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DIGITAL SWITCHOVER STRATEGY OF MONTENEGRO

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1. INTRODUCTION

The development of analogue colour television started in mid twentieth century. The upward trend of this technology has been present for over fifty years now and we can say that it is now at its peak when it comes to reliability, quality and simplicity of its implementation. All of these reasons have led to rapid development of broadcast media, which created a greater demand for more space in the frequency spectrum. In our country, this trend has culminated in the last ten years making the scarcity of this resource increasingly more evident.

Nowadays, we can say that the analogue television has used up almost the entire frequency resource allocated for this purpose by the Radio Frequency Assignment Plan in Montenegro (174-223 MHz and 470-862 MHz). The same problem is also present in other parts of Europe. The need for new frequency allocations has a growing tendency and the change of technologies seems as the only solution. Over the last two decades, the increasing presence of digital technology is more evident in the broadcasting industry. There is an apparent difference between these technologies and, as a rule, they both have certain advantages and disadvantages.

The reasons for digital switchover of television are manifold: higher quality picture, higher resistance to interferences, better utilisation of the radio-frequency spectrum, better possibilities for signal processing, interactivity, and many others. Something similar holds true for the digitalisation of the sound transmission system – radio.

Although the activities related to the digital switchover of television began back in 1991, it was only by the end of the decade that the technological and financial conditions for the introduction of digital television (hereinafter: DTV) for everyday use were met. Through the *DVB Project*, a consortium of over 270 companies and institutions involved in the television industry, Europe has created an open standard for DTV accepted by most countries in the world.

Over the past several years, there is a trend of accelerated switchover from analogue to digital broadcasting systems in the developed countries. International organisations involved in all aspects of broadcasting are the main initiators of the transition, while the International Telecommunication Union and European Union have adopted the deadlines for the final switchover.

The aim of the European Union Member States is a fast transition to digital broadcasting systems, resulting in more space in the frequency spectrum and creating possibilities for its further rational use. The i2020 initiative of the European Commission[1] is a vision of joint and coordinated elimination of limitations related to the spectrum use in all Member States, aimed at the promotion of open and competitive economy. Direct advantages are primarily offered to the citizens who will have faster access to new technologies and pay lower prices for communication services.

Given that modern society relies ever more heavily on advanced electronic communications, the need for radio-frequencies is in high and constant demand. The use of frequency spectrum is present, in different forms, in our daily life, ranging from the use of mobile telephones, wireless Internet access, to broadcasting services. In order to introduce new and competitive services, taking into account the scarcity of available frequency spectrum, the switchover to digital broadcasting systems is deemed a necessary and logical solution.

Advantages offered by radio communications, technological development and convergence of services create a dynamic environment, wherein the radio-frequency spectrum is becoming more attractive resource due to its propagation features and width. Higher efficiency of spectrum use and

[1] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - "i2010 – A European Information Society for growth and employment" .

implementation of the European Union objectives in the area of market development, fostering competition and innovation can be achieved only by introducing digital systems.

1.1 Purpose of the Strategy

The Digital Switchover Strategy is a document intended for the general public: citizens as the end users of the new services, industry, network operators, content providers, public authorities and institutions of Montenegro, as well as to all other stakeholders which will be involved in any way, either actively or passively, directly or indirectly, in the switchover process. Thus, the Strategy aims to investigate the starting points, the opportunities and future challenges and offer sustainable solutions for the Montenegrin society.

The Strategy is based on the following principles stipulating the relations, rights and obligations in the broadcasting sector:

1) freedom, professionalism and independence of broadcast media;
2) prohibition of all forms of censorship or unlawful interference in the work of the broadcast media;
3) balanced development of public and commercial broadcast services;
4) rational and efficient use of broadcasting frequencies as a limited natural resource;
5) free and equitable access of broadcasters to the telecommunication infrastructure for the purposes of broadcasting;
6) development of competition and pluralism in broadcasting;
7) application of international standards and principles relating to broadcasting;
8) objectivity, non-discrimination and transparency in allocating broadcasting frequencies.

The Strategy aims to provide guidelines, propose concrete solutions, inform and prepare all relevant stakeholders involved in the switchover process for efficient implementation in the shortest time possible.

While drafting this Strategy, the compatibility with the digital plans for broadcasting systems of neighbouring countries was taken into account, as well as the timeframe for their switchover.

1.2 Advantages and Reasons for Introducing Digital Broadcasting Systems

Digitalization as the next phase of broadcasting development is unavoidable, given the unstoppable tendency of general convergence of services. In technology, this trend is generally known as technological convergence.

This trend included the terrestrial broadcasting in the 1990s, while satellite broadcasting services were included in the digitalization even before that time. It is safe to say that this process was initiated by the rapid technological development in the compression of audio and video signal. The year 1992 is taken as the beginning of this process, when the first video compression standard, MPEG-1, was created. Its main purpose was to log video and audio files and it was never used for compression of signals for broadcasting purposes. The main reason for that is probably the fact that the chosen image resolution (352x288) was of very poor quality for broadcasting purposes.

As a result of the work on removing deficiencies of the MPEG-1 standard, a new video compression standard, MPEG-2, was introduced in 1993, sharing all good solutions with its predecessor, and introducing some new ones, which resulted in its application in the broadcasting field. Today, this standard is used as the base signal in digital broadcasting.

The MPEG-2 standard is very flexible concerning the bit rate i.e. the quality of the encoded signal. It supports encoding of both the standard digital television (SDTV, 720x576 resolution, 4-6 Mbps bit rate) and the high definition television (HDTV, bit rate over 20 Mbps) as the television of future. In addition to

these standards that have already found its application in practice, the work on improvement of other standards enabling undisturbed development of the digital television continued.

Contemporary user's strive for interactivity resulted in 1999 in the MPEG-4 standard which is, as opposed to the previous one, programmable i.e. adaptable to the user. Its packages are identical to the IP packages, making it easy for the transmission over the IP networks, which is a great advantage over its predecessor given the general tendency of telecommunication networks towards Internet Protocol. Hence, its application exceeds the limit of broadcasting to the Internet and interactive multimedia on PC.

Internationally, there is also a great demand for additional or accompanying contents broadcast together with the television programme, making it more accessible to the viewer. As a result, MPEG-7 standard was created in 2001, which will be used in future in the MHP (***M****ultimedia* ***H****ome* ***P****latform*) settop box. The most recent tendency is to integrate all the above standards into the standard of the future. This latest standard is called MPEG-12 and its unfinished versions have been available since 2003.

The introduction of digital broadcasting will probably have a far-reaching effect on mass communications, as it will completely change and improve the delivery of television and interactive services and result in great increase of the number of available channels. Digital technology will not only increase the choice, quality and control of television content for the users, it will also open an entire range of new business opportunities and broadband telecommunication services for broadcasters, cable operators, telecommunication operators, etc. and the entrepreneurs in general involved in this industry.

The last decade of 20th century brought a remarkable development of digital technology and its implementation in the broadcasting field. At the same time, the requirements of end users concerning the quality of picture and sound in broadcasting systems became considerably more complex. Apart from the highest quality, there is a great demand for contents, i.e. increased number of radio and TV channels. Image quality implies a stable reception and high-quality reception signal. More channels in the same frequency range require a reliable selection (separation) of signal with reduction of interference.

Rapid development of electronics and availability of comparatively cheap components for digital processing of signal have enabled the producers of programme content to contemplate digitalization in a completely new way. Digitalization in parts of the chain related to studio signal processing has been in use for a long time. The next step is digitalization of broadcasting signal at the "RF signal level", which has resulted in abandoning the concept of further development and improvement of analogue TV receiver. Apart from the fact that, in the existing commercial TV receivers, there are blocks doing certain digital processing procedures, new trends show that, in addition to the digitalization of TV transmission signal, a completely digitalized TV receiver must be taken into account. If it is possible to cover certain territory using fewer transmitters or the same number of transmitters and greater number of programmes, the financial effect of the required investment is better if the quality of audio and video reception signal is higher.

As regards the coverage of certain territory and number of possible programmes that can be transmitted (i.e. broadcast), currently used colour TV broadcasting signal mode, PAL, B/G standard, has reached the phase of complete saturation of spectrum. The conclusion is that it is not possible with the current form of (analogue) broadcasting to provide a sufficient number of TV channels for the required number of programmes (transmitters) necessary for covering certain area with the prescribed image quality level. For that purpose, another form of broadcasting of radio and TV signals is necessary in order to use the frequency spectrum better.

Better utilization of frequency spectrum can be attained in one of the following ways:

- increasing the number of programmes per TV channel, and
- using a single-frequency network (SFN).

The introduction of digital broadcasting systems results in infinitely better picture quality as compared to the analogue. Digital broadcasting signal has the picture without reflections in reproduction, which is not

the case with the analogue one. The system of transmission and broadcasting of digital TV signal via terrestrial network of transmitters (DVB-T) enables the transmission and broadcasting of one or more different quality programmes ranging from the highest – HDTV, with the possibility of different picture formats 16:9 and 4:3 (and the possibility of a cinemascope format 2.21:1 in a later phase) to the lowest quality – LDTV, with most programmes per single TV channel. In future, DVB-T system should be HDTV extensible (highest resolution TV).

DVB-T system should enable reception through the external antenna (stationary reception), but also mobile reception (while in motion) and portable reception inside a building (using installed telescopic antenna). Naturally, service area will be the largest in the conditions of stationary reception, smaller for mobile and the smallest for portable reception.

DVB-T is extremely reconfigurable through:

- a great selection of data transfer rates, which directly influences the quality and number of programmes per single TV channel;
- optional duration of the guard interval when the receiver is idle in order to eliminate or reduce reception of the reflected signals as much as possible;
- selection of convolution ratio for the error protection in different conditions of reception;
- possibility of positioning transmitters on great and close distances;
- selection of the most suitable modulation scheme; and
- possibility of hierarchy/non-hierarchy mode aimed at attaining greater reception error immunity.

With the introduction of digital technology, the principles of inter-study and international exchange of programmes are simplified, without signal quality degradation, as it is the case today – trans-coding from one colour TV system (PAL, SECAM, NTSC) and standards (B,G, K, L, M, ..) to another, which is a very important factor in the times of globalization. In addition, there is a possibility of easier connection of the terrestrial, satellite and cable networks, as well as further distribution and lower utilisation prices for transmission and reception devices.

The switchover to digital broadcasting systems also provides more possibilities for meeting the demands of senior and citizens with special needs, offering additional services such as advanced subtitling, descriptive audio and signing. Special attention must be paid to incorporate the demands of users concerning the interface access (e.g. EPG – electronic programme guide) and receivers.

The switchover to digital broadcasting systems reduces operational costs of broadcast networks, creates conditions for higher sale of digital receivers, and simplifies storing and processing of contents.

A very important advantage of digital broadcasting systems stems from releasing a part of the spectrum resources enabling the introduction of new convergent services encompassing mobile telephony and terrestrial broadcasting, as well as new cross-border and pan-European electronic communication services.

Simultaneously with the DVB-T systems, it is possible to have the implementation of DVB-H systems, which use the terrestrial network of transmitters for transmission and broadcasting, while the reception is enabled through handheld devices. The prices of handheld receivers are currently rather high but their reduction is expected in future.

As regards the transmission equipment, DVB-T and DVB-H may function in parallel within the same multiplex, applying the sharing principle, i.e. the hierarchy modulation method.

Apart from the change of technology on the transmitting side, the reception equipment must be able to receive and adequately process television signal, which requires a device (set-top box - STB) that converts the digital signal into the one adequate for the reception by the existing TV receivers. The STB is a device that connects a TV set with an external source of signal, turning the signal into content which is then displayed on the television screen. The signal source might be a satellite dish, a cable television

network, a telephone line, DSL (***D**igital **S**ubscriber **L**ine*), and others, all the way to common VHF and UHF antennas.

Apart from using STB devices in combination with analogue receivers, the reception of digital television signal is possible with the new models of TV sets with an integrated DVB receiver or with IDTV (Integrated Digital Television) receivers.

Finally, the introduction of new services contributes to further development of freedom of expression and information, at the global, national and local level and promotes the development of media pluralism.

2. Analysis of the State of Play

2.1 Current Stage of the Switchover Process in EU

In September 2003 the European Commission published the Communication COM(2003) 541[2] recognising the advantages of switching from the analogue to digital broadcasting systems and giving basic guidelines to the states for the switchover process.

In November 2003, the EU Radio Spectrum Policy Group (RPSG) [3] published its opinion concerning the introduction of digital systems and their influence on spectrum use. The public opinion poll conducted by the RSPG indicated the following obstacles for rapid switchover process:

- on the political scene, absence of important political decisions, such as setting definite deadlines for final switch from analogue to digital systems (e.g. national switch-off of analogue stations leads to resistance and problems quite often jeopardizing meeting the deadlines and creating negative political image);
- in the economic/market field: (1) the need for a large installed base of analogue receivers, (2) poor consumer demand based on lack of incentives to switch, (3) a reluctance, based on financial risks, from operators to invest.

Apart from the advantages at the national level, the accelerated switchover process should also result in new experiences furthering the process in the EU Member States. Numerous new technologies and services they enable depend on the adequate level of penetration among users at the European level, becoming more and more attractive with the level of their introduction in the broadcasting system.

The RSPG has initiated a number of meetings of the EU Member States aimed at reaching a certain level of harmonisation related to the pace, deadlines, regulations and adopted technical standards, on the basis of previously conducted research of the switchover process in certain countries. The accelerated switchover process and the EU deadlines should contribute to the solution of the current problem of lack of the harmonised digital television market. That should enable the stakeholders in the switchover process in Europe to be competitive with all other global interest groups, in all broadcasting segments and all related systems, which will have positive economic effects: increase of import and revenues, better competitiveness with regard to the quality and range of contents, etc.

Bearing in mind that signals emitted by high power analogue transmitters and their sensitivity to interference make the introduction of new services more difficult, because of the presence of analogue stations both in the country undergoing the switchover process and in neighbouring countries, the harmonised approach to switchover to digital broadcasting systems in the EU Member States and their neighbours is essential.

In May 2005 the European Commission published the Communication COM(2005) 204[4] on accelerating the switchover process. It is followed by a Working Document SEC(2005) 661 containing detailed information on the transition from analogue to digital broadcasting in the member states.

In order to harmonize different positions and progress levels in the EU Member States, as well as because of the advantage of a harmonized switchover process, the European Commission proposed the definition of a joint approach related to the deadlines for final switchover to digital broadcasting systems.

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[2] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on transition from analogue to digital broadcasting (from digital 'switchover' to analogue 'switch-off').
[3] Radio Spectrum Policy Group (RSPG), within the European Commission, established by the Decision of the European Commission 2002/622/EC, and its members are the representatives of EU member states and the representatives of the European Commission. The representatives of EEA countries, the representatives of candidate countries, of the European Parliament, CEPT and ETSI are the observers within RSPG. The Group adopts opinions on the issues of the use of the frequency spectrum and has the advisory role before the adoption of the European Commission's decisions.
[4] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on accelerating the transition from analogue to digital broadcasting.

Most of the EU Member States have already adopted decisions to undergo the complete switchover until 2010, while others set the deadline for 2012. On the basis of this, it is expected that in early 2010 the switchover process will have a considerable progress in the EU, thus leaving 2012 as the final deadline for the analogue switch-off.

In September 2005 the European Commission also published the Communication COM(2005) 461[5] in order to establish priorities for digital switchover in the context of the ITU Regional Radiocommunication Conference held in Geneva in 2006.

In order to achieve the common approach to the use of the spectrum released by the digital switchover, the European Commission published the Communication COM(2007) 700[6] providing guidelines for as efficient as possible use of the spectrum through digital dividend.

2.2 Transition from Analogue to Digital Broadcasting Systems in Europe

2.2.1 Commencement of the introduction of digital broadcasting services in Western Europe[7]

The following phases are discernible in the development of digital television and final analogue switch-off in Western Europe:

1. 1998 – 2002:
    a. emergence and failure of pure pay TV platforms (pay TV);
    b. delays and aborted launch plans;
    c. limited, then stagnant growth;
2. 2002 – 2005:
    a. introduction and success of the first free-to-air platforms;
    b. important role of public broadcasters;
    c. emergence of funding controversies concerning the switchover from analogue to digital broadcasting systems;
    d. higher growth compared to the previous phase;
3. 2005 – 2008:
    a. launching of digital broadcasting systems in all western European states;
    b. mixed models adopted, passing final decisions on funding;
    c. further technological development of digital broadcasting systems;
4. 2008 – 2010:
    a. mature platforms stabilize;
    b. HDTV trialled;
    c. launches of digital broadcasting systems in Eastern Europe;
    d. re-definition of analogue switch-off deadlines;
    e. several countries achieve analogue switch-off within set deadlines;
    f. plans to provide stimulus for certain actors in the digitalisation process;
5. 2010 – 2015:
    a. all countries converted to digital broadcasting systems;
    b. HDTV becomes widespread;
    c. high growth of mobile TV and interactive applications.

The first phase of the introduction of digital terrestrial television (DTT) ended in the spring of 2002 with the financial collapse of two commercial ventures in Spain and the UK, and stagnation in Sweden. These platforms attempted to compete against established cable and satellite operators with a traditional pay TV business model that included expensive film and sport content and decoder business subsidies.

[5] EU spectrum policy priorities for the digital switchover in the context of upcoming ITU Regional Radiocommunication Conference 2006 (RRC-06).
[6] Reaping the full benefits of the digital dividend in Europe: A common approach to the use of the spectrum released by the digital switchover.
[7] Analogue Switch-off Strategies in Western Europe, Strategic Information Service – DigiTAG, November 2005.

Without a viable alternative, delays (e.g. France) and aborted launch plans (e.g. Portugal) were characteristic of the period which ended when the UK launched a successful free-to-air platform in 2002.

Key lessons were learned from those early attempts to launch digital broadcasting networks which set the stage for a new structure and model for DTT, including:

- developing strong support and presence of public service broadcasters (PSBs);
- adopting a predominantly free-to-air offering;
- encouraging a free and open market for consumer equipment to put downward pressure on retail prices; relying less on interactivity and other features to drive growth.

An increasing number of DTT strategies show that broad industry consensus and support is required for this development to happen, particularly from commercial broadcasters whose natural instinct is to try to avoid the increased content and transmission costs. Commercial players of the transition process also eschewed the eventual audience fragmentation that would be the logical result of a widespread multichannel offering. Certain Western European countries adopted certain incentives to encourage broadcasters reluctant to switch over to digital systems. They also defined measures to overcome the obstacles in the process by adopting certain indirect financial support mechanisms. Still, notwithstanding all these measures, the Governments were expected to maintain a technology neutral position. Some countries made contingency planning an important part of their implementation blueprints and its absence had a negative impact on the overall process.

Europe is currently making the transition from a high-growth DTT model based on a primarily free-to-air model, and characterized by a pre-eminent role of public service broadcasters (PSBs). The receiving equipment prices are decreasing, and government interventions are limited and neutral. In addition, mixed models will develop, most still based on free-to-air content but with a variety of pay components.

Further development of digital broadcasting systems is characterized by the introduction of new technology making HDTV and broadcasting to mobile devices possible (transition from MPEG-2 to MPEG-4 standard of compression, implementation of DVB-H).

Market conditions in the final phase, during which most analogue switch-offs will likely take place, are hard to predict. It is expected that advanced coding, HDTV and DVB-H, i.e. broadcasting to handhelds will be characteristic of this period. For many markets additional stimulus to spur growth will be required in the final stage, and the way in which funding controversies are resolved will determine what kind of measures can be used, including all actors in the process.

One of significant segments of the digital switchover process is the relationship with competing platforms which in some countries lobby against the introduction of DTT in view of the fact that cable and satellite operators are a constant challenge for a considerable share of actors in the digital switchover process.

The European Commission has been active in encouraging its member states in the switchover process, even proposing a concrete timetable for the final analogue switch-off to avoid, among other things, market distortion due to possible uneven development of DTT in various countries.

2.2.2 Summary of DTT Progress in Europe[8]

Almost all countries have published some kind of a target date for shutting down analogue transmissions, before or after being engaged in frequency planning and coordination, having performed testing digital transmissions to some extent.

