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1 INTRODUCTION

The International Telecommunication Union (ITU) in collaboration with the Ministry of Economic Development of Italy organized a R**egional Seminar for Europe and CIS on "Spectrum Management and Broadcasting"** held from 29 to 31 May 2017 in Rome, Italy. This Seminar was organized in the context of the European Regional Initiatives of the Telecommunication Development Bureau (BDT), approved by WTDC-14, on Spectrum Management and Transition to Digital Broadcasting that works towards identifying issues and implementing actions to maximize the economic and social benefits of the digital dividend.

The seminar provided an opportunity for dialogue between the stakeholders of the regions on strategies and policies directed towards spectrum management and broadband development, while discussing the challenges and opportunities offered via innovative approaches proposed by ITU in regulation of Information and Communication Technologies (ICT), evolution in broadcasting technologies, future usage of UHF spectrum, high speed 5G networks and Internet of Things (IoT) provided over the modern telecommunications and IT infrastructure, and other pertinent topics.

2 PARTICIPATION

Representatives of European and CIS Ministries, Regulatory Authorities, Operators and Manufactures of electronic communications, as well as representatives and experts of international organizations and institutions in charge of the regulation and development policy of electronic communications participated in the Seminar. The meeting was attended by over than 70 participants representing 17 Member States from the regions of Europe and CIS.

3 DOCUMENTATION

The seminar was paperless. 38 presentations were delivered during the meeting. Relevant documentation, including the Agenda and Presentations and Reference Materials were made available on the ITU website

4 OPENING CEREMONY

The opening ceremony was effected by

- **Dr Eva Spina**, Director of Spectrum Management and Planning, Ministry of Economic Development, Italy,
- **Mr Istvan Bozsoki**, Head of Telecommunication Networks and Spectrum Management Division, BDT, ITU.

Dr Eva Spina welcomed and thanked ITU for its long-standing collaboration in the issues related to telecom network development, spectrum management assistance and coordination in broadcasting development with the focus on implementation of Digital Terrestrial Television. She expressed the honour bestowed upon the Ministry of Economic Development of Italy to host the seminar. The seminar is the landmark regional event in exchanging the views of stakeholders on the issues related to development of Broadcasting Service, future generation 5G networks, and innovative approaches in regulation with the primary emphasis on spectrum management. In particular, Dr Spina pointed out the importance of the forthcoming World Telecommunication Development Conference (WTDC-17) to be held in Argentina in October 2017 and invited participants to the exchange of their views on possible topics for regional initiatives with regards to this significant event.

Mr Istvan Bozsoki, on behalf of the guests and ITU, expressed sincere appreciations to the Ministry of Economic Development of Italy for the kind invitation and hosting the Seminar. This event further highlights the commitment of the telecommunications administration of Italy to the activities of ITU. Mr Bozsoki underlined the most significant topics to be discussed during the seminar which included:

- The innovative principles of spectrum management taking into account plentiful growth of cutting-edge radio technologies and permanent growth of demand for spectrum resources.
- The methods to provide adequate protection for incumbent radio services and applications in view of accelerating spectrum turn-over.
- The need to proceed with the most effective policy and regulatory practices with Digital Dividends in UHF spectrum band.

It was highlighted that the seminar was organized based on the regional initiatives coordinated by Telecommunication Development Bureau (BDT) of ITU based on highest possible

maximization of social and economic benefits for the countries of the region. ITU as the international agency will continue its assistance to national administrations on the most vital topics of ICT development. The latest subjects ITU is concentrated on and proposed for discussion during the seminar were country assistance in implementing modern spectrum management practices; provision of scarce spectrum resources for next generation 5G networks; finalization of transition from analogue to digital terrestrial TV. The participants of the seminar were invited for active discussions in all sessions.

5 SUMMARY OF DISCUSSIONS

Session 1: Regional Initiative for Europe, Actions in CIS and Update on the Study Question Q8/1 and Resolution 9

Session 1 covered the issues relevant to ITU assistance in Europe and CIS region. The participants were provided with the overview of the latest BDT activities on broadcasting including projects, country initiatives, capacity building and on the ITU-D SG1 relevant Study questions. Hungary introduced its experience in actions regarding Resolution 9 and Question Q8/1.

Regional Initiative for Europe

Telecommunication Development Bureau of ITU informed the participants on the latest activities in the context of the initiative EUR1 - spectrum management and transition to digital broadcasting. In order to foster the process of analogue TV switch-off, and management of the frequencies in the digital dividend bands, BDT assisted Albania and the Republic of Serbia. With regard to initiative EUR2 - development of broadband access and adoption of broadband – BDT carried out the set of actions including development of ITU Interactive terrestrial map, annual international regulatory conferences (Montenegro), regional workshops (QoS in Italy, Internet Exchange Point (IXP) in Montenegro, mapping of infrastructure in Poland, telecom-energy collaborative regulation in Switzerland).

Taking into account the forthcoming WTDC-17 there is the urgent need to identify actions based on the proposed future initiatives. Draft regional initiative for Europe as it is proposed now - EUR1: Ubiquitous resilient high speed broadband infrastructure and services. Assistance to countries should be provided embracing the issues of ultra-high speed connectivity, 5G/IMT 2020 roll out, deployment of digital radio broadcasting systems and spectrum management. BDT appreciates further proposals from administrations on this matter. Participants were asked to reflect and inform ITU on actions that would benefit their specific countries as well as the region. Planning for operationalising these actions can then be started immediately for a more effective and timely outcome.

Actions in CIS Region

The meeting considered the process and results of ITU Regional Initiatives in CIS region:

- CIS1: Creating a child online protection center for the CIS region;
- CIS2: Ensuring access to telecommunications/ICT services for persons with disabilities;
- CIS3: Introduction of training technologies and methods using telecommunications/ICT for human capacity building;
- CIS4: Development of broadband access and adoption of broadband;
- CIS5: Building confidence and security in the use of ICTs.

The ITU Area Office for CIS countries organized and held seven events in 2016, carried out country's assistance and projects regarding digital broadcasting, trends in Radio-communications development and converged networks implementation. The events for 2017

covering wide range of vital subjects were discussed and administrations were invited to participate.

Update on ITU-D Study Group 1 Q8/1 and Resolution 9

BDT provided participants with the latest information on Study Question 8/1. It was concluded that migration from analogue to digital broadcasting technologies has already been completed in some countries and is underway in several other countries and regions. The Final Report of the Q8/1 discusses best practices for the transition from analogue to digital television, communication strategies to accelerate the process of public awareness about digital broadcasting, spectrum issues related to the Analogue Switch-Off (ASO), and the use of the released spectrum (digital dividend) to implement new services and applications.

In addition, upon the decision of Council 2015, ITU developed an analogue to digital switchover stocktaking for assisting the Member States in their migration process. Information from relevant surveys, questionnaires of the ITU-D and ITU-R and other sources has been uploaded to the DSO (Digital Switch-Over) database [1]. The database has become a convenient mechanism for national administrations to access up-to-date information on transition to Digital Terrestrial Television (DTT), which is useful for planning national actions on the subject as well as handling issues of boarder coordination.

The meeting noted the progress of ITU-D SG1 in respect of Resolution 9. The draft final report on Resolution 9 had been prepared, summarizing several evolving trends in spectrum management in light of ongoing development in radio-communications. It has been developed through close collaboration between ITU-R and ITU-D. Such joint inter-sector collaboration has fulfilled the target of raising awareness of and matching the ongoing radio-communication activities and technical studies with the special and growing needs of the developing countries. Contributions made to this report encompass case studies and system level descriptions submitted by Member States and private sector members, as well as Radiocommunication Bureau (BR) and BDT activities and publications.

Future of ITU-D Study Group 1 Question 8/1

The participants of the seminar noted with interest the presentation on the future of Question 8/1. ITU had conducted two surveys in order to seek the views of ITU-D Study Group 1 and 2 participants on the groups' activities and outputs for the 2014–2017 study-period, and on future activities for the next study period.

