Regional Initiatives – Europe

5G IMPLEMENTATION IN EUROPE AND CIS

OUTCOME REPORT OF THE ITU REGIONAL SEMINAR

HOSTED BY NMH National Media and Infocommunications Authority • Hungary

NATIONAL STRATEGIES FOR 5G DEPLOYMENT

ENABLING ENVIRONMENT

5G PILOT IMPLEMENTATION

NEW BUSINESS MODELS

DIGITAL DIVIDEND

SPECTRUM MANAGEMENT

ITU

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1. INTRODUCTION

The International Telecommunication Union (ITU), in collaboration with the National Media and Infocommunications Authority (NMHH) of Hungary organized a Regional Seminar for Europe and CIS on **"5G Implementation in Europe and CIS: Strategies and Policies Enabling New Growth Opportunities".** The seminar was held from the 3rd to 5th of July 2018 in Budapest, Hungary. The seminar was arranged back-to-back with a meeting of an Experts' Knowledge Exchange on related topics in ITU-D Study Groups 1 and 2.

The event was planned in the context of the European Regional Initiative approved by WTDC-17 on the Broadband Infrastructure, Broadcasting and Spectrum Management siding efforts towards facilitation of high-speed connectivity with resilient and synergistic infrastructure development, deployment and sharing opportunities, whilst ensuring a trusted and quality user experience. It also considered the future challenges to be addressed in infrastructure roll-out, spectrum management and broadcasting to ensure that Europe and CIS regions are equipped with relevant measures and effective tools.

The Seminar discussed, in particular:

- National strategies for 5G implementation

- Case studies on 5G strategies and pilot projects
- Issues to enable environment for 5G deployment
- New 5G related business models and revenue streams
- Electromagnetic fields and 5G roll-out
- Effective use of the digital dividend
- New services in digital broadcasting
- National regulatory and policy measures on spectrum management
- Spectrum monitoring issues
- Update on preparations to WRC 2019.

The meeting also benefited from the presence of the international experts involved in the work of the ITU-D Study Groups 1 and 2, which had held an Expert's Knowledge Exchange opened to all participants of the Seminar.

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 102 participants representing 17 Member States from the regions of Europe and CIS.

Figure 1: Group photo with speakers and participants

3. DOCUMENTATION

The seminar was paperless. 39 presentations were delivered during the meeting. Relevant documentation, including the Agenda and Presentations were made available on the ITU website. https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Pages/Events/2018/5G/default.aspx

4. OPENING ADDRESS AND SETTING THE CONTEXT

The participants of opening ceremony were welcomed by:

- **Dr. Péter Vári** - Deputy Director General of the National Media and Infocommunications Authority, Hungary,
- **Jaroslaw K. Ponder** - Head of ITU Office for Europe, International Telecommunication Union.

4.1 Opening Remarks by Dr. Péter Vári

On behalf of the National Media and Infocommunications Authority of Hungary Dr. Péter Vári welcomed the participants. He emphasised that 5G would reinforce the European industry to compete successfully on global markets and would open innovative opportunities. It will not only be an evolution of mobile broadband networks but it will rather bring new unique network and service capabilities. The impact will go far beyond existing wireless access networks focused just on communication services.

5G will ensure use cases in unprecedented types of environment such as high mobility in very dense or sparsely populated areas, and journeys covered by heterogeneous technologies. Mission critical services requiring very high reliability, global coverage and/or very low latency, which are up to now handled by specific networks, typically public safety, will become natively supported by the 5G infrastructure. The new generation technology will become a key enabler for the Internet of Things by providing a platform to connect a massive number of sensors. 5G will integrate networking, computing and storage resources into one programmable and unified infrastructure. This unification will allow for an optimized and more dynamic usage of all distributed resources, and for the further convergence of fixed, mobile and broadcast services.

To support these innovative functionalities, the existing regulatory, technical and business aspects need to be carefully assessed. Maintaining a stable and predictable regulatory and spectrum management environment is critical for the long-term investments. Dr. Péter Vári expressed confidence that the seminar would allow to review the ideas of operators and spectrum managers on the extremely important 5G topics in the region. He wished all participants successful and fruitful work.

4.2 Opening Remarks by Jaroslaw Ponder

On behalf of ITU, Mr. Jaroslaw Ponder expressed greetings to the National Media and Infocommunications Authority for the longstanding tradition of holding seminars in Hungary. He pointed out the significant growth in global population been connected as the result of the mobile revolution. Mobile technologies are evolving rapidly while offering diverse opportunities not only for traditional humans but also for creating new value chains based on the machine-to-machine communication, artificial intelligence, universe of diverse applications. Policy makers widely consider ICT infrastructure and 5G as a fundamental pillar of national digital economy and digital transformation strategies enabling massive IoT implementation, improvements in logistics, urban planning, transport safety and public security. The participants were encouraged to realize that 5G implementation would require serious reconsideration of spectrum usage, intensive investments and adequate handling of cybersecurity challenges that would need to be addressed in the near future.

Mr. Ponder drew attention of the meeting on the remaining gaps in connectivity, mainly due to the lack of infrastructure, affordability, insufficient skills and shortage of relevant local content. Therefore, significant efforts are anticipated to ensure that global digital divide is diminishing in a long run and new divides of any kind will not emerge. From this perspective, Mr. Ponder urged the meeting to raise an open call for engagement in the implementation of the ITU Regional Initiatives, in particular those related to the ICT infrastructure. Recently held ITU Regional Development Forum for Europe established 2018-2021 Implementation Plan, identifying series of regular actions and projects for implementation. The coordination mechanism of CIS countries leads towards establishment of the similar Plan identifying potential projects to be scoped and proposed for implementation in the upcoming years to advance implementation of global connect agenda.

Finally, Mr. Ponder encouraged all stakeholders of the 5G ecosystem to establish an inclusive and collaborative dialogue in order to build enabling environment that would create demand for new ICT services, drive investment in the infrastructure development, foster innovation, ensure growth of the ICT sector, and most importantly provide solutions to make human life better, safer and more prosperous.

4.3 Setting the Context of the Seminar by Mr Istvan Bozsoki

Mr. Istvan Bozsoki – the Head of Telecommunication Networks and Spectrum Management Division, BDT, International Telecommunication Union – outlined the objectives of the event going in line with current evolution of mobile technologies and measures taken by different players to facilitate forthcoming implementation of 5G networks in the region. The meeting noted that detailed investigation of the key elements of IMT-2020 was already well underway and benefited from the highly successful partnership that ITU had with the mobile broadband industry and the wide range of stakeholders in the 5G community. As of the time of the seminar, IMT-2020 provides the global platform on which to build the next generations of mobile broadband connectivity.

Based on the technical specifications of 5G approved recently and vision on future networks, the speaker highlighted a list of challenges foreseen with implementation of these networks. The most significant of those are:

- small cell deployment versus long national permitting and planning process/lengthy engagement and procurement exercises/high fees and charges to access street furniture/electromagnetic field (EMF) levels;
- need for enhanced fibre backhaul;
- need for additional spectrum.

Mr. Bozsoki warned the meeting that despite the economic benefits potentially realised from 5G, the industry was partly sceptical about the commercial cases for investment in 5G. Given the significant amount of investment that will be required from the operators to deploy 5G networks there is scepticism among some European operators over the hype that 5G has caused and over how they are supposed to make money from it.

On other hand, it is obvious that 5G will directly influence in increasing GDP and greater economic growth or % of gain in GDP. New generation of mobile technology assumes better, faster, more informed decision-making, boosting labour productivity thus resulting in a net gain in jobs.

Finally, Mr. Bozsoki proposed a new organizational approach of the event when notable case studies, insights, guidelines, and findings provided by the participants of the seminar would be attributed to the working questions of the ITU-D Study Groups. The meeting agreed to highlight the topics from the presentations/discussions coming to the scope of specific study Questions of ITU-D SG1 and SG2 at the end of each day of the seminar. The participants decided to have more time on developing suggestions further at the end of the seminar in order to submit them in the form of report to ITU-D SG1 and SG2 meetings later this year.

5. Summary of Discussions and Their Results

5.1 Session 1: National strategies for 5G implementation

Session 1 focused on the guidance available to date to countries on the issues of options to elaborate a National Strategy to enable 5G rollout. The countries that have already started work on their National Strategies for 5G Implementation shared their experience. Mr. Jaroslaw Ponder, Head of ITU Office for Europe, International Telecommunication Union, moderated the panel discussions.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS

The bandwidth requirements will increase dramatically in the next 10 years. New usages and vertical services will need even more bandwidth. This situation will increase even more the requirements for bandwidth available. The bandwidth requirements can only be met by important investments in future technologies. To enable future technologies, an important objective of regulation is to encourage operator's investments in new infrastructures.

There are several specific features of 5G technology that should be addressed by the updated future regulation as described below.

LTE Advanced and 5G will need the large amount of spectrum to enable multi-gigabits speeds in dense areas. The licensing of 700 MHz, 3.6 GHz and 26 GHz bands is key to enable 5G performances and investments. Longer license durations for mobile technologies spectrum will reinforce the predictability needed for investment. From this perspective, extension of spectrum licences duration up to 25 years or more is highly desirable. Technology neutral spectrum licences will allow existing bands used for current mobile technologies be easily refarmed for 5G thus ensuring spectrum to be used most efficiently.

For legacy telecommunication networks, regulation targets to organize competition on already deployed infrastructure. For future telecommunication networks, regulation can have an impact on investments and on the speed of deployments. Too heavy regulation on deploying networks can deter investments. Network sharing is the natural way to reduce deployment costs. In order to avoid anti-competitive effects, network sharing could be restricted geographically (rural areas) and within a defined period.

For LTE advanced and 5G, fibre backhaul is a prerequisite to enable full technological potential. Thus, Fibre To The Home) FTTH networks constitute an opportunity to collect mobile sites traffic. There is the need for the regulation to open access to the FTTH network and to authorise mobile operator to use FTTH networks. In case FTTH is not available, ducts access can enable to lay down backhaul fibre. In order to accomplish this there is the need for regulators to open access to ducts and fair rules for ducts sharing between copper, FTTH and backhaul networks.

EXPERIENCE BY COUNTRIES

Political and Regulatory Developments in Denmark - Mr. Peter Madsen, Senior Advisor, Ministry of Energy, Utilities and Climate, Denmark

Mr. Peter Madsen informed the meeting on 5G Action Plan to be approved in Denmark before the end of 2018. Danish Energy Agency leads the drafting, including issues related to securing sufficient frequencies and lowering frequency charges. The Energy Agency also coordinates the dialogue with the advisory board responsible for bringing together telecom operators, business and trade organisations, ministries, local municipalities, research institutions.