The framework timeframe for drafting legislation and the launch of digital broadcasting services may be outlined as follows:

[8] Analogue Switch-off Strategies in Western Europe , Strategic Information Service – DigiTAG, November 2005

- **adoption of laws and by-laws**: in some European countries adopted legislative framework was too general in nature requiring subsequent review and confirmation. In other cases, it is quite specific even including licensing procedures, and analogue shut-off dates;
- **tender process:** in this stage rules and regulations are developed enough to allow potential bidders to develop business models and present detailed plans. In some countries like Sweden multiple phases of tendering have taken place as new capacity is made available. Without delays, the tendering process typically takes three to four months. An important part of the whole process is the **evaluation of the applicants**. This phase is of approximately the same duration as the application to the tender for allocation of frequencies. It usually involves a detailed review of business models, financial credentials, technical implementation plans**;**
- **soft launch**: this phase is about one year after the completion of the previous phase. In many countries some of the necessary elements were missing: available frequency spectrum, more than half population coverage, and set-top boxes (STB) available;
- **at full launch**: at this phase all necessary elements are in place and it is the appropriate date to begin to evaluate the market impact of the platforms which have been launched;
- **post-launch development**: even after a full launch of digital broadcasting systems in most countries the process is still evolving depending on the technological developments like statistical multiplexing and switching from MPEG-2 to MPEG-4 compression. Further development of the process after at full launch happens also as a result of regulatory provisions related to frequency allocations in internationally binding documents.

European states may be divided into 3 groups, as those who have implemented at full launch, then those which only implemented the soft launch and finally those which have not commenced the DTT launch process.

2.2.3 General Characteristics of the Transition in Western Europe[9]

The dominant model in most countries with full or partial launch of the digital broadcasting service is a free-to-air platform. They may have a separate pay component of the basic free-to-air platforms which takes many forms, from stand alone pay channels, to small pay TV packages, to pay-per-view events. Large penetration may be achieved by launching the free-to-air platforms first, after which other special services may be introduced, i.e. the above separate pay components. The pay element adds value to the platform and thus increases its overall attractiveness. The challenge has been how to get the right balance of free and pay elements.

Most countries are adopting a region-by-region approach with few countries opting to switch off analogue broadcasts in all areas at the same time. The regional approach is preferred for several reasons both practical and political. In some countries, like the UK, switching off in one region is the prerequisite for extending coverage in an adjacent region. For those countries with extensive transmission infrastructure there is a logistical limitation to the rate at which digital build and upgrade can occur. In general a regional approach limits risks linked with the switch-over process and allows lessons learned from one experience to be applied to another. Meanwhile, the national approach is used in some cases when feasible. From a planning standpoint, this approach is easier and all citizens are given the advantages of digitalisation at same time.

Analogue switch-off dates have been determined arbitrarily in many cases. Some countries, like UK, Sweden, Finland, Spain and others have changed their originally targeted dates for full analogue shut-off. This is an indication that the dates previously set were not consistent with a realistic understanding of actual market conditions and their likely development. Final ASO dates were subsequently precisely set, which is highly important for all actors in the switch-over process and consumer psychology to promote purchase behaviour as ASO dates draw nearer.

[9] Analogue Switch-off Strategies in Western Europe , Strategic Information Service – DigiTAG, November 2005.

At the beginning of the process the broadcasting services basing encoding on MPEG-2 were used in most European countries; however, a large number of countries is switching from MPEG-2 to MPEG-4.

Public information and marketing have been recognized as crucial elements in accelerating the process of applying digital broadcasting services. In most countries in advanced stages of transition, where the process has been fully or largely completed, the lessons learned show that timely information to consumers on the final analogue switch-off dates is essential. To that end, information campaigns, call centres, internet sites, and other techniques for facilitating dissemination of information about DTT are planned for or already established. Though marketing is recognized as crucial for raising public awareness concerning the significance of the process, access to adequate funding for the process implementation and proper and comprehensive coordination have proven to be of no lesser importance.

Many countries have established economic support for consumers and broadcasters, where Governments across Europe have provided indirect financial support mechanisms to facilitate the switchover process. Ranging from tax incentives and loans, to direct subsidies to broadcasters and consumers, these supports have proven effective in switching from analogue to digital broadcasting systems.

None of the countries had developed detailed contingency plans. It became evident that major national projects with a substantial degree of uncertainty associated with them require risk management assessments with clearly outlined contingency options. On the other hand, there are some opinions that the publication of these plans would be counterproductive and be indicative of the lack of trust in the project itself.

2.2.4 Methods and Goals of Analogue Switch-off[10]

Although there are many similarities in managing the switch from analogue to digital broadcasting services, European countries have set different goals and ways of achieving them. Final deadlines for analogue switch-off in various European countries are defined differently, but the different methods are not mutually exclusive. The methods for setting the final analogue switch-off dates show two main attributes: (1) the propensity of the ASO date to move and (2) the ultimate objective in terms of actual market conditions at the time of ASO.

- ASO by government fiat

In some countries the switchover process may occur quite rapidly, and ASO does not occur as a result of actual high TV household DTT penetration. This approach was most often taking place in highly-cabled countries with very low number of households that depend on terrestrial reception. The major drawback of this approach is that it eliminates one of the principle benefits of DTT: more platform competition. Since the date set for final shut-off is arbitrary, such a model is called ASO by government fiat.

- Target Date ASO

This is a conditional deadline that can be changed if market conditions warrant. In France, for example, ASO is targeted for 2010 but their national regulatory body has the discretion to alter this date. Target Date ASO is often conditioned on a minimum level of penetration.

- Firm Date ASO

The approach to DTT establishment with a firm date for ASO is less flexible than a target date approach. Typically, it is set in law which makes any modification more difficult, often requiring a lengthy approval and authorisation process. Such an approach implies that other measures may be tried first, before postponement is considered, or that there is a high tolerance for non-switched households. In many countries the firmness of the ASO is linked to the fact that analogue terrestrial licences expire at the

[10] Analogue Switch-off Strategies in Western Europe, Strategic Information Service – DigiTAG, November 2005.

same time. Sweden is one of the countries which has set a firm ASO date of February, 2008 following this approach.

- Digital conversion

In case of digital conversion ASO depends on other distribution technologies in two ways. First, in some countries universal terrestrial coverage is too costly, and satellite, for example, is used to fill the gaps. Second, some countries will require that all television distribution be digitalized. Finland, for example, seeks to have all their cable households equipped with digital set-top boxes at ASO.

- Full digital conversion

Full digital conversion is the most ambitious strategy. It often includes all the conditions of Digital Conversion, as stated above, and in addition that all other television sets and audio-visual equipment in the home be capable of processing digital signals. The UK is the only country under study which is attempting a Full Digital Conversion.

It is also possible to have multiple ASO dates, starting with a basic conversion on terrestrial households, and then moving progressively to full conversion.

The following table shows the data on the timeframe for drafting legislation and launch of digital broadcasting systems in European countries:

Country	Full launch	ASO type	ASO approach	First ASO	Last ASO
UK	October 2002	target	regional	2008	December 2012
Sweden	September 1999	firm	regional	September 2005	February 2008
Spain	November 2005	target	regional	December 2007	April 2010
Finland	October 2002	firm	national	December 2006	December 2006
Netherlands	April 2003	government fiat	national	2007	2007
Germany	May 2004	target	regional	August 2003	2010
Italy	January 2004	target	regional	January 2006	December 2006
France	December 2005	target	regional	2007	March 2010
Switzerland		government fiat	regional	2007	2009
Belgium		government fiat	regional	2010	2010
Austria	2007	target	regional	mid 2007	2010
Norway	2006	firm	fast regional	2007	2009
Denmark	2007	firm	national	2011	2011
Ireland	2007				2010
Portugal	2007				2012
Greece	NA				2015

In the long run and within the digital broadcasting services themselves different transitions will be taking place, for example migrations from MPEG-2 to MPEG-4 advanced encoding and from SDTV (standard definition TV) to HDTV (high definition TV). For final consumers in countries where the MPEG-2 encoding systems were initially used, the switch to MPEG-4 will cause the necessity to purchase new receiving equipment. Also, in the long run, the market will not be immune to the general trend of modernization of the receiving equipment.

2.2.5. Digital Broadcasting Services Launch in Eastern Europe[11]

In the Eastern European market there are yet no conditions in place for full launch of digital broadcasting services, i.e. it is yet not possible to have analogue switch-off. Nevertheless, the international treaties and the switchover timeframe with the ASO date set for 2012 was as such recommended by the European Commission and adopted at the EU level. Consequently, this is the binding ASO date for most Eastern European countries.

With roughly half of TV households in Eastern Europe relying on terrestrial television, the region represents a large market for free-to-air multi-channel television.

Compared to Western European countries, the implementation of digital broadcasting services in Eastern Europe was, among other things, delayed due to the absence or postponement of political decisions. Commercial broadcasters in Eastern Europe have most often been hesitant and uncertain about switchover to the digital systems, in particular when having to renounce the acquired rights on frequency allocations used for analogue television. They are very passive in the sense of analogue switch-off and releasing the frequency spectrum for the needs of the new digital systems notwithstanding manifold benefits attained by the new distribution and transmission technology. Aside from few exceptions, in Eastern Europe Public Service broadcasters (PSBs) are in a much weaker economic position than their western European counterparts. Bearing in mind the strong impact of public service broadcasters on successful commencement and further switchover process, this was another factor causing delays in launching digital broadcasting services.

Although the free-to-air model has been the proven driver for mass adoption in the West, shortage of public funding to subsidize reception equipment led the actors in the switchover process to propose and accept commercially funded models. Also, the Eastern countries which had a late start in launching digital broadcasting services are also faced with more technology choices, especially when it comes to the choice of compression standard. The adoption of MPEG-4 compression, as more advanced and efficient compared to MPEG-2, increases the costs for both broadcasters and consumers. All of this complicates the decision-making process at the national level.

The basic data on digital broadcasting services launch in Eastern Europe are shown in the following table:

Country	MPEG type	Business model	Soft launch	Full launch	Switch-off date
Estonia	MPEG-4	pay	December 2006	2006	2012
Lithuania	MPEG-4	pay	July 2006	2007	2015
Czech Republic	MPEG-2	free-to-air	October 2005	2007	2012
Poland	unclear	unclear	2008	2008	2014
Hungary	unclear	unclear	2008	2008	2012
Slovakia	unclear	unclear	2008	2008	2012
Slovenia	MPEG-4	pay	March 2007	2008	2012
Latvia	MPEG-4	free-to-air	2007	2008	2011
Romania	unclear	unclear	2008	2009	unclear
Bulgaria	unclear	unclear	2008	2009	unclear

[11] Digital Terrestrial Television in Central and Eastern Europe, Strategic Information Service – DigiTAG, December 2006

2.2.6. Key Differences in Switchover Process between Western and Eastern Europe[12]

It was not only Eastern European countries which started the implementation later, but also the Western European countries were facing numerous problems at the beginning of the process for the implementation of digital broadcasting services. The delays in adopting rules and regulations, uncertainty and lack of interest on the part of commercial broadcasters, a high level of competition from cable and satellite operators are all standard factors which have affected the switchover process in Eastern Europe. Apart from the regulatory bodies, the drivers and proponents of the process were in particular public broadcasting services, as well as multiplex and network operators.

The key differences in switching over from analogue to digital broadcasting services in Western and Eastern Europe are as follows:

- Eastern countries are launching later;
- Eastern countries are tending to adopt more advanced compression technology - MPEG-4 resulting in higher costs;
- Eastern countries are planning the introduction of commercial business models (pay TV), resulting in increased costs for end users. The reasons for this are primarily financial, considering the lack of direct and indirect funds;
- Per capita GDP levels are lower in Eastern European countries, having eventually the negative impact on end users in the sense of purchase power for STB and integrated digital receivers;
- Public broadcasting services in Eastern Europe are much more dependent on public funds than is the case in Western Europe;
- Commercial Pan-European networks dominate free-to-air television in Eastern Europe.

2.3 State of Play in the Broadcasting System of Montenegro – Technological Aspect

The broadcasting system of Montenegro includes 125 transmission sites. Previously, two transmission centres – Lovcen and Bjelasica, were the backbone of this network, while other transmission sites used to operate in the repeating mode, receiving broadcasting signal from the transmission centres and retransmitting it on another frequency (channel).

The situation has changed considerably and we have today over twenty transmission sites that do not operate in the repeating mode but as transmitters, which means that the signal is delivered to them by means of microwave links or optical cables. In this way, a network reconfiguration has been completed, improving the quality of its operation, i.e. the quality of signal delivered to the end user (viewer). These transmission sites are the basis of Montenegrin broadcasting system today. The network reconfiguration has resulted in a certain level of centralization of the network in its most important part, reducing its maintenance costs considerably. The transmission centres, Lovcen and Bjelasica, are part of the transmission system of the national public service broadcaster (Radio-Television of Montenegro) and the centre of transmission of modulation signal to the transmitters for most of the broadcasters.

Apart from a certain number of transmission sites operating in the transmitting mode, the rest of the system is quite obsolete and it still operates in the repeating mode with the exception that now, as opposed to the earlier period, the broadcasting signal is transmitted directly by microwave links from the network of transmission sites.

This type of signal delivery to the transmission site is cheap and simple but it has a number of weaknesses, the most important being:

- the signal degradation which increases with the length of range of the repeating transmission sites,
- dependence of the operation of the entire chain on the first in the chain, and
- great sensitivity to interference originating from transmitters from neighbouring countries.

[12] Digital Terrestrial Television in Central and Eastern Europe, Strategic Information Service – DigiTAG, December 2006.

The transmission system in Montenegro is completely comprised of analogue transmitters. Most European countries have finalised pilot projects and trial broadcasting of TV signal by means of digital transmitters long time ago. There are almost no available frequencies in the frequency spectrum of Montenegro, and consequently no possibilities for frequency allocations. The current situation of broadcasting system cannot bear the burden of digital switchover without significant financial investments from several important aspects:

- spatial capacities of transmission sites (both in the facilities and on masts) are insufficient;
- power supply capacities;
- continued reconfiguration of the network (higher number of transmission sites as compared to the repeating ones.

Over the previous period there was also the problem of digital radio-relay high capacity transmission system necessary as the support to future digital broadcasting system, which has been overcome by the implementation of the digital radio-relay links project of the Broadcasting Centre of Montenegro based on state-of-the-art IP technology.

2.4 Broadcasting Centre of Montenegro Infrastructure in Function of Digital Switchover

The core of the broadcasting system of Montenegro is managed by the Broadcasting Centre of Montenegro (hereinafter: BCM). BCM is the only telecommunications operator owned by the state. The system it has at its disposal consists of 125 transmission sites and 9 sites under construction. The company distributes and transmits the signals of public service broadcasters (national and local) and commercial broadcasters.

BCM has carried out substantial reconstruction and extension of the existing infrastructure (sites, antenna posts, electric power supply, access roads...) to enable mounting the above transmission system, and also for the needs of assembling the equipment of the new commercial TV and radio broadcasters, GSM/3G, Wi-Max, MMDS operators and other users, and is to continue with these activities in the upcoming period.

In the second quarter of 2008, the BCM will launch a digital radio-relay system based on state-of-the-art IP platform. This system will enable the linking of 38 transmission sites in Montenegro with 155 Mbps to 622 Mbps bit rates, depending on the distance.

The digital radio-relay transmission project financed by BCM from own funds included the purchase, assembly and launching of the system enabling:

- transmission of digital IP MPEG-2 TV and radio signals of national public service broadcasters to 38 transmission sites in Montenegro;
- permanent monitoring and control of the transmission and distribution equipment at the given sites;
- the precondition for switching over from the analogue to digital (DVB-T, T-DAB) broadcasting;
- transmission facilities for current and future TV and radio broadcasters;
- transmission facilities for public services: Ministry of the Interior, Army, Customs Administration, health care institutions, etc.;
- linkages with transmission systems of neighbouring countries and Europe.

The general approach to the construction of the digital radio-relay system is based on:

- construction of the SDH core network by using wireless point to point links and by linking major transmission sites in Montenegro;
- equipping each node of the network with multiplexers and transport concentrators for cross-connection and ADM multiplexing n x STM-1 of entry signals into the specified number of E1 signals with SNCP protection in the ring or star configuration. Additionally,

GFP mappers are applied at each node to provide for mapping of Ethernet traffic in VC4, VC3 and VC12 containers of the SDH frame. Flexible common use of DH capacities between Ethernet and TDM traffic is also enabled.

The core network of the digital radio-relay system is effectuated as an IP network used as a medium for contribution and distribution of television and radio signals. The IP network is an alternative to the traditional design of the contribution and distribution network (with PDH/SDH connections) and has the following advantages:

- more flexible use of the frequency range being used;
- use of the network not only for broadcasting, but also other services;
- video contribution, possibility of connectivity for data, studio to studio transmission, remote control, Ethernet, VoIP, IPTV;
- greater flexibility concerning network reconfiguration and addition of new channels.

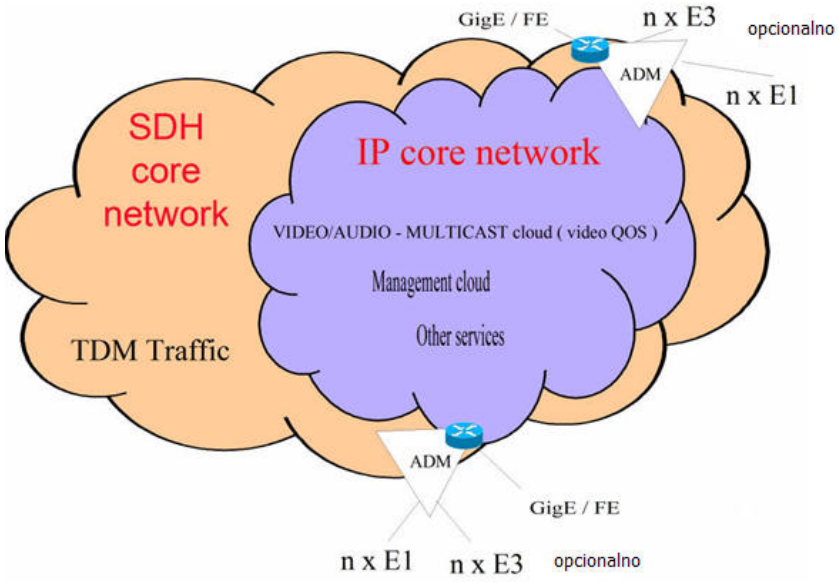


Figure1: Scheme presenting the SDH core and overview of switch routers.

In the southern region of Montenegro the digital radio-relay system has the form of a ring with provided protection. Considering the above, microwave links in the southern region are designed as the 2+0 configuration. Other links are designed as n+1 configuration with frequency diversity. All microwave links are fully in duplex configuration (e.g. for the Sjenica site the microwave link has been designed receiving and transmitting 300 Mbp/s in two ways, if 6 Mbps compression of one TV signal is used. From the Sjenica site it is possible to receive and transmit 50 TV channels in both directions).

The network specification defines the parameters for the SDH radio-relay system with STM-1 rate of transmission designed in accordance with frequency plans defined by ITU for 6 and 7.5 GHz range.

Multipath propagation is the main limiting factor for frequency ranges below 13 GHz and hops at the distance exceeding 30km. In order to provide necessary characteristics of the system for appropriate hop distances, proper measures are applied, i.e. spatial and frequency diversity, as well as adaptive equalizers.

Digital radio-relay system has also the capability of providing side traffic at regional and national routes, as well as the possibility of occasional transmission.

The SDH radio-relay system operates as multiline system (n+m) which may be extended to 8+0 (7+1) configurations. Figure 2 shows the configurations at certain routes. In case of the main system failure, there is an automatic switch over to the standby system, without interrupting the operation.