Concerning Study question 8/1, the ITU survey[2]reported that many transition deadlines for analogue to digital terrestrial television had passed while many countries are still in the experimental phase with new digital sound/radio services.

New topics proposed in the survey include broadening the scope of Question 8/1 to cover the evolution of the digital transition in television broadcasting and digital radio/sound broadcasting; how to use the released spectrum for services and application; economical aspects of the deployment of new broadcasting services and applications; studies of the impact of other television distribution platforms. Collecting countries experiences on interference between broadcasting and new service and the implementation of new services and applications (Community and regional TV on DTV and new Broadcasting services: 3D, 4K, 8K, etc.) had been also deemed important. Introduction of issues related to people with disabilities had been also supported.

It was noted that the Rapporteur Group of ITU-D SG 1 on Q8/1 proposed to continue the Study question. The Administrations are invited to make their relevant proposals to WTDC-17.

Country Experience

Hungarian Participation in Question 8/1 and Resolution 9

[1] http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Default.aspx
[2] https://www.itu.int/dms_ties/itu-d/md/14/sg01/c/D14-SG01-C-0458!N1!PDF-E.pdf

Hungary has actively participated in the activity of ITU related to the Question 8/1. Three national contributions had been delivered to ITU on the topic. The information from the contribution had been included in the Final Report, Guidelines and Case Studies.

With regard to the issues of participation of countries, particularly developing countries, in spectrum management (WTDC Resolution 9), Hungary contributed twice. The information had been incorporated into the Draft Final Report on Resolution 9.

Moreover, Hungary had developed the software tool to visualize the National Table for Frequency Allocation (NTFA) incorporating data on the spectrum uses in different spectrum bands. This software is undoubtedly of great interest for other administrations in their efforts to establish NTFAs.

Challenges Revealed

The participants noted the diversity of views on the subject of the future activities of Question 8/1. The need for further studies was highlighted.

The participants confirmed the importance of ITU activity on the subjects being under the scope of Question 8/1 and Resolution 9. Republic of Serbia and Albania indicated the need for assistance on these particular matters.

Session 2: Future of Digital Terrestrial Television Broadcasting

Session 2 gave consideration to the future use of UHF spectrum in the context of DTT, its evolution and foreseen deployment of IMT in 700 MHz band. The representatives of national DTT spectrum stakeholders shared their experience in the issues related to future of DTT both from technical and service provision points of view. The information on multilateral coordination related to the topics and steps in order to release 700/800 MHz bands and to ensure the continuity of DTT was further noted.

Digital Switchover and Digital Dividend

The meeting noted the summary of the status of the transition. Most Europe region countries have completed ASO (Turkey is pending). The CIS region countries are still in the process of transition to DTT. For several CIS countries there is the additional challenge in the transition due to ongoing use of Aeronautical Radionavigation Service in 700/800 MHz spectrum bands. The need for inter service boarder coordination may lead to certain difficulties for the neighbours of these countries.

The successful future development of DTT depends on the efforts of broadcasters and relevant authorities to introduce advanced technologies, such as DVB-T2/MPEG4 or HEVC to ensure continuity of the DTT broadcasting in the remaining part of UHF band (470-694 MHz) while keeping same capacity of existing DTT broadcasting or enhancing it. This leads to necessity for searching additional DTT channels in this part of the UHF band, taking into account the advanced DTT technologies.

ITU assisted administrations in the activities relevant to coordination of additional frequency channels within the framework of the GE06 Agreement in Sub-Sahara Africa (2011-2013) and Arab region (2014-2015) with the aim to reach four layers for each country in 470-694 MHz band. Similar activity has started in the Central America and Caribbean region, where no GE06 type of agreement exists.

Due to the extremely high interest of IMT systems in implementation in 700/800 MHz spectrum bands, the existing broadcasting assignments/stations and assignments of other primary services of different countries are requiring reliable protection. In this perspective and taking into account Resolution 810 (WRC-15), the broadcasting assignments and assignments of other primary services in operation should be duly notified for inclusion them in the Master International Frequency Register in accordance with Article 11 of the Radio Regulations. The administrations are encouraged to proceed with this notification.

The Evolution of Digital Terrestrial Distribution

The participants noted that EU Member States are releasing the 700MHz band. By 30 June 2020, Member States shall allow the use of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband access. However, it may be delayed for up to two years based on the intensity of its current usage. As soon as possible and no later than 30 June 2018, Member States shall adopt and make public their national plan and schedule ('national roadmap'). Where appropriate, adequate compensation for the direct cost, in particular for end-users, of the migration or reallocation of spectrum use should be provided promptly and in a transparent manner.

An overview of the media consumption indicated that the importance of TV and radio as a media is not decreasing. The success of DTT platform depends on the historical penetration of terrestrial TV in different countries and on the business concepts those countries are choosing. There is the sustainable process of advancing new technologies in broadcasting by moving from DVB-T to DVB-T2, HEVC, etc. Germany has launched DVB-T2/HEVC already in DTT network and in Arab region and sub-Saharan Africa DVB-T2 has been selected (except Botswana with ISDB-T). It was further noted that TV sets would remain predominant in viewing content in the short and medium terms thus leaving Mobile Broadband as the complementary technological platform for TV services.

Public acknowledgement of transition should be considered as a matter of great importance. Public has to be informed properly on the time schedule and details of ASO. With the transparent and clear communication to citizens, the transition process is effectively accomplished, e.g. Georgia completed in one year. There is an ongoing activity of European Broadcasting Union (EBU), African Union of Broadcasting (AUB), Arab States Broadcasting Union (ASBU), Broadcast Networks Europe (BNE), Digital Video Broadcasting (DVB) and ITU on stocktaking on the status of the transition in Region 1. Accordingly, the status of the digital terrestrial television broadcasting was uploaded to the ITU DSO database. There was also a common workshop held in the ITU and organized by the mentioned entities.

Along with DTT, participants of the seminar discussed the issues of digital audio broadcasting. EBU informed that the needs of all radio services in a country should be considered when making plans for the digitalization of radio, including future service expansion, the available spectrum, and the cost effectiveness of different standards for numerous services. Immediate deployment was proposed to be done using Digital Audio Broadcasting (DAB) transmission as defined in ETSI EN 300 401 with DAB+ services as defined in ETSI TS 102 563. Digital Radio Mondiale (DRM) technology can be considered as the second option.

Car market is one of the main drivers for Terrestrial Digital Audio Broadcasting (T-DAB) (e.g. in UK 85% of the cars equipped with DAB). The smartphone with built-in DAB+ receiver (FTA reception of the radio signal) is available at the market currently. Further collaboration is ongoing with mobile industry: 3GPP, R&D 5GXCAST, as the result of mobile-broadcast convergence.

Country Experience

Italian Digital Terrestrial Television towards 2020

The trade association of Italian radio and TV broadcasters shared its view on DTT development in Italy towards the year 2020. It was underlined that Italy unlike other European countries utilize DTT platform significantly. Around 60% of TV services are provided using DTT, 30%+ of TV frequency channels are located in the 700 MHz, 60% of the 700 MHz band is used by national TV, the rest by local TV.

In Italy Single-Frequency Networks (SFN) are used in the national DTT network and DVB-T2/HEVC has applied from July 2016. Italy had phased implementation through different

regions which included also heavy frequency coordination with the neighboring countries. In order to migrate Italy's DTT in the sub 700 MHz and allow the refarming of 700 MHz for mobile broadband use (5G), the cost for users (high legacy of DVB-T only sets, TV sets renewal cycle is estimated in 7+ years) and costs for TV operators (migration to DVBT-2/HEVC, transition and re-farming, network equipment, simulcast) should be taken into account.

Challenges Revealed

The participants indicated several current challenges as related to future development of DTT and usage of Digital Dividend bands in UHF.

