description/Transmission parameters.

At the same time, after disconnecting the analog broadcasting network, a number of technical measures will be carried out aimed at increasing the percentage of population coverage with a signal. For this purpose, it is planned to install about 60 low-power transmitters in the shadow zones located along of the Prut and Dniester rivers. This measure will increase the coverage of the population with the signal of the first national multiplex to 99%, see Figure 11. At the same time, it was decided to use the infrastructure of fiber-optic networks for transporting traffic flow to the input of low-power transmitters deployed in shadow zones, access to which in the Republic of Moldova is available in almost every locality.

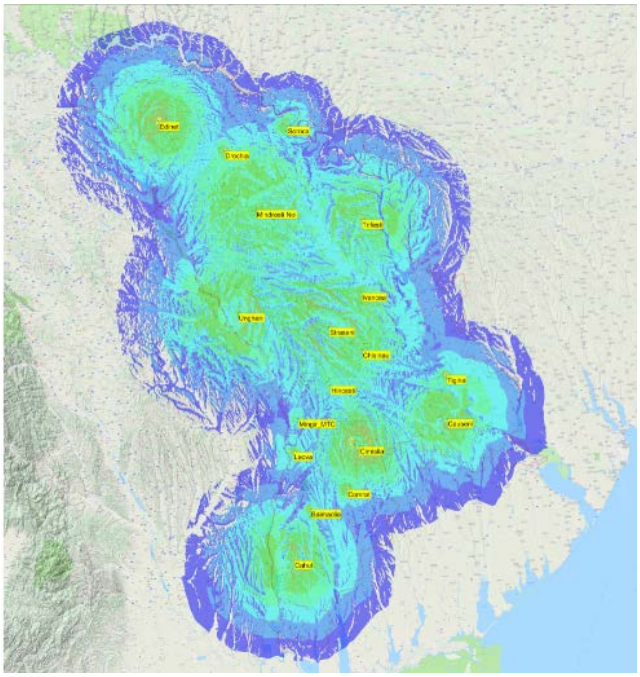

Figure 10. Mux-A coverage map in the transition regime (Simulcast).

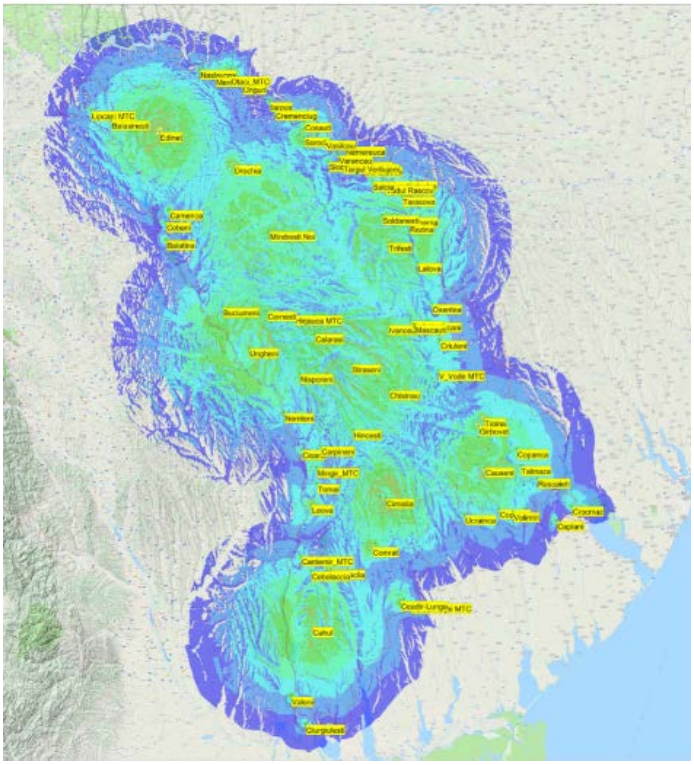

Figure 11. Mux-A coverage map after stopping analog television broadcasts.

Construction of the second national multiplex Mux-B

In 2016, S.E. «Radiocommunication» built the second national multiplex MUX-B which is ready to be put into operation, after stopping broadcasting of the national analog terrestrial television networks.

Conclusions

1. Currently, the Republic of Moldova is going through a transition period in which both TV networks coexist, analog and digital signals. At the same time, based on the fact that a large part of the population in rural areas does not have DVB-T2 converters, the transmission of television signals in analog format remains current.

2. Starting with 2003 in Chisinau, under test mode, there are 2 digital transmitters, DVB-T and DVB-T2, that broadcast digital packages with TV and RD programs on 56 and 58 channels.

3. Starting with 2016 in the Republic of Moldova the first national multiplex of digital television Mux-A (UHF range) was put into operation. At the same time, it has been built and is ready to be put into operation the second national multiplex Mux-B (UHF range).

4. Despite the fact that the transition to digital terrestrial television is slow, from a technological and legislative point of view, the Republic of Moldova is aligned with the latest standards.

5. The decision on the licensing and implementation of the national Mux-C multiplex (VHF range) and regional multiplexes will be able to be taken by the country's regulatory bodies after the stopping of analogue television networks and depending on the requests of national, regional and local operators.

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