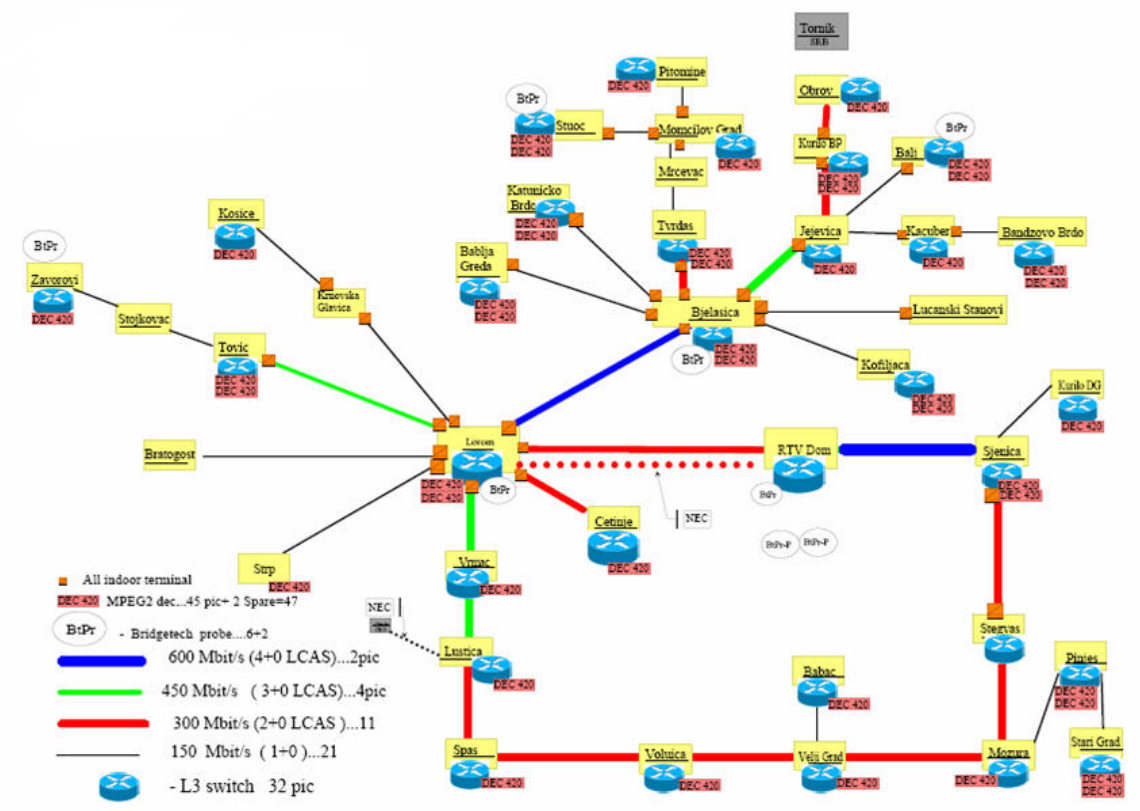


Figure 2: Presentation of the SDH core network and the overview of switch routers

The equipment complies with relevant European standards for transmission rates, channel width, frequency range and other technical parameters.

Digital radio-relay transmission is the initial step in switching from the analogue to the digital (DVB-T, T-DAB) broadcasting and provides the possibility of permanent monitoring and control of the broadcasting and transmission equipment at 38 transmission sites in Montenegro taken as the access points for the system. In addition, the system will resolve certain problems in covering certain parts of Montenegro by better quality signal than has been the case so far. Considering the system is to have 38 access points, some of which located in the northern region of Montenegro, it will also enable a more balanced development of broadcasting in Montenegro.

3. Starting Points of the Strategy

Digital switchover strategy must be a well-coordinated process both in time and in space and must be acceptable to all stakeholders.

3.1 Starting Points - Regulatory Aspect

During the transition process, the introduction of digital broadcasting systems will cause additional costs for all stakeholders. However, there are long-term positive effects both for end users of digital broadcasting systems and for all other stakeholders in the implementation.

The simulcast period is a great financial burden for the broadcasting industry of Montenegro in general. Therefore, an accelerated switchover is recommended and it is expected from the countries undertaking the switchover to adopt adequate legislation and create favourable economic and technical conditions. Special attention is paid to local and regional broadcasting systems. It is also necessary to estimate in the adequate manner the validity of licences granted to the digital operators bearing in mind that it will take several years for the operators to return the funds invested in the digital switchover. Therefore, it is recommended to extend the validity of licences awarded to the operators of digital broadcast networks in relation to the usual validity prescribed by the current legislation.

To that end, the laws and regulations should clearly stipulate the rights and obligations different stakeholders are to face. In doing so, special attention needs to be given to the scope and structure of needs of the following users:

- vulnerable groups;
- people with disabilities and special needs;
- institutions involved in healthcare protection and education;
- institutions involved in sports and culture.

In view of the above, the key actors for Strategy implementation are as follows:

- **Parliament and Government:** they are responsible for timely adoption of proper legislative framework and, if needed, the financing or subsidy scheme. It is particularly important to set the date for analogue switch-off. ASO may contribute to increased public revenues if the frequency spectrum is released and through digital dividend management the decision is made for its sale. Still, it should be borne in mind that analogue switch-off may have considerable negative impact in case of its failure. If managed poorly, without timely identification of unsurpassable limitations for meeting the deadlines, this process would result in preventing the citizens to receive radio and television signals based on free access, as has been the case so far. It would be highly negative for all the drivers of the process and would make their position difficult since it might cause the opposition within some segments of the society towards the whole process.
- **Line ministries for: culture, sport and media; economic development; finance; labour, social welfare and health care; education and science:** after the adoption of relevant regulatory frameworks, these ministries would be in charge of fully supporting the process by concerted measures and policies. It is reflected in timely planning, financing and promotion of measures to stimulate:
    - production of diverse audio-visual contents, particularly those aimed for certain target groups which may count with new, currently unavailable contents, to be made available through digitalisation;
    - activities aimed at raising media literacy;
    - elimination or removal of business barriers for companies within the chain for production, broadcasting and distribution of radio and TV programmes, as well as all other audio-visual services.
- **regulatory bodies for broadcasting and telecommunications:** within their competences and exercising mutual cooperation they should define and carry out frequency allocation in a timely,

transparent and efficient manner. Their significant contribution will be to promote the process and ensure a wide forum for exchange of opinions, recognition of problems and possible solutions. Starting from human and technical resources for carrying out the process, regulatory bodies will also play an important role in timely and good-quality evaluation of the process. Recognising the brevity of time at their disposal (by the end of 2012) within which all important stages are to be implemented before analogue switch-off, competent state authorities and regulatory bodies need to ensure utmost coordination of their activities to be able to meet the deadlines.

- **Broadcasting Centre of Montenegro:** as an operator making the backbone of the broadcasting system. The speed with which implements its digital relay system as well as the reconstruction of the existing infrastructure will have a decisive impact on the whole digitalisation process.
- **educational institutions (academia, secondary and primary schools)**: with their regular, specialist and other trainings and curricula these institutions can greatly contribute to accelerating the process and taking it to a successful closure. On one hand, they need to offer programmes to respond to the need for new qualifications on the labour market specialised for inclusion in the process of production, promotion, sale and distribution of radio and TV programmes, i.e. all audio-visual services and ancillary systems.
- **broadcasters (commercial and public):** are among most important stakeholders essentially determining the success of the process by the timeframe for their inclusion. They will have to be the first to start the process by being, on one hand, the offerers of new, better-quality services, and on the other, an important user of the new digital distribution and transmission systems. Should these two sides of their operation not coincide, broadcasters will be facing huge challenges due to substantial investments they will be exposed to if unable to provide for their timely return. The improvement of their offer of current and new contents and services will have a predominant impact on the trust in and the support for the process. If better offer is not provided, the process may be facing opposition from those who see no interest in switching to new technology causing them extraordinary expenditures. It would also raise the issue of survival of those broadcasters who fail to recognise all the advantages of digitalisation and do not get involved in the process in a timely manner.
- **consumers and broadcasters associations:** they should give significant contribution to education, raising awareness and promotion of digitalisation. They are expected to protect interests of the target groups they represent in a professional and responsible manner, but also to contribute constructively to the implementation of the whole process. They may have a significant contribution in evaluation and timely drawing attention to possible problems and their solutions.
- **reception equipment suppliers (STB and IDTV):** prompt setting of the ASO date and specification of STB and other equipment will enable proper quality offer to be created and consumer (viewer) protection, as well as reduced opposition due to imposed change of receivers. Any delay in setting the ASO deadline only increases the costs for participants in the chain of production, distribution and in particular consumption of audio-visual services in the digital era because marketing campaigns for a certain type of reception equipment may discourage the sale of some other (e.g. STB vs. IDTV or vice versa). All of that, instead of discouraging, may actually encourage the purchase of analogue devices and eventually the dissatisfaction of consumers once when faced with the inevitable purchase of the digital receiver. Thus, prompt definition of clear deadlines will stimulate the change of the reception base and facilitate the process.
- **end users:** all known advantages of the digital compared to analogue broadcasting will stimulate the sales of IDTV and STB for digital reception only if clearly and strongly promoted. It should be kept in mind that one important factor in deciding to change the receiver will be the current living standards of households. Thus, without certain subsidies, a share of households will be facing the inability to cover the costs of switching from analogue to digital receivers. In case the switchover from analogue to digital broadcasting systems fails to provide good coverage, certain households would be facing other costs of transition to other distribution systems for radio/TV signals (satellite, cable,...). It should be borne in mind that one important incentive in making the decision on changing the receiver is the perception of the opportunity of using new or better services. The

belief that the new equipment will not lead to improved offer of contents and services may cause dissatisfaction by imposing the need to transfer to new technologies.

Since late 2002 the relations in the broadcasting sector are regulated by the Broadcasting Law. Other important segments are the Law on Public Broadcasting Services "Radio of Montenegro" and "Television of Montenegro" and the Media Law, all adopted in 2002.

It is expected that in 2008 these laws are to be upgraded by adopting new or amended solutions to enable and stimulate the process of transition from analogue to digital broadcasting systems. Acknowledging the specific features of the process, the decision on the legislative intervention should be adopted as soon as possible to result in:

- clear date set for AOS;
- clear rights and obligations of certain entities in charge of planning, financing, implementation and promotion of digitalisation;
- a frame which is to recognize the results so far in the developments in the sector and enable further harmonisation with Council of Europe and European Union standards in the sector of audio-visual services, as well as the sector of electronic communications.

Considering the importance of the revenues from the broadcasting subscription fee, collected and allocated by the Broadcasting Agency, this issue should be given particular attention in amendments to the Broadcasting Law. The method of collection and the purpose of revenues such collected should be reconsidered particularly from the point of view of their use to support both the transition from analogue to digital broadcasting systems and to stimulate the production of audio-visual contents.

3.2 Starting Points – Technical Aspect

The main technical prerequisite for the introduction of digital broadcasting in the bands ranging from 174-223 MHz and 470-862 MHz is enabled through the development and international coordination of Radio-Frequency Allocation Plan of Montenegro at the conference held in Geneva in 2006 (Regional RadiocommunicationConference RRC-06). During the conference, the text of the new agreement was drafted and adopted, regulating international relations in the broadcasting field in the VHF (band III) and UHF (bands IV and V) frequency bands. These frequency bands will be used in future for broadcasting of digital television and radio programmes, as well as for other electronic communications services. The conference was attended by the ITU member countries from Regions 1 and 3, including 120 countries from Europe, Africa, Middle East, Iran and Russia.

During the second session of the RRC-06, in line with the Resolutions of the ITU Council, two shorter two-day conferences were held, for the purpose of revising the international agreements:

- Stockholm 1961, related to the analogue broadcasting in Europe, and
- Geneva 1989, related to the analogue broadcasting in Africa.

Coordination of digital plans with 120 countries that attended RRC-06 conference was done through 4 iterations and negotiations in 5 coordination groups, out of which the first coordination group included European countries. Taking into consideration the specific features of the terrain, different propagation conditions, and difference in the planned requirements related to digital broadcasting services of a great number of countries included in each of 5 coordination groups, the negotiations were also effectively conducted during the conference within the sub-groups. The delegation of the Republic of Montenegro participated in the negotiations within the Adriatic sub-group with the representatives of Italian, Slovenian, Croatian and Albanian administrations. Also, the delegation of the Republic of Montenegro participated in the negotiations with the representatives of administrations of Bosnia and Herzegovina and Serbia, within a different coordination sub-group related to Central and Eastern Europe.

In the process of coordination with the neighbouring countries certain agreements have been reached, resulting in the allocation plan for digital broadcasting systems of the Republic of Montenegro being harmonized with all neighbouring countries.

In launching digital broadcasting and modernizing the broadcasting system the following should be borne in mind:

- the Government and the Broadcasting Agency must lead the process of devising the modernisation methods and creating conditions for digital switchover within the set timeframe;
- the Broadcasting Agency and the BCM, in cooperation with competent state authorities and other stakeholders, should act promptly to launch the digitalisation process.

According to current legislation, the Broadcasting Centre would be the only digital TV operator, meaning that its implementation could completely depend on the BCM and its financial and technical capacities. In order to avoid this dependence, when upgrading the existing legislation the conditions and the procedure for licensing other (network) operators should be envisaged to enable the development and use own facilities and/or leasing out BCM facilities.

In Montenegro, the following broadcasters either actually broadcast their programme or have obtained the right to do so:

- National public broadcasting service with 2 radio and 2 TV programmes (RTVCG);
- Local public broadcasting services (2 TV and 14 radio stations);
- 18 commercial TV stations;
- 41 commercial radio stations.

National public broadcasting service broadcasts two radio and 2 TV channels. The programme of the Television of Montenegro is broadcast from 125 sites covering 93% of population, while the programme of the Radio of Montenegro is broadcast from 18 sites covering 97% of population. Being in the initial phase of the switchover process, the Television of Montenegro is in a rather difficult position with regard to the existing equipment, and the procurement of new equipment is absolutely necessary. In addition, RTVCG is facing a great challenge related to the change of the broadcasting fee collection model, as these revenues have been the main source of funding of this broadcasting company.

Local public broadcasting service broadcast programme at the municipal level, although some of them (RTV Niksic, Radio Budva) have extended their service area outside of their respective municipal boundaries. They were awarded licences for broadcasting and transmission of radio and TV signals by the Broadcasting Agency, after adapting the existing and procuring necessary equipment in compliance with current standards. All local public broadcasters are members of the ULES association. Local public broadcasters are increasing their own local production with programming intended to all citizens and social groups. Moreover, they are becoming increasingly more market-oriented in spite of the strong competition of a great number of commercial broadcast media both at the national and local level.

Commercial broadcasters in Montenegro broadcast their programmes at the local, regional or national level. Many among them broadcast in nearly all municipalities of Montenegro. Most of the commercial services obtained multi-year licences (until 2012). Generally speaking, commercial broadcasters in Montenegro do not have sufficient funding for the production or procurement of quality programming. In addition, another major problem with certain commercial broadcasters is that they cannot afford to buy and renew their extremely obsolete studio and/or transmission equipment. Most of the commercial broadcasters are members of the Association of Independent Electronic Media (UNEM). Regardless of great competition and tough market conditions involving the need to adapt their operation to highest European standards, very few among them have dropped out of business.

Pursuant to the Broadcasting Law, only one tender for awarding the rights for development and use of the distribution of programmes by means of CDS/MMDS distribution systems was carried out. Although this right was awarded to 6 CDS and 2 MMDS operators, due to the inconsistencies in spatial planning legislation and documentation, as well as because of the construction licensing procedures, liberalization process in the telecommunication sector, the development of traditional cable distribution of radio and TV programmes to end users is rather slow. For this reason, until the end of 2007, only one MMDS, one IPTV

and one DTH operator have started developing and using their respective systems. On the other hand, CDS operators are still in the phase of obtaining adequate construction permits at the municipal level. In order to ensure efficient and successful implementation of the switchover strategy, special attention should be paid to elimination of barriers for the entrance into the market of these services and above all to prevent the abuse of monopoly held by the existing or future telecommunication operators.

4. Strategy Objectives

In accordance with international commitments of Montenegro, expressed orientation for EU standards compliance related to the digital switchover, and respecting the lessons learned and experiences in digital switchover in European countries, the Strategy aspires to attain the following **objectives:**

1. analogue switch-off not later than 31.12.2012 (target date).
2. set up a sustainable regulatory framework for prompt introduction of digital broadcasting, facilitation of the transition from analogue to digital broadcasting systems and their unobstructed development after the target date;
3. for all public broadcasting services and existing holders of transmission and broadcasting licences envisage the possibility for free-to-air digital distribution, and pay TV for other programme contents;
4. until the target date provide the availability of digital broadcasting services to all citizens of Montenegro, ether by terrestrial transmission network (free-to-air), or by satellite digital broadcasting;
5. adopt solutions for the specification of transmission and reception equipment to enable the introduction of additional services such as HDTV etc.;
6. enable unobstructed development of T-DAB and DRM systems;
7. create a reliable, transparent, technology neutral environment, promoting the implementation of digital switchover and development of electronic communication infrastructure intended for the information society development and meeting the needs of the public;
8. during the switchover process, ensure efficient, objective and transparent planning, administration and management of broadcasting frequency spectrum;
9. during the switchover process, ensure the preservation, protection and promotion of national heritage and cultural diversity;
10. create and promote possibilities to satisfy the needs of people with disabilities and of vulnerable groups among Montenegrin population;
11. increase the production both in terms of quantity and quality and reduce transmission/distribution costs for public service broadcasters;
12. ensure a stimulating framework for creating added value services compared to the existing analogue broadcasting systems for all stakeholders;
13. ensure efficient exercise and protection of copyright and related rights using the advantages offered in this field by digital technology.

All objectives have been formulated with a view of importance of clearly defining starting positions, logical procedures and specific causes and consequences to affect the social, cultural, economic and political aspect of the process.

Bearing in mind numerous advantages of digital systems in comparison to the analogue ones, resulting mainly in more and better quality services, it is necessary to ensure the following:

- For end users
  - improvement of audio and video quality (HDTV, Dolby Digital 5.1);
  - better selection of contents, more TV and radio programmes;
  - new services for citizens with special needs and senior citizens;
  - improvement of additional services (user-friendly interface, multilingual broadcasting, translations, special signs, screen size adjustability, interactivity);
  - mobility;
  - convergence of services (all in one terminal).
  - better value/price ratio for services and terminal equipment.

- For providers:
  - possibility of content differentiations (different programmes, target audience);
  - additional possibilities for content mediation (interactivity);

- provision of on-demand service (payable);
- reduction of the transmission costs;
- convergence of services (convergence of television, telephony and data services);
- new sales opportunities for equipment manufacturers (transmitters and receivers).

- For the Government:
  - higher efficiency in the utilization of frequency spectrum;
  - use of the released part of the spectrum for new services;
  - market-related opportunities resulting from the released part of the spectrum;
  - creation of new economic possibilities and employment;
  - promotion of new technology development;
  - increased competitiveness for providers;
  - fostering media pluralism;
  - more opportunities to promote the creative potential, language and culture of Montenegro and its diversity;
  - increased production of local contents;
  - contribution to the development of broadband services and information society;
  - cost reduction for transmission/distribution of public service broadcasters;
  - increased value of BCM.

The objectives of the Digital Switchover Strategy must include systems containing the elements that promote the development and competitiveness in the broadcasting field, which reflects on technical, systemic, legal, financial, economic, public, and environmental issues.

In Montenegro, it is necessary to use all the advantages of digital switchover, preserving, further cherishing and developing media pluralism, freedom of expression, transparency and diversity of programme contents.

After the analogue switch-off, a part of the spectrum will be released and, as such, suitable for the implementation of new services and introduction of additional programme contents, which is also the objective of this Strategy.

We must also enable the distribution of public broadcasting services programme by means of digital broadcasting networks without additional costs involved (must carry rule). Consequently, it should be envisaged that DVB-T, DVB-H operators as well as the network to transmit new convergent services, i.e. multiple digital multimedia contents incorporating broadcasting, telecommunications and information technologies are obliged to provide for the distribution of public service broadcasters.

Digital broadcasting, which entails greater number of programmes and additional services, is becoming ever more complex for access and use by the end user. Therefore, EPG (***E****lectronic* ***P****rogramme* ***G****uide*) is becoming very important as a mean for users to find their way round in the great number of programmes and channels. Since the EPG seems to be the only way for an easy and controlled access to the digital distribution services, it is necessary, through the licensing system, to impose an obligation on multiplex operators and contents providers to enable to all digital service users to have access to EPG. Furthermore, public broadcasting services should be guaranteed a prominent place in the EPG in order to provide an easy access to this service for end users. Introduction of digital broadcasting systems creates the possibility for meeting the needs of disabled persons and target groups which have been less present in the programmes so far.

The switchover strategy must promote the new entrants to the market at all levels of the chain from contents production, to distribution, to end users, in order to have better competitiveness on the market and promote innovation, creative potentials and delivery of new programme contents, interactive and

other services to end users, as well as the competitiveness among the electronic communication operators.