In order to have a clear picture for the future WRCs there was a suggestion from Ukraine – "in light of Resolution 235 (WRC-15), administrations are invited to notify to the BR for recording in the Master International Frequency Register (MIFR) their frequency assignments in operation in the band 470-960 MHz, in order to reflect actual usage of the band." This relates not only to the terrestrial television broadcasting but also to other services in the UHF spectrum band.

During Questions & Answers part of Session the importance of regional initiatives on cooperation with regards to broadcasting coordination was pointed out. In Europe and CIS countries the coordination is currently carried out in the regional Groups: Northern European Digital Dividend Implementation Platform (NEDDIP), Western European Digital Dividend Implementation Platform (WEDDIP), Southern European Digital Dividend Implementation Forum (SEDDIF), Black Sea Region Digital Dividend Implementation Forum (BSDDIF), Black Sea, Caspian Sea and Central Asia Digital Dividend Implementation Forum (BSCSCA). BR is assisting in coordination in BSCSCA Group, Central America and Caribbean (CAC) Group and SEDDIF (as observer). The core activity within the Groups is focused on building informal consensus on the UHF band utilization in concluding formal agreements; searching additional TV channels below 694 MHz and facilitating their coordination; proceeding with modification of the GE06 Plan through the Article 4 procedure by submitting coordinated requirements.

Furthermore, countries were urged to provide information on the status of the digital terrestrial television broadcasting to the ITU DSO database.

Session 3: Towards Effective Uses of the Digital Dividend

Session 3 highlighted additional various issues of Digital Dividend ranging from the background provision of its definition to the specific features of future utilization of 470 – 790 MHz band in the EU. Particular attention was given to the anticipated implementation of IMT2020 systems in 700 MHz band.

Understanding the Digital Dividend

In order to deal with consequences of DSO, there is need to be based on unambiguous definition and understanding of the Digital Dividend as the notion. The definition as agreed in the ITU Report SM.2353 "The challenges and opportunities for spectrum management resulting from the transition to digital terrestrial television in the UHF bands" and in the Coordination Committee on Vocabulary (CCV) of ITU was presented to the meeting as following - *the improved efficiency in the use of the spectrum, consequential to the DSO*.

There are several approaches on how to estimate the amount of spectrum able to be released as the result of DSO. Most of the factors influencing the process relate to the legacy of incumbent broadcasting stations and intensity of such usage. The existence of other incumbent spectrum uses should be taken into account. Typically, three methods can be used by administrations in spectrum redeployment in the UHF band namely administrative, market based and combination of the two. In particular, Recommendation ITU-R SM.1603 "Spectrum

redeployment as a method of national spectrum management" provides the required background information for Administrations concerned.

Simultaneously, spectrum redeployment in favour of mobile technologies presumes the need to solve purely engineering tasks relevant to TV channel re-planning and protection of non-broadcasting applications unable to be supplied with alternative bands.

Integrated system for the assessment of coverage, QoS and transmission capacity of TV broadcasting

The availability of an integrated tool based on measurements and predictions on coverage, QoS and transmission capacity of TV broadcasting, is essential to assess effectiveness of current uses for UHF band and to elaborate future scenarios. The mentioned tool was developed by Fondazione Ugo Bordoni and demonstrated to the participants of the seminar.

The integrated tool is based on the logical interaction among various functional units sharing multiple databases (transmitters, DTT reference networks, etc.) and various simulation algorithms. The tool aims on the simultaneous control of the trends in parameter variations arising from applying different models of the UHF band utilization. The integrated platform proved to be effective tool for assessment of the penetration of more efficient compression technologies (primarily MPEG4) as well as the assessment of the capacity used in MUXs of DTT. The proposed solution is extremely efficient and may be consider by other interested stakeholders.

Utilization of the digital dividend and the use of 470-790 MHz band in the EU

Radio Spectrum Policy Group (RSPG) of EU adopted Opinion 2, which supports a coordinated EU approach to providing wireless broadband in the 700 MHz frequency band. The UHF band strategy should be based on harmonized technical conditions, technology and service neutrality, common deadline for making the 700 MHz band available for use by wireless broadband electronic communications services in line with the harmonized technical conditions, and coordination measures to support this transition.

The meeting noted the Decision 2017/899 of European Parliament Decision prescribing:

- By 30 June 2020, Member States shall allow the use of the 694-790 MHz for terrestrial systems capable of providing wireless broadband electronic communications services only under harmonised technical conditions set by the Commission pursuant to Article 4 of Decision 676/2002/EC.
- Member States may, however, delay allowing the use of the 700 MHz frequency band for up to two years on the basis of one or more of the duly justified reasons set out in the Annex to this Decision
- In order to allow the use of the 700 MHz frequency band in accordance with paragraph 1, Member States shall, by 31 December 2017, conclude all the necessary cross-border frequency-coordination agreements within the Union.
- This Decision is without prejudice to the right of Member States to organise and use their spectrum for the purposes of public order, public security and defence.

In order to provide sustainable background for DTT, the Member States shall ensure availability at least until 2030 of the 470-694 MHz ('sub-700 MHz') frequency band for the terrestrial provision of broadcasting services, including free television, and for use by wireless audio PMSE on the basis of national needs, while taking into account the principle of technological neutrality.

700 MHz as the Key to Success for Wide-Area 5G Services

The representatives of telecommunications industry shared their views and positions on 700 MHz future usage. For the time being, the concept of multiple spectrum band 5G networks is supported by major vendors as well as by Mobile Network Operators (MNO). Three levels of network are assuming three spectrum ranges to be utilized.

Level 1. 700 MHz band targeted to become available latest 2020 in Europe. Re-use of existing 900/800 MHz grids allows for timely coverage. Low band is pre-condition for new services like connected cars, smart sensors etc.

Level 2. C-band (3400 – 3800 MHz) is sparsely used in most parts of Europe. Re-use of existing 1800/2100/2600 MHz grids. Carrier bandwidths of 100 MHz + allow for single Gbps data rates.

Level 3. 24.25 – 27.5 GHz for hot spots and common tuning range is expected to allow for common economies of scale. Carrier bandwidths of several 100 MHz allow double digit Gbps data rates.

When defining national policies of spectrum usage for 5G, the above mentioned three levels model can be considered.

Country Experience

Digital Broadcasting Implementation in the Kyrgyz Republic

The State Committee of Information Technologies and Communication of the Kyrgyz Republic carried out tremendous work on implementation of DTT in the country. It is worth to note that ASO was accomplished in 2017 providing 95% of population coverage. It deserves even more attention taking into account the mountainous landscape of the country. Multiple technical decisions were applied including broad usage of earth satellite stations.

Challenges Revealed

The meeting agreed on the importance of Digital Dividend notion in terms of future efficient utilization of UHF spectrum. Misunderstanding of the definition of Digital Dividend may create a situation when the whole amount of released spectrum in UHF bands would be considered as the primary resource for mandatory re-farming from broadcasting to land mobile service.

Certain views on the possibility of mass provision of TV content through LTE-broadcasting are arguable in case of seeking appropriate quality of service and influencing of EMF on human being. Each administration should set their strategy in the field of future use of UHF range considering total value of this resource for society as well as noting international, regional and multilateral agreements.

Session 4: National Policy and Regulatory Measures for Spectrum Management and Broadcasting

Session 4 was focused on discussions of the basic principles of regulation and policy making relevant to spectrum management and broadcasting in the region. The participants were informed on the current activity of ETSI in European market access regulation. The meeting was given an overview of BDT activities in spectrum management including projects, country assistance, capacity building, spectrum management software and other topics. The impressive experience of countries on spectrum policy topics was reviewed.

Spectrum Access in Europe: ETSI's Pivotal Position

The participants observed the situation with European market access regulation based on its deregulation with the adoption of the Radio and Telecommunications Terminal Equipment (R&TTE) Directive in 1999. The experience gathered have led to the consolidation of the regulatory framework with the adoption of the Radio Equipment Directive (RED) in 2014 that repeals the RTTE Directive. Of prime importance for the implementation of this Directive are harmonised standards published in the official journal of the European Union (OJEU) as, if complied with, they provide a presumption of conformity for a radio equipment. The standards are elaborated by the European Standardization Organizations, one of which being the European Telecommunications Standards Institute (ETSI), following a mandate issued by the European Commission.

