

Digital Dividend Review in Armenia

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Introduction

Research Background

Digital Dividends Policy Research has been carried out to respond to most recent challenges that Armenian policy maker, media and telecommunication industry representatives and civil society activists would face in the light of forthcoming digital switchover. Transfer from analogue broadcasting to digital transmission of television channels and as a result release of significant spectrum resources require specific policy agenda and well planned action plan. The purpose of digital dividends policy is to ensure that released radio spectrum resources would better serve to needs of information society and help the society to overcome digital divide.

Armenia plans to complete digital switchover by 2015 and introduce digital television broadcasting on the entire territory of the country. In spite of uncertainty of financial and technical aspects of the planned transition analogue broadcasters will have be switched-off according to the timetable, unless Armenian lawmakers adopt relevant changes to Television and Radio Law to expend the terms of switchover. Digital switchover brings several policy issues and one of them is digital dividends and new approach towards the spectrum management policy.

The switchover will release spectrum in the UHF bands usually referred to as “digital dividends” that if properly used could make a significant impact on the country economic development. In transitional economies there is always a risk of non-transparent allocation of radio frequencies. Influence of large businesses, financial interests of government and other short-term political interests often prevents from the adoption of an effective digital dividends policy. Utilization of digital dividends is always an issue of finding balance between short-term political goals and long terms public benefit oriented policy.

Telecommunications and broadcasting policy in Armenia has been always driven by political interest and neither civil freedoms nor economic efficiency have ever been a priority while making decisions on allocation of radio frequency resources. At the early stage of the development of Armenian television and radio broadcasting Armenian authorities restricted independent broadcasters access to broadcasting market referring to limited radio frequencies resources. Later the restrictions have been justified by the switchover. In both cases neither industry nor civil society known actual situation with spectrum resources and could not justify the protest.

Even when direct political interest was not an issue frequencies assignment policy was always driven by permanent interest of the government and has not sufficient level of transparency. The only case of a transparent and competitive assignment of radio spectrum resources was third mobile operator license auction in 2008 won by Orange Armenia, a subsidiary of France Telecom. Recently, Armenian Regulatory Authority has announced tender for 800 MHz, which generally in line with international standards: transparent, predictable, with clearly defined selection criteria.

As in many countries, including such traditional democracies as USA and France the transparency of radio spectrum assignment is affected by the interests of military authorities that usually keep resource just in case. Frequencies conversion was declared a public policy trend in many countries, but a few governments succeeded in that. One of the reason is also lack of public awareness about actual needs of military. Unfortunately, many countries policies lacking transparency on the ground of national security and defense issues that usually just a formal justification of unwillingness of spectrum liberalization.

Importance of the digital dividend

Almost all European Union policy documents emphasize the importance of digital dividends as a tool for the improvement access to broadband services. Value of digital dividends in context of broadband development policy could be even quantitated and represented in monetary value. Thus, some researchers¹ assesses potential economic benefits of digital dividends that might be up to 30% income surplus, taking into account content distribution mechanism changes. Moreover, in opposite to standard digital broadcasting television over the broadband access could be commercially and socially important mechanisms that will not merely solve problem of the access to digital quality television, but make it more diverse providing in parallel voice and Internet access services. The above benefits of digital dividends would be gained in case of placing an effective policy and might be failed in case of its absence.

Definition of the Digital Dividend

The digital dividend was initially perceived as the spectrum made available over and above what is required to accommodate the existing analogue television services. This was an attractive definition because it could lead to a digital dividend of 80 per cent of the UHF/VHF spectrum or more. This definition however, did not consider that, in order

¹ Analysys Mason. Report for the GSM Association Benefits of the digital dividend spectrum in Russia 24 June 2010. <http://www.gsma.com/spectrum/wp-content/uploads/2012/03/gsmadigitaldividendrussia.pdf>

to obtain any digital dividend, analogue transmissions need to be switched-off, which requires that a successful transition to digital TV has occurred, and in turn that digital terrestrial broadcasting has been able to attract analogue viewers in sufficiently large numbers to make this possible. This can only happen if digital service offering is attractive enough to the viewers to justify the purchase of digital adaptors. This in turn requires a significant increase in the number of programmes and perceived quality (e.g. HDTV), hence a consequential increase in spectrum consumption by terrestrial broadcasting. The considerations in this report are therefore based on the following definition: the digital dividend is the amount of spectrum made available by the transition of terrestrial television broadcasting from analogue to digital.

Size of the digital dividend

The size of dividends depends on several factors including, but not limited to number of multiplexes planned, number of channels in a multiplex and, therefore, the bandwidth of multiplex, broadcasting quality (whether HDTV planned), extend of DTV coverage and what is specifically important in Armenia is the degree of cross-border co-ordination required. Since the VHF and UHF broadcasting bands are also allocated to services other than broadcasting, e.g. to aeronautical radionavigation. Protection of these services may reduce the size of the digital dividend (e.g. aeronautical radionavigation). In order to increase size of digital dividend services need to be adapted to the new situation or re-allocated, which may entail additional costs.

In European countries, the planning of the UHF and VHF bands for digital television and radio services, results from the second session of the ITU Regional Radiocommunications Conference (Geneva-06 Plan).¹⁶ Due to spectrum scarcity, 120 countries in Europe, Africa and the Middle East agreed to transmit Digital Video Broadcasting-Terrestrial (DVB-T) and Terrestrial-Digital Audio Broadcasting (T-DAB¹⁷) technologies in VHF frequency Band III (174-230 MHz) and DVB-T technology in UHF frequency Band IV/V(470-862 MHz). Armenian government also allocated these two bands for DTV broadcasting purpose (Gov. Decision No 1112-N of 20.09.2012), which means that digital dividends to be released are the same as in EU countries.