Producers of programmes aimed to direct reception by the public should be released from the obligation to construct own transmission systems. Thus, programme producers could devote to their basic activity and rationalise their operational costs of. It will have a beneficial effect on viability of broadcasters and as a result strengthen media pluralism and the quality and quantity of local contents. On the other hand, network operators could more easily introduce new multimedia services.

In conclusion, the overall aim of this Strategy is to make the digital switchover acceptable for most of the population who will enjoy its beneficial effects. Since a critical success factor towards attaining this aim is an efficient, clear and timely promotion campaign, this document should be informative enough for all relevant stakeholders concerning what and when is expected of them in order to timely plan and carry out activities within their scope of competences.

5. Strategy Implementation - Activities

5.1 Main Guidelines

The activities on digital switchover (adoption of legislation, financing, licensing) must be aligned with the Council of Europe and European Union standards.

In order to have a rapid switchover process, it is expected that Montenegro will provide, by means of certain subsidies, funds for the procurement of equipment i.e. basic devices for reception of digital broadcasting signal (STB) for low income households. Likewise, the households living in the areas where other systems for transmission and broadcasting of radio and TV signals are not developed making them dependant on the terrestrial systems only, especially if these are sparsely populated or underdeveloped areas, could also be subsidized when purchasing the STB equipment.

Bearing in mind the importance of the process for the improvement of citizens' quality of life, as well as tight deadlines for analogue switch-off, it is vital to devise promptly the financing model for the whole process or parts thereof. To that effect, while amending the legislation, the possibility of the law stipulating the sources of finance should be considered through the establishment of special funds for:

- infrastructure upgrading and development;
- provision of good quality coverage by the digital signal of rural or sparsely populated or underdeveloped areas.

Recognising the importance of stable funding of the activities foreseen by the Strategy, special attention should be paid to the definition of terms and timeframe for the establishment and management of a special fund intended for this process. Setting up of the Fund, and management and allocation of funds should be in line with the EU standards related to public funds and state assistance if the provision of these funds is foreseen from the state budget. The funds should be primarily used for subsidizing the transmission and reception equipment (STB), informing and encouraging the end users about deadlines, advantages and benefits of participation in the switchover process, as well as for ensuring that digital signal covers sparsely populated areas in which commercial investors will have no economic interest to deploy digital broadcasting systems. Apart from the central level authorities, also the municipal bodies and institutions should play an important role in setting up the Fund.

After considering the funds necessary for this process of public interest, an important set of activities will be timely planning, application and implementation of actual projects using the European funds.

In view of the above, the main sources of funding for the implementation of switchover process should be the following:

- funds set up in compliance with the Broadcasting Law and the Digital Switchover Law;
- a share of fees for the use of broadcasting frequencies for analogue distribution;
- funds of broadcasters/providers/operators;
- budget of Montenegro;
- EU funds;
- other sources.

In the attainment of the above objectives, the following needs to be done:

- reconsider the justification for further tenders for granting the right to analogue TV broadcasting;
- stimulate and encourage the installation of spare transmitters at all significant sites, bearing in mind that it is the best solution for the system reliability;
- understand and acknowledge the needs and capabilities of Montenegrin citizens to the greatest extent possible;

- guide the process on a non-discriminatory and technology neutral basis to the extent applicable, from the point of view of the end user, content provider and transmission provider (network operator);
- stimulate and promote open and regular cooperation with mutual respect and fair approach of the operators of digital free-to-air broadcasting network or station, programme providers and other providers of digital services;
- within the digitalised broadcasting system, stimulate the offer of technologically harmonised electronic communication networks, services, digital programme contents and additional digital services towards creating a technologically uniform system;
- adopt legislation (laws and/or regulations), which should envisage and stimulate efficient shared use of equipment/systems, on non-discriminatory grounds and under acceptable terms, in order to reduce digital switchover costs, as well as the utilization costs for the future system. The possibility of broadcasting produced contents should not be conditioned by possessing own broadcasting system and vice versa;
- special attention needs to be given to ensure the compatibility of equipment owned by users with the new reception equipment, and also mutual compatibility of the equipment of various providers;
- envisage and enable for end users to have at their disposal the range of digital reception equipment from the simplest with cheapest solutions to most advanced supporting the combination of multiple digital broadcasting services;
- enable to citizens wishing only free-to-air to continue receiving these now as digital broadcasting signals without disproportionate costs involved.

5.2. Recommendations to Facilitate the Switchover Process[13]

Recommendation 1: Public Opinion Polls
Conduct public opinion polls concerning annual progress achieved in digital switchover, and also harmonize the transition process with the strategic document of the European Commission Initiative i2010.

Recommendation 2: Cost-Benefit Analysis
The optimal timeframe for the switchover process depends on the balance between costs and benefits achieved by switching from analogue to digital broadcasting systems. In that sense we recommend market research aimed to identify user views and readiness to pay for specific services.

Recommendation 3: Promotion and Information Campaigns
Timely implementation and completion of the switchover process offering at the same time support to the public related to benefits of digitalisation depends also on the proper level of end user awareness concerning the purchase of the reception equipment and service pricing.

Recommendation 4: New Approaches to Spectrum Management
New approaches to spectrum management which accelerate the switchover and the flexibility in future spectrum use are recommended. Some if these models include the application of administrative incentive pricing policy as well as market oriented approaches such as (1) overlay licensing and bidding (simultaneous participation of several types of operators for the use of the same resources) and (2) trading or selling the right to use the spectrum.

Recommendation 5: Access to Transmission Capacities of Multiplex Networks
A key requirement in opening the market for new broadcast or convergent applications is access either to radio spectrum or transmission capacity. It is particularly important during the switchover process. In view of the above, it is recommended that some share of the capacities (e.g. minimum 20% of capacities of one or several multiplex networks) should be released for trial operation and introduction of new

[13] "Implication of Digital Switchover for Spectrum Management" - Study on Spectrum Management in the field of Broadcasting,(DG Information Society), European Commission, 2004

services. In the long run, a viable secondary market may be envisaged within multiplex transmission capacities, similarly to the satellite transponder capacities.

Recommendation 6: Differentiation between "general interest" and other broadcasting services
Different treatment of broadcasting services which are of general interest (subject to relevant provisions) and services which are purely commercially based is recommended. It is moreover recommended that the provisions relating to general interest services should not be extended to include their technological enhancement such as HDTV and mobile TV. If broadcasting services require additional spectrum resources for the introduction of new services or enhancement of what is considered to be general interest, such demands must be market-based, on the same grounds as envisaged for non-broadcasting services.

Recommendation 7: Efficient Use of Digital Dividend
Based on the market needs, it is necessary to envisage the development of the broadcasting services in the long run, which is one of vital requirements for efficient use of the digital dividend. The regulatory frameworks need to be as flexible as possible to include various opportunities for future development and implementation of services in general in the part of the band considered to be the digital dividend.

Recommendation 8: International and Cross-Sector Cooperation
It is recommended to have active international and cross-sector cooperation towards successful implementation of the digital switchover and the promotion of open and competitive economy.

5.3 Guidelines – Programme Contents

Standards related to programme contents will be subject to special consideration in the switchover period. With the Strategy implementation, the introduction and application of programme standards will be intensified both for linear and non-linear audio-visual services.

The Broadcasting Agency will pay special attention to the creation of conditions and capacity building to fulfil the obligations ensuing from the Media Law, Broadcasting Law, European Convention on Transfrontier Television, EU Television without Frontiers Directive (i.e. new Audio-Visual Services Directive).

Enabling the citizens to exercise their right in the field of information and broadcasting, preservation and promotion of national culture, cultural diversity and media pluralism should be the main guidelines for the implementation of the switchover process and harmonization of legislation and practice with the European standards (adoption and application of new measures, laws and bylaws).

In the digital switchover process, special attention should be paid to the measures for ensuring sustainability of public service broadcasting and maintenance of media pluralism. In this respect, the must-carry rules and condition for national and local public broadcasting services should be redefined and reconsidered on regular basis. In any case, the conditions should be provided for end users to be able to receive these programmes without additional financial burden, regardless of distribution method.

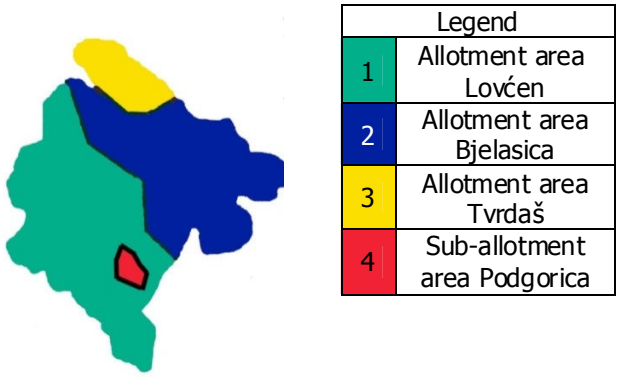
An important factor for the success of the switchover process at the national level is the efficient communication with end users concerning the entire process, but also the availability of programme content and equipment necessary for the reception. This segment of the switchover strategy will be very important as the level of initial awareness of all social segments concerning this process and its consequences is currently not satisfactory. In this field, the following stakeholders will have a special role: media (both public and commercial) and their associations, Broadcasting Agency, Government of Montenegro and line ministries, consumer associations and others.

5.4 Guidelines – Digital Networks

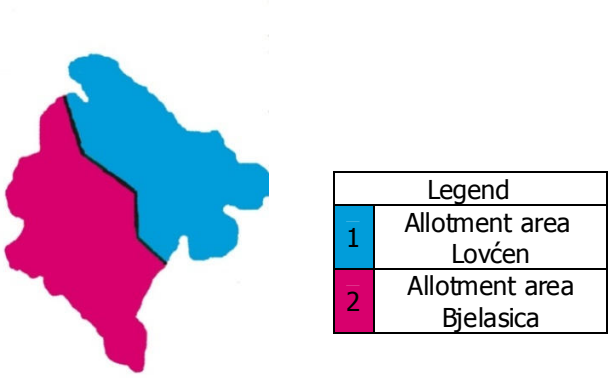
The Radio Frequency Allocation Plan for digital broadcasting systems of Montenegro, contained in the Final Act of the GE06 Agreement has been developed by combining the allotment and assignment planning and includes:

- Plan for digital terrestrial television systems i.e. DVB-T plan, including seven national coverages in the UHF band and one national coverage in the VHF band;
- Plan for digital terrestrial audio systems i.e. T-DAB plan, including three national coverages for digital radio.

Every national coverage is comprised of 3 separate geographic areas i.e. allotment areas. The Digital Plan also includes an additional sub-allotment area for the coverage of the capital city, defined, in addition to the basic seven coverages, by additional 11 coverages in UHF band.



Graphical overview: 3 allotment areas for UHF band named after the main transmission sites within each of the areas – Lovcen, Bjelasica and Tvrdas and sub-allotment area for the coverage of capital – Podgorica.



Graphical overview: 2 allotment areas for VHF band named after the main transmission sites within each of the areas – Lovcen and Bjelasica

Drafting and coordination of the plan based on the allotment planning method in combination with the assignment method, i.e. defining of parameters for all important transmission sites in Montenegro enabled the flexibility of implementation and purpose of the plan for digital broadcasting systems.

Number of coverages within each allotment area is in line with the principle of equitable access to the spectrum, meaning that Montenegro will be able in future to exercise its rights to use digital transmission systems in the broadcasting part of spectrum as a limited resource on an equitable basis with other countries in the region. Taking into consideration the results achieved considering the number of planned and coordinated coverages with the capacity for transmission of 4 to 10 different programmes using a single frequency channel, current and future needs of broadcast media in Montenegro have been met.

One of the main conditions for the beginning of implementation of digital broadcasting systems is the availability of frequency spectrum, most of which is already in use for the analogue broadcasting systems. Therefore, the beginning of implementation of the third and following multiplexes is directly conditioned by releasing the spectrum used by analogue broadcasters.

The starting points stemming from such a digital plan and current level of spectrum saturation are the following:

- Switchover is different in frequency allotments for 3 regions (allotment areas) and the capital (sub-allotment areas);
- Criteria for the inclusion of programme and other contents in the multiplex have been defined (division taking into consideration the type of content and coverage area);
- For the purpose of 2 multiplexes, actual frequency allocation have been defined within the GE06 Plan, making possible the implementation of two national networks;
- Other multiplexes (third and more) which can also form national networks will be operational depending on the availability of frequencies in the individual allotment areas;
- Conditions regarding programme contents and capacities of a single multiplex have been defined;
- Switchover deadlines must be harmonized with the countries in the region and with the EU recommendations and directives;
- All stakeholders in the switchover process are obliged to coordinate their activities in order to meet the foreseen deadlines.

The implementation of digital broadcasting systems in Montenegro will be based on single-frequency networks (SFN), meaning that several time and frequency synchronized transmitters will broadcast the same signal on the same frequency. In order to provide for the efficient use of the frequency spectrum, digital transmitters will operate in the SFN mode wherever technically feasible from the point of view of synchronization. Combining the SFN networks of separate allotment areas, national networks are set up, efficiently utilizing the frequency spectrum.

In the switchover process, the protection of future of transmission of broadcasting signals at local and regional level should be ensured. Since only local coverage cannot be provided within the multiplex for national networks, it is necessary to continue working on further coordination of frequency allocations for separate sites in order to form multi-frequency networks (MFN). After conducting coordination procedures for MFN networks with local coverage, their implementation will greatly depend on the switchover pace, i.e analogue switch-off and releasing a part of spectrum used by the analogue systems.

Channels for the national networks MPN A and MPN B have been selected on the basis of:

- Allocations contained in the Final Act of the GE06 Agreement for Montenegro;
- Availability of frequency spectrum;
- SFN operational capacities;
- Equality of networks with national coverage.

The Appendix to this document contains a detailed elaboration of implementation of individual multiplex networks for each of the three separate allotment areas, in compliance with the international digital broadcasting plan Geneva 06 (Appendix 1). Frequency allocations for the first and second national coverage network referred to in Appendix 1 relate to the DVB-T networks to be implemented. After analogue switch-off a certain number of channels of the broadcasting spectrum will be used also for DVB-

H, and the selection of frequency allocations for DVB-H systems will be harmonised with EU recommendations.

For rural areas, where DVB-T network is not commercially viable, it is recommended to provide reception via satellites or other distribution systems, which will reduce the costs for the construction and maintenance of DVB-T low power repeater network.

National coverage network may not be used for the needs of local broadcast services. It can only be resolved by defining the network of individual transmitters within municipalities (MFN network transmitters). Broadcasting Agency will conduct necessary measures to create MFN network to be used for the needs of both national and local public broadcasting services, as well as for additional services of national public broadcasting service (HD etc.).

After beginning the digital launch, the areas with great population density (major towns in Montenegro) will be additionally studied and, depending on the need, the "indoor" reception will be provided.

Main parameters characterizing digital broadcasting systems

Apart from the standard parameters such as frequency or channel, site, system radiation pattern, effective radiated power, etc., the following parameters are characteristic for digital transmitters:

- type of modulation COFDM (QPSK, 16-QAM, 64-QAM);
- code rate (1/2, 2/3, ¾, 4/6, 7/8);
- guard interval (1/4, 1/8, 1/16, 1/32);
- compression standard (MPEG-2, MPEG-4);
- other parameters.

As regards the above parameters, the Strategy foresees the implementation of systems using MPEG-4 as a compression standard. The advantages of introduction of MPEG-4 standard over MPEG-2 are related to the following issues: future improvement of the system; two times better utilization of frequency spectrum; and better utilization of capacity of distribution network.

Bearing in mind that future digital broadcasting systems should be HDTV ready, for the purpose of further development of the system, MPEG-4 has incomparable advantages over MPEG-2. Transmission of only one HDTV signal using MPEG-2 compression requires 1 TV channel, which implies inefficient use of frequency spectrum. Two times better efficiency of spectrum utilization can be explained on the following example. With the selected configuration of parameters 64-QAM, with ¾ error correction, 1/8 quard interval and 8K mode, using the MPEG-2 compression, one channel can transmit 5 SDTV programmes (standard resolution TV), while using MPEG-4 system, 10 SDTV programmes can be transmitted.

Video compression system MPEG-4 is characterized by a lower bit rate as compared to MPEG-2 system, while it provides the same quality. In view of that, using MPEG-4 compensates for the demand for higher bit rate which is important for the introduction of HDTV.

Countries opting for MPEG-2 compression are facing difficulties in the introduction of HDTV, with the inefficient spectrum use and reduction of capacities for distribution of greater number of television programmes. Some countries that implemented digital broadcasting systems with MPEG-2 compression standard are already undertaking measures necessary for switching to MPEG-4 standard. This results in additional complications and problems in finalization of switchover process related to the implementation of SFN networks and need for additional frequency allocations necessary for introduction of MPEG-4 system. Many European countries, currently initiating the deployment of digital broadcasting systems, are considering or have already decided to adopt the MPEG-4 standards for the purposes of DVB-T.

MPEG-4 standard is officially approved by the European Telecommunication Standardization Institute – ETSI. Since the migration from SDTV to HDTV is expected in the upcoming period, it is required to monitor developments globally and in Europe and adapt the plan for the needs of HDTV in line with the

ITU and EU recommendations. The adoption of DVB specifications for digital terrestrial television in HDTV resolution (DVB-T2) is expected in late 2008. Since STB and DVB-T receivers will not be able to receive DVB-T2 signals, there is a possibility that HDTV may for a certain period operate in the DVB-T system with MPEG-4 compression requiring a special STB type.

Networks for digital broadcasting systems can be planned for different types of reception:

- fixed reception;
- mobile reception (antenna installed in the receiver);
- portable reception in open space – portable outdoor (with external antenna and antenna installed in the receiver);
- portable reception in closed space – portable indoor (with external antenna and antenna installed in the receiver).

6. Strategy Implementation - Timeframe

6.1 Deadlines

The digital switchover strategy of Montenegro is based on the following:

- 2003 EC Communication on transition from analogue to digital broadcasting, COM (2003) 541[14];
- Final communication of European Commission on acceleration of transition from analogue to digital broadcasting COM (2005) 204.
- 2005 EC Communication COM (2005) 229 "i2010 – A European Information Society for growth and employment"[15];
- Proposed deadline for analogue switch-off in the EU Member States;

The Strategy is based on the analyses of the switchover process in other countries, taking into consideration the information society strategies, financial aspects, network capacities, transmission systems, and the overall situation in the broadcasting industry of Montenegro.

The digital switchover process is complex considering the necessity of its implementation on the entire territory of Montenegro. This involves the implementation of new digital transmitters and adaptation of the existing infrastructure on most of the transmission sites used today, which requires a considerable investment. On the other hand, additional expenses involved are those for the reception base for end users. Given that the EU members states have initiated this process intending to finish it by 2012, some of them even sooner, Montenegro has a rather short period of time left to carry out this process keeping pace with them. Bearing in mind enormous expenses each of the switchover phases entails, as well as their complexity, it is necessary to initiate this process as soon as possible.

The Strategy also takes into consideration the EU researches and policy guidelines related to the importance and future use of spectrum resources, which will be available after the analogue switch-off, as well as the conclusions of market research and further management of the free part of frequency spectrum, conducted by the European Commission.

This Strategy sees 2012 as the final deadline for the finalisation of the switchover process, by which time all analogue broadcasting stations will have stopped working, which is in line with the Final Communication of European Commission on acceleration of transition from analogue to digital broadcasting COM 82005) 204 aimed at the EU member states. Positive effects of the switchover will be visible earlier if such a transition is completed as soon as possible at the national level. The Strategy also defines methods of transition from analogue to digital broadcasting, as well as the deadlines in line with the EU Directives.

6.2 Switchover Phases

The Strategy foresees 2012 as the final deadline for the transition from analogue to digital broadcasting. The switchover phases have been harmonized with the EU recommendations, but also with the final date of analogue switch-off in the EU Member States and the countries of the region.

The transition process of the national public broadcasting service is a complex process and it is one of the priorities at the same time. The network operator which will have, in compliance with the awarded licence and the legislative framework, the largest service area with the greatest population in Montenegro, will at

[14] Communication From The Commission To The Council, The European Parliament, The European Economic And Social Committee And The Committee Of The Regions on the transition from analogue to digital broadcasting (from digital 'switchover' to analogue 'switch-off').

[15] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - "i2010 – A European Information Society for growth and employment" .

the same time carry out the transition process for the purpose of the national public broadcasting services. In this process, we must take care that sufficiently numerous reception base is achieved to make the switch-off of individual analogue stations of the national PBS justifiable. Other TV and radio stations can decide for themselves about their respective coverage areas on the basis of the options proposed and determined criteria.