Within the working topics of the advisory board there is the significant scope of issues including spectrum, regulatory barriers, lowering frequency charges for backbone radio links, Danish test environment for 5G. It should also encourage local and national authorities to explore how 5G can contribute to a growth and productivity – smart cities, smart energy etc. The similar Action Plan for four Nordic countries is currently being elaborated and would be submitted for the approval by the Nordic Council of Ministers later this year.

5G in Hungary - Dr. Péter Vári, Deputy Director General, National Media and Infocommunications Authority, Hungary

Dr. Péter Vári informed the meeting on the sound country's ambition for the development of digital infrastructure including early introduction of 5G mobile technologies. Digital Welfare Program (DJP) based on the National Infocommunications Strategy and Digital Nation Development Program of Hungary defines the key objectives concerning the introduction of 5G. The major objective for Hungary is to become one of the 5G development centres by 2018 while playing important role in the region in testing process of 5G applications. Introduction of 5G in planned round after 2020. Meanwhile the 5G pilot project is under construction in Zalaegerszeg to make tests of use cases on autonomous driving and smart city functions.

National Media and Infocommunications Authority of Hungary held public hearing (23 November, 2017) on future plans regarding spectrum available for the provision of wireless broadband services in 700 MHz, 1500 MHz, 2300-2400 MHz, 2100 MHz, 2600 MHz, 3400-3800 MHz, 26 GHz. Preparation of the detailed regulatory frameworks concerning the spectrum award for 5G bands is ongoing with the priority to 700 MHz, 3400-3800 MHz and 24.25-27.5 GHz bands. Commencing of spectrum awarding procedure is expected by Q3 2019.

Introduction of 5G - Mr. Dimitar Bukovalov, Head of Department for Communications, Ministry of Information Society and Administration, FYR Macedonia

The meeting noted with interest the vision of the Republic of Macedonia on future introduction of 5G. In order to prepare a National Operational Broadband Plan, the Ministry of Information Society and Administration established several working groups including the Working Group for determining the measures and activities necessary for introduction of 5G mobile technology. The Agency for Electronic Communications of Macedonia has agreed to start authorization of 694 – 790 MHz band use for 5G in the second half of 2019 to make it active from July 2020. The spectrum band 3400 – 3800 MHz is available now and could be authorized through tender procedures immediately based on the demand from the interested operators. Nowadays the spectrum band 26 GHz is under reconsideration for implementation of 5G.

The Republic Macedonia should further study the issues and modify the existing regulatory basis in order to ensure quick and easy obtaining of permissions for construction of 5G infrastructure, shared use of infrastructure, coordination of construction works etc. Special attention will be applied to the issues of simplifying regulation of small cells installations in urban areas, roads and railway corridors.

The Agency for Electronic Communications of Macedonia will further facilitate greater involvement of vertical industries, IT industry and local governments in future 5G deployment.

Towards the National 5G Strategy for Republic of Poland - Mr. Dominik Kopera, Deputy Director, Ministry of Digital Affairs, Republic of Poland

Mr. Dominik Kopera shared the views on establishing National 5G Strategy. This strategy will become a tool enabling the effective implementation of the 5G networks in Poland, and will provide citizens with access to new technologies and will provide undertakings operating on the telecommunications market effective with competitive advantage. Its goal is also to implement the initiative of the European Commission regarding the creation of an action plan in the process of implementing and launching the 5G network within the European Union. In order to ensure the most effective realization of the Strategy the Agreement "5G for Poland" was signed in 2017. The main goal of the Agreement is the collaboration between the Parties to deliver the actions associated with the creation and realization of "5G for Poland". These actions are aimed at preparation of optimal conditions for making Poland a front runner in the field of introducing 5G technology and at allowing for the delivery of the associated economic benefits for the country, thanks to the development of Industry 4.0.

In order to support timely implementation of the 5G networks in Poland there are still several challenges that should be solved in the short term. The most significant among those are:

- speeding and improving of the investment process;
- reducing the infrastructure maintenance costs;
- timely ensuring availability of radio spectrum;
- actively participation in the international implementation of 5G networks;
- ensuring network security;
- reviewing existing regulatory solutions in the field of telecommunications to ensure that they are adapted to the upcoming needs related to the development of mobile technologies.

National 5G Strategy of Republic of Serbia - Ms. Aleksandra Vučić, Chief Advisor, Regulatory Agency for Electronic Communications and Postal Services (RATEL), Republic of Serbia

Ms. Aleksandra Vučić informed participants on the status of the National 5G Strategy created in accordance with the provisions of Law on Electronic Communication, Radio Frequency Allocation Plan, Strategy for the development of electronic communications 2010-2020, Strategy of the Next Generation Networks. There are currently three mobile operators in the Republic of Serbia using spectrum in 800 MHz, 900 MHz, 1800 MHz and 2100 MHz bands. Based on the traffic demand, it is estimated that current spectrum will be sufficient until the end of 2018.

Serbia is the member of South East Digital Dividend Implementation Forum (SEDDIF) which approved multilateral framework agreement between 13 administrations in order to enable optimization of the future use of 470-694MHz for digital terrestrial television and to facilitate the re-planning of the 700MHz band. Digital dividend 2 is ready to be used in Serbia for mobile broadband in accordance with the result of SEDDIF. 3.5 GHz band is seen as "golden" and "innovation" band with 400 MHz of continuous spectrum. Unlike in most European countries, in Serbia this frequency band is completely unused. With regard to mm-wave band RATEL granted licences for almost 900 microwave links in frequency band 24.5-26.5 GHz, while 1.3 GHz is unused in continuity.

5G Networks Development in Russia: Experience and Plans - by Mr. Evgeny Tonkikh, Deputy Head of Department, Radio Research and Development Institute (NIIR), Russian Federation

Mr. Evgeny Tonkikh provided latest information on development of regulatory and business aspects related to 5G in Russia. The issue of 5G is considered to be the inherent part of national ICT

infrastructure evolving to its all-digital stage. The Federal Program "Digital Russia" has been approved in 2017 thus obtaining the strategic framework of digital economy including 5G and IoT segments. The new generation communication networks in general and networks based on 5G mobile communication technology in the mobile segment should become an infrastructural background for the digitalization of Russia (and the world) as the most relevant to current challenges and opportunities of the industrial business processes transformation.

The task of the digital transformation of infrastructure based on the latest innovations and technology is advisable to be solved together with the maximum participation of private business. To implement it, it is planned to build and develop a new generation of communication networks, satisfying the needs of the industry and economy. In Russia, such efforts will require a significant amount of radio frequency resources and complicated work to realize it.

CHALLENGES REVEALED AND FOLLOW-UPS

The participants of the meeting concluded that the issue of National 5G Implementation Strategies had acquired special significance up to date in view of forthcoming initial network deployments. In order to elaborate the most efficient strategies and action plans regulators should bring together the broad range of stakeholders including telecom operators, businesses and trade organisations, ministries and local municipalities, industries, research institutions etc. At large extent, the objective to proceed through the digital transformation of infrastructure based on the latest innovations and technology is advisable to be accomplished combing efforts from both governmental and private business sectors.

The meeting further pointed out several challenges to solve as a matter of urgency that would support timely implementation of the 5G networks. The most significant among those are below:

- speeding and improving of the investment process;
- reducing the infrastructure maintenance costs;
- timely ensuring availability of radio spectrum;
- provision of network security.

The existing regulatory frameworks encapsulate practices typical to mobile broadband networks of generations up to 4G. 5G constitutes the next step in technological evolution featured with the innovative operational characteristics going outside the scope of those in traditional networks. At large extent the advanced technical and operational capabilities of 5G could only be realized by applying updated regulation. It should ultimately take into account the foreseen significant increase in investment of operators into the infrastructure of future networks against the backdrop of stagnating revenues from these networks at least in the short term. To promote vital investments in new networks, regulators can leverage on the following:

- timely licensing of 700 MHz, 3.6 GHz and 26 GHz for mobile networks;
- extension of spectrum licences duration up to 25 years or more;
- introduction of technology neutral spectrum licences;
- lighter regulation on newly deployed infrastructures;
- incentives to and authorisation of mobile infrastructures sharing;
- obligation to provide access to FTTH and/or ducts for mobile backhauling;
- negotiation of low license prices against large investment obligation.

5.2 Session 2: Case Studies on 5G Pilot Projects

Session 2 focused on the implementation of projects based on 5G at both governmental and private sectors. Mr. Kirill Oparin – Head of ITU Regional Office for CIS, International Telecommunication Union – moderated the panel discussions.

The second session was preceded by the special address by the Body of European Regulators for Electronic Communications (BEREC) describing its status of work on 5G. Mr. Stefan Felder - BEREC Representative and Telecom Economist at RTR, Austria – delivered the presentation on the subject.

BEREC informed the meeting that in the short and medium term 5G would develop rather evolutionary and not revolutionary. Enhanced Mobile Broadband is likely to be the main driver of 5G deployment in the short term. Succeeding realization of 5G use cases will be a step-by-step process since many potential uses are currently at very early stages of development. In the longer run wide variety of different niche applications (but not a killer application) and verticals with special requirements for new services would be enabled by 5G. New generation use cases include private deployments of 5G within spaces such as factories or warehouses. The technology will be procompetitive and will help to drive coverage featured by access to small cell sites, availability of backhaul and infrastructure sharing.

BEREC foresees a number of challenges for regulators arising from the nature of 5G networks. The most notable are:

- small cells - exclusive site access, public owned sites, infrastructure sharing;
- access to spectrum - spectrum for public networks, access to spectrum for private 5G networks indoor, non-traditional entry;
- coverage issues - mixed connectivity environment, coverage obligations in the context of differentiated services;
- competitive issues - non-traditional market entry, complementarity between fixed and mobile, infrastructure sharing and upstream concentration, backhaul, net neutrality;
- infrastructure sharing - cost savings vs competitive issues.

BEREC proactively tackles upcoming challenges and supports the consistent deployment of 5G in Europe. A variety of projects are under way in close cooperation with relevant institutions addressing 5G hot topics on coverage obligations, award and authorisation procedures, infrastructure sharing and net neutrality as an input to evaluation.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

The speakers representing regulators, industry, operators expressed their considerations on options conducive to successful initial deployments of 5G networks. 5G Pilot Projects could tackle the problem of the most efficient future launches.