In the United Kingdom, for example, the regulator Ofcom estimated up to 112 MHz of spectrum dividend in the UHF Band for new uses additional to the 6 DTT multiplexes already provided for. In the UK, the spectrum bandwidth for analogue terrestrial TV channels in the UHF band is 368 MHz (46 8-MHz channels) ranging from channel 21 to 68 (470-854 MHz) except channel 36 (for radar use) and 38 (for radar astronomy). The assigned 6 multiplexes need 32 8-MHz channels (256 MHz) to meet specified

broadcasting coverage with certain technical parameters. Therefore, up to 112 MHz of spectrum in the UHF band can be released.

Apart from the spectrum dividend which will be released after analogue switchover, some European countries recognized that there would be a number of unused analogue and digital TV channels, in a given geographical area, during and after digital switchover. This is because such terrestrial TV stations will not be able to operate without causing interference to co-channel or adjacent channel stations. These minimum distances between stations were determined based on the assumption that the stations will operate at maximum power. Thus, low power transmitters, for example, could potentially operate on vacant channels that could not be used by high power TV stations due to interference concerns, provided such operations did not cause harmful interference to the TV service and did not negatively impact or slow down the transition from analogue to digital television.

Research summary

Research purpose

The research has been initiated to provide Armenian policy makers, civil society and industry representatives with a strategy guide, based on best international experience and recommendation of international and regional organizations. More specifically it was aimed at:

- Assessment of current status of Armenian spectrum plan and potential impact of digital switchover on spectrum refarming;
- Study best international experience and practices in spectrum management with special focus on digital dividends policy;
- Comparative analysis of Armenian and European Union digital dividends utilization approaches, as well as other elements of spectrum management policy;
- Development of policy recommendations concerning the spectrum assignments and spectrum refarming based on ITU recommendations and best European and international practices.

Taking into account European integration policy special focus has been made on comparative analysis of Armenian spectrum management policy with relevant policy trends of the European Union, Western and Eastern European countries. Meantime, the research was aimed to identify most important elements of spectrum management policy, expand their importance and find how these elements could be incorporated into relevant policies of Armenian authorities.

Research Scope

The research mainly focused on study of digital dividends management policy. More specifically, the research objectives are to compare public policy of selected European countries with relevant public policy elements of the Republic of Armenia. Though, the research mainly address the policy of newly released spectrum, it also covers some other policy elements related to spectrum general policy, such as, for example, spectrum conversion or trading. The research also cover public policy issues related to methods and approach towards the spectrum planning and management such as tender conditions and license renewal. The research was not designed to study new media opportunities that digital dividends policy may result and address this issue in very general way without detailed study of alternative (to digital television) media content.

Research team

To respond better to the needs of target audience research has been carried out by group of professionals including information policy analytic, legal and technical expert. Despite of primarily focus on policy aspect of spectrum management the research also include recommendations on legal and technical issues, such as preferred technologies and regulatory framework design.

Key findings

The research identifies that opening of the 800 MHz (790-862) as the most pragmatic way forward to optimize the impact of the digital dividend. However, an effective spectrum management policy shall not be limited to utilization of spectrum of analogue television broadcasting, but define long-term comprehensive spectrum management policy including plans and purposes of other spectrum bands such as 400 MHz, 2 MHz, 2.6 MHz. In this context transparency of spectrum distribution policy and public debates must be elements of policy and directly recommended under the European Parliament and the Council programme (RSPP).

The research results also proved another hypothesis concerning the absence of universal effective policy solution, but existence of principles that help authorities to develop policy better serving the achievement of public benefits. In spite of general principles defined by European Parliament and the Council each country developed its own policy taking into account existing obligations (acting licenses), market development and social policy priorities including demand of industry and scope of universal services.

Research methodology

Research methodology is structured taking into account specific nature of research subject, which is combination of public policy with elements of technology models and business solutions. Nevertheless, the methodology was developed in accordance with traditional policy research approaches, e.g. includes research question, research hypotheses, description of methods and activities. Researches questions has been developed on the basis the overall objective of the initiative. Research hypothesis is based on the positive experience of European countries and assumption that Armenian authorities ready to choose the best way for economic and social development of the country. And finally main research method is comparative analysis of European and Armenian spectrum management policy carried out on countries sampling basis.

Research questions and hypotheses

To achieve project objectives the research team had to formulate research questions that will enable the researchers to analyze the research subject and develop recommendations that would have practical value for the target project audience: policy stakeholder, civil society activists, industry representatives. Since the main project

objective was target at development of policy recommendations for building a sound public policy the research questions have been formulated to identify key elements of effective policy and the extent to which current policy reflects such elements. These research questions were:

- What are the most important elements of a sound digital dividends management policy?
- What is the current status of digital dividends management in Armenia?
- To what extent Armenian spectrum management policy contains important policy elements reflecting best practices?
- Which policy elements should be incorporated into existing policy to respond better of the need of the information society and the industry?

Main research hypothesis could be formulated as following: there is not universal policy solution, but principles that may help governments to develop effective spectrum management policy to meet better demands of information society, media and telecommunication industry.

Another important hypothesis is that effective digital dividends policy may faster deployment of broadband services competing or at least complementing digital television services contributing thus to diversity of media content.