In essence, digital reception of those programmes for which users currently have analogue reception needs to be made possible by the end of the transition period. Considering current state of the broadcasting system in Montenegro, digital launch will be carried out as follows:

- **2008**
  - commencement of the pilot project for Podgorica and some other areas in Montenegro;
  - setting up the fund for the switchover process;
  - adoption of legislation;
  - coordination in drafting by-laws;
  - preparation of the first DVB-T tendering process.
- **2009**
  - tender for the first multiplex;
  - research of the multimedia and interactive services demand;
  - launching the first multiplex;
  - deployment of planned networks;
  - development of multimedia and interactive services
- **2010**
  - tendering the second multiplex;
  - further expansion of networks of the first two multiplexes;
  - development of multimedia and interactive services;
- **2010 - 2012**
  - gradual switch-off of analogue transmitters with 31 December 2012 as the final deadline;
  - adoption of decisions related to new/other multiplexes.

Following the switchover timeframe, communications campaign is essential to inform the citizens of the importance of the transition to digital broadcast systems, advantages compared to the analogue ones and the schedule of activities so that quite early in the process, based on the information provided, citizens may become active participants.

Despite clear and precisely defined plan and phased timeframe for the switchover process, there may be some delays due to contingencies or difficulties in setting the equipment for digital broadcasting systems, possible complications related to equipment procurement or lack of response on the part of end users concerning the purchase of digital reception equipment. It is to be expected that initial difficulties which might be encountered in the switchover process will be reduced or fully eliminated in time and following the developments. Technology development and implementation of digital broadcasting systems in EU member states and in the neighbouring countries will additionally contribute to the digital launch in Montenegro.

7. Strategy Implementation – Legal Aspects

In general, the transmission and broadcasting of digital signals is seen from the legal perspective as a separate issue for the following category: producers or providers of content, multiplex operators, network operators.

a) Content producers or providers

The legislative provisions of most European states expressly stipulate that content providers do not have the right to act at the same time as a multiplex operator and a network operator. This is an issue that needs detailed elaboration by the Broadcasting Law and Digitalisation Law considering the anti-monopoly norms related to multiplex operators and content providers and taking into account that it is a limited natural resources granted to the multiplex operator.

Considering that the convergence of networks and services, as well as technological enhancements delivers the opportunity for the separation of production of content from their transmission, thus enabling to content producers to focus solely on producing programme content, which essentially is their basic activity, the legislative framework should stipulate the details of the licensing procedure to recognize separate categories of entities, i.e. to clearly separate the contents production activity from its transmission and distribution.

b) Multiplex operators

A multiplex operator is a provider of the multiplex service as a standardized signal flow for digital broadcasting services including, apart from television and radio programmes, also other digital services, electronic communication services and other accompanying identification signals and data. In some countries the licence limits the data rate which can be used for additional digital services, electronic communication services and other accompanying identification signals and data. In addition, the transmission of contents other than radio and/or television programmes, is in some countries regulated by the issuance of a special license for transmitting additional contents. The legislative provisions need also to stipulate the terms for limiting the data rate for additional contents.

Services other than radio and/or television programmes transmitted in the same multiplex with radio and/or television programmes which are technologically possible and meaningful to be offerd together are called complimentary services. For complimentary services, the legislative framework should stipulate the issuance of separate licences, where both multiplex operators and network operators may be holders of such licences.

In case multiplex is not intended for digital broadcasting of television and/or radio programmes, such a multiplex offers innovative services for the transmission of which there need to be in place regulatory provisions harmonised with internationally binding documents.

c) Network operators

The network operator transmits the multiplex signal to end users via transmission network as a set of technical procedures, electronic communications and other devices for linking the signal with the transmission environment (medium).

Transmission network may be:

- free-to-air broadcasting network and station broadcasting digital free-to-air signals – a set of electronic communication devices and accompanying electronic communication infrastructure where broadcasting of digital signals to end users is done in the form of a multiplex on frequencies allocated to free-to-air broadcasting systems;

- conditional access network is a system in which access to protected broadcasting service in its non-coded form is conditioned by the conclusion of a subscription relation or other form of prior individual authorisation.

Public broadcasting service programme distribution to end users must be carried out via digital broadcasting services without extra costs for PBSs (must carry rule). In addition, the distribution of PBS programmes to end users must be realized without extra costs for end users via free access networks.

The first national coverage network must be free-to-air transmitting multiplex signal to end users without extra charges and to contain the programmes of the national public broadcasting service on the principle of must carry rule. With the above in view, BCM, according to the automatism to be further elaborated by legislation should be the operator of the first network with national coverage, and the holder of the multiplex operator licence as a provider of the multiplex service containing the programmes of the national PBS. The remaining capacities within the multiplex may be used by the BCM for the transmission of other programme contents and complementary services. In doing so, other content providers and complementary service providers need to comply with the conditions to be granted proper licences by the Broadcasting Agency following the tender procedure. The conditions for the transmission of programme content (with the exception of the national PBS) of the first multiplex, via the first national coverage network which will not be subject to tender procedure, but be automatically assigned to BCM, from the point of view of rights and obligations of this company towards the regulatory body, should be precisely stipulated in relevant law or by-laws.

Other multiplexes and national coverage networks will be subject to public tender procedure to be elaborated in legislative provisions. On tenders for allocation of licences for multiplex operators and network operators the applications of entities (including BCM, if applying) which are not content providers will be assessed on equal footing. The criteria for granting licences will be subsequently defined in legislation.

8. Strategy Implementation – Economic Aspects

The digital switchover process must be market-oriented, requiring at the same time a high level of harmonization for the purpose of achieving an equal and market-based implementation (e.g. compatibility of plans, joint presentation).

However, determining switchover modalities and the digital switchover itself was faster in countries that did not rely on the market-orientation only, but also on clearly defined and determined objectives and procedures binding both for the existing operators of broadcasting services and content providers. It is beyond any doubt that the accelerated transition to digital broadcasting at the national level gives a direct positive effect. Harmonization as regards duration of the switchover process is a key factor. Earlier beginning of the transition period results in its shorter duration, giving the expected positive effects at an earlier date.

Public awareness of the advantages of digital broadcasting services and acceptance of new services is crucial for rapid commencement of the process, while the release of radio-frequency spectrum caused by the analogue switch-off and creation of a competitive environment related to the cable distribution networks provides an additional incentive for the switchover process.

There are no precise analyses of costs involved in the switchover process and the level of increase of costs as compared to the analogue broadcasting. However, on the basis of the experience of other countries, it can be concluded that the costs caused by digital transmission are by 40 to 70% higher. Savings in electric power after the digital switchover are considerable, given that one digital transmitter replaces four or even more analogue ones.

The retail prices of digital receivers (STB) have decreased considerably since the first report of the European Commission on the transition process. The prices of digital ready TV sets are also lower. For most of the population, it should not be a problem to buy the equipment necessary for the reception of the digital TV signal. A possible version of the accelerated transition process is the solution through financing/subsidizing of the STB procurement for end users, which is economically acceptable by the providers. Such measures have showed the best results in Germany, while their effect was also satisfactory in Italy. At the EU level, there is still no common practice, while the related legal options have not been defined in enough level of detail.

The principle of technological neutrality emphasized in the EU legislation implies that the use of special technologies need not be imposed but also not disregarded. This, however, does not prevent the EU member states to adopt adequate measures for promotion of special technologies for digital broadcasting systems, aimed at the increase of efficiency of the frequency spectrum use.

The European Commission emphasizes that the switchover process is related to and includes different services, networks, and business models, and that different treatment of the stakeholders in the market and technology must be justified (based on facts) in this process.

To that effect, some of the acceptable financing models from public funds are as follows:

- investment in the transmission networks in the areas with weak signal or the areas not very interesting to investors (rural areas, sparsely populated areas);
- financial compensations for the transmission of public broadcasting services, in order to make them available to the entire population, by defining separate provisions dealing with these services;
- Subsidies for the procurement of reception equipment for digital broadcasting signal intended for end users should support technological neutrality, especially when they are incited to use open standards for interactivity;
- financial compensations for broadcasters that must switch-off their analogue transmitters before the expiry of the licences for the transmission and broadcasting of radio and TV

signals on account of special interest related to the acceleration of the switchover process and releasing a part of spectrum necessary for the promotion of this process.

Data on the switchover process in the European countries show that the success of the transition to digital broadcasting in the sense of the shortest possible simulcast period, is conditioned by financial and other forms of support to content providers, subsides for the households, provision of the equipment such as STB for the reception and demodulation of terrestrial signals and intensive public awareness campaigns about the aims and advantages of the implementation of digital broadcasting (one of the examples is Germany).

Planning of the switchover strategy and implementation of previous systems must include and take into consideration the advantages and disadvantages for all stakeholders and interested parties involved in this process, define and emphasize the value-added services to be provided and new services to be implemented by means of digital broadcasting systems.

The economic impact on the individual stakeholders/interested parties in the transition process can be presented in the following manner:

Switchover stakeholders:	***Investment:***	***Positive effects:***
Programme content providers	- new studio equipment - new signal transmission systems - new methods of programme production	- lower costs of signal transmission - possibility of higher revenues from commercials and ads - new revenues
Network operators	- new signal transmission systems - new antenna systems - partly new connection systems	- lower energy consumption after the full launch - rationalisation of equipment and space - cheaper monitoring
End users	- new reception equipment - partly new antenna systems	- fewer devices needed (all in one) - lower energy consumption
Equipment manufacturers	- introduction of new technologies - new manufacturing models	- new jobs - extension of sale possibilities - rationalisation of production and use of materials
Government, administration	- financing information campaign - testing subsidies for equipment and certain services	- greater competitiveness and media pluralism - frequency dividend

The investment and cost estimate for the first DVB-T national coverage network is given in **Appendix II – Cost Assessment for the first DVB-T national coverage network**.

Based on that, the following may be concluded:

- Cost estimate for **complete DVB-T national coverage network**, given in table 2.3 of the Appendix II, amounts to **€2,578,300** and includes transmitters, diplexers and gap fillers. More detailed cost estimate for specific sites and equipment type is given in Tables 2.1 and 2.2. of Appendix II;
- Cost estimate for **multiplexers and coders**, given in Table 2.4 of Appendix II, amounts approximately to **€300,000;**

- The funds required for the **pilot project** with equipment, shown in Table 2.5, amount to **€678,400**. Having in mind this as well as the cost estimate for multiplexers and coders and basic measuring equipment, the total of **€1,000,000** will be needed for the pilot project bearing in mind that this amount does not include equipment costs and infrastructure works;
- Digitalisation of **complete network** would amount to **€3,000,000**, not taking into account the costs for spare transmitters and equipment, as well as infrastructure works;
- If taking into account the **spare transmitters**, total costs would be increased according to prices quoted in Table 2.1 of Appendix II, depending on the number and type of spare transmitters that need to be provided. Best quality solution by the way of system reliability is achieved by installing spare transmitters, so we recommend their installation at all significant sites. The list of significant sites is identical to the list of sites from Table 2.1, meaning that by taking into account the costs for spare transmitters for 36 most significant transmission sites from Table 2.1, the total costs of digital switchover to the first DVB-T national coverage network **are increased for additional €1,500,000;**
- The digitalisation of **complete network with spare transmitters** (without infrastructure works) would amount to some **€4,500,000;**

The following should also be taken into account:

- At least one measuring receiver, one measuring decoder, stream analyser, several STBs of various manufacturers, a monitor and other measuring equipment as needed should be provided for the needs of the Broadcasting Agency;
- Given estimates do not include costs for the implementation of signal distribution, since they fall within a separate BCM project for digital radio-relay transmission;
- The above estimates do not include costs for the provision of reliable power supply, antenna systems, air-conditioning, spatial capacities, etc. Due to the substantial amounts needed here, these costs should be estimated as soon as possible by the BCM in cooperation with the Agency.

Cost assessment for consumers:

- The cheapest way to enable digital signal reception for consumers is by STB;
- In early 2008, the market price of a STB for MPEG-2 compression was approximately €30-50. On the other hand, it is estimated that the price of STB with MPEG-4 compression will be in the range of €60-80 in 2008.

The recommendation is to purchase solely the equipment which enables the reception of DVB-T signals with MPEG-4 compression. It may be a DVB-T receiver with MPEG-2 compression with CI slot.

Considering that digital broadcast systems are a brand new technology, some training for the new systems will be needed. The training will be needed for the staff at transmission sites, as well as those in charge of maintenance of the transmitter and repeater network. When selecting the equipment manufacturer the training by the manufacturer finally selected should be borne in mind.

Investment and cost estimates for the purchase of STB reception equipment for the total population of Montenegro may not be done since there are no estimates of the number of households that would need support to purchase the equipment. Thus, through cooperation of relevant authorities and institutions, the size and structure of this target group needs to be defined, as well as the amount of subsidies needed.

It is estimated that the procurement of 100,000 STB is needed for the pilot stage, and that the subsidy needed amounts to 30% of the STB receiver price. Taking €80 as the price of the STB receiver with MPEG-4 compression, the minimum amount of funds to be provided is approximately €2,400,000 for STB procurement.

Taken into account the cost estimates for the first network with national coverage, spare transmitters and minimum funds required for STB procurement (for the pilot stage), the total investment amounts to some €7,000,000.

9. Strategy Implementation – Attainment of Objectives

With clearly defined Strategy and precise dynamics of the switchover process, the effects achieved by the transition from analogue to digital broadcasting can be both positive and immediate at the same time, reflected directly and indirectly.

As regards the complexity of procedure and involvement of different stakeholders in the transition process, as well as the impact of digital broadcasting systems on everyday life, it is necessary to have a broader political, economic, public and individual consensus.

Performance indicators for strategy goals implementation are as follows:

- Required legislation to be adopted by late 2008;
- Ensure pilot project launch in 2008;
- Timeline (see Chapter 6.2.) without undue delays;
- Solutions with specification of transmission and reception equipment to enable the introduction of additional services such as HDTV etc to be adopted in first quarter 2009;
- Increased quantity and quality of production;
- Reduced transmission/distribution costs for PSB programmes;
- Increased selection of added value services compared to existing analogue broadcast systems.

10. Digital Broadcast Systems for the Transmission of Audio Signals

10. 1 Reasons for Introducing Digital Radio

The first broadcasting standard for transmission of audio signals was based on the amplitude modulation (AM) transmission of processed audio signal of 50 and 4500 Hz in LF, MF and HF frequency bands (long-wave, medium-wave and short-wave). In addition a larger number of narrow sub-bands were allocated, the total of 3 MHz in the range between 4 – 27 MHz.

The main shortcomings of such transmission were:

- transmission bandwidth was not adequate for attaining good quality of sound reproduction;
- amplitude modulation (AM) did not enable adequate removal of interferences occurring within the frequency band of the broadcast signal;
- there are frequent changes in the strength of the primary radio signal (fading) in the HF frequency band which affect considerably the reception quality.

In late 1950s the transmission of audio signals of much better quality was introduced, based on frequency modulation (FM) in the VHF frequency band 87.5 – 108 MHz. Its main advantage is in the good-quality of sound reproduction in the range between 20 Hz – 15 KHz. Transmitter radio signal undergoes frequency modulation by audio signal where the broadcast signal has the width of 150 kHz. By extending the spectrum in modulation much greater resistance to interferences in signal reception is achieved. Due to these advantages, the FM has remained predominant in broadcasting to our times.

Good reception may be achieved with stationary VHF receivers of FM signal; however, the same does not hold true for the reception in vehicles in cases when there are changes in the field strength due to various obstacles or due to the reception of a direct or reflected signals with various delays.

Since frequency bands for AM and FM signals have been used almost to the full, further development of these systems quality and quantity-wise is practically limited, and addition of new data services is not possible. It may be achieved only through the allocation of new or better utilisation of already allocated frequencies. Due to general lack of available frequency band, it is unlikely that existing broadcasting services will be allocated new frequency bands.

In early 1990s national radio operators in Europe have established the following main shortcomings of analogue transmission:

- inadequate sound quality;
- problems in mobile reception;
- saturation of the frequency spectrum;
- inability to transmit programmes with associated additional data services.

The above conclusions led to seeking suitable new solutions. In doing so it was obvious that analogue signal processing and transmission will not prove to be good enough to remove the shortcomings of current devices. At the very same time digitalisation of signal transmission and processing has advanced to such an extent to enable numerous improvements to broadcasting devices. These improvements are primarily as follows:

- compression of digitalised sound enables transmission rates up to 50 kb/s (sound of the same quality as CD with 1.4 Mb/s writing);
- protective coding of compressed audio signal and digital modulation of radio signals attain high utilisation of the frequency spectrum and great resistance to interferences due to errors in received digital signal ;
- simple digital procedures attain time and frequency distribution of audio signals resulting in great resistance to changes in the strength of the primary radio signal (fading);
- digitalisation of transmission and digital signal processing in the receiver enable multi-system receivers and reception of signals in different frequency bands, and with appropriate

programming equipment and various modulation procedures. Thus, receiver may be constantly adapted to new technical standards by simple change of the programming equipment. Also, additional equipment for communication with other digital communication devices such as GSM or UMTS may be installed within a radio receiver, opening the opportunities for active interaction between users and radio operators, either to take part in programmes or to order various additional services, putting in practice the idea of an interactive radio.

Throughout the development of new digital systems for transmission of audio signals the issue of economics was constantly raised. Due to its profitability, digitalisation of signals was already fully introduced in studios for analogue broadcasting since it greatly simplified programme production and reduced costs. The new technology and opportunities it offers will incite new programme creators from the local to global level and lead to the separation of broadcasters to content providers and network operators.

With this in mind, the introduction of digital systems to broadcast audio signals is the consequence of the development of society, services and technology. Considering the development to date, it is likely that various technical solutions will be complementing each other.

10.2 T-DAB Systems

10.2.1. Basic Characteristics of DAB Systems

Digital broadcasting systems for the transmission of audio signals (DAB) were developed by the Eureka 147 consortium. The development of these systems for the transmission of audio signals was actively supported by the European Broadcasting Union (EBU).

DAB systems are primarily designed for the transmission and broadcasting of high-quality digital audio signals. The reception of digital audio signals can be achieved by means of mobile, portable and fixed receivers. DAB systems were developed for broadcasting in different frequency bands ranging up to 3 GHz by terrestrial, satellite, hybrid (terrestrial and satellite), as well as cable networks.

Basic features of DAB systems are as follows:

- multiplexing, so that an individual transmitter broadcasts 6 to 7 programmes with the digital transmission rate of 2.4 Mbp/s, contributing to better utilisation of the transmission infrastructure;
- digital transmission rate of the broadcast signal is shared among sound programmes, their associated data (which define programme name, daily programme, names of authors and performers, etc) and information of advanced multimedia services (various reports, timetables, sport results, ads, etc.);
- considering the desired quality of sound transmission, certain sound signals have data rates of 128 to192 kbp/s. The compression procedure used – MUSICAM requires for current conditions a relatively high rate, but yields very high quality sound;
- correction of bits received with errors is achieved by protection coding and ensures flawless reception regardless of the existence of errors at the receiver input. The level of protective coding of certain signal bits is proportionate to the importance of information transmitted;
- compression and modulation at the transmitter side and inversion procedures in the receiver are based on extensive digital processing of the signal which enables high-performance integration of transmission and reception system and the implementation of programmable receiver for DAB and other systems;
- time and frequency distribution of information in the transmitted signal contribute greatly to the reduction of interferences in transmission. If short interval sound recording is distributed over the further interval, the fall out of the transmission within the short interval will destroy only part of information while the rest will yield to satisfactory reconstruction on reception. The same applies for frequency distribution since strong changes in the power of primary signal (fading) usually occur only in lower frequency ranges compared to the total broadcasting bandwidth;

- In the transmitted signal a large number of ortogonal carriers in the frequency range of 1.5 MHz is modulated with digital signal. For broadcasting using the terrestrial network of transmitters in the range below 375 MHz there is the total of 1,536 carriers and for broadcasting below 1.5 GHz there are 384 carriers. For satellite broadcasting below 3 GHz there are 192 carriers. Each carrier is modulated by differential quadrature phase shift keying (DQPSK). Overall modulation sequence is distributed per carriers so as for the phase between individual carriers to be changed relatively slowly with the interval of 1.25 ms in the band with 1536 carriers, i.e. 312.5 and 156.25 ms in other two bands with fewer carriers;
- Two frequency bands are dedicated for DAB broadcasting: part of VHF band (209 – 230 MHz) and L-band (1452 – 1492 MHz, lower part for the terrestrial network, upper part for satellite broadcasting);
- Economic utilisation of the transmitter power and frequency bands;
- Transmitter networks may be built as single-frequency networks (SFN). Signals received at the transmitter input are aggregated. Due to phase differences among the signals of the same carrier aggregation causes strengthening or weakening at certain carrier at the receiver input. With a large number of carriers we may conclude that inter-relations of several transmitters are expressed in the aggregation of power of the total primary signal. Mutual interferences of carriers are not destructive, as is the case with systems with one carrier (with AM and FM modulations), since due to phase differences among carriers some carriers are strengthened while others are weakened. This feature enables that the signal may cover extensive areas by the application of AB in the allocated frequency band;
- When using the same frequency for transmitter of different distance of various multiplexes in the DAB system there are much lower demands concerning the impact of other transmitters then is the case in analogue broadcasting;
- To achieve regional coverage, DAB has much lower consumption power than FM. For the sake of comparison, required broadcasting power and equal quality of reception for 6 DAB programmes and 5 FM programmes in Bavaria showed the ratio 1:170 (9.7:1662 KW), best illustrating great savings attained by the application of DAB systems.

