DIGITALEUROPE WHITE PAPER ON 5G SPECTRUM

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Contents

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1. Introduction

Over the last few decades, commercial mobile communication has evolved from voice-only to mobile broadband (MBB), enabling a multitude of services including ubiquitous use of the internet and, as a consequence, providing an important contribution to global economic and social development. In 2014, there were close to 7 billion subscriptions globally and this number is expected to increase further to 9.5 billion by 2020, including machine-to-machine (M2M) connections. Furthermore, forecasts from industry and academia as well as general consumer trends point towards continuing growth beyond 2020 in the demand for MBB.

The percentage of data subscriptions is now increasing very rapidly as a result of the rising number of smartphones, tablets, etc. As a result, the volume of data traffic in mobile networks has exploded. The set of available services is expected to expand considerably, for instance with e-health, education and intelligent transport systems and will facilitate development of other industry sectors. In a more general perspective, 5G[1] mobile systems should support the development of a fully networked society, the internet of things/ M2M communication and cloud-based services. Requirements on these services will be instantaneous access/low latency, very high bitrates and Quality-of-Service (QoS), low energy consumption and long battery life. It is however worth noting that not all these requirements necessarily will be relevant all the time. Mobile services should enable access to any type of content anytime and anywhere.

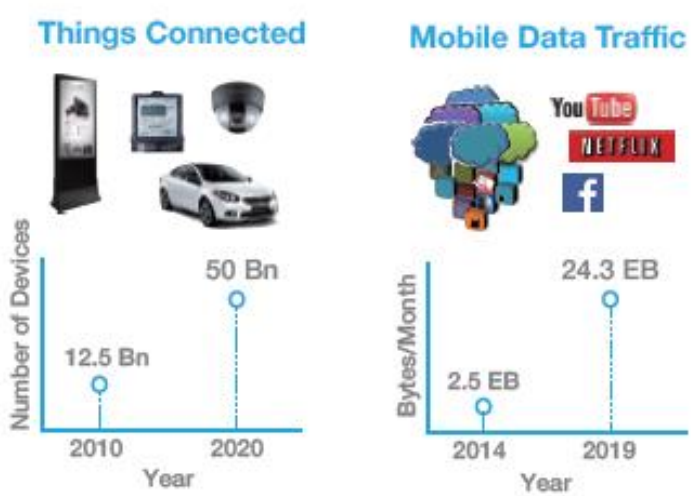

Figure 1: Projected increase in connected devices and mobile data traffic

5G will need to operate in a multi-Radio Access Technology environment where evolution of current MBB technology families and 5G are expected to co-exist. In addition, 5G should incorporate a robust multi-connectivity architecture leveraging the range of available radio access technologies to provide seamless wireless connectivity. 5G networks may integrate a range of technological solutions for frequencies below 6 GHz as well as for new spectrum bands above 6 GHz[2], not previously considered for MBB.

1 The term “5G” is here used loosely, to denominate the next generation of mobile systems expected to emerge around 2020. This concept is embodied in the ITU-R framework for IMT and specifically IMT-2020.

2 For simplicity a lower bound of 6 GHz is used here, noting that the details of a potential agenda item for WRC-19 will not be decided until WRC-15, November 2015, and that Agenda Item 1.1 for WRC-15 incorporates candidate bands up to 6425 MHz

5G networks will incorporate technologies for ultra-narrowband to ultra-wideband operations and provide support to a fully connected networked society where access to information and sharing of data, including cloud-based services, is provided anywhere and anytime for anyone and anything (Internet of Things). Mobile access to internet services shall match the capabilities of fixed networks. Mobile user equipment will play a wide and continuously evolving variety of roles in everyday life.