Research activities

To answer first research question research team had to collect and review spectrum management (including digital dividend utilization) policies and identify the most important component pursuing public objective in a most efficient way. Second research questions, which was aimed to describe current spectrum management policy trends in Armenia, had to be answered through the review of existing spectrum plan and other regulations defining principles and approaches governing the distribution of the spectrum resources. Third research question could be answered after detailed comparative analysis of Armenian spectrum policy with policies of selected European countries. The results of comparative analysis also help to identify which of the important policy elements are missing in current policy trends in Armenia.

Sampling is another important phase of the research which limits the scope of research data and enables to analyze only relevant policy cases. Unlike sociological or statistic researches sampling in policy study does not pretend to represent the subject of study in a way others could be ignored, it just provide researchers with most similar situation, which, however, could be quite different from the subject of study and vary from one to another. Thus, in spite of comparable territory and approximately same size of population of Estonia and Armenia, the first is quite different in terms of economic opportunities due to access to sea and EU neighboring. Meantime, due to the

neighborhood with Russian Federation Estonia is one of the countries that face a problem with spectrum use negotiations with non-EU states. Another such a bright example is Latvia, which delayed introduction of digital switchover due to neighborhood with Russia and Belarus.

Similarities in area, geographic location and population does not automatically include a country on the list of selected for comparative analysis, the most important criteria is existence of a sound public policy and its effective implementation. This criteria limits selection to those countries that effectively implemented basic principles indicated during the review of digital dividends policies and especially implementation of EU principles of spectrum management. Countries selected as an example of effective digital dividends policy have been identified using the following criteria:

- Relatively small territories and population that comparable with the territory and population of Armenia.
- Where possible necessity to coordinate spectrum use with non-EU state, i.e. absence of unified policy with neighboring countries.
- Limited market capacity, which is also similar to the economic situation in Armenia.

Comparative analysis has been carried out based on existence of a sound digital dividend policy containing both public policy interest, commercial benefits of market and fiscal interest of the state. Existence of these three public policy elements will be the main indicator of the overall efficiency of public policy. According to the above described criteria the project team decided to select the following countries for comparative analysis:

1. Estonia, which is comparable in size and population and faced negotiation problems with neighboring non-EU countries. Estonia is notable due to early switchover, which enables the country to build a competitive broadcasting system and be one of the first countries that released digital dividends for the needs of information society.
2. Belgium, also small size country with, however, bigger comparing with Estonian population, which in spite of EU policy neighborhood had has sophisticated market situation.
3. Netherlands also a country which in spite of European neighborhood had to solve complicated problems of spectrum refarming and allocations. The example of Netherlands is also worth due to the fact of awarding frequency band to cable operators, i.e. company with on experience in operation of radio networks.

The project team reviewed part of the radio spectrum plan, which could be potentially released in results of digital dividends switchover (UHF band: 470-862 MHz) and which is a subject of specific policy of the European states and recommendations of international and intergovernmental organizations²³. Apparently, digital dividends depend on current frequency allocation policies that in their turn defined in accordance with ITU regional spectrum plan.

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In European countries⁴, the planning of the UHF and VHF bands for digital television and radio services, results from the second session of the ITU Regional Radiocommunications Conference (Geneva-06 Plan). 16 Due to spectrum scarcity, 120 countries in Europe, Africa and the Middle East agreed to transmit Digital Video Broadcasting-Terrestrial (DVB-T) and Terrestrial-Digital Audio Broadcasting (T-DAB17) technologies in VHF frequency Band III (174-230 MHz) and DVB-T technology in UHF frequency Band IV/V(470-862 MHz). Armenian government also allocated these two bands for DTV broadcasting purpose (Gov. Decision No 1112-N of 20.09.2012), which means that digital dividends to be released are the same as in EU countries.

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² GE06 Agreement for Digital Broadcasting <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:008E:0060:0066:EN:PDF>, International Telecommunication Union, Guidelines for the transition from analogue to digital broadcasting. ITU Regional Radiocommunications Conference in 2006. http://www.itu.int/dms_pub/itu-d/opb/hdb/D-HDB-GUIDELINES.01-2010-R1-PDF-E.pdf

³ "The Spectrum Dividend: Spectrum Management Issues", OECD Digital Economy Papers, No. 125, OECD Publishing. <http://dx.doi.org/10.1787/231084750678>

⁴ European Parliament resolution of 24 September 2008 on reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover (2008/2099(INI))

Apart from the spectrum dividend which will be released after analogue switchover, some European countries recognized that there would be a number of unused analogue and digital TV channels, in a given geographical area, during and after digital switchover. This is because such terrestrial TV stations will not be able to operate without causing interference to co-channel or adjacent channel stations. These minimum distances between stations were determined based on the assumption that the stations will operate at maximum power. Thus, low power transmitters, for example, could potentially operate on vacant channels that could not be used by high power TV stations due to interference concerns, provided such operations did not cause harmful interference to the TV service and did not negatively impact or slow down the transition from analogue to digital television.

The research team also carried out extensive desk research, and interviewed policy stakeholders to reveal need of information society, industry demands and identify thus long term policy objectives that authorities must take into account when making decision on spectrum allocation or planning. Generally spectrum management related decision are publicly available in Armenia⁵, however, practice of white paper publications is rare and underdeveloped. Lack of public debates on spectrum purposes and planning is one the problematic areas of Armenian spectrum management policy.