The quality features of DAB system greatly exceed the analogue transmission. It is primarily seen in reception in vehicles. In the conditions of great variations in the strength of the primary radio signal, where FM reception is usually burdened with frequent interruptions, DAB ensures flawless reception. The same applies for harmful Doppler Effect for reception in vehicles. The reception of the DAB signal broadcasted at 230 MHz becomes critical due to Doppler Effect only at greater speeds.

According to the DAB forum data, there is currently a great variety of DAB receivers by different manufacturers available at the market. The prices of receivers able to receive both DAB and AM and FM signals are still relatively high.

Notwithstanding great European coverage (DAB systems are most developed in Germany and the UK) there are still very few receivers. The signal covers mostly densely populated areas and most important crossroads. Lack of motivation on the part of users is caused by several factors:

- Few programmes using solely DAB;
- Additional services enabled by DAB are still not well developed;
- Relatively high receiver price.

The following may have a positive impact on future development of the DAB system:

- allocation of frequency band below 300 MHz;
- more specialised audio programmes and a wide range of data services;
- reducing the receiver price.

This Strategy focuses on digital broadcasting systems for the transmission of audio signals by means of terrestrial network, namely T-DAB systems in VHF frequency band.

The most important positive effects of the implementation of T-DAB system as compared to the analogue FM systems are the following:

- robustness of the system;
- improvement of the reception signal quality;
- better utilization of frequency spectrum by means of SFN networks (one VHF band frequency block can transmit much more radio programmes than the VHF of the similar bandwidth, which is used to broadcast FM signal);
- lower susceptibility to interference;
- lower susceptibility to environmental conditions;
- transmission and broadcasting of additional contents and information.

10.2.2 Frequency Allocation Plan for Terrestrial Digital Audio Broadcasting in Montenegro (T–DAB plan)

Frequency allocation plan for digital broadcasting systems of Montenegro, contained in the Final Act of the GE06 Agreement, except from the part related to DVB-T, includes the frequency allocations for T-DAB in the VHF band.

For the purposes of T-DAB service, two allotment areas, Lovcen and Bjelasica, were defined, named after their respective main transmission sites.

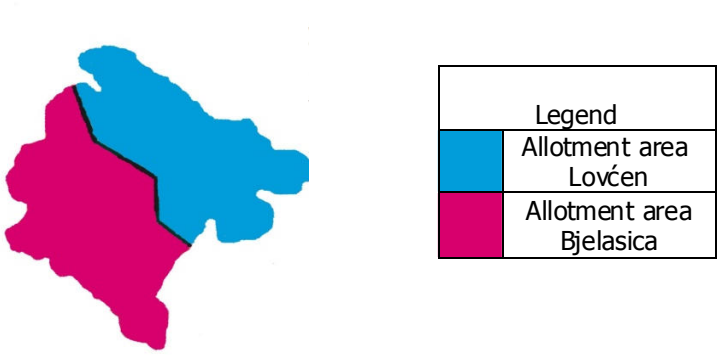


Figure 3: Allotment areas for T-DAB:

T-DAB plan of Montenegro in the Final Act of the GE06 Agreement contains the following frequency allocations for the Lovcen allotment area:

Administrative unique reference ID (GE06 Agreement)	Block	Name of the allotment area
ARD CG L 10B	10B	LOVCEN
ARD CG L 11C	11C	LOVCEN
ARD CG L 12C	12C	LOVCEN

For the Bjelasica allotment area, T-DAB plan contains the following frequency allocations:

Administrative unique reference ID (GE06 Agreement)	Block	Name of the allotment area
ARD CG 10A	10A	BJELASICA
ARD CG 11A	11A	BJELASICA
ARD CG 12A	12A	BJELASICA

According to the T-DAB plan of Montenegro, contained in the Final Act of GE06 Agreement, three networks with national coverage can be set up.

10.2.3 Implementation of the T-DAB System

For the purpose of T-DAB plan, the Final Act of GE06 Agreement foresees the VHF frequency band currently used for analogue television stations. Hence, the beginning of T-DAB implementation greatly depends on the switchover pace, especially on the switch-off of analogue stations broadcasting TV signals in the VHF band.

In Montenegro, the VHF frequency band is mainly used for broadcasting TV programmes of the national public service broadcaster. In view of the aforementioned, the beginning of T-DAB implementation will follow in the later phases of the switchover process when the conditions have been met for the switch-off of analogue stations for broadcasting of TV signals in the VHF frequency band.

In European states the implementation of the T-DAB system has been limited so far. The main reason for such a state is relatively high receiver price, even in the countries which have almost fully completed the digital switchover process, thus releasing a share of the VHF band from analogue television transmitters.

Although T-DAB systems have superb characteristics compared to analogue FM services for transmission of sound signals in view of their robustness and other features listed in Chapter 9.2, enabling mobile reception even in mountainous region, the original sound compression algorithms have already been outdated from the point of view of the development of these systems. There are already ideas for the development of a more state-of-the-art version, T-DAB+ or the interactive version of the digital signal transmission T-DMB (Terrestrial Digital Multimedia Broadcasting). However, no receivers are yet available in the market for these versions.

On the other hand, the FM frequency band 87.5-108 MHz used for transmission of analogue radio signals has been already fully utilised in most European countries, the same applying to Montenegro as well when it comes to possible use of this part of the frequency spectrum. With this in view, it is expected that in near future new proper solutions will be sought globally towards further development of audio signal transmission systems. Consequently, this strategy does not give any detailed guidelines, but envisages detailed elaboration of further digital audio systems development through the legislative framework, after the adoption of the EU Recommendation.

10.3 Digital Radio Mondiale – DRM Service

10.3.1. Basic Characteristics of the DRM Service

Digital Radio Mondiale (DRM) is the universal, openly standardised, digital radio system for short-wave, medium-wave and long-wave - digital radio for the radio frequencies below 30MHz. It has been endorsed by the ITU, and is standardised as ETSI ES 201 980.

DRM has near-FM sound quality plus the ease-of-use that comes from digital transmissions. The improvement over AM is immediately noticeable. DRM can be used for a range of audio content, and has the capacity to integrate text and data. This additional content can be displayed on DRM receivers to enhance the listening experience.

DRM uses the existing AM broadcast frequency bands and is designed to fit in with the existing AM broadcast band plan, based on signals of 9 kHz or10 kHz bandwidth. It also has modes requiring only 4.5 kHz or 5 kHz bandwidth, and modes that can take advantage of wider bandwidths - 18 kHz or 20 kHz - allowing DRM to operate alongside AM transmissions in every market of the world. The differences in certain versions of the system concern the rate used for audio, error protection and error correction compared to the data transmission rate, depending on the band (LF, MF, HF) and purpose. In general, by

using the channel with the band exceeding 9/10 kHz the quality of audio signal and transmission rate may be greatly increased.

The DRM system uses COFDM modulation with a large number of carriers modulated by the conventional quadrature amplitude modulation (QAM). Different parameters of the OFDM and coding can be varied to allow DRM to operate successfully in many different propagation environments. The DRM system uses MPEG 4 HE AAC v2 for mixed programming providing high quality at low data rates. In addition, CELP and HVXC coders are available to provide speech-only programming at even lower data rates.

The system features are satisfactory even in poor propagation conditions characteristic of multipath HF propagation at great distances. In most cases in HF propagation a high level of system robustness needs to be attained, which reduces the audio quality compared to MF digital systems, but audio quality is still better than the one achieved in AM systems.

The following table shows the characteristics of different types of DRM services for various frequency bands:

Service	Band	Description
DRM		
9/10 kHz RF channel	LF, MF, HF	- LF: large coverage area; - MF: local and large coverage area; - HF: large coverage area; - 26 MHz special: local coverage area; - Audio quality: mono FM and partly stereo; - Up to 4 multiplexed speech channels.
18/20 kHz RF channel	MF, HF	- Full FM stereo for local coverage; - There are possibilities for larger coverage area; - Up to 4 multiplexed speech channels.
50/100 kHz RF channel	VHF < 108 MHz	- Best quality, close to CD quality; - Larger number of higher quality programmes.
Simulcast (DRM + AM or FM)		
18/20 kHz RF total (1/2 for each)	MF, HF	- DRM signal is independent of AM, because of which the same or totally different programmes may be broadcasted via DRM.
27/30 kHz total (2/3 DRM)	MF, maybe HF also	- Full stereo for the part used by DRM.
250 – 300 kHz total (50/100 kHZ DRM)	VHF < 108 MHz	- Close to CD quality; - Multiplex high quality audio.
15 kHz total (10 kHz DRM)	MF	- Special single-channel simulcast with one analogue sideband

Apart from the ones already listed in the Table above, the DRM services may have the following general characteristics:

- Possibility for single frequency networks (SFN);
- Possibility for multi frequency networks (MFN);
- Automatic frequency switching (AFS), particularly important for signals broadcasted at several different frequencies;

- AM signalling system (AMSS);
- Data display;
- Lower rates for other data.

Apart from general characteristics, certain versions have the following characteristics:

1. The DRM service with 50/100 kHz width of the RF channel is the extension of the physical layer (on-air) of the DM standard to ensure DRM signal broadcasting in regular VHF broadcasting applications within the band below 108 MHz (Band I and II). When developing this type of the DRM service, currently the RF bandwidth and the selection for other basic variables have been made. Laboratory simulations started with several propagation scenarios based on measurements of the signal field levels in these bands.
2. Simulcast with 27/30 kHz total width (2/3 DRM) is a system expected to be used for local MF broadcasting services. Total bandwidth may be too large for non-linear power increase. Such systems may have limitation in linear increase in power. It has not been tested yet.
3. Simulcast with 250 – 300 kHz total bandwidth is a system in which the part relating to DRM is the same as the system mentioned in point 1, but on the same channel as the existing FM broadcasting allocation. The part relating to the DRM service may be used for the same or totally different programme compared to the part related to the FM signal.
4. Simulcast with 15 kHz total width (10 kHz DRM) is a system in which one side band is used for the M signal. Currently this type of service is being developed as an extension to the existing service of 10 kHz bandwidth where 5 kHz is for AM, and 5 kHz for DRM.

The DRM receivers need to enable the reception of digital signals in all broadcasting bands up to 30 MHz. Still, most favourable solution from the point of view of users are more complex DRM receivers which need to be able to decode various signal types, i.e. narrowband digital (for frequencies up to 30 MHz), broadband digital (for frequencies above 30 MHz), analogue in LF, MF and HF bands as well as VHF/FM band. If the same signal is broadcasted on different frequencies, the receiver should be able to automatically select the frequency with best quality of the received signal for the given programme, without any action on the part of the user.

10.3.2. Implementation of the DRM System - International Regulatory Aspect

Possibility for application in LF and MF frequency bands

Broadcasting LF and MF bands are regulated by an international agreement adopted in 1975 in Geneva, at the Regional Administrative LF/MF broadcasting conference of Regions 1 and 3 (Plan GE75). The above agreement was the basis for a part of the Broadcasting Frequency Allocation Plan in Montenegro, in the part concerning medium-wave broadcasting. The frequency allocations contained in this agreement were used for broadcasting Programme I and II of the Radio of Montenegro, as well as radio programmes of some radio stations founded by local governments. Due to its technical features and capabilities, this broadcasting band has not been very attractive for some time already.

Frequency bands allocated at the level of the International Telecommunications Union for broadcast services in LF and MF bands are:

– 148.5 - 283.5 kHz in LF band for Region 1. This band has 15 channels used mostly in Europe;

– 526.5 - 1606.5 kHz in MF for Regions 1 and 3. This band has 120 channels, 3 of which are reserved for low radiation power transmitters, known also as LPC channels (1.485 kHz, 1.584 kHz and 1.602 kHz). For these LPC channels maximum effective monopole radiated power must not exceed 1 KW.

In 2002 the International Telecommunications Union endorsed the change of the Rules of Procedures by the Radio Regulations Board (RRB) which allowed in the regulatory sense the possibility for the implementation of digital broadcasting sistems within LF and MF frequency bands for Regions 1 and 3.

After considering the relevant ITU-R studies it has been decided for frequency allocations for AM broadcast services in Plan GE75 may be temporarily used also for signals with digital modulation (of DRM A2 or B2) types, where radiated power compared to the power planned for allocations with AM modulation should be reduced for at least 7dB in all directions. Allocations from the GE75 Plan, which, pursuant to the procedure from Article 11 of Radio Regulations, are notified in terms with the given power reduction, are considered compatible and automatically, without additional coordination, are entered into the Master International Frequency Register (MIFR).

The power of the transmitter to be notified in case of digital modulation shall be the total power within the necessary bandwidth.

For the needs of coordination, when testing the compatibility among allocations related to systems with AM modulation and systems with digital modulation, in the examination of the probability of interference from notices related to assignments using digital modulation, the Bureau shall use co-channel protection ratio increased by 7dB, and an adjacent channel protection ratio increased by 1dB compared to the one applicable to the interfered transmitter.

Amendments to Rules of Procedures allowing the application of digital broadcasting signals is temporary in nature and will be valid until the new decision is made concerning the conditions for the use of LF and MF frequency bands at the future conference.

From the point of view of existing allocations in the GE75 Plan, under the conditions stipulated in Rules of Procedures the application of DRM service is possible in Montenegro based on the allocations contained in the above Plan.

Possibility for Implementation in HF Frequency Bands

Introduction of digitally modulated signals and signals with single sideband (SSB) in HF frequency band 5.900–26.100 kHz was adopted on the World Radiocommunication Conference in 2003 (WRC-03), by the resolution which reflected the changes in the HF broadcasting part of the spectrum aiming for transition towards digital systems.

Article 12 of the Radio Regulations defines "seasonal planning of the parts of HF band 5.900 kHz – 26.100 kHz allocated to broadcast services" following the coordination procedure. The implementation of the coordination procedures within ITU is defined in direct communication with the member states administrations, broadcasting organisations, organisations dealing with frequency spectrum management, and in particular the regional HF coordination groups (Arab State Broadcasting Union – ASBU, Asian-Pacific Broadcasting Union - ABU-HFC, High Frequency Coordination Conference – HFCC, African Regional Coordination Group – ARCG).

Frequency bands allocated for HF broadcasting services are as follows:

5 900 - 5 950 kHz **
5 950 - 6 200 kHz
7 100 - 7 300 kHz *
7 300 - 7 350 kHz **
9 400 - 9 500 kHz **
9 500 - 9 900 kHz
11 600 - 11 650 kHz **
11 650 - 12 050 kHz
12 050 - 12 100 kHz **
13 570 - 13 600 kHz **

13 600 - 13 800 kHz
13 800 - 13 870 kHz **
15 100 - 15 600 kHz
15 600 - 15 800 kHz **
17 480 - 17 550 kHz **
17 550 - 17 900 kHz
18 900 – 19 020 kHz **
21 450 - 21 850 kHz
25 670 - 26 100 kHz

* Only for Regions 1 and 3

** The bands which until 01.04.2007 were allocated to fixed and mobile services, since than have become the subject of the general procedure stipulated by Article 12 of Radio Regulations. Administrations of the ITU member states should use these bands to facilitate the implementation of digitally modulated signals in terms with the WRC-03 decisions.

The coordination principles are based on equitable access for all states, so that the demands of broadcasting services, regardless whether national or international, should be treated on equal bases after the submission to the ITU. The procedures strive to ensure the efficient use of the spectrum and adequate quality of reception, whenever possible using only one frequency.

DRM services in bands up to 120 MHz

In 2005, the DRM consortium passed the decision to extend the use of DRM systems to broadcast bands below 120 MHz, including the following bands:

- 47 – 68 MHz;
- 65.8 – 74 MHz;
- 76 – 90 MHz;
- 87.5 – 107.9 MHz.

The above bands are not officially specified for the use by DRM extended systems with the project title DRM+.

With the view of the above, further technology and regulatory developments concerning the use of LF, MF and HF bands for the needs of the DRM service, as well as in the bands up to 120 MHz, need to be followed, in order to ensure timely availability of the extended DRM service in Montenegro depending on future needs.

11. Digital Dividend

11.1 Technical Aspects of Digital Dividend

A part of the frequency spectrum necessary for broadcasting of programme contents by means of analogue television systems will be considerably reduced after the deployment of digital broadcasting system. In view of the aforementioned, a part of the spectrum, within UHF frequency band (470-862 MHz), released after the final transition to digital broadcasting is considered to be the digital dividend.

The RSPG group of the European Commission has given a general initiative for approaching the issue of digital dividend from the aspect of all its potential users in the EU Member States, within the Opinion on the EU Spectrum Policy Implications of the Digital Dividend. According to the RSPG group, potential users of digital dividend, in addition to the digital broadcasting systems, are certain electronic communication services.

Digital broadcasting systems can use the released part of the spectrum, or digital dividend, for the following purpose:

- Deployment of digital broadcasting systems, which will broadcast new programme contents that have not been broadcast previously by means of the analogue broadcasting systems;
- Increase coverage of broadcasting signals;
- Deployment of broadcasting systems, which will have local and/or regional coverage;
- Introduction of HDTV;
- Enabling mobile and portable reception;
- Data broadcasting;

The electronic communications services can use digital dividend for the purpose of introducing:

- Mobile communications services;
- Broadband access to scarcely populated areas;
- Services ancillary to broadcasting services;
- Military communications;
- Other services.

Digital dividend as a term is often related to the introduction of new convergent services. In the general sense, the convergent services are considered to be services of multiple digital multimedia contents encompassing broadcasting, telecommunications and information technologies.

The Final GE-06 Agreement de facto harmonised technical parameters for digital broadcast systems. However, this Agreement also gives a certain level of flexibility to administrations in introducing future systems such as convergent services in the following manner:

- The concept of allotment planning provides a high degree of flexibility regarding the location of broadcasting transmitters within the corresponding service area and interference envelope of the entry in the GE-06 Plan;
- The concept of spectral mask offers flexibility for implementing broadcasting services with different characteristics or other applications, provided the interference and the protection requirement are kept within the envelope of the corresponding entry in the Plan. If the proposed use exceeds the limits of this envelope, it requires prior agreement from affected administrations. Additional flexibility with protection rights, is afforded by means of a Declaration, made at the time of signing the Final Acts of GE-06, by all Member States.

The introduction of electronic communication services, new convergent services and the development of digital broadcasting services within the UHF frequency spectrum have certain limitations in the sense of using the digital dividend:

- Protection of analogue broadcasting services until their switch-off slows down the process of digital dividend utilisation;

- The use of digital dividend is in general limited by the services using the UHF band on the secondary basis;
- Although the procedures for the modification of the GE-06 Plans give appropriate framework in which administrations adapt their demands to future needs, the flexibility offered to administrations in doing so is already leading to variations of needs for spectral resources which in a wider sense limits the possibility for harmonised use of the spectrum in future;
- In many states the implementation of mobile multimedia services deviates from the reference planning configurations on which the GE-06 Agreement is based;
- The reception equipment design and costs in case of mobile multimedia services condition minimum frequency separation that needs to be provided between frequencies to be used for the reception of multimedia contents, i.e. the downlink and frequencies to be used for broadcasting by mobile receiver, i.e. uplink;
- Notwithstanding the fact that the GE-06 Agreement gives a certain level of flexibility to administrations by introducing the concept of spectral mask, the Agreement procedures do not envisage the possibility for notifying requests for uplinks for mobile multimedia services;
- The use of uplinks for fixed/mobile services in the UHF band creates the need for introducing a protective guard between frequencies envisaged for uplinks and channels used for digital broadcasting signals. It makes the coexistence of fixed/mobile and broadcasting services difficult and also creates the need for coordination. Harmonisation of sub-bands within the UHF band to be used for the needs of fixed/mobile services at the European level, and desirably so at the level of ITU member states, is the solution proposed by the European Commission's RSPG group, where the administrations intending to use the whole UHF band for broadcast systems can still continue to do so;
- Harmonisation of the part of the VHF band for the needs of introducing uplinks is not appropriate due to not adequate bandwidth.