In order to meet these requirements for future mobile communication, a number of technological advancements will be necessary, and, in addition, availability of larger channel bandwidths as well as an increased total bandwidth. Whereas the purpose of World Radio Conference 2015 (WRC-15) Agenda 1.1 is to identify additional spectrum for the mobile service below 6.5 GHz, addressing MBB growth up to around 2020, discussions for an agenda item for WRC-19 are concerning spectrum bands needed to support the development of future human and machine-based type communication and associated economic growth beyond 2020. Although some 5G services may be delivered in spectrum below 6.5 GHz, the focus of this position paper is on spectrum above 6 GHz that could be the topic of an agenda item for WRC-19.

2. Long-term evolution of traffic in mobile networks

Data traffic in wireless communication networks has increased very substantially in the last few years a trend that is expected to continue. Some of the factors driving this development, and thus the need for additional spectrum, are the following:

- Increasing number of smart phones and tablets
  It is expected that by 2017 more than 1.4 billion smartphones and tablets will have been shipped. These types of devices invite an increased consumption of audio-visual content.
- Increased bit rates
  Video streaming will undoubtedly be one of the main contributors to increased data traffic in mobile networks. Availability of audio-visual content in Ultra High Definition (UHD), unicast distribution, improved screen resolution and increased usage of smartphones and tablets will all be contributing factors.
- M2M communication
  The M2M segment is growing fast and there is the potential for tens of billions of M2M devices in the coming years that may rely on mobile networks for communications.
- Cloud computing
  Access to cloud servers and storage is expected to significantly increase the data traffic, as traffic grows between mobile terminals, servers and storage in the cloud.
- Increase of global population and its concentration in large cities.
  Not only is global population increasing, but it is becoming more and more concentrated. This migration to urban areas will result in an increase in MBB data traffic, as people living in cities generate the largest amount of data traffic in mobile networks.

The projected development for global mobile traffic in the future (ITU-R. (forthcoming a) is described in Figure 1 below, showing the relative increase in global mobile traffic between 2010 and 2030.