⁵ decision for frequency allocation published by Public Services Regulatory Commission of the Republic of Armenia <http://resolutions.psrc.am/>

Research data

As in any policy related research the initial phase of the research activities has been aimed to collect policy documents necessary for the identification of important elements of relevant public policy. Initial data collection was focused on the identification of most important policy elements contained in Geneva 2006 Agreement and relevant public policy documents of the European countries⁶.

After initial review of digital dividend policy EU countries a short list of selected countries made for further detailed study. Selection was made taking into account:

- Landscape and territory, i.e. preferred countries should not be too large and must have mountainous landscape, which is a critical issue for spectrum planning.
- More or less similar level of urbanization and demography, i.e. predominance of urban population over the rural, relatively mono ethnic / mono lingual demography.
- Natural resources and geography, i.e. countries with limited natural resources, fully or partially (free non-custom transit to seaports) landlocked territories.

Focus on European countries is explained by the similar technical standards and spectrum planning approach, which is significantly different from American countries, Africa, Asia and Pacific regions. Comparative analysis carried out within the research framework included:

- Comparing scope of spectrum resources (bandwidths) to be released in results of switchover;
- Analyzing policy objectives and policy elements in the light of industry and community's needs;
- Identification of the most important policy elements and development of policy guidelines.

The main source of information concerning the status of Armenian spectrum policy and the future of digital dividends have been legal framework of telecommunications regulation, which is composed of Law on Electronic Communication and several Regulations of the National Regulatory Authority. Important source is also National Spectrum Plan adopted by the government (ministry of transport and communication).

⁶ One of the main EU policy documents is the European Parliament resolution of 24 September 2008 on reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover (2008/2099(INI)) <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:008E:0060:0066:EN:PDF>

Relevant spectrum assignments of the selected European countries have been used for comparative analysis of the status and policies (see Annexes).

Research results

Digital Dividends policy of European countries is fully driven by European Union policy. One of the core policy documents of the European Union is Digital Agenda for Europe, defining strategy of the European nations to get maximum benefits of the information society. Digital Agenda for Europe includes 101 actions “which will help to reboot the EU economy and enable Europe's citizens and businesses to get the most out of digital technologies.” Wireless broadband is one of the focuses of DAE with special emphasis on harmonization spectrum policies and building effective regulatory framework. In 2012 European Parliament and the Council adopted Radio Spectrum Policy Program (RSPP), which defines general principles and calls for concrete actions to meet the objectives of EU policies. Earlier, in 2008 and 2009 European Commission adopted Decisions on harmonization of radio frequencies in 900 MHz, 1800 MHz, 2.5 GHz and 3.6 GHz (Commission Decision 2008/477/EC, 2008/411/EC and 2009/766/EC).

Based on the policy objectives as defined in the RSPP, the European Commission together with all Member States work on the following concrete actions:

- Ensuring that at least 1200 MHz spectrum are identified to address increasing demand for wireless data traffic; and assessing the need for additional harmonized spectrum bands;
- Allowing spectrum trading throughout the EU in all harmonized bands where flexible use has already been introduced;
- Making available sufficient harmonized spectrum for the development of the internal market in for wireless safety services and civil protection;
- Fostering different modes of spectrum sharing in Europe, to ensure efficient use of spectrum and to increase spectrum access opportunities for wireless innovation;
- Ensuring that the radio spectrum can be used to support a more efficient energy production and distribution in Europe so that wireless innovations contribute to a low-carbon society;
- Finding appropriate spectrum for wireless microphones and cameras (PMSE); and
- By mid 2013 at the latest defining the details for the EU's radio spectrum inventory - as well as for an adequate analysis of the efficiency of spectrum use in particular in the 400 MHz to 6 GHz range. This will form the basis, where appropriate, of further action to coordinate or harmonize specific bands.
- In particular the Member States have to authorize the use of the following frequency bands which have been reallocated for high speed electronic communication services:
- The harmonized bands 900/1800 MHz, 2.5-2.69 GHz, 3.4-3.8 GHz by the end of 2012

- The 800 MHz band (the "digital dividend") by 1 January 2013, in particular to cover sparsely populated areas (except in case of individual derogations obtained before that date).

In spite of absence of formal obligations of the Republic of Armenia to comply with above mentioned policy actions the later could be used to assess overall efficiency of spectrum planning and management policy of the country and any of EU, Eastern European or Central Asia country. This is valid statement due to the fact that European Union frequency policy reflects most of international policy trends. Selection of countries for the comparative analysis was carried out taking into account successful implementation of RSP and spectrum management achievements of EU member stated. Meantime, specific similarities with Armenia, such as neighborhood with non-harmonized (either EU or regional) policy, limited market capacity and/or high market entry costs (substantial investments) have been taken into account.

Apparently, some of the RSP benchmarks have been developed to achieve specific goals across the European Union to ensure and promote harmonized business environment and cross country cooperation. For the purpose of practical value of this report focus is made on policy objectives reflecting global trends applicable to both industrial and developing countries (hereinafter "selected policy objective") rather than specific European policies. Selected policy objectives are:

- Introduction of technological neutral spectrum assignments for entire licenses (2G/3G/4G) to enable mobile network operators (MNO) plan their networks according to market demands and feasibility of a particular business models. In the light of this benchmark release of 900 MHz spectrum for 3G/4G networks is key policy elements.
- Harmonization of spectrum and authorization to use the following frequency bands which have been reallocated for high speed electronic communication services:
 - The harmonized bands 900/1800 MHz, 2.5-2.69 GHz, 3.4-3.8 GHz by the end of 2012;
 - The 800 MHz band (the "digital dividend") by 1 January 2013, in particular to cover sparsely populated areas (except in case of individual derogations obtained before that date).
- Allowing spectrum trading, which will require radio spectrum inventory for carrying out adequate analysis of the efficiency of spectrum use in particular in the 400 MHz to 6 GHz range and, if necessary, refarming both assigned and unassigned spectrum.