Hybrid networks created by joining traditional broadcast and mobile communication services are the systems which provide multimedia broadcasting applications. With the development of the DVB-H system end users were enabled the reception of television signals via handheld devices. Despite the fact that such multimedia broadcast services may use the same frequency resources as DVB-T systems, there is still a need for the implementation of networks which from technical standpoint may provide the reception of signal by handheld devices. The configuration of such networks needs to enable a high level of signal compared to the level of fixed DVB-T reception by offsetting the small value of reception antenna gain, lower receiver height in relation to the ground and additional losses for indoor reception.

Technically, the following needs to be borne in mind for the implementation of mobile multimedia networks:

- Compatibility issues between "cellular/low-power transmitter" networks and "larger coverage/high power transmitter" type of networks;
- The possibility of harmonising a sub-band within the UHF band for multimedia applications, minimising the impact on GE-06 Plan.

In view of the above, two approaches have been identified for the implementation of mobile multimedia networks in the UHF band:

- approach 1 – implementation based on the entry into the GE-06 Plan without specially defined, or harmonised sub-band;
- approach 2 - implementation within a harmonised sub-band.

Approach 1 explains the implementation of mobile multimedia services in the UHF band based on the registration in the GE-06 Plan. As a rule, in most European countries this Plan contains entries which enable the application of 7 national coverages. Having in mind the flexibility of the GE-06 Agreement with the concept of the allotment planning method and spectral mask, entries may be used for multimedia broadcast services. Then network configuration may be conventional (networks already used for broadcast services, of cellular type and combination of conventional and cellular type). In some European states the multimedia broadcasting services have already been launched.

Approach 2 implies the definition of relevant sub-band for the implementation of multimedia broadcast services due to which technical characteristics of receivers may be improved (greater antenna gain), as well as reduce network maintenance costs depending on the type of network applied. However, reception devices designed for operation within a certain sub-band may not be used for reception of signals outside the defined sub-band, and if the implementation of multimedia broadcasting services is done according to the Approach 1.

Harmonisation of sub-bands for the introduction of multimedia broadcasting services in near future is non-mandatory for European states, having in mind that in many states licences have already been issued for a large number of digital broadcasting, but also a certain number of multimedia broadcasting services.

Approach 1 minimizes the impact of the GE-06 Plan, and taking into account that the above plan will further develop through modification procedures, it may after a certain period evolve in the sense of harmonisation of sub-bands to be dedicated to multimedia applications.

To implement fixed/mobile services in the part of the UHF band the following needs to be taken into account:

- technical feasibility of harmonising sub-band within the UHF band for the mobile applications (including uplinks), minimizing the impact on the GE06 Plan;
- technical roadmap proposing relevant technical options and scenarios to optimise digital dividend, including steps requir during the transition period before analogue switch-off.

Fixed/mobile services are two-way systems requiring downlink and uplink transmission, where uplinks are not covered by GE06 Agreement, i.e. may not be defined by the application of spectral mask to existing entries into the GE06 Plan. However, technological trends initiate the need to request access to the UHF part of the frequency spectrum for broadband fixed/mobile service IMT (***I****nternational* ***M****obile* ***T****elecommunication*) and WiMAX, taking into account the following:

- improvements in the quality of mobile broadband services, for example higher data rate services, with good coverage inside buildings, particularly in main population areas;
- extension of broadband services coverage to rural areas, not covered by 3G networks.

Uplinks of fixed/mobile services may cause interference in case that such services would operate on channels adjacent to the DVB-T service, and due to the fact that the source of such interference is the signal broadcasted from the very mobile device, generally operators are not able to reduce interference by usual methods applied for fixed services.

The advantages that UHF service may offer to mobile services greatly depend on the receiver price so that the device may operate within the UHF band, and also the expectations that the above services have the benefit by being introduced into the UHF band greatly depend on the size of the market, i.e. the level of harmonisation of the sub-band within the UHF band to be used for their implementation. According to a research conducted in UK, at least 100 million subscribers are needed to achieve benefits by introducing mobile services into a harmonised sub-band.

The GE06 Plan shows a high degree of inter-dependence of the entries of a large number of countries achieving equitable access to the spectrum by allocating UHF band channels for allotment areas and assignments. It means that the allocation of a harmonised sub-band to be used by mobile services results in the disturbance of the number of layers in practically all the states, where entries, or coverages contained in the GE06 Plan, which would be covered by such a sub-band could not be easily reconstructed. With this in mind, the introduction of sub-bands would inevitably cause re-planning involving bilateral or even multilateral activities in seeking solutions for those GE06 Plan entries belonging to a certain sub-band envisaged for mobile services.

Considering the fact that a large number of states have launched digital switchover, the introduction of sub-bands would additionally complicate the switchover process, which is already highly complex as it is.

In that sense administrations may apply any of the following methods to simplify the GE06 Plan reconstruction due to the introduction of sub-bands for mobile services:

- **Method A** - Reduction of the allotment area/assignment coverage area size. This method has two options.
    - **The first option** is the reduction of the allotment area/assignment coverage area size taking into account possible overlapping with adjacent allotments/assignments.
    - **The second option** is the modification of other characteristics of certain allotment areas, e.g. limiting the characteristics of the reference network which defines the allotment area or by modifying the reference location probability.

  Both options cause the reduction of the coverage area for broadcast services and imply a considerable negative impact on the GE06 Plan.

- **Method B** – Removal/extension of the existing allotment areas/assignment coverage areas. This method concerns the increase in the size of the allotment areas/assignment coverage areas which are adjacent to critical areas wherever possible, if such increase does not cause additional coordination activities with other states or does not affect other layers, or allotment areas of the same layer. In most cases, Method B may increase interference levels with other allotments or assignment coverage areas for which the same channel is defined, which eventually results in reduced coverage and has a considerable negative impact on GE06 Plan.

The application of both A and B methods is greatly limited when it comes to the states with small territory.

- **Method C** – Maintain existing allotment areas/assignment coverage areas. This method implies seeking new frequency allocations for allotments or assignments having allocations within a relevant sub-band in case of allocating such sub-band to be used by fixed/mobile services, and then new allocations need to be outside the defined sub-band. Method C may also have a negative impact in light of further development of the GE06 Plan.

In all cases, for any chosen segment, states with larger territories may reconstruct layers for broadcasting systems in a much simpler manner. Reconstruction always means the increase in the number of layers from 7 to 8 or 9 within the GE06 Plan, which is certainly not going to be an easy task considering prior experiences in defining and coordinating frequency demands for digital broadcasting.

Based on the results of analyses conducted by EBU, it may be concluded that despite the fact that CEPT states with great territory have entries in the GE06 Plan equally distributed within the full UHF range, most of small CEPT countries have entries concentrated in some of the considered segments. With this in mind, certain segments of the UHF band considered for possible introduction of fixed/mobile services will have a considerable negative impact on the GE06 Plan, i.e. layers intended and coordinated for the needs of broadcasting services in countries with small territory. In some cases the introduction of certain segments would cause harmful consequences for 60-75% of the total number of GE06 Plan entries.

Consequently, due to the introduction of harmonised sub-band for fixed/mobile services and layer reconstruction for broadcasting systems, the countries with small area would be facing greatest difficulties.

Pursuant to the opinion of the RSPG group on digital dividend and the European Commission's mandate, CEPT has to the greatest extent possible taken into consideration the Community law[16] on the principle of technology neutrality, non-discrimination and proportionality as much as feasible.

The working group dealing with digital dividend concluded that from the technical, regulatory and administrative standpoint it is possible to harmonise sub-bands within the UHF band used for mobile services (including uplinks), with this harmonisation being non-mandatory within CEPT member states. The possibility to implement mobile services within a harmonised sub-band of the UHF band will depend on the decision to be adopted by relevant administrations at the national level, taking into account the GE06 Agreement and licences already issued to existing broadcasting services.

In addition, the CEPT working group concluded that the preferred sub-band for harmonisation is the upper part of the UHF band, with minimum inclusion of channels 62-69 (798-862 MHz). The use of the harmonised sub-band for mobile services should be technically aligned in the sense of the adoption of the plan for its use to contain the channel band, options for placing a duplex gap and spacing, guard band when using paired duplex with frequency division duplex - FDD or non-paired, i.e. time division duplex - TDD. Appropriate technical harmonisation will be subsequently established, and need to be as flexible as possible, within the limits of technical feasibility, aiming to facilitate the adoption of harmonised sub-band by administrations, emphasising various situations administrations will be facing when adopting the decision to introduce mobile services in the appropriate harmonised sub-band.

It is underscored that the level of interference to be caused by digital broadcasting systems, contained within the GE06 Plan will practically make the introduction of mobile services into a harmonised sub-band of the UHF band in any state impossible without the agreement with neighbouring countries. It is also stressed that in all cases neighbouring states do not have to be CEPT or EU/EEC states.

Consequently, the implementation of mobile services in a harmonised sub-band will demand bilateral and multilateral negotiations in terms with the GE06 Agreement established with the aim of providing equitable access of all administrations to the spectrum. Although negotiations may be time-consuming, they are needed to provide equitable access to spectrum for all administrations, independently of the impact which harmonisation of sub-bands will cause to the existing GE06 Plan entries, in order to provide for the reconstruction of layers which will not be used for broadcasting, but mobile services.

11.2. Market Aspect of the Digital Dividend

Considering that the digital switchover releases a part of the frequency spectrum that may be used for other services, apart from technical, a number of other researches related to market demands and regulation of the introduction of such services into the released part of the spectrum are also needed.

Apart from regulatory provisions required for broadcasting services of general interest, it is necessary to forecast the development of broadcasting services in the long run based on market needs. It is one of vital requirements for the most efficient use of the digital dividend.

Regulatory frameworks need to be as flexible as possible to cover all possibilities for future development and implementation of services in general in the part of the band considered as digital dividend. According to the new regulatory frameworks, EU operators of broadcasting services, if using broadcasting frequencies, should be subject to authorisations to be applied also for other electronic communications networks. It is recommendable that additional content be released of any obligations of general interest, which also pertains to enhanced services such as HDTV and systems enabling mobile reception.

Key factors for market development and convergence of services are as follows:

- technology neutral regulatory framework in which regulation would be based only on the principle of technical sustainability of coexistent services is the best way to support innovations;

[16] Regulation adopted by the EU Council of Ministers.

- new services based on wireless transmission may be developed only if there is acceptable level of certainty that there is frequency spectrum available;
- convergence and flexibility may be facilitated if the part of the spectrum primarily used by broadcasting services is allocated to mobile services also on the primary basis.

Spectral dividend may be fully utilised after analogue switch-off not only for the territory of one state but even for the neighbouring countries, which in a wider sense implies most or even all European countries. Therefore the final deadline for analogue switch-off is one of key factors determining the effects of the digital dividend.

11.3. Digital Dividend from the ITU Regulations Perspective

ITU-R studies envisage that by 2020 spectrum demands by these systems, including the systems before IMT-2000, IMT 2000 and upgrading thereof, as well as IMT Advanced systems, will amount from 1,280 MHz for lower user demand and 1,720 MHz for greater user demand. Such forecasts pertain to the development of only one network, and it is reasonably expected that the demands will only increase with the development of several networks.

At the World Radiocommunication Conference WRC-07 held within ITU in Geneva from 22.10.–16.11.2007, it was decided that allocations table of Article 5 of the Radio Regulations regulating the use of radiofrequency spectrum part of the UHF band 790-862 MHz will on primary basis also be given to mobile services, in addition to the existing broadcast and fixed service.

For the signatories of the GE-06 Agreement for digital broadcasting systems, Montenegro included, the use of mobile services in the part of the UHF band must be subject to coordination specified by the Agreement. Thus, allocation and identification in the part of UHF band for mobile services does not set the priority in relation to the services for which the band was previously allocated on primary basis, namely broadcasting and fixed services.

Over the period until the next World Radiocommunication Conference to be held in 2011, the ITU study group has the task to carry out research related to common use of the part of the UHF band by broadcast, fixed and mobile services, as well as to set criteria for technical protection and co-existence conditions for broadcast, mobile and fixed services in the part of the band between 790 – 862 MHz.

In addition, it is necessary for all administrations to individually assess realistic needs in reference to existing and the intended services. When making such decisions, administrations will have to take into account the solutions of neighbouring countries they need to harmonise their plans and activities with and that such decisions should be based on a regional consensus.

12. Glossary of Terms and Abbreviations

- **ADM (Add/Drop Multiplexing)** – multiplexing function by which new signals are added, and corresponding old ones removed without disturbing other signals that continue to be transmitted;
- **Allotment** – geographic area for which coverage certain channel was allocated;
- **Assignment** – frequency allocation for certain t site with clearly defined technical parameters (coordinates, effective radiated power, polarization, characteristics of antenna pattern, i.e. attenuation in azimuths from 0 to 359° in 10-degree steps, etc.);
- **Analogue Broadcasting Systems** – systems for the transmission of analogue radio and/or TV programmes and other telecommunication signals in the encoded form by means of terrestrial transmitters, cable or satellite, intended for direct reception by the public;
- **API (Application Programming Interface)** – in the sense of digital broadcasting systems, software inter-element between the applications in the electronic communication devices, available by the network operators or providers of other electronic communications services and elements of the system for digital broadcasting signal reception;
- **COFDM (Coded Orthogonal Frequency Division Multiplexing)** - digital signal modulation technique applying a great number of orthogonal carriers, where each of them is modulated conventionally (such as quadrature amplitude modulation);
- **DAB (Digital Audio Broadcasting)** - digital broadcasting systems for the transmission of audio signals in different frequency bands up to 3 GHz by means of terrestrial, satellite, hybrid (satellite and terrestrial) and cable networks;
- **Digital Dividend** – a part of spectrum not yet used for digital broadcasting systems, which will be released after the complete switch-off of analogue stations and may also be used for deployment of other services;
- **Digital free-to-air broadcasting network (free access network) and station broadcasting digital free-to-air signals (with free access)** – a series of electronic communication devices and related electronic communication infrastructure, where the broadcasting of digital radio and TV signals to end users is done in the form of multiplexes on frequencies allocated for broadcasting services with free access;
- **DVB-H (Digital Video Broadcasting – Handheld)** - system of transmission and broadcasting by means of a terrestrial transmission network, where the reception is enabled through handheld devices;
- **DVB – S (Digital Video Broadcasting – Satellite)** - system of transmission and broadcasting by means of satellite;
- **DVB-T (Digital Video Broadcasting - Terrestrial)** - digital television signal transmission system by means of a terrestrial transmission network;
- **i2010 - A European Information Society for growth and employment** – a document defining EU policy for information society and media and promoting a positive contribution of ICT to economy, society and quality of life of individuals (http://ec.europa.eu/information_society/eeurope/i2010);
- **EPG (Electronic Programme Guide)** – an application (including the service content) enabling inter alia a direct access to broadcasting and additional contents;
- **Ethernet** – architecture of local area networks - LAN, developed by Xerox corporation in cooperation with DEC and Intel in 1976. It uses the bus and star

topology, and supports data transfer rates in the range of 10Mbps (10BASE-T systems are most often used). Ethernet specification is the bases for IEEE 802.3 standard specifying the physical layer and lower software layers. Fast Ethernet support rates up to 100Mbps (100BASE-T systems typically used as the backbone of LAN). There are also Gigabit Ethernet and 10-Gigabit Ethernet versions supporting greater rates up to 1Gbps and10Gbps respectively;

- **E1 signal** – the signal with 2Mbps bit rate (32 channels with 64 Kbps bit rate, with 2 channels reserved for signalling and control);
- **Spectrum (radiofrequency spectrum)** - radio-frequency band defined by its limiting frequencies;
- **HDTV (High Definition Television)** – television standard with the highest resolution, offering different picture formats;
- **IDTV (Integrated Digital Television)** - Integrated digital TV receiver showing digital TV signal without a STB;
- **IP** – Internet protocol;
- **Mapping** – provision of logical connection between entities, translation from one layer to another;
- **ITU (International Telecommunication Union)**;
- **Must-carry-rule** – transmission and broadcasting of programmes of public service broadcasters by means of digital broadcasting systems without additional costs for end users and programme content providers;
- **MHP (Multimedia Home Platform)** – digital television standard enabling the processing of digital applications from different sources, an interface of open source software;
- **Multiplex (MP)** - a standardized signal stream used for digital broadcasting services, including television and radio programmes, additional digital content services, electronic communication services, and other associated identification signals and data; DVB-T signifies a system functioning as a single-frequency or multi-frequency networks;
- **Multiplexer (MUX)** – a device, part of the digital broadcasting equipment combining different input signals for the purposes of transmission and broadcasting;
- **Operator of digital broadcasting free-to-air network (free access network) or station broadcasting free-to-air radio and TV signals (with free access)** – a provider of the service of content distribution, additional programme contents, and other telecommunications services by means of free-access digital broadcasting networks, or by means of stations broadcasting free-access signals, which signs a contract with the end users or content providers;
- **QAM (Quadrature Amplitude Modulation)**;
- **Content Provider** – a legal or a natural person holding a licence to broadcast radio and/or TV signals and having editorial responsibility for the broadcast contents;
- **RRC-06 (Regional Radiocommunication Conference 2006)**;
- **SDH (Synchronous Digital Hierarchy) -** international standard for synchronisation of data transfer developed by ITU as G.707 an its addition G.708;
- **Simulcast** - Simultaneous transmission and broadcasting of analogue and digital broadcasting signals;

- **STB (digital set-top-box)** – a device enabling, together with the antenna, an analogue TV set to receive and display digital TV signals;
- **Value-Added Services** - public communication services for which the provider gives added value to the information provided to the end user, by enhancing their form or content or providing their storage or retrieval;
- **VoIP (Voice Over Internet Protocol)** – hardware and software providing the use of Internet as the medium for transfer of telephone calls by sending speech data packages using the IP technology instead of the traditional transfer via public switched telephone network (PSTN).

Sources (links)

- http://www.ardcg.org/
- http://www.apek.si/
- http://www.digitag.org/
- http://www.drm.org
- http://www.dvb.org/
- http://www.ebu.ch/
- http://www.elti.com/
- http://www.ero.dk/
- http://www.etsi.org/
- http://europa.eu.int/
- http://www.itu.int/
- http://www.ofcom.org.uk

APPENDIX I

Deployment of Individual Multiplex Networks for Allotment Areas
- FIRST MULTIPLEX

The first network with national coverage MPN A includes three separate multiplex networks for each of the three respective allotment areas:

MPN A = MPN AL + MPN AB + MPN AT

Where the letters denote the following:
MPN A – the first network with national coverage;
MPN AL – the first multiplex network for the coverage of Lovcen allotment area;
MPN AB – the first multiplex network for the coverage of Bjelasica allotment area;
MPN AT – the first multiplex network for the coverage of Tvrdas allotment area.