The delegates acknowledged spectrum supply as the imperative for the success of the innovative technology. Operators will need more spectrum for 5G, not least because its benefits are fully achieved in new mm wave frequencies, with extremely wide bands. Here, the ultra-high peak rates and low latency are most likely to be used by operators to add new levels of capacity and throughput for enhanced mobile broadband, especially as a way of offloading congested 4G networks and for new special use cases. But there is also broad interest in deploying 5G technology in new mid bands (3.4–6GHz) and existing, legacy mid bands (1,800–2,600 MHz) as a way of achieving national 5G coverage as rapidly as possible.

5G will need to coexist and interwork with 4G for many years to come, leading to the vast majority of these deployments as non stand-alone (NSA) initially, as a way of reducing time to market and ensuring good coverage and mobility. The 5G standard for stand-alone (SA) mode is planned for first release mid-2018. This mode requires a new service-based core network architecture enabling deployments of 5G as an overlay to or independent of 4G coverage. The new service-based core network has many important properties, including advanced network slicing support, both SIM and non-SIM authentication support and multi-access handling. Most of the technical decisions realizing the network features has already been specified by the standardization entities. The participants took into account the timeline of specification process by 3GPP as follows in Figure 2.

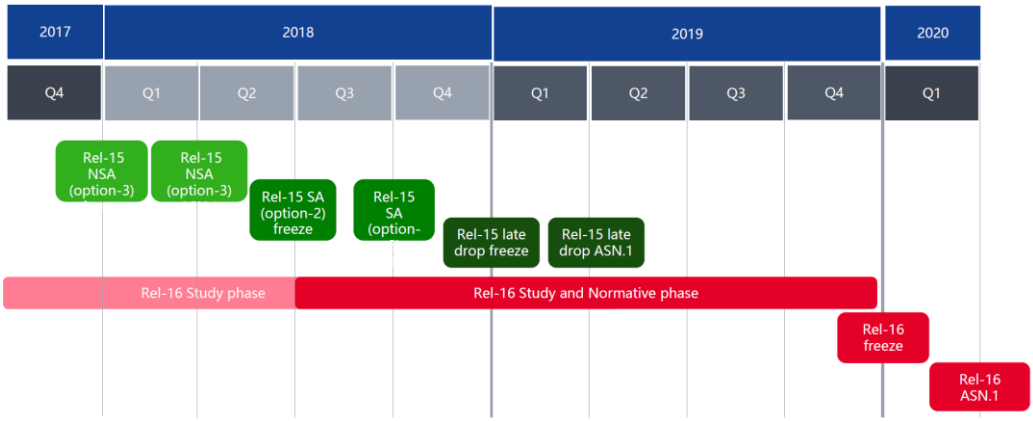

Figure 2 - 3GPP 5G Specification Timeline

Initial use cases for 5G will be eMBB and FWA, although this will vary from market to market. eMBB is likely to be by far the biggest use case for 5G globally. This is because it can provide an enormous capacity and peak rate boost wherever increased spectrum is available, thanks to the very wide carriers in high bands and the beam-forming ability of NR radios. The optimized lean design of 5G NR offers both increased spectral efficiency and lower cost per bit. To achieve nationwide coverage as fast as possible, 5G deployement is also foreseen in low/mid bands, which will also be suitable for massive IoT use cases in the future. Deployment of 5G NR in low bands, such as 600 or 700 MHz, is of interest to boost coverage. Deployment in mid bands may also be driven by earlier availability of spectrum in these bands (compared with high bands). 5G in high bands is more likely to be used mainly for data offload in high-traffic areas, as separate networks in factories or campuses, and for critical IoT in data-intensive applications.

Finally, the speakers representing industry at the Session 2 summarized the lynchpin factors of the success for future 5G as follows.

1. Allocate sufficient amount of low-band, mid-band and high-band spectrum for 5G

- include licensed and license-exempt bands;
- consider economies of scale, global harmonization based upon tuning range approach;
- change regulatory paradigm from dedicated spectrum management to ad-hoc bandwidth/coverage assignment.

2. Adopt policies needed to facilitate 5G

- ensuring sufficient backhaul spectrum for 5G (71-76 GHz/81-86 GHz);
- fibre policy (optical fibre is the prerequisite for 5G, V2X, FTTx);
- liberalize access requirements to ultra-fast networks;

- targeted, efficient subsidies in high cost areas.

3. Establish a National 5G Committee and develop a plan to accelerate the 5G and vertical applications.

4. New EU telecoms framework

- must foster incentive based competition and favour ex-post oversight over ex-ante control;
- remedies must balance the impact on incentives to make risky, expensive broadband investments;
- end-users interests and rights must continue to be observed.

EXPERIENCE BY COUNTRIES

Slovenian 5G pilot projects" - Mr. Kory Golob, Ministry of Public Administration, Republic of Slovenia

Mr. Kory Golob informed the meeting on the ongoing 5G PPDR Pilot Project in Slovenia. 5G PPDR network is combining 5G network, advanced operational centre, multi-agency collaboration and interoperability mechanisms such as enhanced communication among stakeholders (police, army, rescue agencies etc.), supportive regulatory environment (1st responder prioritization etc.), advanced services (video surveillance – extreme BB, unmanned aerial vehicle (UAV) – real time control, self-controlling UAVs – massive IoT, data analytics etc.), interoperability with other technologies (TETRA, DMR etc.).

Up to date, there is a plan to build a 5G Centre of Excellence for Public safety domain. Later on Slovenia intents to bring expertise in Public Safety Eco-system to other interested parties in order to create and develop advanced 5G solutions that will benefit both the Public Safety and Emergency Services. The Project also aims to extension from national via cross-border to European collaboration. It will include development of new business models of deployment and operation (MVNO for PPDR, consolidation of PPDR networks, multi-agency collaboration), establishment of complete chain of stakeholders, gaining further insights to develop and enhance services/applications through cooperation with international partners.

Turkcell's 5G Vision as a Digital Operator" - Dr. Izzet Saglam, Turkcell, Turkey

Dr. Izzet Saglam shared the views of Turkcell on future 5G implementation as well as provided latest information on current 5G trials in Turkey. In the framework of preparatory activities for 5G deployments Turkcell is testing three major types of services – enhanced mobile broadband (eMBB), enhanced machine type communications (eMTC) and ultra reliable low latency communications (URLLC) – for applications in education, health, smart cities and autonomous transport. Within the pilot projects Turkcell seeks to test the full range of 5G network elements and functionalities including Network Function Virtualisation and Software Defined Networking (SDN/NFV) Core Network, Autonomous Network Management System/Self Optimized Network (NMS/SON), massive MIMO technique etc.

The experience of Turkcell revealed the lynchpins of future success of 5G technology. Those relate to well elaborated use cases and capacity needs, sufficient spectrum availability, timely modified regulation, infrastructure and technology readiness. Turkcell' experience proves the maturity of most of the listed aspects thus paving the way for future 5G deployment.

Findings and follow-up from 5G pilot projects in Russia" - Mr. Pavel Mamchenkov, Megafon, Russia

The meeting noted with interest findings from 5G pilot projects of MegaFon in the Russian Federation. There were several trial events in Russia during St. Petersburg Economic Forum and World Cup 2018. The major objectives of pilot projects were to assess technical readiness of network and terminal

equipment as well as to validate nascent use cases taking the opportunities of populous public events. The trials got utilized both 3400 – 3800 MHz and 26 GHz spectrum bands. The results of the trials squarely demonstrated the maturity of technical decisions of 5G for emerging deployment on the networks. Initial use cases based on low latency functionalities, VR and autonomous transport revealed their practical applicability.

The pilot projects of MegaFon in Russia had pursued further objective to estimate spectrum sharing conditions in 5G bands. The sophisticated functionalities of 5G equipment primarily based on varying antenna patterns and EIRP characteristics are unfolding unprecedented frameworks for the assessment of electromagnetic compatibility (EMC). Obviously, it complicates interference scenarios taken in EMC analysis thus making accurate calculations hardly possible. Consequently, traditional regulation based on interference prediction or deterring of harmful interference is no longer a pertinent mechanism with regard to 5G. The evolution from ex ante to ex post regulation may leverage spectrum management for future 5G networks. From this perspective, spectrum redeployment in favour of the advanced technology should be applied predominantly in cases when spectrum sharing with incumbent uses is impractical.

5G Trials: the BBC's involvement - Mr. David Hemingway, British Broadcasting Corporation (BBC), and Vice-Chairman of ITU-R Working Party 6A

Mr. David Hemingway described the involvement of broadcasters in future 5G technology implementation. The predictions of BBC show that most TV viewing will take place in the home, on large screen TVs via fixed internet. Some viewing will take place in the home on tablets & smartphones, via WiFi. Outside the home, it will be achieved on mobile devices via 5G networks. Most radio listening will happen indoors via fixed internet. In-car listening will remain important via 5G networks. Minding this landscape there is the need for broadcasters to develop an architecture that allows seamless reception of content on different devices as users move between different environments and available networks.

Nowadays broadcasters are participating in several projects being focused on two specific verticals, namely Media & Entertainment and Public Warning. The projects aim to develop an architecture that allows seamless reception of content on different devices as users move between different environments and available networks. It will achieve this through the design of new radio access, transport and application layers that build on the emerging 5G specifications targeting traditional unicast delivery.

Ukraine on the way of 5G implementation - Ms. Iryna Pokhabova, State University of Telecom, Ukraine

Ms. Iryna Pokhabova provided the update of the existing situation with implementation of the advanced mobile broadband technologies in Ukraine. 4G implementation has successfully emerged in 2600 MHz and 1800 MHz (200 settlements in 18 regions). In the spring 2018, two 4G auctions were held in Ukraine, where the government distributed frequencies between the mobile operators in the 2600 MHz and 1800 MHz bands. According to the terms of the tender, telecommunication operators, starting July 1, 2018, must provide the opportunity to receive services using 4G in the range:

- within 12 months (that is, until July 2019) not less than 90% of the population of each regional center of Ukraine;
- within 42 months (that is, by December 2021) not less than 90% of the population of each settlement with a population of more than 10,000 people.

The development of the market for information technology and innovation is impossible without the interaction of the IT sector and government. Starting from 2016, the government of Ukraine began to

pay extra attention to the development of IT industry and the implementation of IT innovations in all fields of activity through cooperation with business and commerce IT-sector as well. Ukraine considers preparing of high-qualified specialists, who will implement all new technologies and IT solutions in practice, to be the separate issue of great importance.