In spite of the fact that Armenia is not a part of European Union and even close cooperation with EU, including Association Agreement, does not foresee compliance with spectrum planning and management policy, it is worthy for any country of ITU First Region to follow the trends that at least predefine future technological standards of network and terminal equipment. For that purpose review and comparative analysis of the spectrum plans are carried out taking into account preferred purpose of a particular spectrum band. More specifically, when analyzing a particular spectrum band an

attention is paid on 4G/LTE deployment conditions and coverage requirements (whether National Regulatory Authority set-up 4G/LTE deployment schedule).

Overall situation with the use of digital dividends in EU and USA

In spite of early adopted unified policy implementation of digital divides slowed down due to difference in local policies. European operators have deployed LTE in a variety of bands, but the mostly used bands--1800 MHz and 2600 MHz--do not allow for efficient deployment outside of densely populated urban areas. The 800 MHz band is used in less than 10 percent of commercially launched LTE networks in Europe. Germany moved quickly to switch off analog TV, and German operators rapidly deployed LTE in the digital dividend band in rural areas, as required by licensing conditions, making them the exception rather than the rule. Germany will likely remain Europe's largest LTE market during the next five years. The European Commission's Radio Spectrum Policy Program required all 27 European Union member states to make the 800 MHz band available for mobile broadband services by Jan. 2, 2013. However, 18 countries, which represent almost half of total mobile connections in the region, have missed the deadline.

The United States completed its analog-to-digital TV transition in June 2009, and major U.S. operators Verizon Wireless and AT&T have aggressively deployed LTE using U.S. digital dividend spectrum in the 700 MHz band. The FCC's rush to auction this highly encumbered spectrum has prompted legal and regulatory battles between large and small U.S. operators over the issue of device interoperability across 700 MHz spectrum bands. Nonetheless, the rapid LTE rollout by leading U.S. operators has also led to widespread availability of LTE-enabled smartphones in the United States, while Europe's slow LTE rollout has resulted in limited LTE smartphone portfolios in that region.

European mobile operators are expected to focus on existing HSPA offers until 800 MHz frequencies are more widely allocated. In the United States, the next major auctions for mobile broadband spectrum are expected to occur in 2014, when the FCC initiates incentive auctions for broadcast TV spectrum in the 600 MHz band. Under the FCC's proposed rules, broadcasters will submit bids to relinquish their 6 MHz pieces of spectrum in a reverse auction where the FCC will pay them.

Estonia

Estonia is on the list of countries with earlier switchover: digital television was introduced in 2008 and switchover completed in 2010. At the time of switchover Estonian government has clear strategy on use of digital dividends. One of the main similarities between Estonia and Armenia in terms of digital dividends policy are neighboring countries that has their own policy different from the European policy trends. Most of Baltic states had to carry out negotiations with neighboring Russian Federation and Belarus that in spite of being member of RCU (Regions Communication Union) does not have, however, harmonized spectrum management policy.

According to the Digital Dividend Plan, the Ministry of Economic Affairs and Communications of Estonia has to organize a public competition for the use of the radio frequencies freed up in the 790 – 862 megahertz (MHz) frequency band. However, actual release of these frequencies has been delayed due to coordination with neighboring countries and auction for two 10 MHz band in 800 MHz spectrum has been announced only in 2013, though earlier in 2010 Estonian government made decision on allocation of 2.6GHz spectrum awarded to mobile operators on technologically neutral conditions. Other mobile communication spectrum bands (900 MHz, 1800 MHz, 2 GHz and 2.6 GHz) have been assigned on technologically neutral basis.

Belgium

Unlike Estonia Belgium did not faced problems of negotiating frequencies interference with neighboring states, but had to carry out deep inventory of spectrum plan. Belgium's telecoms regulator has published a preliminary timetable for its 800 MHz radio spectrum auction, which it still aims to complete during this financial year. Belgian Institute for Postal Services and Telecommunication (BIPT) defined a time schedule will allow the candidates to start their technical tests. However, in order to be able to allocate the digital dividend spectrum within this time frame, the regulatory framework needs to be modified. Belgian parliament has voted on the amendments to the regulatory framework which shall be published in the Belgian Official Gazette shortly.

The Belgian telecoms regulator, BIPT has published details of its forthcoming 4G license auction for spectrum in the 800 MHz bands. A total of three licenses are available, each consisting of 2x10MHz of spectrum, available for a 20 year term. A reserve price of EUR 120 million (US\$156 million) has been set for each license. Although the number of licenses matches the number of incumbent mobile networks, in order to encourage new entrants into the market, the regulator has relaxed the conditions applied to a winner that lacks an existing GSM license. The incumbents will be required to reach 98% population coverage with 4G services within six years, whereas a new entrant would be given nine years to achieve that. Any of the incumbent operators that win a license will be required to offer national roaming to any new entrant that wins a license. The regulator will also make a block of unsold 2.6 Ghz spectrum available to any bidder winning an 800Mhz spectrum licensee who lacks spectrum in the 2.6Ghz band. BIPT is appeared most conservative of the selected countries regulators and officially introduced technology neutral licenses only in 2.6 GHz spectrum band.