Spectrum access regulation is also undergoing a steady process of deregulation. In particular, in Europe the principle of technological neutrality of spectrum access regulation has induced a shift of the decision-making power with respect to the conditions for accessing spectrum towards ETSI that is thus entrusted with a significant role in the regulation of spectrum usage in Europe. Indeed radio interface specifications (RIS) that regulate the conditions of access to spectrum often refer in their informative part to harmonised standards.

Assistance of BDT in Spectrum Management

The BDT informed meeting on its latest activities in assisting national administrations on spectrum management issues. It was noted that within a project funded by EC, based on the European cross-border frequency agreement BDT together with the beneficiary countries developed the Harmonized Coordination Method for Africa (HCM4A) that provides a solid basis for bilateral and mutual agreements for Administrations in Central, East, Southern and West Africa.

Under the scope of the project mainly funded by Canada, BDT carried out missions on assistance in spectrum management in Hungary (benchmark study), Timor-Leste, Cambodia, Lao PDR, Sierra Leone, Zimbabwe, Gabon, Suriname, Barbados. Within the framework of the project funded by the Republic of Korea, assistance in establishing Spectrum Management Master plan was provided to seven Asia-Pacific countries (Brunei Darussalam, Bangladesh, Pakistan, Fiji, Thailand, Samoa, Vietnam) and three Caribbean countries (Jamaica, Grenada, St. Vincent and Grenadines). Based on the results on the Korean project, Spectrum Management Master Plans were developed and agreed by national administrations for implementation.

It was noted that the vast majority of countries under the above mentioned projects succeeded in establishing independent spectrum management regulators, approving primary regulation and NTFAs. The less developed issues are secondary legislation in spectrum management and spectrum pricing that could be further improved. There is the set of spectrum management issues that are still at the emerging stage such as spectrum trading, spectrum sharing, spectrum reallocation and technologically neutral regulation. The latter should be reviewed by the national administrations in order to implement the adequate practices. BDT will continue to assist national administrations on these topics.

ESIMS: A Harmonized Licensing Framework for Mobile Broadband Provision on a Global Scale

The participants considered the information on up-to-date large portfolio of satellite services using different frequency bands (in L, extended L, S and Ka-bands). Earth Stations in Motion (ESIMs) expand the traditional FSS and MSS type applications providing truly global broadband services to mobile platforms. ESIMs operate in Ka-band GSO Fixed-Satellite Service (FSS) networks (RR. 5.527A and Res.156 (WRC-15). It utilizes user terminals with small directional antennas for the provision of broadband communication services that may be mounted on aircraft, ships, land vehicles & platforms.

Harmonised approach is beneficial to business and consumers of ESIMs. National Administrations were suggested to establish commonly agreed (globally or regionally harmonized) approach to ESIMs licensing following the set of principles:

- Foreign visiting ESIMs: free circulation when already authorised in the country of origin.
- Domestic ESIMs: class/blanket licences, e.g. no cumbersome individual terminal-by-terminal licenses.
- Clarity and transparency in the national licensing framework.
- Reasonable spectrum pricing.

Country Experience

The Italian Transition from Analogue to Digital Terrestrial Television: Challenges, Problems and Lessons Learnt

Italy has shared the country's experience in DSO and future plans on UHF band utilization. DSO in Italy began in heavy analogue terrestrial TV legacy with the adoption of analogue switch off schedule. The specific feature of DSO in Italy was the extensive use of SFN technology. The switch-off schedule assumed on gradual implementation of DTT by regions of the country and ASO was accomplished in 2012.

According to the Law No. 220/2010 frequencies in the band 790 MHz to 862 MHz (61-69 UHF channels) were intended for terrestrial mobile service as of 01.01.2013. Consequently, Italy auctioned released spectrum in 800 MHz in September 2011. With regard to repurposing of 700 MHz band the Telecommunications Administration of Italy is considering the following plan:

- 31 December 2017: deadline for bilateral coordination agreement;
- 30 June 2018: deadline for publication of national roadmaps to make 700 MHz Band available to mobile service;
- 30 June 2020: deadline to make 700 MHz Band available to mobile service;
- Possibility for Administrations to ask, for justified reasons only, to postpone the deadline to 30 June 2022;
- The Sub-700 MHz Band will be available for broadcasting service and radio microphones (PMSE) at least until 2030.

Italy is considering a mix of different solutions that includes a general re-arrangement of both VHF and UHF bands. A number of MUX will be definitely switched off, a number of MUX will be restacked in the sub-700 MHz Band. Remaining MUX will transitionally adopt MPEG-4 encoding in order to double the number of carried program. Only after the release of 700 MHz Band (2020/2022), the remaining MUX will start the definitive upgrade towards DVB-T2/HEVC technology (assuming that meanwhile a significant number of customer's TV receivers will be renewed).

Spectrum Management Policy for Mobile Broadband Promotion in Republic of Serbia

The Telecommunications Administration of the Republic of Serbia being in line with the Digital Agenda for Europe has developed the Digital Agenda for Serbia until 2020 embracing Electronic Communications Strategy until 2020 and Information Society Strategy until 2020. The meeting was provided on the details of both national strategies.

Both Ministry of Trade, Tourism and Telecommunications and The Regulatory Agency on Electronic Communications and Postal Services conducted intensive activity in the process of DSO in Serbia. Starting from March 2012 with initial network for testing of digital broadcasting DSO was accomplished in June 2015 with population coverage over 97%. In order to maximize Digital Dividend Serbia introduced broadcasting standard DVB-T2 enabling high bit rates in TV channel with efficient compression allowing small bit rates for satisfactory video/audio quality(MPEG-4, part10, i.e. ITU-T Recommendation H.264 AVC). Single Frequency Networks were introduced over the allotments enable efficient spectrum usage.

Digital Dividend in 800 MHz has been offered to operators for further enhancement of the mobile broadband. Public bidding procedure was carried out by RATEL in November 2015. Three mobile operators providing services in Serbia obtained 2x5 MHz blocks. Currently Digital Dividend 2 is ready to be used for mobile broadband in Serbia. Public auctions in 700 MHz frequency bands are expected to stimulate the investment in the broadband access networks of the country.

Experience in the Area of Electromagnetic Field

The participants appreciated the information from the Republic of Poland on the electromagnetic field levels in the context of anticipated implementation of 5G. Exposure limit such as 0.1 W/m² may lead to the following consequences:

- Limited range of the base station grids.
- The necessity to build much denser net of base stations (cost inefficient) and thus enforce increase of oversized investments costs.

- Inability to share with existing technologies.

In order to implement innovative and intelligent solutions, based on 5G networks, efforts should be made to guideline a coherent approach for the standardized EMF levels across the ITU countries. Taking into account present variety of EMF levels across the ITU countries, it should be estimated in various scenarios which EMF levels will grant the minimum requirements for the 5G establishment. Exchange of good practices in the field of social information campaigns on increased power limits and their environmental impact is required.

Challenges Revealed

The meeting identified the components of spectrum management that could establish the basis for further assistance from ITU to national administrations. Among those are the issues of secondary legislation in spectrum management and spectrum pricing as being insufficiently developed in some countries and requiring further improvement. There is the set of spectrum management issues that are still at the emerging stage such as spectrum trading, spectrum sharing, spectrum reallocation and technologically neutral regulation. The latter should be reviewed by the national administrations in order to implement the adequate practices. ITU-D will continue to assist national administrations on these topics.

The technical issue of acceptable levels of electromagnetic fields in the context of future 5G networks is of great importance for the countries with heavy legacy on the subject. The existing restrictions in these levels can result in additional capital investments in the networks which might delay the successful implementation of 5G. ITU is invited to consider the topic of acceptable electromagnetic fields strength to assist administrations facing with this challenge.