CHALLENGES REVEALED AND FOLLOW-UPS

Regulators are envisioning a list of challenges arising from the nature of 5G networks as follows:

- small cells - exclusive site access, public owned sites, infrastructure sharing;
- access to spectrum - spectrum for public networks, access to spectrum for private 5G networks indoor, non-traditional entry;
- coverage issues - mixed connectivity environment, coverage obligations in the context of differentiated services;
- competitive issues - non-traditional market entry, complementarity between fixed and mobile, infrastructure sharing and upstream concentration, backhaul, net neutrality;
- infrastructure sharing - cost savings vs competitive issues.

The sophisticated functionalities of 5G equipment primarily based on varying antenna patterns and EIRP characteristics are unfolding unprecedented frameworks for the assessment of EMC. Obviously, it complicates interference scenarios taken in EMC analysis thus making accurate calculations hardly possible. Consequently, traditional regulation based on interference prediction or deterring of harmful interference is no longer a pertinent mechanism with regard to 5G. The evolution from ex ante to ex post regulation may leverage spectrum management for future 5G networks. From this perspective, spectrum redeployment in favour of the advanced technology should be applied predominantly in cases when spectrum sharing with incumbent uses is impractical.

To provide palatable spectrum resources environment for future 5G networks regulators should allocate sufficient amount of low-band, mid-band and high-band spectrum for 5G including licensed and license-exempt bands while considering economies of scale based on band harmonization and tuning range approach. Regulatory paradigm should be changed from dedicated spectrum management to ad-hoc bandwidth/coverage assignment. It is highly advisable regulators will adopt policies needed to facilitate 5G in

- ensuring sufficient backhaul spectrum for 5G (71-76 GHz/81-86 GHz);
- fibre policy (optical fibre is the prerequisite for 5G, V2X, FTTx);
- liberalize access requirements to ultra-fast networks;
- targeted, efficient subsidies in high cost areas.

5G development provides broadcasting industry with additional incentive for its active involvement in the converged environment. There is the urgent need for broadcasting industry to develop an architecture allowing seamless reception of content on different devices as users move between different environments and available networks. It should be achieved through the design of new radio access, transport and application layers that build on the emerging 5G specifications targeting traditional unicast delivery.

5.3 Session 3: Enabling environment for 5G deployment

Session 3 focused on the enabling factors that need to be placed and nurtured for successful deployment of 5G. Such enablers would include international and regional technical standards and

guidelines as well as national regulatory components. Mr. Krisztián Stefanics from the National Media and Infocommunications Authority of Hungary moderated the panel discussion.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

Mr. Istvan Bozsoki opened the session outlining opportunities and challenges at the scene of 5G. The speaker highlighted the key topics opened currently in the context of 5G. He emphasised that regulators should scrutinize socio-economic implications of 5G technology implementation. The issues of technology and spectrum requirements for 5G are still under consideration in ITU in parallel with studies of costs and investment implications. Those will tackle establishment of viable cases for investment in 5G. Meanwhile, policy makers may consider undertaking their own independent economic assessment of 5G to evaluate the commercial viability of deploying 5G networks. Until time when the case for 5G networks can be finalized, the policy makers may consider enhancing the availability of and boosting the quality of 4G networks.

With regard to establishing environment stimulating fastest deployment of 5G the efforts of regulators were classified by several blocks.

Block 1 – Spectrum Issues. National Regulatory Authorities (NRAs) may consider allocating/assigning globally harmonized spectrum bands for 5G. In doing so, NRAs may consider a spectrum roadmap with a predictable renewal process. Regulators should consider allowing spectrum sharing to maximize efficient use of available spectrum particularly to benefit of rural areas. In order to favour investment through the astute spectrum pricing NRAs should select spectrum award procedures avoiding financial burdening of market players. Policy makers may consider supporting the use of affordable wireless coverage (e.g. through the 700 MHz band) to reduce the risks of the digital divide.

Block 2 – Backhaul Issues. Where market failure may occur, policy-makers may consider stimulating fiber investment and passive assets through PPPs, investment funds and offering grant funds, etc. NRAs may consider removing any tax burdens associated with deploying fiber networks to reduce the associated costs. Policy-makers may consider policies and financial incentives to encourage the migration from copper to fiber and to stimulate the deployment of fibre services. Operators may consider a portfolio of wireless technologies for 5G backhaul in addition to fibre including point-to-multi point (PMP) microwave and millimetre wave (mmWave) and satellite where possible.

Block 3 - Access/Sharing of Infrastructure. Policy makers may consider allowing access to government-owned infrastructure such as utility poles, traffic lights and lampposts to give wireless operators the appropriate rights to deploy electronic small cell apparatus to street furniture. NRAs may consider continuing to elaborate existing duct access regimes to encompass 5G networks allowing affordable fibre deployments. Policy-makers may consider ensuring reasonable fees are charged to operators to deploy small-cell radio equipment onto street furniture. Policy-makers may consider holding a central database identifying key contacts, showing assets such as utility ducts, fibre networks, CCTV posts, lampposts, etc. to help operators cost and plan their infrastructure deployment more accurately. Policy-makers may consider agreeing upon standardized wayleave agreements to reduce the cost and time to deploy fibre and wireless networks.

The meeting noted with interest the information from Mr. Srdjan Mihaljević - ITU Consultant - on ETSI and 3GPP 5G standardization process toward IMT-2020 Radio spectrum and interface. There are several international standardization bodies including ETSI as the European entity. ETSI provides support for European Commission including efforts to coordinate spectrum issues within CEPT. ETSI is main contributor to CEPT work in this perspective.

To facilitate 5G focused activities ETSI has convened mm wave group responsible for the issues of spectrum fees in mm-bands. The group will deliver technical methodology to calculate fees together with supporting documents.

The participants noted the details on ETSI's structure and procedure to establish EN standards as the harmonized document for products to be placed on European market. The speaker provided some additional information special class of deliverable – System Reference Documents – being sent to CEPT for discussion and subsequent transformation to a CEPT Report including spectrum aspects. In the context of 5G ETSI makes partnership agreements – 3GPP - to produce specification on new generations of equipment 3G, 4G and 5G. Upon completion 3GPP submits specifications to ITU. The delegates noted the detailed timelines of ITU and 3GPP on documents delivery as illustrated in Figure 3.

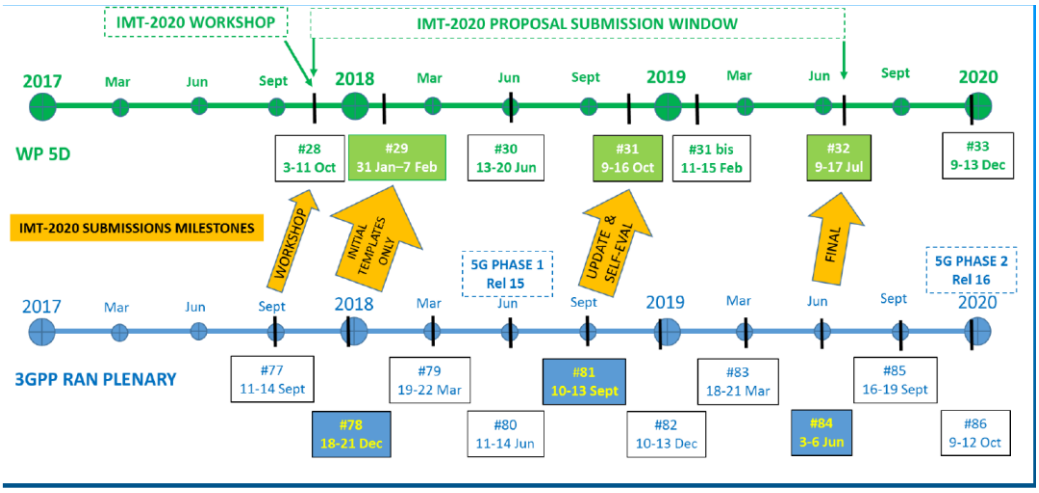

Figure 3 - IMT-2020 Deliverables Submission Timetable

EXPERIENCE BY COUNTRIES

Enabling Environment for 5G Deployment in Poland - Mr. Dominik Kopera, Ministry of Digital Affairs, Poland

Mr. Dominik Kopera informed the meeting that the Ministry of Digital Affairs in the partnership of the Office of Electronic Communications of Poland and the National Institute of Telecommunications signed the Agreement for the Strategy "5G for Poland". As the result of the Agreement six working groups were established to deal with different 5G implementation issues, namely 5G network standards and architecture, radio spectrum, tests and pilots, legal regulation and cooperation, 5G network security and 5G network promotion.

In general, 5G targets of Poland will comply with the EU targets. As so, Poland will follow the approaches similar to other EU countries. Nevertheless, there are items specific to Poland that should be solved in the short run. There is a fear of the high levels of electromagnetic field in the country inherited historically. There are still the complicated environmental procedures that do not keep up with technologies evolution. The limits of electromagnetic field are strict thus assuming certain risks for future deployment of massive infrastructure of 5G networks. The Telecommunications Administration of Poland is going to tackle those challenges through the series of legislative acts to be approved in the next three years.

Organizational and technical aspects of enabling environment creation for 5G deployment in the developing countries - Vadim Kaptur, O.S. Popov ONAT, Ukraine

Mr. Vadim Kaptur noted elements both of technical and socio-economic nature that would define the success of new generation technology. Four major elements were indicated, namely 5G access network, availability of terminal equipment, content and services requiring 5G and the readiness infrastructure of broadband fixed networks. The speaker highlighted fixed broadband access networks as the primary factor of the success of 5G deployment. Among the other factors, the speaker emphasised national plans of 5G and fixed broadband development, investment procedures and public-private partnership, new regulatory frameworks and capacity building (educational programs, certification etc.). The weight of these factors depends on country and specific national situations. Internal factors should be studied in each country in order to make prioritization.

The speaker proposed the methodology of assessment of different parameters allowing estimation of economic indicators of telecommunications projects. With the assistance of ITU-D the broadband network access calculator was elaborated with the multiple input and output parameters. It is included in the ITU-D Report "Policy, regulatory and technical aspects of migration from existing networks to broadband networks in developing countries" prepared during previous study period on Study Question 4/1.

Enabling environment for 5G deployment - Dr. Csaba Simon, Budapest University of Technology and Economics, Hungary

Dr. Csaba Simon proposed academic view on the issues of enabling environment for future 5G. There is the common agreement that 5G will encompass innovative vertical industries. Hungary considers the priority task as to encompass automotive industry by 5G decisions. The country benefits from the strong governmental support on digital transformation in this particular area.