Netherlands

Similar to Belgium the Netherlands apparently did not faced problems of cross border spectrum use negotiations. Agentschap Telecom, Dutch regulator, has published the results of the multiband spectrum auction in December 2012. Four operators have acquired spectrum including existing MNOs KPN, Vodafone and T-Mobile and newcomer Tele2 Netherlands. The fifth participant in the auction was the Zum jv between Dutch cable operators Ziggo and UPC, which did not acquire any spectrum as

the prices were too high. The total yield of the auction amounts to EUR 3.8 billion, with Vodafone Netherlands paying EUR 1.38 billion, KPN paying EUR 1.35 billion, T-Mobile paying EUR 911 million and Tele2 paying EUR 161 million. Vodafone acquired spectrum in the 800 MHz, 900 MHz, 1800 MHz and 2100 MHz bands, KPN bought spectrum in the 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2600 MHz as well. T-Mobile acquired spectrum in the 900 MHz, 1800 MHz and 1900 MHz bands and Tele2 bought spectrum in the 800 MHz band.

The Netherlands made all above listed spectrum bands technologically neutral. It is worthy to note that Dutch regulator has assigned two 20 MHz bandwidths of 2.6 GHz frequency band to a largest Dutch cable operator Ziggo, which also provides virtual mobile services and fixed line telephony.

Conclusion of selected European countries policy review

The most important findings of the selected countries review is the prove of hypotheses concerning the absence of universal solutions for digital dividends policy. Moreover, each country had to develop post-switchover spectrum management policy taking into account historical, market and geographic conditions. However, European Union has clear policy agenda and general principles that every member state had to comply with. The most important principles are harmonization (refarming and reallocation) of spectrum plan in a way to meet needs and demands of information society and telecommunication industry. Digital dividends policy development is a good chance for countries authorities to reform general spectrum management policy and EU countries used that chance to develop comprehensive policies that defined pan-european standards in use of spectrum bands for growing broadband services.

In all selected countries legislative and regulatory authorities adopted spectrum neutrality as a cornerstone of new spectrum policy promoting thus innovations and new technological and business models. Spectrum neutrality is closely linked with another EU policy basic principle: free spectrum trading. Both principles are important elements for effective spectrum management policy and are aimed to promote effective and flexible utilization of spectrum, removal of administrative barriers and delays for introduction of innovative business models and new technologies. Spectrum sharing is another model that European countries incorporated into their policies to provide access to spectrum for wider category of undertakings.

And finally, all the studied countries strictly followed the European Parliament and the Council recommendation concerning public discussion of spectrum utilization and purposes, which is rare practice in post-soviet countries including Armenia. Importance of public discussions are not just a matter of transparent and accountable governance, but also valuable mechanisms for the identification of industry needs and preferences.

Status of digital dividends policy in Armenia

Armenia does not enter the age of digital television yet, but is already defied key policy elements of digital switchover. Digital switchover action plan defines future regulation of

television and radio broadcasting and does not address general principles of spectrum management and utilization of digital dividends in particular. Armenian authorities (both the National Regulation Authority and the government) decided to auction frequencies in 800 MHz band and referred to digital dividends, which is not correct due to the fact that there was no actual switchover and therefore these are frequencies released in result of termination of broadcasting license at the pre-switchover stage. The objective of auctioning released frequency is very simple: to use the price that purchaser would pay for the purpose of digitalization of television. In the other words, the only political objective of the Armenian authorities in this sphere is to gain budget benefits that enable the government to finance building of state owned digital television network.

So far, Armenian authorities have not developed comprehensive long-term spectrum management policy based on the society needs and demands of telecommunication industry. In particularly, in spite of frequent reference to the importance of frequencies conversion (transfer of frequencies allocated for sole government use to joint use and jointly used frequencies to commercial use) there is still lack of harmonized spectrum allocations in 2.0 GHz and 2.6 GHz, which are internationally recognized telecommunication service bands. Similarly, 420 MHz - 450 MHz spectrum, which is currently reserved for sole use of government, might be refarmed to meet the industry demands.

Analysis of spectrum management in Armenia

Key objectives of the research included identification of important elements of digital dividends and spectrum management policies, European countries achieve reasonable success in implementation of both digital dividends and spectrum management policies, status of spectrum management policy in Armenia and measures to build an effective policy in the country. Research results reflect not only the difference of digital dividends policies of European countries and Armenia, but also variety of policy implementation across the European countries. One of the key results of the research is the which means that there is no detailed universal solutions in digital dividends policy, but general principles that shall be kept in mind then deciding on utilization of spectrum resources.

The key elements of European spectrum management policy defined under the European Union's Radio Spectrum Policy Program (RSPP) adopted by the European Parliament and the Council. Whenever Armenian policy stakeholders will want to assess efficiency or compliance of policy trends with relevant European framework RSPP should be referred to. Important elements of European spectrum management approaches inter alia are the introduction of technological neutrality of spectrum assignments, harmonization of spectrum and its refarming to meet broadband demands and, finally, introduction of spectrum trading to facilitate more efficient use of resources. RSPP defines other policy objectives, but these are the most appropriate and practical in terms of adaptation to the local policy.