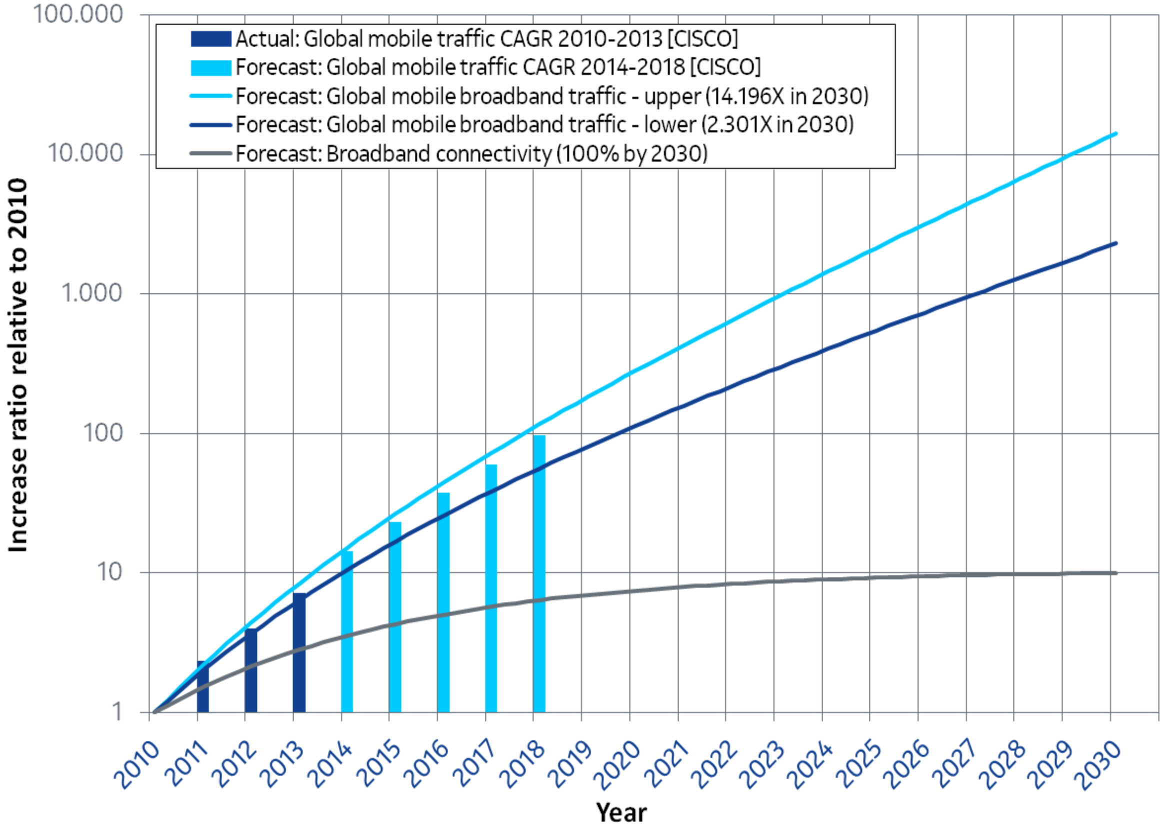

Figure 2: Forecast from a study for global mobile broadband traffic growth for the period 2010 – 2030

3. 5G Requirements

Another way of describing future mobile network communications is to analyze the expected utilization by the users. It is clear that future mobile communication systems should be prepared to support diverse services and user scenarios. Key aspects are further developments of MBB and machine-type communication, stressing the need for network characteristics such as very high data rates and latency as well as guaranteed QoS and handling of large numbers of devices.

Enhanced MBB

The demand for mobile broadband to access multi-media content, services and data will continue to increase. UHD capabilities of user equipment for video consumption, augmented reality, usage of cloud services (e.g. network-based file storage), etc. will lead to expectations of considerably higher data rates and instantaneous connectivity – anywhere and anytime in urban environments. In scenarios with high user densities such as for instance open air festivals, sports/music events in arenas, offices and shopping malls, this will result in network traffic capacities way beyond what can be delivered today.

In order to meet the data rate needs of enhanced MBB, both an increased total amount of spectrum and spectrum to support wider contiguous channels for efficient delivery will be needed. It is expected that suitable spectrum will mainly be found in new higher frequency bands, above 6 GHz.

To enable sufficient performance across a range of mobile environments, for provision of coverage in urban/suburban areas and to support outdoor-to-indoor scenarios, it will be also be necessary to have access to a range of frequency bands in different frequency ranges. This is considered further in Section 8.

M2M

It is stated in ITU-R's forthcoming report on a vision for International Mobile Telecommunications for 2020 and beyond that "In the future, every object that can benefit from being connected will be connected through wired or wireless internet technologies". A massive increase of connectivity capabilities will serve the increasing number of connected devices (Internet of Things), exhibiting different characteristics and with different complexities (e.g. simple sensors vs. medical devices) and with a very large variation in requirements on bit rates, latency and coverage. This will lead to different spectrum needs.

In some cases such as in industrial automation ("industrial internet"/"smart factory"), remote medical surgery, some automotive applications (driver assistance/autonomous driving), requirements on throughput and latency will be very high. In others, however, requirements on both throughput and latency may be considerably lower, e.g. in so-called massive machine-type communication with a very large number of connected devices but with very limited amounts of data to transmit.

For the first kind of machine-type communication, spectrum bandwidth will need to be high, although requirements on coverage may be moderate. For the second type, the situation will be the opposite with very high coverage requirements for which frequency bands below 6 GHz will be of interest.

Scenarios and Capabilities

Figure 3 below from (ITU-R. forthcoming b) illustrates some usage scenarios of the types described above.