Academic and educational background is of the strengths in Hungary. 5G related activity is carried out in collaboration with leading vendors. There is the need to look on and explore technologies not only from the radio side but in more general aspects of new paradigm of ICT such as cloud networks, virtualization of core networks, network control etc. For these purposes, the 5G Coalition – consortium of the 5G stakeholders - under the umbrella of DJP (Digital Welfare Program of the Hungarian Government) was organized. In drafting a strategy for 5G policies the Coalition is covering many facets of the 5G ecosystem with strong focus on verticals, networking and dissemination, media events, pilots and trials.

CHALLENGES REVEALED AND FOLLOW-UPS

With regard to establishing environment stimulating fastest 5G deployment the efforts of regulators should be concentrated on three blocks.

Block 1 – Spectrum Issues. NRAs may consider allocating/assigning globally harmonized spectrum bands for 5G. In doing so, NRAs may consider a spectrum roadmap with a predictable renewal process. Regulators should consider allowing spectrum sharing to maximize efficient use of available spectrum particularly to benefit rural areas. In order to favour investment through the astute spectrum pricing NRAs should select spectrum award procedures avoiding financial burdening of market players. Policy makers may consider supporting the use of affordable wireless coverage (e.g. through the 700 MHz band) to reduce the risks of the digital divide.

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5.4 Session 4: New business models and revenue streams

Session considered emerging models that industry was adopting to enhance revenue streams from a business perspective. Industry challenges and opportunities in both the developed and developing countries were be discussed. Mr. Jaroslaw Ponder, Head of the ITU Office for Europe, International Telecommunication Union moderated the panel discussion.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

The representatives of telecom industry shared their views on business potential of 5G networks. According to market indicators, telecom operators today are facing multiple challenges. Despite high growth in both mobile subscriptions and mobile data traffic, overall mobile service revenue growth has flattened out, compared to the 10 to 15 percent annual growth a decade ago. Operators are struggling to turn the growing usage of mobile data services into greater revenues. In this perspective, 5G presents huge financial opportunities for operators over the next decade.

As the world becomes ever more digitally and globally connected, industries are experiencing an ICT-driven transformation. Digitalization has risen industrywide across the globe, and it is predicted that digital revenue for ICT players will be worth around USD 3.5 trillion by 2026 across the 10 key industries. Global business trends such as hypercompetition, new customer power and sophistication, the fast-paced change in business ecosystems and disruptive technological advances all affect vertical industries to different extents. For operators the market for industry digitalization is just beginning to encompass new service and business options.

Digitalization of industry-specific business processes generates a vast opportunity for operators assisting their customers from various vertical industries with new strategic direction. Although operators have the capabilities and technological advantage to offer such ICT services, they will need to focus their organization’s engagement, operation and production models to succeed in these innovative opportunities. Coming to generating revenue through 5G industry digitalization operators should note their three roles foreseen as follows:

- Network developers with excellent competences in operating network infrastructure, including access, core and transport, and apply powerful IT enablers to support consumers and businesses with uniquely tailored connectivity solutions.
- Service enablers, in addition to empowering connectivity, provide digital platforms on which businesses can easily configure and integrate value-enhancing digital capabilities into their business processes in highly automated ways.

- Service creators create new digital services, build innovative businesses and collaborate beyond telecoms to set up new digital value systems, in addition to providing digital platforms and infrastructure services.

In 2026, there will be an anticipated USD 619 billion revenue opportunity for telecom operators addressing industry digitalization with 5G technology. The largest opportunity for operator-addressable 5G-related revenues will be in the manufacturing and energy and utilities sectors. The breakdown of different industries in overall 5G industry for 2026 as presented by Ericsson is shown in Figure 4.

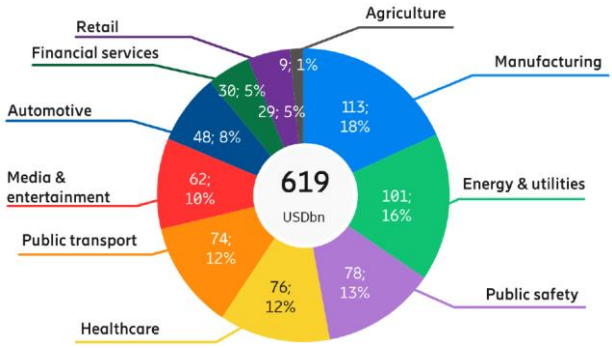

Figure 4 - Breakdown of Industries Segments in 5G Revenue in 2026

The speakers also pointed out that in preparation for 5G rollout operators would be faced with the need to solve three major tasks. The first is to define business strategy and use cases. The operators should identify emerging business models while evaluating and prioritizing use cases based on client context and aspirations, market conditions and emerging trends. The second task is detailing network design and architectural solutions. In the framework of the second task, operators should define functional specifications, use cases blueprint and high-level architectures, as well as prototyping and testing of networks. Within the third task operators are expected to conclude on rollout models including options for different partnerships for joint-rollout, tower joint ventures, national networks etc.

With the anticipated implementation of 5G networks, several implications on regulators are foreseen. Network management roles might be shifting towards new players requiring new regulatory attention. The business cases will most likely not support 3-4 independent country-wide networks, which has an impact on spectrum auctions. Governments should stimulate industry development strategies to involve telecommunication as a key enabler of digitalization. The special attention should be given to the rural and scarcely populated areas which might lag behind without state support in coverage.

EXPERIENCE BY COUNTRIES

Proving Ground Zalaegerszeg: a unique opportunity both for classic tests and autonomous vehicle validation - Dr. András Háry, Automotive Proving Ground Zala Ltd, Hungary

Dr. András Háry noted constraints in Europe in area of vehicle dynamic testing. In parallel, there is a technology change in vehicle industry – single vehicle vs. co-operative vehicle control: To address the issue different development environment is required. It was the reason for the decision of Hungarian Government in 2016 on contribution to the European automotive community. Promoting this objective, a 5G pilot mobile communication network at the motor vehicle test area was established in Zalaegerszeg (Hungary).

Currently the 4G and 4G+ mobile networks represent the most modern mobile network technology in Hungary, however the infrastructure of future will clearly be built on 5G. The test environment in Zalaegerszeg offers a good basis for Hungary to become one of the regional centers of 5G developments, playing a leading role in the region in the field of testing new network technology and smart solutions built on them. Resulting from the competences of mobile network operator T-Systems Hungary, as the result of the project Zalaegerszeg will have access to applications operating on the most sophisticated actual digital infrastructure, and the company cooperates actively in testing and establishing self driving cars as well as smart transport solutions.

Behind the use cases: Dad I want a Pony - Mr. Ákos Bóna, Digital Champion of Hungary to the EU

Mr. Ákos Bóna informed the meeting on the current position with early 5G market development in the region. Massive_4G national rollout is still ahead in many countries. Nevertheless, market is featured by rapidly increasing individual data usage, lack of structured data, fragmented, non-standardized contents. There is still the need to define and approve worldwide standards of 5G network radio components and the end user device specifications. To address the evolving market the European Commission recently initiated the studies of Fixed and Mobile Convergence in Europe – Quality Measurements for 5G and Network Densification.

Noting the current situation the speaker identified focus areas for 5G in 2018. There is the need to reshape current ways of daily work flow management/office setups as people are mobile and flexible (atypical work management and structures). Health and Lifestyle (e-medical prescription, remote diagnostics, remote surgery, 24h online services, ...) are becoming daily reality. Security services (cybersecurity, smart living), industry/agriculture (smart factories, production activity), entertainment services (VR, Streaming, 8K) and public services – all of those will constitute the background for successful implementation of 5G in the short term.

CHALLENGES REVEALED AND FOLLOW-UPS

Telecom operators today are facing multiple challenges. Despite high growth in both mobile subscriptions and mobile data traffic, overall mobile service revenue growth has flattened out, compared to the 10 to 15 percent annual growth a decade ago. Operators are struggling to turn the growing usage of mobile data services into greater revenues. In this perspective, 5G presents huge financial opportunities for operators over the next decade.

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5.5 Session 5: Electromagnetic fields and 5G rollout

Session 5 continued the work initiated in 2017 on an exchange of views and experiences to identify current practices and proposed future collaborative actions in addressing Electromagnetic Field (EMF)

levels without slowing down 5G deployment. Panel discussion was moderated by Mr. Peter Walop, ITU Expert.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

Mr. Istvan Bozsoki opened the session outlining opportunities and challenges related to EMF, while pointing to the work of ITU in this field. ITU-T is responsible for the Question "Human exposure to electromagnetic fields from information and communication technologies". Recommendation K Suppl.9 (11/2017) "5G technology and human exposure to RF EMF" takes into account the set of specific features of 5G - higher frequencies, small cells, shared infrastructure, IoT, etc.

ITU-R is conducting studies of the Question 239/1 (2016) with the emphasis on the measurements techniques to assess the human exposure from wireless installations of all types and on the options to present EMF measurements results. ITU-D Study Group 2 as the result of WTDC has modified the Question 7/2 "Strategies and policies concerning human exposure to electromagnetic fields" to include policies and legislation on EMF effecting 5G rollout.

BDT of ITU jointly with Ministry of Economic Development of Italy conducted the expert meeting "EMF and 5G Roll-out". The expert meeting asked for taking stock of some selected and basic aspects of national regulations on the protection from EMF. It also considered a list of suggestions for further stocktaking of national experiences and areas for further cooperation.

EXPERIENCE BY COUNTRIES

EMF and 5G: Challenges and Opportunities - Mr. Dominik Kopera, Deputy Director, Ministry of Digital Affairs, Poland

Mr. Dominik Kopera gave consideration to the issues of EMF in the context of 5G implementation in Poland and in Europe. H drew attention of the seminar to the fact that future 5G networks would dramatically expand penetration of wireless devices and enforce high infrastructure density. As for the time being Polish exposure limit 0.1 W/m^2 may lead to negative consequences such as limited range of the base stations grids, the need to build much denser network of base stations and thus enforce increase of oversized investments, inability to share with existing technologies.

In order to overcome the potential difficulties arising from the severe restrictions of EMF the institutions in Poland are conducting scientific researches. The essence of the studies is not just to explore the effect of exposure but to an information activities to combat disinformation about electromagnetic radiation. Permanent environmental monitoring is carried out by the Institute of Communications and state environmental agencies. The noted activities are aimed to produce the background for national legislative changes, e.g. introducing amendments to the Environmental Protection Law and to other acts in the context of future 5G networks.