1. MPN AL – the first multiplex network for the coverage of Lovcen allotment area, as an integral part of the first network with national coverage MPN A, will be deployed on the basis of the entry in the GE06 Plan for Montenegro, presented in the following table:

Administrative unique reference ID (GE06 Agreement)	Channel	Name of the allotment area
ARD CG L 35	35	LOVCEN

Frequency allocations shown in this table, which are a part of the GE06 Plan, can be used for the deployment of MPN AL network:

Administrative unique reference ID (GE06 Agreement)	Channel	Site	Longitude	Latitude
ARD CG BUDVA 35	35	BUDVA	18° 50' 51" E	42° 17' 21" N
ARD CG FRASKANJEL 35	35	FRASKANJEL	19° 21' 57" E	41° 58' 06" N
ARD CG KURILO DG 35	35	KURILO DG	19° 04' 12" E	42° 34' 05" N
ARD CG LOVCEN 35	35	LOVCEN	18° 49' 24" E	42° 23' 55" N
ARD CG LUSTICA 35	35	LUSTICA	18° 36' 37" E	42° 24' 34" N
ARD CG MAMULA 35	35	MAMULA	18° 33' 35" E	42° 23' 41" N
ARD CG MOZURA 35	35	MOZURA	19° 14' 48" E	41° 57' 48" N
ARD CG PERAST 35	35	PERAST	18° 42' 05" E	42° 29' 14" N
ARD CG PETROVAC 35	35	PETROVAC	18° 57' 01" E	42° 12' 13" N
ARD CG PINJES 35	35	PINJES	19° 12' 46" E	41° 55' 38" N
ARD CG PLUZINE 35	35	PLUZINE	18° 50' 21" E	43° 10' 14" N
ARD CG RISAN 35	35	RISAN	18° 42' 00" E	42° 30' 44" N
ARD CG RT ZAVALA 35	35	RT ZAVALA	18° 51' 39" E	42° 16' 41" N
ARD CG RTV DOM 35	35	RTV DOM	19° 15' 03" E	42° 26' 28" N
ARD CG SJENICA 35	35	SJENICA	19° 19' 41" E	42° 27' 54" N
ARD CG SPAS 35	35	SPAS	18° 49' 30" E	42° 17' 01" N
ARD CG ST GRAD 35	35	STARI GRAD	19° 12' 15" E	41° 55' 35" N
ARD CG STRP 35	35	STRP	18° 40' 28" E	42° 30' 18" N
ARD CG TOVIC 35	35	TOVIC-SUDJINA GLAVA	19° 00' 07" E	42° 48' 36" N
ARD CG VELJA GORA 35	35	VELJA GORA	19° 05' 20" E	42° 24' 27" N
ARD CG VELJI GRAD 35	35	VELJI GRAD	19° 01' 01" E	42° 09' 04" N
ARD CG VOLUJICA 35	35	VOLUJICA	19° 05' 58" E	42° 04' 35" N

ARD CG VRMAC 35	35	VRMAC	18° 45' 00" E	42° 26' 00" N
ARD CG ZELENIKA 35	35	ZELENIKA	18° 34' 40" E	42° 27' 00" N
ARD CG ZVINJE 35	35	ZVINJE	18° 29' 59" E	42° 26' 44" N

2. MPN AB – the first multiplex network for the coverage of Bjelasica allotment area, as an integral part of the first network with the national coverage MPN A, will be deployed on the basis of the entry in the GE06 Plan for Montenegro, presented in the following table:

Administrative unique reference ID (GE06 Agreement)	Kanal	Name of the allotment area
ARD CG B 43	43	BJELASICA

Frequency allocations shown in this table, which are a part of the GE06 Plan, can be used for the deployment of MPN AB network:

Administrative unique reference ID (GE06 Agreement)	Channel	Site	Longitude	Latitude
ARD CG BALJ 43	43	BALJ	19° 49' 21" E	42° 44' 41" N
ARD CG BAN BRDO 43	43	BANDZOVO BRDO	20° 10' 47" E	42° 50' 24" N
ARD CG BJELASICA 43	43	BJELASICA	19° 41' 02" E	42° 51' 06" N
ARD CG DURMITOR 43	43	DURMITOR	19° 03' 04" E	43° 10' 37" N
ARD CG JEJEVICA 43	43	JEJEVICA	19° 53' 44" E	42° 52' 18" N
ARD CG KACUBER 43	43	KACUBER	20° 01' 29" E	42° 50' 24" N
ARD CG KAT BRDO 43	43	KATUNICKO BRDO	19° 33' 26" E	42° 56' 38" N
ARD CG KURILO BP 43	43	KURILO BP	19° 51' 27" E	43° 02' 05" N
ARD CG OBROV 43	43	OBROV	19° 45' 35" E	43° 01' 35" N
ARD CG PLAV 43	43	PLAV	19° 57' 36" E	42° 35' 40" N

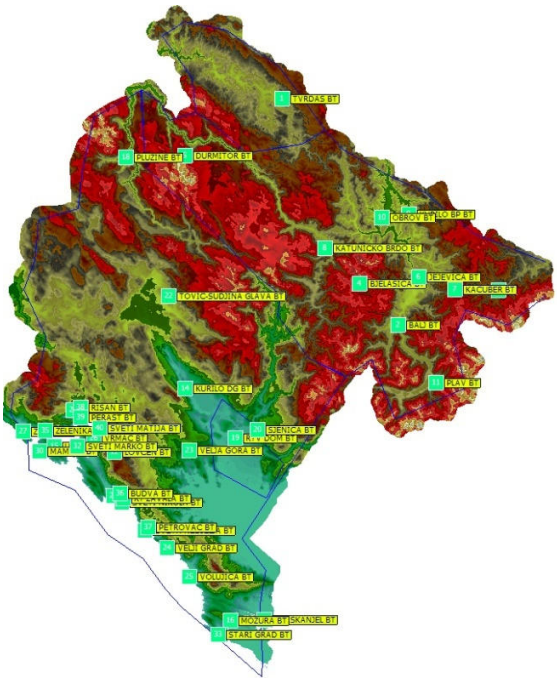
3. MPN AT – the first multiplex network for the coverage of Tvrdas allotment area, as an integral part of the first network with the national coverage MPN A, will be deployed on the basis of the entry in the GE06 Plan for Montenegro, presented in the following table:

Administrative unique reference ID (GE06 Agreement)	Channel	Name of allotment area
ARD CG T 49	49	TVRDAS

Frequency allocation shown in this table, which is a part of the GE06 Plan, can be used for the deployment of MPN AT network:

Administrative unique reference ID (GE06 Agreement)	Channel	Site	Longitude	Latitude
ARD CG TVRDAS 49	49	TVRDAS	19° 23' 41" E	43° 19' 56" N

More specific data on allocations within the GE06 Plan the first network with national coverage MPN A was based on are contained in the Allocation Plan for digital broadcasting systems of Montenegro, i.e. Final Act of the GE06 Agreement



***Graphic presentation**: Network A – MPN A*

Deployment of Individual Multiplex Networks for Allotment Areas - SECOND MULTIPLEX

The second network with national coverage MPN B includes three separate multiplex networks for each of the three respective allotment areas:

MPN B = MPN BL + MPN BB + MPN BT

Where the letters denote the following:

MPN B– the second network with national coverage;
MPN BL – the second multiplex network for the coverage of Lovcen allotment area;
MPN BB – the second multiplex network for the coverage of Bjelasica allotment area;
MPN BT – the second multiplex network for the coverage of Tvrdas allotment area;

1. **MPN BL** – the second multiplex network for the coverage of Lovcen allotment area, as an integral part of the second network with the national coverage MPN B, will be deployed on the basis of the entry in the GE06 Plan for Montenegro, presented in the following table:

Administrative unique reference ID (GE06 Agreement)	Channel	Name of the allotment area
ARD CG L 67	67	LOVCEN

Frequency allocations shown in this table, which are a part of the GE06 Plan, can be used for the deployment of MPN BL network:

Administrative unique reference ID (GE06 Agreement)	Channel	Site	Longitude	Latitude
ARD CG FRASKANJEL 67	67	FRASKANJEL	19° 21' 57" E	41° 58' 06" N
ARD CG KURILO DG 49	67	SVETA NEDJELJA	18° 56' 14" E	42° 11' 41" N
ARD CG KURILO DG 54	67	SVETI MARKO	18° 41' 30" E	42° 24' 40" N

ARD CG KURILO DG 67	67	KURILO DG	19° 04' 12" E	42° 34' 05" N
ARD CG LOVCEN 67	67	LOVCEN	18° 49' 24" E	42° 23' 55" N
ARD CG LUSTICA 67	67	LUSTICA	18° 36' 37" E	42° 24' 34" N
ARD CG MOZURA 54	67	STARI GRAD	19° 12' 15" E	41° 55' 35" N
ARD CG MOZURA 67	67	MOZURA	19° 14' 48" E	41° 57' 48" N
ARD CG PINJES 49	67	RT ZAVALA	18° 51' 39" E	42° 16' 41" N
ARD CG PINJES 67	67	PINJES	19° 12' 46" E	41° 55' 38" N
ARD CG PLUZINE 67	67	PLUZINE	18° 50' 21" E	43° 10' 14" N
ARD CG RTV DOM 67	67	RTV DOM	19° 15' 03" E	42° 26' 28" N
ARD CG SJENICA 67	67	SJENICA	19° 19' 41" E	42° 27' 54" N
ARD CG SPAS 54	67	PETROVAC	18° 57' 01" E	42° 12' 13" N
ARD CG SPAS 67	67	SPAS	18° 49' 30" E	42° 17' 01" N
ARD CG STRP 67	67	STRP	18° 40' 28" E	42° 30' 18" N
ARD CG TOVIC 67	67	TOVIC-SUDJINA GLAVA	19° 00' 07" E	42° 48' 36" N
ARD CG VELJA GORA 67	67	VELJA GORA	19° 05' 20" E	42° 24' 27" N
ARD CG VELJI GRAD 67	67	VELJI GRAD	19° 01' 01" E	42° 09' 04" N
ARD CG VOLUJICA 49	67	PERAST	18° 42' 05" E	42° 29' 14" N
ARD CG VOLUJICA 67	67	VOLUJICA	19° 05' 58" E	42° 04' 35" N
ARD CG VRMAC 67	67	VRMAC	18° 45' 00" E	42° 26' 00" N
ARD CG ZVINJE 67	67	ZVINJE	18° 29' 59" E	42° 26' 44" N

2. MPN BB – the second multiplex network for the coverage of Bjelasica allotment area, as an integral part of the second network with the national coverage MPN B, will be deployed on the basis of the entry in the GE06 Plan for Montenegro, presented in the following table:

Administrative unique reference ID (GE06 Agreement)	Channel	Name of the allotment area
ARD CG B 60	60	BJELASICA

Frequency allocations shown in this table, which are a part of the GE06 Plan, can be used for the deployment of MPN BB network:

Administrative unique reference ID (GE06 Agreement)	Channel	Site	Longitude	Latitude
ARD CG BALJ 60	60	BALJ	19° 49' 21" E	42° 44' 41" N
ARD CG BAN BRDO 60	60	BANDZOVO BRDO	20° 10' 47" E	42° 50' 24" N
ARD CG BJELASICA 60	60	BJELASICA	19° 41' 02" E	42° 51' 06" N
ARD CG DURMITOR 60	60	DURMITOR	19° 03' 04" E	43° 10' 37" N
ARD CG JEJEVICA 60	60	JEJEVICA	19° 53' 44" E	42° 52' 18" N
ARD CG KACUBER 60	60	KACUBER	20° 01' 29" E	42° 50' 24" N
ARD CG KAT BRDO 60	60	KATUNICKO BRDO	19° 33' 26" E	42° 56' 38" N
ARD CG KURILO BP 60	60	KURILO BP	19° 51' 27" E	43° 02' 05" N
ARD CG OBROV 60	60	OBROV	19° 45' 35" E	43° 01' 35" N
ARD CG PLAV 60	60	PLAV	19° 57' 36" E	42° 35' 40" N

Note: putting into operation of MPN BB network is conditioned by the switch-off of the analogue television of APR, which broadcasts from the Jejevica transmission site on Ch 60.

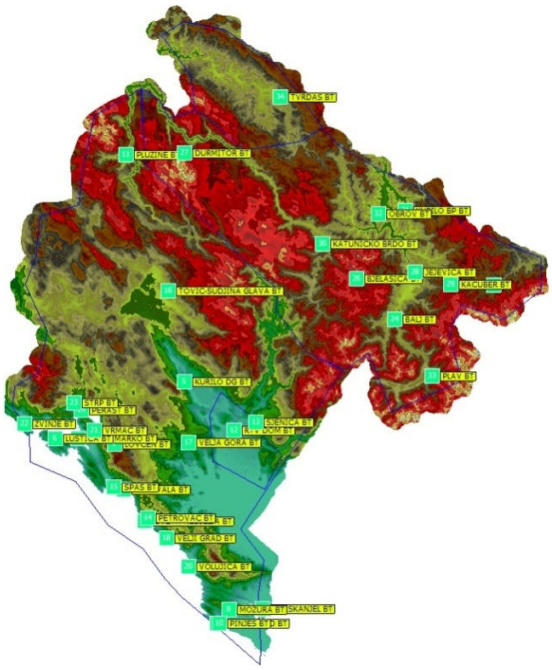
3. MPN BT – the second multiplex network for the coverage of Tvrdas allotment area, as an integral part of the second network with the national coverage MPN B, will be deployed on the basis of the entry in the GE06 Plan for Montenegro, presented in the following table:

Administrative unique reference ID (GE06 Agreement)	Channel	Name of the allotment area
ARD CG T 26	26	TVRDAS

Frequency allocation shown in this table, which is a part of the GE06 Plan, will be used for the deployment of MPN AB network:

Administrative unique reference ID (GE06 Agreement)	Channel	Site	Longitude	Latitude
ARD CG TVRDAS 26	26	TVRDAS	19° 23' 41" E	43° 19' 56" N

More specific data on allocations within the GE06 Plan the second network with national coverage MPN B was based on are contained in the Allocation Plan for digital broadcasting systems of Montenegro, i.e. Final Act of the GE06 Agreement.



Graphic presentation: *Network B – MPN B*

MPN A and MPN B networks have the same national coverage of the territory of Montenegro.

The third network MPNC cannot be completely operational before the switch-off of certain number of analogue transmitters. The same is true for all other multiplexes, i.e. networks with national coverage MPN D, MPN E, etc

APPENDIX II

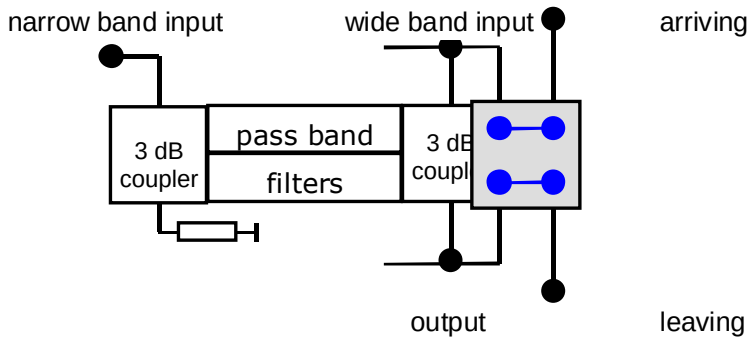
Estimate of Investments for the First DVB-T Network with National Coverage

The state of current broadcasting systems needs to be assessed in order to estimate investments required for launching the first DVB-T national coverage network. Generally speaking, existing infrastructure will be used for the implementation of digital broadcasting systems. For each transmission site of interest for launching it needs to be verified whether the existing antenna systems may support additional power of new digital transmitters. Considering the characteristics of digital modulation, allowable maximum power may be one of key factors in using existing antenna systems.

The checks of existing antenna systems in the light of radiation diagrams are also needed for the new digital systems. If the radiation diagram is not appropriate, additional space on posts needs to be provided for its installation or in some cases placement of new posts. The former may be critical particularly in the transition period, due to simultaneous operation of analogue and digital systems at the same transmission site.

Considering that a greater number of programmes is broadcasted with each digital transmitter to be installed, in case of failure of one of the transmitters the reception of all programmes the digital transmitter was broadcasting will be lost in the relevant area, not just one programme as is the case with the failure of an analogue transmitter, and thus spare transmitters need to be provided. From the point of view of the implementation of one DVB-T national coverage network it implies 1+1 digital transmitter for each broadcasting site. When the same broadcasting site is used for several networks, it implies n+1 digital transmitter for each broadcasting site, which becomes an economical solution from the point of view of investments for spare transmitters.

If existing antenna systems are used, the required element is the diplexer to provide for simultaneous use of such an antenna system for both analogue and digital transmission, and the former is particularly important for the simulcast period. In that case diplexers with 3dB couplers are used, where existing analogue signal is brought to the wide band input, and the new digital transmitter is connected to the narrow band input. The digital transmitter is connected to narrow band input via a patch panel, so that in case of interruption due to failure, maintenance and measurements automatic connection to the antenna input of the spare transmitter would be enabled, and not the artificial load of the transmitter not working properly. Diplexers for large power transmitters are quite costly.



Schematic presentation: *diplexer*

It is highly recommended to provide automatic and remote control systems when procuring equipment.

Considering that over the simulcast period the digital transmitters will considerably increase energy consumption, transmission sites should have proper energy feed and generators in case of loss of power, incurring additional costs which will not be considered by this Strategy.

In order to provide for effective utilisation of the frequency spectrum, digital transmitters will operate in the SFN mode wherever technically feasible to obtain synchronisation. With this in view, the costs for GPS receivers for synchronisation will constitute additional costs compared to those considered by this Strategy. Additional costs for gap fillers will refer to echo cancellers as an important element in this case.

Cost estimate for transmitters, gap fillers and diplexers of one DVB-T national coverage network

Table 2.1: Cost estimate for transmitters and diplexers for the first DVB-T national coverage network

Site	P(W)	Transmitter price (€)	Diplexer price (€)
Lovćen	5.000	200.000	0
Sjenica	2.500	110.000	5.000
Velja Gora	250	22.500	2.000
RTV Dom	250	22.500	2.000
Stegvaš	250	22.500	2.000
Cetinje	50	12.400	1.000
Luštica	2.500	110.000	5.000
Žvinje	250	22.500	2.000
Strp	50	12.400	1.000
Vrmac	250	22.500	2.000
Spas	1.250	66.000	5.000
Velji Grad	250	22.500	2.000
Volujica	500	32.500	3.000
Babac	50	12.400	1.000
Možura	2.500	110.000	5.000
Pinješ	100	15.400	1.500
Stari Grad	20	9.500	1.000
Kurilo DG	250	22.500	2.000
Suđina Glava - Tović	1.250	66.000	5.000
Bratogošt	100	15.400	1.500
Zavorovi	100	15.400	1.500
Krnovska Glavica	50	12.400	1.000
Košice	20	9.500	1.000

Bablja Greda	100	15.400	1.500
Katuničko Brdo	100	15.400	1.500
Tvrdaš	500	32.500	3.000
Mrčevac	20	9.500	1.000
Pitomine	50	12.400	1.000
Jejevica	250	22.500	2.000
Bandžovo Brdo	100	15.400	1.500
Balj	250	22.500	2.000
Kurilo BP	100	15.400	1.500
Obrov	250	22.500	2.000
Kofiljača	250	22.500	2.000
Bjelasica	5.000	200.000	30.000
Durmitor	2.500	110.000	5.000
Individual costs (€)		1.482.800	106.500
Total for transmitters and diplexers (€)	**1.589.300**		

Table 2.2: Cost estimates for gap fillers

Gap filler network	Power of a single gap filler (W)	Gap filler price (€)	Diplexer price(€)
90 gap filler	20	10.500 X 90 = 945.000	500 X 90 = 45.000
Total for gap fillers (€)	**990.000**		

Table 2.3: Summary cost estimate for transmitters, diplexers and gap fillers

Costs	Transmitters	Diplexers	Gap fillers
Individual (€)	1.482.800	106.500	990.000
Total (€)	**2.578.300**		

Table 2.4: Costa estimate for MUX and coders for 5 programmes plus 1 spare

Device	Amount	Description	Price (€)
Multiplexer	1	Device connecting streams from encoder into one stream	50.000
MPEG-4 encoder	5+1	Performs transformation and compression of PAL signal into MPEG-4 stream	300.000
MIP inserters	Depend on network configuration	Enables synchronisation and SFN operation of transmitters	(not calculated)
		Total:	**350.000**

Table 2.5: Proposed sites for the pilot stage and cost estimates

Site	P(W)	Transmitter price (€)	Diplexer price(€)
Lovćen	5.000	200.000	0
Sjenica	2.500	110.000	5.000
Cetinje	50	12.400	1.000
Volujica	500	32.500	3.000
Možura	2.500	110.000	5.000
Suđina Glava - Tović	2.500	110.000	5.000
Tvrdaš	500	32.500	3.000
Jejevica	250	22.500	2.000
Obrov	250	22.500	2.000
Individual costs (€)		652.400	26.000
Total for transmitters and diplexers (€)	**678.400**		

Note: the possibility of installing equipment at specified facilities and the total coverage, as well as strategic positions concerning possible interference from the neighbouring countries have been taken into account.