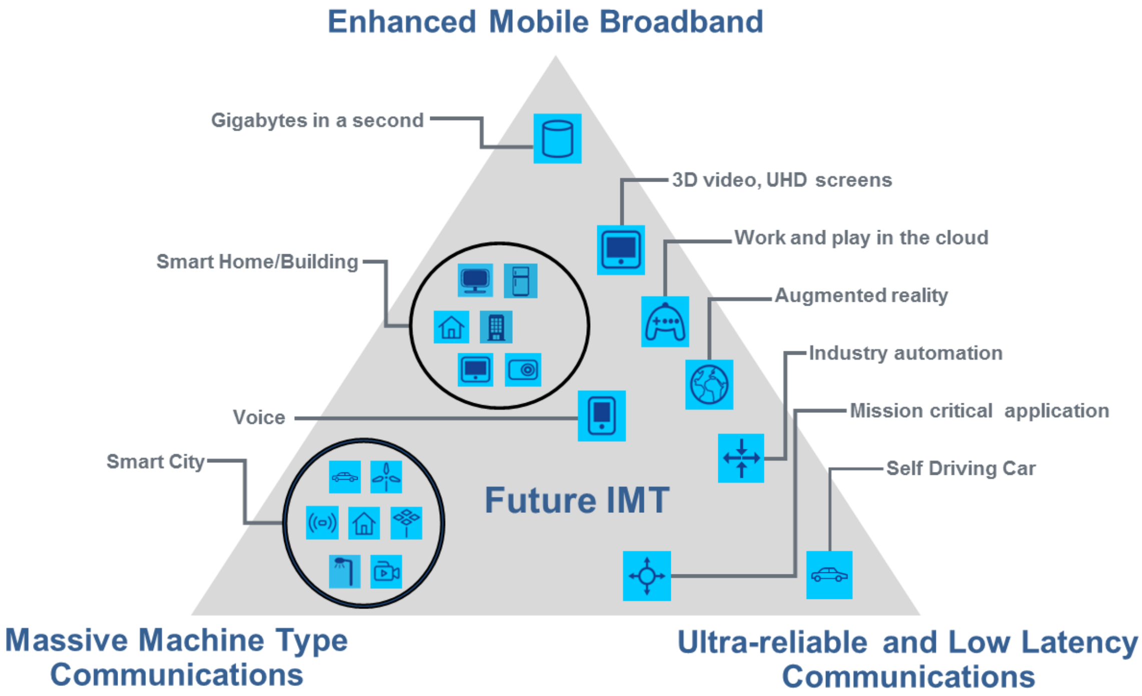

Figure 3: Usage scenarios

Figure 4 below (ITU-R. forthcoming b) describes the key capabilities envisioned to meet these requirements.