An important finding, which must be taken into account at least during the process of long-term policy development is the adoption of a comprehensive approach including spectrum refarming and defining clear plan for utilization of all the released frequency band. What the research team recorded in Armenia is completely different from comprehensive policy approach and could be characterized as situation or case driven policy. Tendering 800 MHz spectrum is a bright example of case driven policy, when decision is made based on the ground of digital television founding. In general, one of the shortcomings of spectrum management policy in post-soviet countries are dominance of fiscal objectives in frequency management policy and lack of public discussions on spectrum management issues. .

Lack of systematic approach towards the spectrum planning and situation driven decision making resulted in fragmental frequencies assignment or are not properly planned spectrum. Planning of low frequency spectrum (440 MHz - 880 MHz) release and upper (2.0 GHz, 2.6 GHz) spectrum harmonization should be carried out to meet better public policy objectives. Special attention of civil society and industry representatives should made on low frequency spectrum (420 MHz - 440 MHz) which is not very transparent in terms of its assignments (government and amateur radio) especially that to best knowledge of the researchers amateur radio is not popular and not demanded in Armenia as it use to be in pre-Internet years.

A positive side of present spectrum management practice in Armenia is sound license assignment conditions, which was not a case since the establishment of new regulatory framework. Auction of 800 MHz is the first case of defining clear public policy objectives in form of encouraging rural area coverage, network/service deployment timetable and coverage requirements. None of previously awarded spectrum licenses contained so detailed operation conditions and what is the most important is the absence of technological standards, i.e. technological neutrality of spectrum assignment. Notably, Armenian regulatory authority undertook revision of existing licenses to shift them to technologically neutral assignments. However, principal of spectrum neutrality is not legally obliged, e.g. the law does not address issue of spectrum neutrality and must be amended to ensure mandatory policy approach.

One of the most important findings is that if properly used digital dividends may faster rapid deployment of broadband telecommunication services that complement digital television services and may became even better source of independent information than digital television itself. In spite of the fact that study of new media potential in digital dividends policy content has not been the priority of the research, general assessment of new media potential proves promising future of new media and therefore importance of digital dividends policy as an important precondition for broadband growth.

Policy recommendations

In spite of the fact that each European country developed its own spectrum management policy all the policies of EU member states are based on principles defined under the Radio Spectrum Policy Project (RSPP) adopted by the European Parliament and the Council. RSPP defined several policy objectives, but the most

essential for the development of spectrum management policy in general and effective digital dividends policy in particular are:

- introduction of technological neutrality of spectrum assignments,
- harmonization of spectrum and its refarming to meet broadband demands and, finally,
- introduction of spectrum trading to facilitate more efficient use of resources.

Recommendations developed on result of this research are based on the above listed policy principles and practices of selected countries.

Armenia already made a step towards the spectrum neutrality, but it rather good practice of the Regulatory Authority rather than a institutionalized policy. One of the first and important policy changes must be legislative prescription of spectrum neutrality, i.e. adoption of law amendment defining neutrality as a main principles and preferable conditions of spectrum assignments.

Another important policy change must be introduction of spectrum trading, which, however, should be introduced step-by-step, taking into account experience of the European countries. Free trading of spectrum resources is one of the elements of efficient spectrum management policy. Spectrum trading is still limited even in Europe and is not applicable to some categories of spectrum, but even limited trading opportunities positively influence efficiently of spectrum utilization. Armenia may start from conditional spectrum trading (change of ownership with remaining purpose of assignment) as a pilot policy action and afterwards introduce wider spectrum trading practice. Assistance of foreign experts with strong regulatory background might be needed to avoid mistakes that may cause in undesirable consequences.

One of the important policy issues not only for Armenia, but also for neighboring countries is absence of coordination mechanisms across the region. Taking into account that Armenia has unsettled conflicts with two of four neighboring countries and absence of unified spectrum allocation policy across the region (only two are RCC⁷ members) minimizes Armenia's opportunities to adopt efficient policy without coordination of spectrum allocation and actual assignments. Armenia needs to seek direct or indirect (through mediatory organizations or foreign missions) harmonization of near border communication, which also other countries of the region face. Apparently both sides, Armenia and neighborhood will benefit from seeking harmonized policy. A role of industry and civil society in this process could be critical and contribute to the regional stability. Civil society organizations should be encouraged to build cross border relationships and carry our regional coordinating conferences and workshops involving both policy-makers and industry representatives.

And, finally, Armenia should review spectrum allocation plan and reform it for better benefit of society and industry. As mentioned 800 MHz is one of the obvious resource which Armenian authorities are going to use for the promotion of broadband services, which is generally in line with relevant European practices. However, study of spectrum management policy of selected European countries demonstrates importance of comprehensive policy including assignment of 2 MHz and 2.6 MHz spectrum bands

⁷ RCC Regional Commonwealth of Communication

parallel with release and auctioning of digital dividends. Moreover, the research team believes that other spectrum segments, such as 400 MHz and lower 800 MHz also could be released for the benefit of telecommunication industry. In other words Armenia needs to carry out inventarisation of spectrum resources that according to the research results (review of spectrum plan) contains significant resources that might be utilized for the benefit of public and business. Harmonization of spectrum resources is viewed in many countries including US and EU as a potential for the development of universal services that usually a part of assignment conditions.

Future Challenges

Dealing with the evolving nature of the digital dividend issue is a "dynamic" process. Developments in technology, services and market demand changing situation. Particularly relevant factors of uncertainty which have been identified are:

- The extent of consumer take-up of HDTV on the terrestrial platform in the future, compared to the take-up on other platforms such as satellite and IPTV on broadband networks;
- Growth of broadband wireless usage leading to a spectrum bottleneck;
- The emergence of unforeseen additional broadband uses which would require access to more spectrum below 1 GHz, for example public service uses such as Public Protection and Disaster Recovery (PPDR) or public security;

The pace of introduction of new technologies: new transmission compression standards, new frequency agile technologies and their ability to take advantage of the white spaces.