Session 5: Economics of Spectrum Management, Including Spectrum Pricing Strategies and Tools

Session 5reviewed economical aspects of spectrum management with the emphasis on Administrative Incentive Pricing (AIP) and economics in the process of spectrum re-allocation. The experience of national administrations in the process of introducing economical methods in spectrum management with regard to Digital Dividend was also observed.

Administrative Incentive Pricing

A duly established scheme for spectrum pricing can assist in the efficient management of spectrum by any administration. One prerequisite is that the stable financing of spectrum management is founded on one-off and/or recurrent administrative charges paid by spectrum users and/or the Budget of the State (income from taxes). Spectrum pricing should not be considered as an additional source of finances for State Budget. One major benefit of AIP is that through the height of the spectrum fees it sends signal to spectrum rights owners on the value of spectrum they are utilizing. AIP could be used in order to influence their behaviour in operating scarce spectrum resources.

Some practical considerations with introducing AIP were considered. The most significant are those presented below:

- fees should be set under due consideration of economic realities of a country
- benchmark fees with comparable States are of great importance
- different spectrum „price" / spectrum „value" ratio for spectrum management authorities than for spectrum users
- AIP is inapplicable in license-free frequency bands
- periodical adjustments of fees required

Spectrum Re-allocation Issues

Spectrum re-allocation is becoming a significant issue in modern spectrum management due to rapid radio technologies turnover. Traditionally, administrations relied on technocratic approach dealing with spectrum re-allocation. Nevertheless, in the last decade it appears obvious that spectrum re-allocation is more economic notion.

In order to proceed with correct regulatory decisions with spectrum re-allocation, administrations should estimate total value of spectrum resources for the society as a whole. The elements of the total value of spectrum were discussed, as well as the options and methodology of re-allocation based on economic principles. The role of ITU was underlined with regard to approved Recommendations and Reports on spectrum redeployment topic.

It was concluded that in conducting strategic policy on spectrum re-allocation, regulators should be guided by the need to guarantee sustainability in the interests of society including social and public demands, benefits of consumers, service providers, and industry while securing optimal utilization of spectrum resources.

Country Experiences

Economics of Spectrum Management including Spectrum Pricing in Albania

Albania introduced recent alignments of the national regulatory framework for electronic communications. Competition in electronic communications market has increased as a result of the government's policies and regulatory measures through regulating termination tariffs, implementation of mobile and fixed number portability, granting rights to use free frequencies from 900/1800/2100/2600 MHz bands, removing technology restriction, etc. As the result;

- Increased usage of broadband access by 3G / 4G mobile networks.
- Increased volume of data transmitted on mobile networks. In 2014, the annual growth of data traffic in mobile networks was 148%, and this trend continues in 2015 and 2016, with annual growth of 103% and 110% respectively.
- In the period 2013-2016, the volume of Internet access data in mobile networks has increased more than 10 times.

The existing principles and methodology of national spectrum pricing were introduced. It is worth to note that those correspond to best practices identified by ITU, in particular those included in the Report ITU-R SM.2012 - Economic aspects of spectrum management.

Digitalization and Usage of Digital Dividend in Montenegro

Digitalisation of TV broadcasting in Montenegro was completed by the 17th June 2015. For the entire digitalisation of analogue TV broadcasting in Montenegro, one MUX was enough, allowing to release the maximum amount of spectrum in 800 MHz band.

The Telecommunications Administration of Montenegro has successfully introduced spectrum pricing mechanisms, such as auctions, in awarding the use of available radio-frequencies in the bands 800 MHz, 900 MHz, 1800 MHz, 2 GHz and 2.6 GHz for the implementation of a public mobile electronic communication networks. The auction was held in Combinatorial Clock Auction (CCA) format.

For the time-being Montenegro is considering ways to provide 700 Mhz band for mobile broadband applications. In most cases, the band 694-790 MHz has been avoided for the implementation of DVB-T2 networks (only channel 49 is used). It is expected that 700 MHz band would be completely released by the end of 2017. The regulator considers also the possibilities for usage of following radio-frequency bands: 1452-1492 MHz, 2300-2400 MHz, 3400-3600 MHz and 3600-3800 MHz also for IMT systems.

Challenges Revealed

The participants underlined current challenges with practical implementation of economic methods in spectrum management. Most of them relate to optimal size of spectrum fees and incentive nature of pricing models.

The issues of spectrum re-allocation are becoming burdensome for the majority of administrations in view of extensive radio technologies turn-over. There is still the lack of experience in applying economic methods in the process of re-allocation. The assistance from ITU on this topic is highly appreciated by regulators in different countries.

–Report ITU-R SM.2012 "Economic aspects of spectrum management" and Recommendation ITU-R SM.1603 "Spectrum redeployment as a method of national spectrum management" provide practical guidance for national administrations in dealing with the above mentioned challenges.

Session 6: Spectrum Monitoring

In recent years, a number of countries, including developing ones, are upgrading and expanding their spectrum monitoring networks, primarily at the level of local networks. Some countries are creating or planning to create their national spectrum monitoring networks from a scratch. In this context, Session 6 of the seminar reviewed the issues of optimal configurations and compositions of spectrum monitoring networks. Special attention was given to implementation of large scale monitoring networks as well as to the role of ITU in evolution of spectrum monitoring as the element of spectrum management.

Practical Implementation of the ITU-R Methodology for Planning and Optimizing Spectrum Monitoring Networks

In order to ensure an efficient spectrum management framework, the sustainable national spectrum monitoring network should be established. In this regard, ITU developed several deliverables providing basic information on modern spectrum monitoring networks. The participants were informed on the following ITU deliverables with the analysis of thereof:

- Recommendation ITU-R SM.1392 giving Essential requirements for a spectrum monitoring system for developing countries;
- ITU-R Handbook on Spectrum Monitoring giving general methodology on planning and optimization of a convenient Angle-of-Arrival (AOA) spectrum monitoring networks in the context of monitoring coverage;
- Report ITU-R SM.2356 "Procedures for planning and optimization of spectrum-monitoring networks in the VHF/UHF frequency range".

The details on Angle-of-Arrival (AOA) spectrum monitoring networks, Time-Difference-of-Arrival (TDOA), and Computer-Aided Techniques for Spectrum Management (CAT) were further presented to the participants.

Also the participants were informed about the software tools on the optimization of spectrum-monitoring networks in the VHF/UHF frequency range, which were successfully implemented as the part of assistance projects in several countries (Armenia, Nepal, Saudi Arabia, Costa Rica, Albania, Swaziland).

Bringing the worlds of Spectrum Management, Policy, and Monitoring together through Big Data analysis

The meeting considered the issue of Big Data Analysis in the context of spectrum monitoring. It is normal for spectrum management, policy making and monitoring to be separate functions within a National Regulatory Agency (NRA). The use of large-scale spectrum monitoring networks is ever increasing. Session 6 explored the use of these networks, the application of big data approaches, the analytical advantages from the data, and the value it can add to spectrum planning, decision-making, and audit.

Modern spectrum monitoring networks requiring a distributed monitoring system that covers everything, everywhere. There should be flexible design, packaging, performance so devices can be matched to operational environment/requirement. Rich storage of spectrum data should be created thus making possible a historical picture to be built up. Small monitoring devices that can be placed anywhere, both antennas and receivers could become the sources for spectrum utilization date. The operator should be able to use equipment remotely, as if being directly connected to it.

Cloud monitoring data platform can assist in solving the above mentioned tasks. This platform will significantly increase the value of monitoring data and the overall value of spectrum monitoring.

Evolution of Spectrum Monitoring

Being the part and parcel of the spectrum management process, spectrum monitoring continues to play a key role in the management of scarce spectrum resource, radio stations and electromagnetic environment, by providing valuable monitoring data to maximize spectrum efficiency, minimize interference and eliminate unauthorized and improper use of the spectrum.