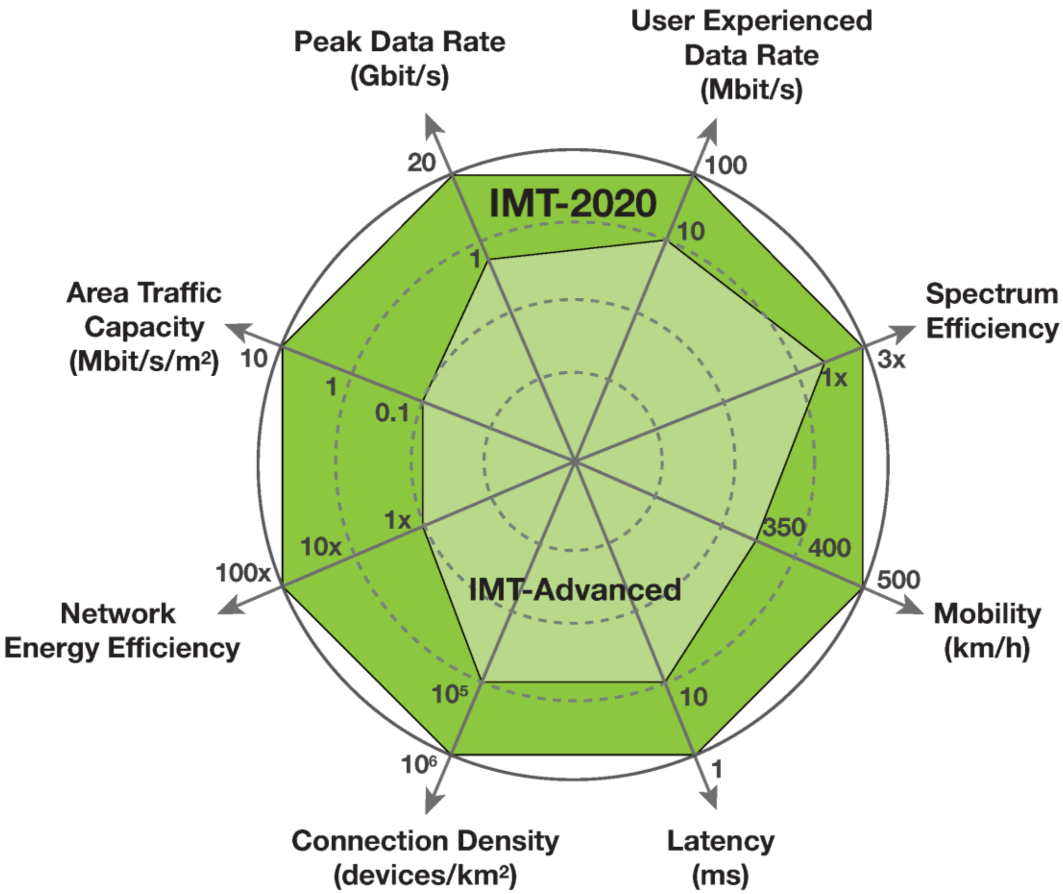

Figure 4: Enhancement of key capabilities from IMT-Advanced to IMT-2020

Capabilities with the strongest connection to spectrum availability are the following:

- Peak data rate (available channel bandwidth)
- User experienced Data Rate (available channel bandwidth/total available bandwidth)
- Area Traffic Capacity (total available bandwidth)

Peak data rates of 10 Gbps or more, up to 20 Gbps under certain conditions, indicate the need for a contiguous channel bandwidth of the order of 1 GHz which is considerably more than what is available today. High data rates and capacity will be provided to meet increasing requirements on quality and bit rates (e.g. for high resolution video streaming and augmented reality) and to satisfy the requirements of more cloud-based services from a range of sectors: financial, entertainment, educational and many others. Different data rates can be expected in different environments, for instance 100 Mbps where more extensive coverage is needed in urban and suburban scenarios. In consequence, not all channel bandwidths need to be as high as 1 GHz.

User Experienced Data Rate and **Area Traffic Capacity** cannot be so easily translated into spectrum requirements but substantially exceed what can be delivered today and in the near future. It is proposed that IMT-2020 should support 10 Mbit/s/m2 area traffic capacity, for example in hot spots. In hotspot cases, the user experienced data rate is expected to reach higher values (e.g. 1 Gbit/s indoor). Different frequency regions have different properties and may be used for different purposes and provide a different balance between data rates and coverage.

The METIS project (METIS 2013) has defined the objectives for a 5G system in relative terms, compared to today's systems, where the spectrum related aspects are as follows:

- 1000 times higher mobile data volume per area,
- 10 times to 100 times higher typical user data rate,
- 10 times to 100 times higher number of connected devices,

Another analysis of future mobile networks (NGMN 2015) carried out by NGMN, concludes that in a demanding indoor scenario, the required user experienced data rate would be about 1 Gbps for the downlink, and 500 Mbps for the uplink. The traffic densities in such a scenario would be 15 and 2 Tbps/km^2 respectively. In an alternative scenario, referred to as broadband access in dense areas, user experienced data rates is expected to be 300 Mbps for DL and 50 Mbps for UL, with traffic densities of 750 Gbps/km^2 for DL, and 125 Gbps/km^2 for UL.

4. Propagation

Compared to traditional cellular bands (below 6GHz), the frequency bands under consideration exhibit increased pathloss, gaseous absorption and rain loss. Generally, these are not considered the main propagation issues over the anticipated relatively short path lengths. However, aspects such as building entry loss, foliage and clutter attenuation and diffraction may be important to consider.