Before 5G roll-out: Microenvironment and personal RF exposure measurements in Hungary - Dr. György Thúróczy, National Public Health Institute, Hungary

Dr. György Thúróczy informed the participants on the studies of microenvironment and personal RF exposure currently conducted in Hungary. Study – indoor microenvironmental and individual RF exposure measurement – aims to measure the indoor microenvironmental level of RF exposure and individual personal exposure in urban area. The hypothesis was that the RF components of indoor exposure emitted by household wireless devices (e.g. DECT, WiFi, Bluetooth etc.) would be already higher than the exposure from downlink frequency bands of mobile base stations. The results of measurements concluded that the indoor downlink RF exposure level was still higher than the averaged exposure from indoor wireless devices over24h. The 900 MHz DL is still the highest component within the DL bands. The lower exposure levels emitted by the household wireless systems

may caused by the facts that the indoor sources work low RF power and the results obtained based on 24h time average.

The aim of the second study was to determine the resultant RF exposure and its frequency distribution radiated by base stations, mobile phones or other household devices in kindergartens in Budapest. Under the evaluation organizers compared the exposure levels between the teachers' room and the children's room. The results of the second study revealed that because the Wi-Fi routers and DECT telephones are usually in the teachers' room, the exposure coming from indoor wireless sources in these rooms are significantly higher than the exposure from outdoor sources such as mobile base stations. In the children's room the exposure from indoor RF sources is much lower, while the average field strength of external sources (mainly downlink-DL of mobile base stations) is similar in both type of rooms. The ratio between downlink (DL) and all non downlink RF radiation is significantly depends on the site inside the building. There as on is that the indoors sources usually emit low RF power and produce such as a 'hot-spot" in the indoor environment.

CHALLENGES REVEALED AND FOLLOW-UPS

The RF environment is changing continuously (i.e. new services, new indoor wireless devices, new site deployments etc.). Much higher radiation is registered in the Up-Link direction thus making closer of human beings to the sources of radiation. New innovative decisions are required to protect human beings from smartphone emissions. New methods of RF exposure assessment in complex environment (e.g. using smartphone data by specific apps.) are envisaged and are great importance.

5.6 Session 6: Effective use of the digital dividend

Session 6 focused on the issues of Digital Dividend ranging from the background topic 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 IMT-2020 systems in 700 MHz band. Mr. Krisztián Stefanics from National Media and Infocommunications Authority of Hungary moderated panel discussions.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

The process of analogue switch-off is practically completed in Europe. The breakdown of number of European countries in DSO/ASO process as of July 2018 is shown in Figure 5.

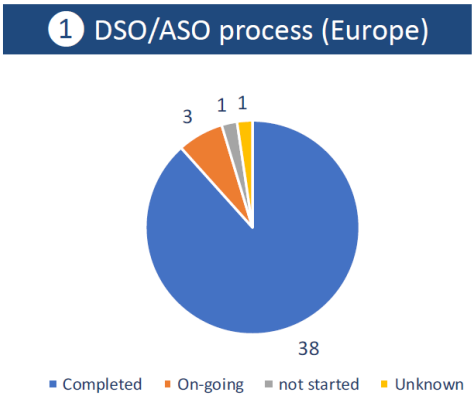

Figure 5 - DSO/ASO Process in Europe

With regard to 700 MHz spectrum band the European Commission requires it to be re-purposed for Mobile Service as of the year 2020. Consequently, multilateral coordination through several groups (NEDDIP, WEDDIP, SEDDIF) were organized to coordinate this process.

On other hand, 4K and 8K standards are sensitive for the spectrum resources due to increase in the net bit rates and transition to higher modulation type, e.g. 64 QAM and 256 QAM. More capacity is also required for higher screen resolutions. Actually, with 4K (DVB-T2 and HEVC) typical 8 MHz frequency channel will be sufficient for one video program. For 8K and large home flat panels 8 MHz channel is no more sufficient while transmission efficiency in data rates converge to Shannon limit (see Fig. 5).

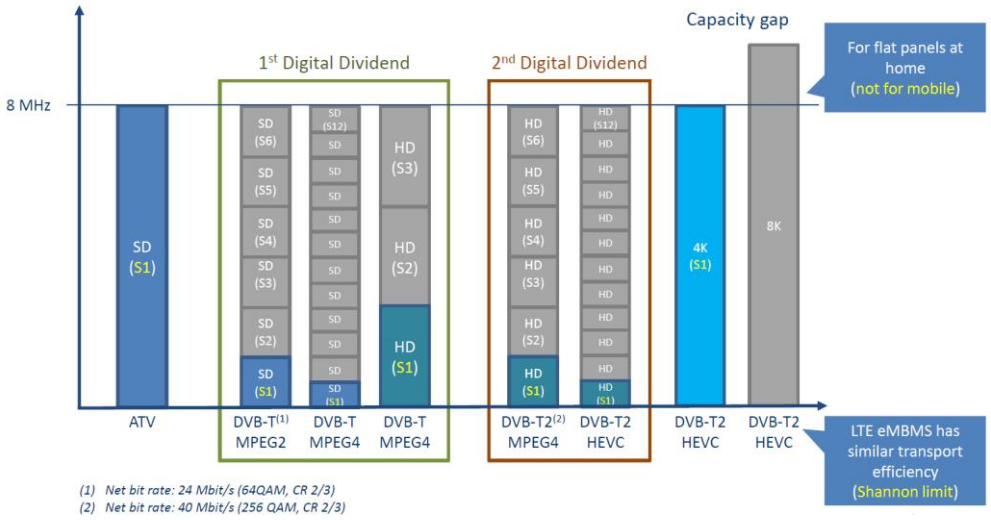

Figure 6 - Band Width and Capacity of TV Technologies

That is the reason for many administrations, especially for those countries with essential proportion of users receiving television by terrestrial broadcasting, to be careful in allocating additional UHF bands to Mobile Service.

EXPERIENCE BY COUNTRIES

Strategies and Policies Enabling New Growth Opportunities: Effective Use of DD - Mr. Fotjon Kosta, Head of ICT at Ministry of Industry and Energy, Republic of Albania

The delegates noted with interest the presentation done by Mr. Fotjon Kosta on the status of Digital Dividend bands in Albania. Currently there are three mobile network operators in the market. The mobile market is well developed with good coverage with 3G/4G which is offered from all mobile market players. Mobile broadband provided based on HSPA/HSPA+ was introduced late in Albania on 2010, while 4G/LTE was presented on September 2015. The exploitation of the digital dividend for further development of broadband services as a result of the Digital Switchover (DSO) is still ongoing - three regions of the country (Berat, Korce and Fier) finalised. The analogue switch off is ongoing in the regions of Tirana and Durres, which are the most populous regions in Albania. The deadline for analogue switch off in these regions is 31 July 2018. Frequency spectrum would be made available for other applications such as mobile broadband when switching from analogue to digital TV broadcasting.

Law no 34/2017 approved to release Digital Dividend one (800 MHz). The New National Allocation Table, based on WRC-2015 and ECA Table, approved by the Government of Albania on March 2017. The deadline to free 800 MHz was agreed as 30 June 2017 and the band was released from broadcasting applications to this period. In February-April 2018 the public consultation for licensing of 800 MHz was initiated. In June 2018 licensing process for 800 MHz was launched, tender is expected to open in July 2018.

Making the most of the Digital Dividend - Mr. David Hemingway, British Broadcasting Corporation (BBC), UK

Mr. David Hemingway informed the meeting on the development of spectrum and services situation in broadcasting spectrum band IV. Since 1996 the DTT band was reduced from 368 to 224 MHz in 470 – 862 MHz. Simultaneously the number of services increased from 5 to 83. Thus spectrum efficiency of broadcasting band increased 5.7 times. On other hands only 95 MHz from 266 MHz of predominantly mobile band (694 – 960 MHz) is dedicated to downlink. It contradicts with the estimates that by 2021 82% of all IP traffic will be video. The alternative ways how this spectrum could be used should be studied making it more suitable for downlink-dominated use.

There are several options how to rearrange the band 694 – 960 MHz for the innovative mobile broadband technologies. Significant increase in DL capacity should be found under any option. Large contiguous spectrum is obvious for 5G benefits. In addition. cost reductions could be obtained from operating fewer bands. None of these are easy options, but neither is a further "salami slicing" of broadcasting spectrum. These have to be long-term options and implementation would need to be carefully planned and is unlikely to be possible before 2030.

CHALLENGES REVEALED AND FOLLOW-UPS

4K and 8K standards are sensitive for the spectrum resources due to increase in the net bit rates and transition to higher modulation type, e.g. 64 QAM and 256 QAM. More capacity is also required for higher screen resolutions. That is the reason for many administrations, especially for those countries with essential proportion of users receiving television by terrestrial broadcasting, to be careful in allocating additional UHF bands to Mobile Service.

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5.7 Session 7: New services in digital broadcasting

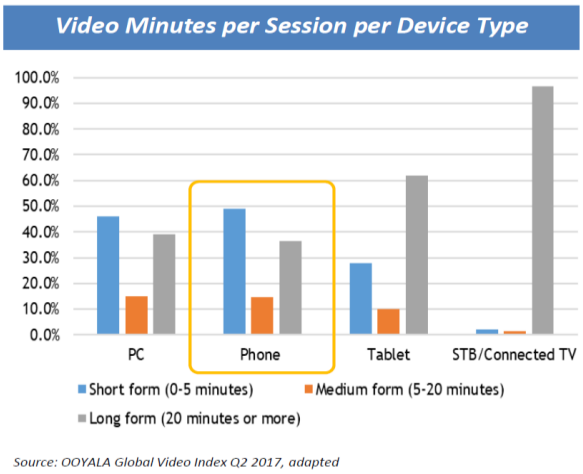
Session 7 highlighted the issues related to innovative services in broadcasting. Technology changes are providing new opportunities to video-based applications. Mr. Krisztián Stefanics from National Media and Infocommunications Authority, Hungary Panel Discussion moderated the panel discussions.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

There are three major trends resulting in transformation of broadcasting industry, namely technology, consumers and regulatory innovations. The key driver of transformation process is the demand for ubiquitous video-based services by the digital customers. Technical innovations are making it possible to use new modulations and compression technics in transmitting video signals ensuring the dramatical increase in capacity. The larger screens requiring high bit rates UHD video delivery are the next drivers of demand for more bandwidth.