Appendices

Literature:

1. ITU Spectrum Management Handbook
2. Digital Dividend: Insights for spectrum decisions http://www.itu.int/ITU-D/tech/digital_broadcasting/Reports/DigitalDividend.pdf
3. European Commission, Information Society and Media Directorate-General, “Consultation Document—Transforming the Digital Dividend Opportunity into Social Benefits and Economic Growth in Europe”, July 10, 2009.
4. OFCOM, Digital dividend: clearing the 800 MHz band. 2009
5. Benefits of using LTE in Digital Dividend spectrum, November 2011
6. Assessment of the EU potential for improving spectrum efficiency. Authors: J. Scott Marcus, John Burns, Frederic Pujol, Phillipa Marks; WIK-Consult GmbH
7. Guidelines for the transition from analogue to digital broadcasting. ITU 2010 Geneva
8. Directorate for Science, Technology and Industry, Committee for Information, Computer and Communications Policy. The spectrum dividend: spectrum management issues, 2006

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Annex I

Frequency Allocations According to Spectrum Plan in Armenia as of July 2013 (Potential digital dividends bands 420 MHz - 860 MHz).

Frequency band	ITU recommendation	National spectrum plan	PSRC ⁸ /NRTC assignments
420-430 MHz	Fixed mobile excluding aeronavigation	Fixed mobile excluding aeronavigation	421.5 MHz is allocated solely for government purposes
430-432 MHz	Amateur radio	Fixed radiolocation and amateur radio	
432-438 MHz	Amateur radio and radio location, earth study satellite service (active)	Fixed, amateur radio, radiolocation, earth study satellite service (active)	432.3 MHz is allocated solely for government purposes
438-440 MHz	Amateur radio	Fixed, amateur, radio location	
440-450 MHz	Fixed, mobile excluding mobile air, radiolocation	Fixed, mobile	Fixed mobile (CDMA 450) also used by government (police 450-470 MHz) 443.1 MHz and 451.6 MHz are allocated solely for government purposes
450-455 MHz	Fixed, Mobile	Fixed, Mobile	Fixed mobile (CDMA 450) also used by government (police 450-470 MHz)

⁸ Public Service Regulatory Commission

455-460 MHz	Fixed, Mobile	Fixed, Mobile	Fixed mobile (CDMA 450) also used by government (police 450-470 MHz)
460-470 MHz	Fixed, Mobile meteorology service satellite (cosmos-earth)	Fixed, Mobile meteorology service satellite (cosmos-earth)	Previously used for meteorology, currently service terminated
470-790 MHz	Television and radio broadcasting	Television and radio broadcasting	Digital broadcasting (470 - 862 MHz)
790-862 MHz	Fixed, Mobile, Broadcasting, excluding aero mobile	Fixed, Mobile, Broadcasting, excluding aero mobile, Aeronautical radionavigation service (ARNS)	800 - 850 MHz 20 MHz of this band is recommended for tender based assignment (broadband services) after digital switchover 776 - 880 MHz + (880 - 890 Orange, 925 - 990 MHz) 890,2 - 902.4 935.2 - 967.4 Armentel 902.6 - 914.8 947.6 - 959.8 Vivacell
790 - 880 MHz			Allocated solely for use by government
862-942 MHz	Fixed, Mobile excluding air mobile, radio broadcasting	Fixed, Mobile excluding aero mobile, radio broadcasting	Mobile telecom, government services

Annex II
Awards of 800 MHz and 2.6 GHz in EU countries

Country	Date	800 MHz	2.6 GHz paired	2.6 GHz unpaired	Coverage obligations
Germany	5/2010	€3,576m	€252m	€85mha	800 MHz only
Sweden	3/2011	€195m	€216m	€18m	800 MHz only
Spain	7/2011	€1,305m	€173m	€16m	800 MHz only
Italy	9/2011	€2,962m	€432m	€74m	both bands
Portugal	11/2011	€270m	€36m	€3m	800 MHz only
France	12/2011	€2,639m	€936m	–	both bands
Switzerland	2/2012	€810m in total for all bands			800 MHz only
Denmark	6/2012	€100m	€136m		800 MHz only*
Romania	9/2012	€682m in total for all bands			both bands
UK	2/2013	€2,900m in total for all bands			800 MHz only

Annex 3

Average prices paid in European auctions for spectrum in bands used for public mobile services⁹

Frequency range	No. of data points	Average €/MHz/pop	Min. value	Max. value
450	2	0.0598	0.0103	0.1093
800	6	0.5862	0.4089	0.8144
900	11	0.2515	0.0049	0.7253
1800	9	0.1638	0.0048	0.4326
2100	21	0.7844	0.0742	4.5579
2300	1	0.0097	0.0097	0.0097
2600 FDD	13	0.0500	0.0011	0.1644
2600 TDD	9	0.0230	0.0025	0.0457
3500	7	0.0087	0.0004	0.0186
3700	1	0.0007	0.0007	0.0007
All IMT	80	0.3160	0.0004	4.5579

⁹ According to Assessment of the EU potential for improving spectrum efficiency. Authors: J. Scott Marcus, John Burns, Frederic Pujol, Phillipa Marks; WIK-Consult GmbH