Different use cases, e.g. urban/suburban coverage, outdoor-to-indoor coverage, indoor deployments, etc. may require different types of propagation characteristics and therefore different frequency ranges may be suited to different types of deployments.

Generally, the lower bands in the considered frequency range above 6 GHz have better propagation characteristics for coverage and building penetration whereas the higher bands are more suitable for outdoor hot-spot and indoor deployments with relatively poor outdoor-to-indoor coverage capabilities.

The traditional cellular bands and new spectrum above 6 GHz will be used for deployments in a complementary manner to support all the usage scenarios.

5. Enabling technologies

In order to meet the expected requirements of future mobile systems and to counter the propagation characteristics for new higher frequency bands, a number of technological advances may be considered. These are currently studied in research projects and by development organizations as well as in ITU-R.

The key technical components that are directly related to spectrum aspects are the following:

- Semiconductor technology
- Antenna technologies
- Deployment methodologies
- Carrier aggregation
- Spectrum sharing
- Wireless backhaul

Semiconductor technology for frequencies beyond 6 GHz is a key enabler for ensuring implementation feasibility. It has been concluded in recent studies (ITU-R. forthcoming c) that such technology will be available, and that indeed wireless communication already now is possible for different types of systems including fixed wireless.

Antenna technologies: It is well known that increasing frequency can enable better antenna performance in some respects. Solutions based on massive beamforming with a large number of antennas compensating for the propagation loss have become increasingly feasible with higher frequencies due to smaller antenna sizes and the ability to exploit chip-scale antenna solutions. These can be utilized to improve beamforming and for massive Multiple Input Multiple Output (MIMO)[3]. It is to be noted that prototyping activities are already ongoing in the bands between 6 GHz and 100 GHz, but that challenges remain to be solved. These include beam tracking with very narrow beams or implementation of a very large number of antenna elements in smaller form factor devices. Nevertheless, at least some of the additional propagation loss for higher frequencies may be mitigated by deployment of these more advanced antennas. Narrow antenna beams can further reduce interference within a network and between networks/systems. Antenna technologies may thus be an important enabler for usage of spectrum above 6 GHz. Further investigation will be carried out to determine which of the advanced solutions can be implemented in practice. For instance, there will be additional studies on such issues as the computational power required for very large numbers of antenna elements and the aspect of energy consumption.

Deployment methodology may vary substantially both from one frequency band to another and depending on the deployment scenario. Networks using spectrum above 6 GHz will work in unison with deployments using traditional cellular spectrum below 6 GHz, frequencies that will provide a better coverage in e.g. rural areas. High frequency small cells rolled out on top of the lower frequency networks will deliver focused high capacity services. An essential feature of such overlay network architecture is to facilitate the separation of network control signaling and user data transmission. Control signaling can be transmitted by existing macro cells whilst high frequency small cells can be focused on providing high-rate data transmission only. In addition, communication links that require critical reliability can also be established to macro cells. Therefore, overlay network architecture can overcome the mobility and signaling issues of standalone architecture.

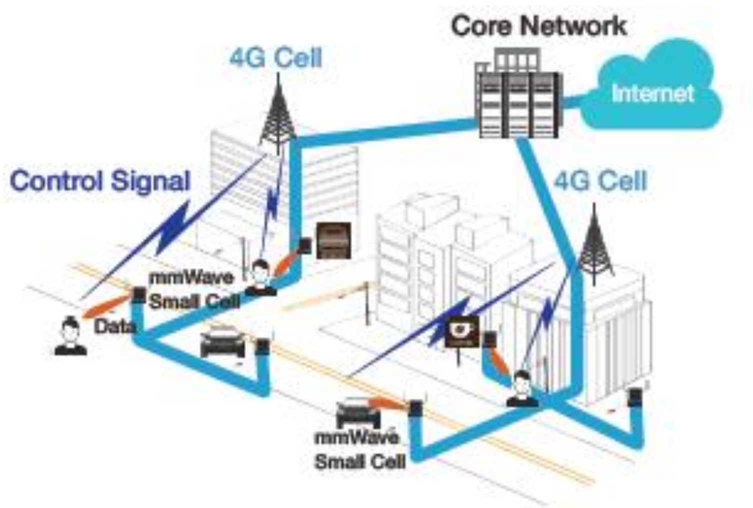

Figure 5: Overlaid Network of mm-wave small cell integrated with the underlay 4G system.