Future spectrum monitoring systems should have capability for monitoring new radiocommunication technologies and systems, such as detection of weak signal, co-frequency signal separation and multi-mode location based on digital signal processing (DSP) and network, etc.

After the presentation of this information, the BR Counsellor for ITU-R Study Group 1 indicated that these topics and many others on spectrum monitoring will continue to be addressed at the future meetings of ITU-R Working Party 1C. The participants of the seminar were requested to contribute to these activities.

Country Experience

Moldova Experience

The representative of Moldova shared the country's experience in spectrum monitoring practices. Due to daily activities with spectrum monitoring the Administration is able to collect information on current utilization of spectrum resources. It is of great value in the issues related to implementation of new services such as IMT networks in 790 – 862 MHz band and DSO in UHF band. For the time being Moldova has accomplishing ASO with the first MUX A already been in operation. The whole band 470 – 694 MHz is planned for DTT while Digital Dividend 700 MHz band is under consideration for IMT systems.

Challenges Revealed

The participants had opened the discussions on possible development of spectrum monitoring networks in view of expected implementation of 5G systems. ITU will undoubtedly be involved in this process. Contributions from the interested parties are welcomed.

The issue of spectrum monitoring becomes even more vital with the anticipated massive implementation of unlicensed SRD-based IoT applications. In order to avoid intolerable spectrum saturation special radio monitoring expertize might become necessary. It could presume implementation of innovative hardware and software, as well as big data processing. ITU is requested to participate actively in studies of these trends.

Session 7: International Mobile Telecommunication (IMT) for 2020 and Beyond

Session 7 considered the issues of future development of IMT for 2020 and beyond. The aspects of ubiquitous connections with 5G along with inherent IoT functionality of next generation networks was emphasised. The participants were apprised of technical and business opportunities arising from implementation of 5G in short and medium term. The representatives of ICT Industry shared their views with participants on spectrum related subjects including the significance of 470 – 694 MHz for IMT technologies.

5G: The Connected World of Tomorrow

ITU-R is playing the key role in studies of the following bands to prepare for WRC-19 under the Agenda Item 1.13 (spectrum for IMT): 24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz, which have allocations to the mobile service on a primary basis; and 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz, which may require additional allocations to the mobile service on a primary basis. If approved by WRC-19, timeframe of networks' availability is ~2020. Some countries are making spectrum available domestically in the 2016-2018 timeframe.

Industry recommends allocation of sufficient low-band, mid-band and high-band spectrum for 5G including licensed and license-exempt bands. Furthermore, regulators are encouraged to consider economies of scale; global harmonization based upon tuning range approach. Adopt policies needed to facilitate 5G, as the examples:

- ensuring sufficient backhaul spectrum for 5G (71-76 GHz/81-86 GHz);
- providing of license-exempt spectrum at 66-71 GHz to enable systems such as Wireless Gigabit Networks (as defined in Rec. ITU-R M.2003).

Towards 5G Opportunities and Challenges

The participants of the seminar highlighted the topic of 5G network platform. It was discussed that radio technologies evolution was of great value in future 5G networks. Nevertheless, other part of infrastructure is important to enable envisaged opportunities of the next generation of networks.

Industry is focused on delivering full end-to-end 5G systems, which will allow customers to take advantage of all the capabilities of 5G. A common network platform with dynamic and secure Network Slices is essential to provide efficient interconnection between different verticals. High capacity and data rates, flexibility, sustainability, low latency, security, robustness, and scalability are the imperatives for 5G networks industry is working on.

View on the Future Use of the 470 – 694 MHz Band for IMT

It was the common understanding of the meeting that key regulatory requirements to enable the IMT evolution included:

- Enabling economies of scale by selecting bands with high potential for harmonization.

- Ensuring coverage & capacity by making available both low and high frequencies.
- Timely development of appropriate regulatory frameworks.

The representatives of telecom industry informed the meeting that major mobile vendors and chipset manufacturers had announced the plans to support 600 MHz (early 600 MHz smartphones are expected on the market as early as 2017). GSMA (over 800 members) strongly supports making available 600 MHz for IMT. It was pointed out that IMT use cases required wide and deep coverage (e.g. IoT, Last Mile Fiber in the Air, Rural) and this demand would continue to grow. From this perspective a harmonised repurposing the 470-694 MHz band for IMT after 2023 seems to be the best scenario for Europe. This could be achieved via a co-primary allocation to the mobile service in Region 1 at WRC-2023. The opinion was presented to the meeting that alternative DTT/IMT co-existence scenario would require severe power and geographical restrictions on IMT, both within countries and along the borders with neighbouring countries, and would thus lead to a low spectrum efficiency.

Countries Experience

The Experience of Moldova with the UHF Spectrum Band

The representative of Moldova introduced the latest information on the use of UHF band in this country. It was underlined that the band 790 – 862 MHz has been allocated for LTE networks, licences has been awarded to two market players. The spectrum band 694 – 790 MHz would be finally used for IMT technology based on ECC/DEC/(15)01 on technical requirements for Mobile/Fixed Communications Networks (MFCN). The implementation of IMT in 700 MHz band is under the condition of DSO which is planned for 31 of December 2017. The future use of 470 – 694 MHz is defined for DTT in Moldova according to the set of governmental decisions. Nevertheless, Moldova is monitoring the development of the situation with 470 – 694 MHz in ITU and Europe to proceed with the harmonized approach in its future utilization.

Challenges Revealed

The items below were mentioned by participants after the presentations.

In response to a question about the time delays faced today when watching on mobile devices some TV programs (e.g. live sport events) using advanced technology such as UHDTV (4K), it was indicated that today not all big events are provided on DTT channels (free-to-air) and that already most of these programs are on Pay-TV services, which are moving from DTT to other supporting platforms. With the development of Internet and 5G, this trend will continue to evolve and the quality will improve, in particular in city areas.

In response to a question on whether it is reasonable to start implementation in 2018 while the European road map targets 2020, it was indicated that 2018 is a reasonable time to start assessing at least some of the 5G technologies and not to wait that all parts of the 5G networks be ready. It was also indicated that regulatory actions are needed to make available frequency bands, in particular in the frequency ranges 3.4-3.8 GHz, 26 GHz and 42 GHz, so that frequency bands and standards could be ready at the same time by 2019 or 2020.

Session 8: Spectrum Management for IoT Development

Session 8 highlighted the most important issues related to future development of IoT in the countries of the region. The participants emphasised the need for further activity of ITU regarding standardization and harmonization of technological decisions of IoT based on applications within different Radio Services. In order to encourage efficient implementation of IoT effective spectrum management policy of regulators should be conducted. The vital topics of current IoT implementation in the countries of the region have been discussed.

ITU Studies in Support of IoT

The BR Counsellor for ITU-R Study Group 1 acknowledged the participants on current ITU studies with regard to IoT. In particular, an overview of activities within ITU-R Study Group 1 (Spectrum Management), Study Group 4 (Satellite Services), and Study Group 5 (Terrestrial Services) were noted. Those refer to on-going studies in response to Resolution ITU-R 66 (from RA-15), as well as to the topic of Machine-Type-Communications (MTC) infrastructure in response to Item 3 of the Annex to Resolution 958 (WRC-15).

A variety of radio technologies will be used to implement the IoT, extending from the SRD to Wide Area Sensor Networks (WASN) and global terrestrial IMT systems as well as satellite systems. Currently WASN systems supporting M2M communications to a large number of sensors and/or actuators are under studies (Recommendation ITU-R M.2002 and Report ITU-R M.2224). Both ITU deliverable provide detailed information on system design policy, the wireless applications and examples of WASN systems for information sharing. In the short term, the current IMT-Advanced standard (Rec. ITU-R M.2012) is being enhanced to include support for IoT. In the longer term, IoT is seen as an integral element of the IMT-2020 (5G) standard being developed in ITU – extending the benefits of the IMT massive economies of scale and globally harmonized frequencies and standards to all industry sectors (Recommendation ITU-R M.2083). Satellite systems are the next opportunity to cover a wide area with high capacity and can instantaneously connect any place within their footprint, allowing rapid connection of cities, villages, businesses and homes with a predictable quality of service.