Video-based services are changing following convergence of OTT and IP TV technologies. OTT video consumption will grow further from current 20% (of all video consumption). Consumer's preferences today are focused on having video on demand and TV services on the move by means of smartphones and tablets. Mobile video on demand seems not to cannibalise TV revenues as far as it is only idle time used (when on the move) and 4/8K (UHDTV) viewing is not one to be viewed on mobiles. However, mobile video on demand viewing may change viewing habits also at home. Media-meshing between mobile video on demand and live TV forms an innovative opportunity. Figure 7 demonstrates the

proportion of different type of devices in video minutes of viewing as of 2017. The diagram proves that long-viewing TV is dominating with the traditional TV devices while PC and mobile devices are widely used for short and medium form video.



Source: OOYALA Global Video Index Q2 2017, adapted

Figure 7 - Proportion of Different Type of Devices in Video Minutes of Viewing

From the regulatory point of view audio-video (AV) content requirements should be as much as possible technology-neutral. Regulating non-linear services poses two challenges - no natural capacity constraint and more viewer's control over content. Regulatory cornerstone in the EU is based on AV Media Service Directive (AVMSD). AVMSD is currently under review to include social media services, to make advertising rules more relaxed (20% rule only between 07:00-23:00), to apply relaxing of product placement & sponsoring rules (by self-regulation), to oblige video on demand service providers to provide at least 30% local content.

EXPERIENCE BY COUNTRIES

The evolution of Digital Broadcasting - Mr. David Hemingway, BBC, UK

Mr. David Hemingway - BBC, UK – provided the meeting with the latest information on the trends in the evolution of digital broadcasting. He pointed out the trend of smooth increase in video on demand (VOD) and personal video recording/play back services (PVR). Live TV currently occupying 80% of viewing time will decrease down to 63% of viewing time in 2026. It is not the critical decline but it underlines the need for transformation of traditional broadcasting towards digital environment.

It is obvious that traditional broadcasters will continue to cater for both customers who watch and listen to traditional linear channels and those who use the web as their premium consumption method. Nowadays the question is not when, but how broadcasters will make the transition to become digital players. TV is going to evolve into something more immersive, more pervasive, more interactive and more personalised. From this perspective for the web to become an effective distribution network it needs to not only be robust, but also universally available to everyone without exception.

CHALLENGES REVEALED AND FOLLOW-UPS

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From the regulatory point of view AV content requirements should be as much as possible technology-neutral. Regulating non-linear services poses two challenges - no natural capacity constraint and more viewer's control over content. Regulatory cornerstone in the EU is based on AV Media Service Directive (AVMSD). AVMSD is currently under review to include social media services, to make advertising rules more relaxed (20% rule only between 07:00-23:00), to apply relaxing of product placement & sponsoring rules (by self-regulation), to oblige video on demand service providers to provide at least 30% local content.

5.8 Session 8: National regulatory, policy measures on spectrum management and spectrum monitoring

Session 8 focused on discussions of the basic principles of regulation and policy making relevant to spectrum management and broadcasting in the region. Mr. Istvan Bozsoki, Head of Spectrum Management and Broadcasting Division, BDT, ITU moderated the panel discussion.

Essentials of the Subject. Overview of Discussions.

The participants and speakers of this session exchanged their views on the most important contemporary topics in spectrum management given due account to emerging innovative technologies. In particular, two topics were discussed – spectrum redeployment and spectrum monitoring – in light of the anticipated implementation of 5G networks.

The speakers highlighted that traditional regulation based on the technical criteria of electromagnetic compatibility was no longer acceptable with the rapid radio technology turnover in the mostly demanded spectrum bands. In order to ensure the efficient implementation of the innovative radio technologies the economic methods should be introduced by regulators at the highest extent possible. In decision making process regulators are obliged to assess total value for the whole society of spectrum being intended for utilization by one or another radio technology.

The framework methodology to be used by regulators in defining the need and practice of spectrum redeployment was proposed. Regulators should estimate total economic benefit and incremental costs of redeployment. Redeployment benefits are arising from additional revenues/lowering of costs for producers (producer surplus) and reduction of price/increased quality of new services for customers (consumer surplus). The value placed by potential user on new spectrum is a proxy for economic benefits of redeployment. Auction is the best way to capture value placed by potential user on new spectrum in making decision on potential redeployment. Incremental costs are arising from the need to invest replacement of the incumbent services to alternative spectrum bands or out of air. Constant and variable cases should be distinguished. Constant output and variable output cases should be distinguished. In constant output cases there is no change in final output while a reduction in producer surplus is anticipated due to the costs from providing service in alternative band or using alternative technology. Variable output cases assume a change in final output impacting producer surplus, consumer surplus and broader social benefits of spectrum.

There will be a net economic benefit for a society if the spectrum redeployment benefits of the band being available for 5G licensing is higher than the incremental costs of displacing incumbent licences. This will ultimately mean that the new use following redeployment would be the highest value use of the spectrum.

New radio technologies are influencing spectrum monitoring equipment, methodologies and practices. The meeting agreed that the role of radio monitoring is increasing in view of the anticipated growth of spectrum efficiency on 5G networks thus requiring excellent conditions of band utilization.

On other hand, the transition from ex ante to ex post regulation with 5G will require the improved functionality of radio monitoring systems to ensure immediate feedback and reaction to prevent harmful interference.

With the introduction of 5G radio monitoring equipment has to be enhanced/developed for new frequency ranges and bandwidths having due regard to service specific parameters of future networks. Radio monitoring equipment for 5G should encompass enhanced functionalities with wave propagation/micro cells scenarios of 5G networks. It should be mobile and portable equipment incorporated into easily deployable compact, autonomous systems. SHF/EHF frequencies should come in main focus of regulators as far as real usage in these bands is rather unknown and situation in adjacent channels is also unknown.

In this context Mr. Thomas Krenz, Product Manager, Spectrum Monitoring Systems Rohde & Schwarz GmbH & Co. provided a comprehensive presentation on emerging challenges and opportunities related to the spectrum monitoring related to 5G.

EXPERIENCE BY COUNTRIES

Spectrum Management in Kyrgyz Republic – Ms. Aichurok Maralbekkyzy, State Communications Agency under the State Committee of Information Technologies and Communications of Kyrgyz Republic

Ms. Aichurok Maralbekkyzy acknowledged the meeting on the current aspects of spectrum management in the Kyrgyz Republic. The State Commission for Radio Frequency Spectrum is the highest regulatory body of the country responsible for spectrum allocation. It coordinates the rules of spectrum utilization by other spectrum users in the country. It is also responsible for drafting and submitting of the National frequency Allocation Table for the final approval to the Government.

The Telecommunications Administration of the Kyrgyz Republic coordinates timely decision on allocating spectrum bands for the mobile broadband networks. Recently the band 790 – 862 MHz was auctioned for the usage by LTE networks in the country. Currently the frequency band 694 – 790 MHz is used by the Broadcasting Service. But based on the fact that ASO was accomplished in May 2017 there is a potential option for this band to be allocated for Mobile Service. Currently this issue is under consideration.

CHALLENGES REVEALED AND FOLLOW-UPS

Traditional regulation based on the technical criteria of electromagnetic compatibility is no longer an acceptable option with the rapid radio technology turnover in the mostly demanded spectrum bands. In order to ensure the efficient implementation of the innovative radio technologies the economic methods should be introduced by regulators at the highest extent possible. In decision making process regulators are obliged to assess total value for the whole society of spectrum being intended for utilization by one or another radio technology.

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propagation/micro cells scenarios of 5G networks. It should be mobile and portable equipment incorporated into easily deployable compact, autonomous systems. SHF/EHF frequencies should come in main focus of regulators as far as real usage in these bands is rather unknown and situation in adjacent channels is also unknown.

5.9 Session 9: ITU-R works on preparations for WRC-19 concerning 5G

The issues of primary importance in the development of 5G and in allocation of spectrum bands for this radio technology are included in the agenda of forthcoming WRC 2019. The seminar gave credit to the activity of ITU-R on the subject and considered the information on ITU-R preparations for WRC 2019. Mr. Istvan Bozsoki, Head of Spectrum Management and Broadcasting Division, BDT, ITU moderated the panel discussion.

ESSENTIALS OF THE SUBJECT. OVERVIEW OF DISCUSSIONS.

Mr. Juan Castro - Radiocommunication Bureau, ITU - introduced the background information on the preparation of the Union for the WRC 2019. Among the others, WRC-19 will consider agenda items related to wireless broadband systems as follows

- 1.13: International Mobile Telecommunications (IMT), Responsible ITU-R Group: TG 5/1
- 1.14: High-Altitude Platform Stations (HAPS), Responsible ITU-R Group: WP 5C
- 1.16: Wireless Access Systems (WAS) and Radio LANs (RLAN), Responsible ITU-R Group: WP 5A
- 9.1.8: Broadband Machine-Type Communications (MTC), Responsible ITU-R Group: WP 5D

There is the growing consensus of countries, regional groups and industry on some initial 5G bands: 700 MHz, 3.4 GHz, and 26 GHz in CEPT. Regional differences could be resolved by harmonised tuning ranges, e.g. 40 GHz tuning range could cover the 38 GHz and 42 GHz bands. Bands above 24 GHz (worldwide development concentrates on 24.25-43.50 GHz) are critical for IMT-2020. They will provide wide channels, high data rates and backhaul links to base stations.

With regard to High-Altitude Platform Stations (HAPS) - AI 1.14 - Resolution 160 (WRC-15) calls for a study on additional bands for HAPS in Fixed Service allocations:

- globally: 38-39.5GHz, and
- regionally: in R2: 21.4-22GHz and 24.25-27.5GHz

There are the existing allocations as listed below:

- 2 GHz (170 MHz in Regions 1 and 3) –MS
- 6.5 GHz (2x80 MHz in 5 countries) –FS
- 27/31 GHz (2x300 MHz, 23 countries)-FS
- 47/48 GHz (2x300 MHz worldwide) -FS

The above listed bands have geographical limitations and may be not large enough to provide high-rate broadband (about 10 Gbps for mobile service backhaul needed around 2 GHz bandwidth).

With regard to Wireless Access Systems (WAS) and Radio Local Area Networks (RLANS) – AI 1.16 - Resolution 239 (WRC-15) calls to conduct compatibility and sharing studies for WAS/RLAN applications between 5 150 and 5 925 MHz. The growth in demand for WAS is acknowledged and worldwide harmonized spectrum for WAS/RLANs is highly desirable (economies of scale and compatibility of equipment).