3 MIMO is a method for multiplying the capacity of a radio link using multiple transmit and receive antennas to exploit multipath propagation.

Distributed and self-configuring network technologies will make it easy to deploy many small base stations in urban and suburban areas. In-band wireless backhaul can be used between base stations for cooperative communication, reducing the cost and complexity of backhaul network deployment.

Carrier aggregation for more efficient delivery of high data rate services using the available frequency resource will be further enhanced with the introduction of 5G systems. It can be either intra-layer (i.e. different carriers from the same network layer, e.g. from the frequency range below or above 6 GHz), inter-layer (i.e. different carriers from different network layers) and even inter-system (e.g. 5G-RLAN) cases, the two latter ones though being mostly technically challenging in the dynamic mobile environment. Whereas carrier aggregation may enhance performance of 5G systems this comes at a cost of increasing complexity. Therefore, while preference is to use wide contiguous bands for 5G, carrier aggregation in 5G systems should be seen as a complementary means of increasing spectrum efficiency where the radio environment allows.

Sharing spectrum with other services implies an optimized coexistence with other radio technologies and dynamic use of the radio resources. Managing access to supplementary spectrum on a licensed-shared and/or on a license-exempt basis requires that coordination mechanisms are in place to manage equitable access to the shared spectrum. This is of relevance to the 5G service providers for maintaining high spectrum efficiency as well as ensuring that the interference is controlled and managed as required.

Backhaul is an important part of any wireless networks, linking sites with the core subsystem. Wireless backhaul allows faster deployment and in many cases is the only feasible alternative from a technical or economical perspective. As 5G is expected to use spectrum bands above 6 GHz, ideally any spectrum in this range should be flexible enough to be used for both access and backhaul technologies. However, the spectrum requirements for backhaul should be carefully considered to assure a good functioning of the overall 5G systems.

6. Research and Test Beds

The 5G PPP (Public Private Partnership) is a research program within the European Union Horizon 2020 research program (see 5GPPP 2014) that will deliver solutions, architectures, technologies and contributions to standards for the ubiquitous 5G communication infrastructures of the next decade. It has been initiated and funded by the EU Commission and industry manufacturers, telecommunications operators, service providers, SMEs and researchers. The total budget for the 5GPPP program is 1.4 billion Euros.

The program has a lifetime from 2014 to 2020 and is open for international cooperation and participation.

On the 1st of July 2015 the first phase projects of the 5G-PPP were started. Notable industry-led projects addressing specific challenges of 5G wireless infrastructure include mmMAGIC, METIS-II, Fanatastic-5G and 5G-NORMA.

METIS-II, Key objectives are to develop the overall 5G radio access network design and to provide the technical enablers needed for an efficient integration and use of the various 5G technologies and components currently developed. On the strategic level, METIS-II will provide the 5G collaboration framework within 5G-PPP for a common evaluation of 5G radio access network concepts and prepare concerted action towards regulatory and standardisation bodies.

mmMAGIC, brings together key vendors and major European operators to develop concepts and key components for a new 5G mobile radio access technology which is expected to operate in a range of frequency bands between 6 and 100 GHz. The project aims to accelerate standardisation of millimeter wave technologies for 5G so that the industry and citizens will benefit from commercialisation by 2020.

FANTASTIC-5G, will develop a new flexible and scalable multi-service Air Interface (AI) for below 6 GHz through a modular design with ubiquitous coverage and high capacity where and when needed while being highly efficient in terms of energy and resource consumption. The project gathers key vendors and major European operators to agree on reasonable design choices and to foster 5G standardization by building up consensus on key elements of the air interface. It targets to be future proof and to allow for sustainable delivery of wireless services far beyond 2020.