The ITU-R Study Groups are developing technical and operational standards to facilitate the deployment of IoT on a global basis, including harmonized frequency spectrum and appropriate regulatory regimes. Associated aspects will also be addressed at the forthcoming World Radiocommunication Conference 2019 - Agenda items 1.11, 1.12, 1.13, 1.16 and 9.1 (issues 9.1.5 & 9.1.8).

Spectrum Management Aspects Enabling IoT Implementation

The meeting considered the ways in which the elements of modern spectrum management elements should be applied in order to ensure efficient implementation of IoT. It is obvious that nearest future will witness enormous development of IoT revealing essential spectrum demand thus requiring effective spectrum supply and regulatory policies by administrations. New regulatory approaches are foreseen to facilitate implementation of IoT applications. Nevertheless, the pivotal spectrum management principles will remain relevant. Unbiased view on spectrum management environment for IoT should be established in order to proceed with this market entrant.

The landscape of spectrum management environment in IoT regulation includes dedicated (licenced) and shared (unlicensed) spectrum. Accordingly general authorization regime and individual authorization regimes should co-exist in any country implementing IoT applications. With the unlicensed and ISM spectrum bands multiple networks are envisaged to be deployed. However, those networks are practically should be focused on applications not requiring low latency and guaranteed QoS. Conversely, the applications in the licenced bands should cater a limited number of market players, effectively the existing MNO in a country. The distinguishing features of their IoT networks would be ultra-reliability and low latency with the guaranteed QoS. The Administrations are urged to proceed with both regulatory regimes and types of IoT networks.

Country Experience

Regulatory Practices with IoT in Netherlands

The Radiocommunications Agency of Netherlands shared its experience on implementation of IoT application. The dominated consumers of IoT now in the country are agriculture and e-health. The environmental control is much-promising area in the nearest term.

The impact of short range IoT usage in unlicensed spectrum is expected to be limited due to a very high level of frequency re-use for short-range applications. Current regulatory framework may not be adequate in the light of large-scale deployments of long-range technologies, such as for LPWA IoT. Two new scenarios of interference are of particular interest for further studies:

- a scenario where short-range devices are close to a base station of a long-range network, and cause interference that harms long-range communication in the whole long-range cell;
- a scenario where there is interference between different long-range technologies in the same spectrum.

In general, current position of the Radiocommunication Agency of Netherlands is to refrain from allocating additional spectrum for Low Power Wide Area (LPWA) IoT upon the results of studies and practical requirements would prove of doing so in future.

Challenges Revealed

Following the presentations of the Session, a brief Question & Answer exchange took place. The following challenge was noted. IoT applications intend to utilize SRD's using spectrum on non-interference and non-protected basis. SRD's are primarily used at low distance from the ground and compatibility studies are being carried out taking into account this fact. The case of LPWAN's, that require a massive use of SRD's, implies a completely different scenario from that one used by single SRD. How ITU intend to carry out compatibility studies in order to protect radio communication service in case the satellite is to be used for backhauling?

The ITU-R SG1 Counsellor replied that ITU is well aware of this issue but, for the time being, the interest of ITU-R is focussed on the harmonization of technical parameters and frequency bands. ITU-R intends also to carry out studies related to the protection of Radiocommunications Services. These studies will be based on inputs from members as the ITU process is, as well known, contribution-driven.

Among the others the participants outlined the challenges in providing spectrum availability since monitoring the trade flows of SRD is not an easy task due to the diverse supply chains.

Administrations will also be faced with the issue of IoT reliability as deployment of LPWA IoT in licensed spectrum is expected to be gradual and smooth. It was emphasized that IoT in unlicensed spectrum below 1 GHz is much more complex (e.g. 863-870 MHz band) compared to IoT in licenced spectrum.

The issues of security (hacking) is becoming the crucial element with IoT

During the Q & A session, it was also pointed out that ITU-T SG 20 is the leading SG in IoT and its applications, in Smart Cities & Communities (SC&C) including its services and smart services and IoT identification. In the framework of SG 20 there are to be included the activities of JCA on IoT and SC&C, that has developed and maintained a roadmap for IoT and SC&C standardisation, contributed by the various SDO's.

Concluding the Session 8, the moderator suggested that ITU studies should address, as far as IMT based systems and devices are concerned, the questions of embedded SIM, for guaranteeing the service provider portability of a large number of devices and of the permanent roaming, for ensuring smooth operations of international and global applications. Further, he invited the floor and the ITU representatives to consider the activities on IoT regulation recently carried out by the Body of European Regulator for Electronic Communications (BEREC), which

has prepared a report, published in 2016, and conducted a workshop, in February 2017, on the topic. References to these activities could be found through the following links:

BEREC Report BoR (16) 39: BEREC reports on enabling the Internet of Things:

http://www.berec.europa.eu/eng/document_register/subject_matter/berec/reports/5755-berec-report-on-enabling-the-internet-of-things

BEREC Report BoR (17) 40: Summary report on the outcomes of the workshop on IoT technologies and their impact on regulation:

http://www.berec.europa.eu/eng/document_register/subject_matter/berec/reports/6972-summary-report-on-the-outcomes-of-the-workshop-on-iot-technologies-and-their-impact-on-regulation

Session 9: Towards the WTDC 2017 and WRC 2019

The issues of primary importance in the development of radio technologies and in allocation of spectrum bands for those ones are included in the agendas of forthcoming WTDC 2017 and WRC 2019, respectively. The seminar gave credit to the activity of ITU on both subjects and considered the information on ITU preparations for WTDC 2017 and WRC 2019.

ITU Preparations for WTDC 2017

ITU TDAG Vice-Chairman provided the participants with the updated information on preparations for WTDC 2017. WTDC 2017 will set the strategies and objectives for the development of telecommunication/ICT, providing future direction and guidance to the ITU Telecommunication Development Sector. According to the draft agenda, WTDC will review the report on the implementation of the Dubai Action Plan, consider ICT Policies and strategies for achieving Sustainable Development Goals as well as will develop ITU-D workplan for 2018-2021.

It was emphasised that draft ITU-D contribution to the ITU Strategic Plan for 2020-2023 will include international cooperation and agreement on telecommunication/ICT development issues; the development of infrastructure and services, including building confidence and security in the use of telecommunication/ICTs; enabling policy and regulatory environment conducive to sustainable telecommunication/ICT development; development and use of telecommunications/ICTs and applications to empower people and societies for socio-economic development and environmental protection.

The list of regional initiatives is under development and for the time being it encompasses the following items:

- EUR 1: Broadband infrastructure, broadcasting and spectrum management;
- EUR 2: A citizen-centric approach to building services for national administrations;
- EUR-3: Accessibility, affordability, and skills development for all to ensure digital inclusion and sustainable social and economic development;
- EUR-4: Enhancing trust and confidence in the use of ICTs;
- EUR-5: ICT-centric innovation ecosystems.

The participants were invited to provide their concrete proposals for actions pertaining to the regional initiative on Broadband infrastructure, broadcasting and spectrum management

ITU Preparations for WRC 2019

The BR Counsellor for the Conference Preparing Meeting (CPM) for World Radiocommunication Conference (WRC) introduced the background information on the preparation of the Union for the WRC 2019. Among the others, the major objectives of the Conference were noted:

- Create regulatory certainty for a multi-trillion dollars industry which plays an increasingly important role in the development of our societies.
- For fixed, mobile, satellites and broadcasting industries, global spectrum harmonization is essential for economies of scale, roaming and interoperability.
- Creating certainty requires consensus in order to achieve stable results.