Concerning mMTC - massive Machine Type Communications- and URLLC - Ultrareliable and Low Latency Communications – included in AI 9.1.18 Resolution 958 (WRC-15) calls for studies on technical

aspects as well as spectrum needed to support their implementation. There is the common understanding that Internet of Things (IoT) is growing very fast (20 billion devices estimated by 2030). Low latency of 1 ms and high mobility up to 500 km/h are important for mission critical services (example: self driving cars). 5G networks might support a number of such applications: connected cars, connected drones, wireless robotics, etc.

CHALLENGES REVEALED AND FOLLOW-UPS

WRC-19 will consider virtually all radiocommunication services. Several technologies target the same bands thus requiring studies of compatibility between them. The overlaps between bands and potential Radio Services are demonstrated in Table 1.

Table 1

1.6 – NGSO FSS Res. 159 (WRC-15)	1.13 – IMT Res. 238 (WRC-15)	1.14 – HAPS Res. 160 (WRC-15)	9.1 (9.1.9) – FSS Res. 162 (WRC-15)
	24.25-27.5	24.25-27.5 (Reg. 2)	
37.5-39.5 (s-E*)	37-40.5	38-39.5 (globally)	
39.5-42.5 (s-E*)	40.5-42.5		
47.2-50.2 (E-s*)	47.2-50.2		
50.4-51.4 (E-s*)	50.4-52.6		51.4-52.4 (E-s*)
* E-s: Earth-to-space; s-E: space-to-Earth.			

6. CONCLUSION

The organizers of the event thanked the participants and speakers for their contributions to the regional seminar. The participants highly appreciated the proposed format of the event benefiting from simultaneous work of the seminar and Experts' Knowledge Exchange. It was emphasised that this approach makes it possible to combine the wealth of expert and national knowledge with the current activity of ITU-D Study Groups on the questions of their working program. Effective exchange of opinions and close cooperation during the event been arranged in the mentioned manner are of great value for finding synergy in the activities of all the parties involved – ITU, regulators, industry, researches etc.

Some main takeaways from the seminar related to Experts' Knowledge Exchange that could also be addressed further in the study period of ITU-D are listed below. Those could also be attributed to future infrastructure roll-out, spectrum management to ensure that Europe and CIS regions are equipped with relevant measures and effective tools.

1. The issue of National 5G Implementation Strategies had acquired special significance up to date in view of forthcoming initial network deployments. In order to elaborate the most efficient strategies and action plans regulators should bring together the broad range of stakeholders including telecom operators, businesses and trade organisations, ministries and local municipalities, industries, research institutions etc. At large extent, the objective of digital transformation of infrastructure is recommended to be accomplished by combing efforts from both governmental and private business sectors.

2. The most significant challenges to support timely implementation of the 5G networks are:

- speeding and improving of the investment process;

- reducing the infrastructure maintenance costs;
- timely ensuring availability of radio spectrum;
- provision of network security.

3. The existing regulatory frameworks encapsulate practices typical to mobile broadband networks of generations up to 4G. The advanced technical and operational capabilities of 5G could only be realized by applying an updated regulation. It should ultimately take into account the foreseen significant increase in investment of operators into the infrastructure of future networks against the backdrop of stagnating revenues from these networks at least in the short term. To promote vital investments in new networks, regulators can leverage on the following:

- timely licensing of 700 MHz, 3.6 GHz and 26 GHz for mobile networks;
- extension of spectrum licences duration up to 25 years or more;
- introduction of technology neutral spectrum licences;
- lighter regulation on newly deployed infrastructures;
- incentives to and authorisation of mobile infrastructures sharing;
- obligation to provide access to FTTH and/or ducts for mobile backhauling;
- negotiation of low license prices against large investment obligation.

4. Regulators are envisioning a list of challenges arising from the nature of 5G networks as follows:

- small cells - exclusive site access, public owned sites, infrastructure sharing;
- access to spectrum - spectrum for public networks, access to spectrum for private 5G networks indoor, non-traditional entry;
- coverage issues - mixed connectivity environment, coverage obligations in the context of differentiated services;
- competitive issues - non-traditional market entry, complementarity between fixed and mobile, infrastructure sharing and upstream concentration, backhaul, net neutrality;
- infrastructure sharing - cost savings vs competitive issues.

5. The sophisticated functionalities of 5G equipment primarily based on varying antenna patterns and EIRP characteristics are unfolding unprecedented complex frameworks for the assessment of electromagnetic compatibility (EMC). Consequently, traditional regulation based on interference prediction or deterring of harmful interference is no longer a pertinent mechanism with emerging 5G. The evolution from ex ante to ex post regulation may leverage spectrum management for future 5G networks.

6. To provide palatable spectrum resources for future 5G networks regulators should allocate sufficient amount of low-band, mid-band and high-band spectrum including licensed and license-exempt bands while considering economies of scale based on band harmonization and tuning range approach. Regulatory paradigm should be changed from dedicated spectrum management to ad-hoc bandwidth/coverage assignment. It is highly advisable that regulators will adopt policies needed to facilitate 5G in

- ensuring sufficient backhaul spectrum for 5G (71-76 GHz/81-86 GHz);
- fibre policy (optical fibre is the prerequisite for 5G, V2X, FTTX);
- liberalize access requirements to ultra-fast networks;
- targeted, efficient subsidies in high cost areas.

7. 5G development provides broadcasting industry with additional incentive for its active involvement in the converged environment. There is the urgent need for broadcasting industry to develop an architecture allowing seamless reception of content on different devices as users move between different environments and available networks.

8. With the aim to establish stimulating environment for fastest 5G deployment the efforts of regulators should be concentrated on three blocks:

Block 1 – Spectrum Issues. NRAs should consider allocating/assigning globally harmonized spectrum bands for 5G while allowing spectrum sharing to maximize efficient use of available spectrum particularly to benefit rural areas. In order to favor investment through the astute spectrum pricing NRAs should select spectrum award procedures avoiding financial burdening on market players. Policy makers may consider supporting the use of affordable wireless coverage (e.g. through the 700 MHz band) to reduce the risks of the digital divide.

Block 2 – Backhaul Issues. Policy-makers should stimulate fiber investment and passive assets through PPPs, investment funds and offering grant funds. Removing any tax burdens associated with deploying fiber networks to reduce the associated costs is highly advisable. Policy-makers should encourage the migration from copper to fiber and stimulate the deployment of fibre services. Operators may consider a portfolio of wireless technologies for 5G backhaul in addition to fibre including point-to-multi point (PMP) microwave and millimeter wave (mmWave) and satellite where possible.

Block 3 - Access/Sharing of Infrastructure. Policy makers should consider allowing access to government-owned infrastructure and to give wireless operators the appropriate rights to deploy small cell apparatus to street furniture. NRAs may consider continuing to elaborate existing duct access regimes to encompass 5G networks allowing affordable fibre deployments. Regulators should hold a central database identifying key contacts, showing assets such as utility ducts, fibre networks, CCTV posts, lampposts, etc. to help operators cost and plan their infrastructure deployment more accurately.

9. Despite high growth in both mobile subscriptions and mobile data traffic, overall mobile service revenue growth has flattened out. Operators are struggling to turn the growing usage of mobile data services into greater revenues. 5G presents huge financial opportunities for operators over the next decade. Health and Lifestyle (e-medical prescription, remote diagnostics, remote surgery, 24h online services, ...) are becoming daily reality. Security services (cybersecurity, smart living), industry/agriculture (smart factories, production activity), entertainment services (VR, Streaming, 8K) and public services – all of those will constitute the background for successful implementation of 5G in the short term.

10. With implementation of 5G, the role of network management might be shifting towards new players requiring new regulatory attention. The business cases will most likely not support 3-4 independent country-wide networks, which has an impact on spectrum auctions. Governments should stimulate industry development strategies to involve telecommunication as a key enabler of digitalization. The special attention should be given to the rural and scarcely populated areas which might lag behind without state support in coverage.

11. The RF environment is changing continuously and much higher radiation is registered in the Up-Link direction thus placing human beings closer to the sources of radiation. New innovative decisions are required to protect human beings from smartphone emissions. New methods of RF exposure assessment in complex environment (e.g. using smartphone data by specific apps.) are envisaged and are of great importance.

12. 4K and 8K broadcasting technologies are sensitive for spectrum resources due to the increase in the net bit rates and transition to higher modulation types. More capacity is required for higher screen resolutions. That is the reason for many administrations, especially for those countries with essential proportion of users receiving television by terrestrial broadcasting, to be careful in allocating additional UHF bands to Mobile Service.

13. Video-based services are changing in view of convergence of OTT and IP TV technologies. Consumer's preferences today are video on demand and TV services on the move by means of smartphones and tablets. Mobile video on demand seems not to cannibalise TV revenues as far as it is only idle time used (when on the move) and the 4/8K (UHDTV) viewing is not one to be viewed on mobiles. However, mobile video on demand viewing may change viewing habits also at home. Media-meshing between mobile video on demand and live TV forms an innovative opportunity.

14. Traditional regulation based on the technical criteria of electromagnetic compatibility is no longer an acceptable option with the rapid radio technology turnover in the mostly demanded spectrum bands. In order to ensure the efficient implementation of the innovative radio technologies the economic methods should be introduced by regulators at the highest extent possible. In decision making process regulators are obliged to assess total value for the whole society of spectrum being intended for utilization by one or another radio technology.

15. New radio technologies are influencing spectrum monitoring equipment, methodologies and practices. The meeting agreed that the role of radio monitoring is increasing in view of the anticipated growth of spectrum efficiency on 5G networks thus requiring excellent conditions of band utilization. On other hand, the transition from ex ante to ex post regulation with 5G will require the improved functionality of radio monitoring systems to ensure immediate feedback and reaction to prevent harmful interference.

16. With the introduction of 5G radio monitoring equipment has to be enhanced/developed for new frequency ranges and bandwidths having due regard to service specific parameters of future networks. Radio monitoring equipment for 5G should encompass enhanced functionalities with wave propagation/micro cells scenarios of 5G networks. It should be mobile and portable equipment incorporated into easily deployable compact, autonomous systems. SHF/EHF frequencies should come in main focus of regulators as far as real usage in these bands is rather unknown and situation in adjacent channels is also unknown.

ITU representatives and Participants thanked the National Media and Infocommunications Authority (NMHH) of Hungary for hosting the Regional Seminar for Europe and CIS and for the warm hospitality during the stay in Budapest.