The primary issues for consideration by the WRC 2019 could be summarized as follows:

- Fix. & Mob. BB Apps. (24.25 < IMT < 86 GHz, HAPS, Apps. Id>275 GHz, WAS/RLAN @ 5 GHz)
- Amateur in Region 1 @ 50-54 MHz
- New Transport systems (harmonized bands for railways, ITS)
- Earth resources & Climate monitoring, weather forecast, DCS improvement, TT&C for N-GSO Sat. of short duration
- Maritime (GMDSS modernization (+Sat.), use of radio devices, VDES Sat component)
- Aeronautical (GADSS needs)
- Satellite issues (BSS/FSS @12 GHz, ESIM, regul. for N-GSO FSS @ 37.5 to 51.4 GHz)
- Regulatory Issues.

In addition, the seminar was informed on other useful information regarding regional activities and calendar of the major events in preparation process towards the CPM and the Conference.

Future Use of Millimetre Waves in 5G

The development of 5G technology assumes utilization of multiple spectrum ranges. It is the first time in the history of Land Mobile systems when the millimetre (mm) waves are envisaged for intensive utilization. It is obvious that mm waves are presuming to provide short transmission paths and high propagation losses. Nevertheless, the extremely short wavelengths of mm wave signals make it feasible for very small antennas to concentrate signals into highly focused beams with enough gain to overcome propagation losses, where longer paths are required. The short wavelengths of mm wave signals also make it possible to build multi-element, dynamic beamforming antennas that will be small enough to fit into handsets. It also forms large bandwidths of the order of multiple GHz, unavailable at other frequency ranges. All these arguments are demonstrating the extremely high importance of mm waves in future 5G networks.

The meeting took these arguments into account while underlining the need for further studies of applicability of bands which have allocations to the Mobile Service on a primary basis - 24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz 81-86 GHz – and bands that may require additional allocations to the Mobile Service on a primary basis - 31.8-33.4 GHz, 40.5-42.5 GHz, 47-47.2 GHz. Both issues should be studied under Agenda Item 1.13 of WRC 2019.

Fixed service (FS) and Fixed-Satellite Service (FSS) Coordination Procedure for 3.6 – 3.8 GHz Frequency Band

In the context of 5G the participants of the seminar highlighted the need to understand interference scenarios between terrestrial and satellite operators in the frequency band 3600 – 3800 MHz.

The meeting considered the proposals from Italy on new solutions to manage the interfering aspects allowing that coordination between the applications of two Radio Services is possible. Starting from the measurement results and based on the characteristics of the equipment, the studies had the objectives to identify a protection area around teleports able to protect the FSS from harmful interference.

Challenges Revealed

The meeting highlighted the challenges related to the use of millimetre radio waves in future 5G networks. It is not clear yet on the possible options on providing compatibility of 5G with the existing radio applications. This issue should be further studied. On other hand, the issue of 5G network effectiveness is still open and arises from the poor propagation characteristics compared to the traditional land mobile spectrum bands.

The specific question on spectrum sharing between FSS applications and 5G is the next challenge requiring active studies by ITU. Those issues are included in the agenda of forthcoming WRC 2019. In its turn, ITU-D will provide assistance to interested administrations on the topic. It can be presumably done through the list of future regional initiatives to be approved at WTDC 2017.

6 CONCLUSION

All stakeholders were thanked for their contributions to the regional conference. Concrete actions discussed included:

- The participants confirmed the importance of ITU activity on the subjects. Republic of Serbia and Albania indicated the need for assistance on these particular matters.
- Hungary had developed a software tool to visualize the National Frequency Allocation Table (NFAT) incorporating data on the spectrum uses in different spectrum bands. This software is of great interest for other administrations in their efforts to establish NFATs.
- Ukraine – "in light of Resolution 235 (WRC-15), administrations are invited to notify to the ITU Radio-communication Bureau for recording in the Master International Frequency Register their frequency assignments in operation in the band 470-960 MHz, in order to reflect actual usage of the band."
- Countries were urged to provide information on the status of the digital terrestrial television broadcasting to the ITU DSO (Digital Switch Over) database. https://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Default.aspx.
- The definition of digital dividend as agreed in ITU was presented to the meeting as - the improved efficiency in the use of the spectrum, consequential to the Digital Switch-Over (DSO).
- When defining national policies of spectrum usage for 5G, a three levels model can be considered.
- Each administration should set their strategy in the field of future use of UHF range considering total value of this resource for society as well as noting international, regional and multilateral agreements
- ITU is invited to further consider the topic of acceptable electromagnetic fields strength to assist administrations facing with this challenge.
- The issues of spectrum re-allocation are becoming burdensome for the majority of administrations in view of extensive radio technologies turn-over. There is still the lack of experience in applying economic methods in the process of re-allocation. The assistance from ITU on this topic is highly appreciated by regulators in different countries.

- In order to ensure an efficient spectrum management framework, the sustainable national spectrum monitoring network should be established in optimal way.
- The evolution of spectrum monitoring will continue to be addressed at the future meetings of ITU-R Working Party 1C. The participants of the seminar were requested to contribute to these activities.
- With the anticipated massive implementation of unlicenced SRD-based IoT applications and in order to avoid intolerable spectrum saturation, special radio monitoring expertize might become necessary. Studies of these trends are well on-going within ITU-R Study Group 1.
- Discussions on possible development of spectrum monitoring networks in view of expected implementation of 5G systems with involvement of ITU has been requested and contributions from the interested parties are welcomed.
- Regulators are encouraged to consider economies of scale; global harmonization based upon tuning range approach. Adopt policies needed to facilitate 5G such as
    - ensuring sufficient backhaul spectrum for 5G (71-76 GHz/81-86 GHz);
    - providing of license-exempt spectrum at 66-71 GHz to enable systems such as Wireless Gigabit Networks (as defined in Rec. ITU-R M.2003).
- 2018 is a reasonable time to start assessing at least some of the 5G technologies and not to wait that all parts of the 5G networks be ready.
- Regulatory actions are needed to make available frequency bands, in particular in the frequency ranges 3.4-3.8 GHz, 26 GHz and 42 GHz, so that frequency bands and standards could be ready at the same time by 2019 or 2020
- All agreed to the hosting a similar event next year possibly **b**ack to back with Forum Global Conference in 2018. Hungary showed interest in hosting.
- A proposal to assist from countries through ITU twinning programme was formulated by Italy
- Technical advice on acceptable EMF with respect to 5G roll out was requested by Poland.
- Possible assistance to interested administrations on spectrum sharing between FSS applications and 5G.
- Member states as well as sector members were requested to
    - avail of relevant spectrum management capacity building services provided through ITU Academy amongst other.
    - join relevant ITU-D and ITU-R Study Groups

A feedback questionnaire was circulated to participants. From the 17 responses received, it was noted that

- all agreed that the event was useful
- session 4 and session 7 were the most interesting ones
- all agreed to attend the next seminar

The feedback indicated that topics proposed for next seminar included

- IOT Management, Spectrum Monitoring, Digital Dividend
- international coordination problems
- regulation of small satellites
- spectrum conversion experiences of countries
- ongoing activities related to GE06 plan, modification to release 700Mhz spectrum for IoT, scenario for introducing mobile services in 700 Mhz band
- future use of spectrum
- influence of EMF on population in urban areas (limit values, exposures), human exposure to EMF

- harmonisation of exposure limits, EMF levels across ITU in relation to 5G implementation
- 5G regulation, spectrum management for 5G
- radio monitoring
- new models for spectrum management despite the rules adopted today which seem a bit old
- future of broadcasting, digital radio

The feedback indicated actions that would be useful to country / organisation from 2018-2021

- CIS/ ITU assistance, experience sharing on spectrum pricing and re-allocation
- interoperability standards for IoT, frequencies for 5G
- digital terrestrial broadcasting
- country experience for DD1, DD2 implementation, future harmonisation for IMYT systems and IoT deployment
- twinning proposal to assist countries
- granting authorization in 800Mhz, spectrum strategy
- spectrum management future challenges, spectrum trading, sharing, 5G
- facilitate discussions between broadcasters and mobile community
- action on harmonisation of exposure limits of EMF
- 5G implementation evaluation

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