5G NORMA, The key objective is to develop a conceptually novel, adaptive and future-proof 5G mobile network architecture. The architecture is enabling unprecedented levels of network customisability, ensuring stringent performance, security, cost, and energy requirements to be met; as well as providing an API-driven architectural openness, fuelling economic growth through over-the-top innovation. With 5G NORMA, leading players in the mobile ecosystem aim to underpin Europe's leadership position in 5G.

Globally there are a number of organisations either carrying out or sponsoring specific research programs on IMT for 2020. In the Asia Pacific region examples include the Korean led 5G-Forum[4] and the Chinese IMT2020 5G Promotion Group[5] which was jointly established by three ministries of China and is the major platform to promote 5G technology research in China to facilitate international communication and cooperation. In the US, NYU Wireless[6] is conducting its own 5G mm-wave related research program.

Collaborative activities such as the 5G Innovation Centre[7] in the UK have received both government and industry financial support to build test-beds to drive the development of future networks suitable for the 5G era.

Several different test beds have been developed in order to demonstrate the capabilities of 5G and to provide proof-of-concept of various technology components.

Active antenna beam-forming and beam switching techniques utilising an 800MHz wide channel in the 28 GHz band have successfully demonstrated data transmissions (Samsung 2014) of 7.5 Gbps in a stationary environment, and 1.2 Gbps in a mobile environment (100 km/h).

In another test bed (Huawei 2014), 115 Gbps has been achieved using spectrum in the 70 – 90 GHz range together with advanced transmission technologies for multiple-input multiple-output (MIMO), orthogonal frequency-division multiplexing (OFDM) and an innovative multi-antenna precoding technology.

Ericsson (2015) has demonstrated 5 Gbps in live, over-the-air 5G trials. In addition, massive MIMO and multipoint connectivity with Distributed MIMO were demonstrated.

An experimental system (Nokia 2014) has been used to describe how a 4*4 antenna array with 28 dBi gain is used in a small cell to track terminals moving with pedestrian speed.

Test beds have also been implemented in the European research project METIS (METIS 2015). The focus has been on radio resource management algorithms (e.g. interference cancellation) and digital baseband algorithms.

4 http://www.5gforum.org/
5 http://www.imt-2020.cn/en/introduction
6 http://nyuwireless.com/
7 http://www.surrey.ac.uk/5gic

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7. ITU-R and 3GPP Activities

ITU-R activities towards 5G have been on-going for some time in Working Party 5D, with a two-fold purpose; to describe the future of IMT from a more general perspective, and to define the process towards specifying IMT-2020.

The first of these two activities has resulted in several deliverables:

- "IMT Vision" (ITU-R. forthcoming b) is an ITU-R Recommendation that defines the framework and overall objectives of the future development of International Mobile Telecommunications (IMT) for 2020 and beyond, including a broad variety of capabilities associated with envisaged usage scenarios as well as further enhancement of existing IMT and the development of IMT-2020.
- "The technical feasibility of IMT in the bands above 6 GHz" (ITU-R. forthcoming c) is an ITU-R Report that provides information on the technical feasibility of using IMT in the bands between 6 GHz and 100 GHz, and describes how current IMT systems, their evolution, and new IMT radio interface technologies can be used in the bands between 6 GHz and 100 GHz. Technology enablers such as active and passive components, antenna techniques, deployment architectures are considered.
- "IMT Traffic estimates beyond the year 2020" (ITU-R. forthcoming a) is an ITU-R Report describing drivers for a future increase of IMT traffic, different approaches to cope with the increasing traffic and provides estimates of global as well as country-specific IMT traffic beyond 2020.

Regarding the process towards specifying IMT-2020, Working Party 5D has developed a work plan, milestones and required deliverables that will enable conclusion of this work by 2020, see Figure 6 below.

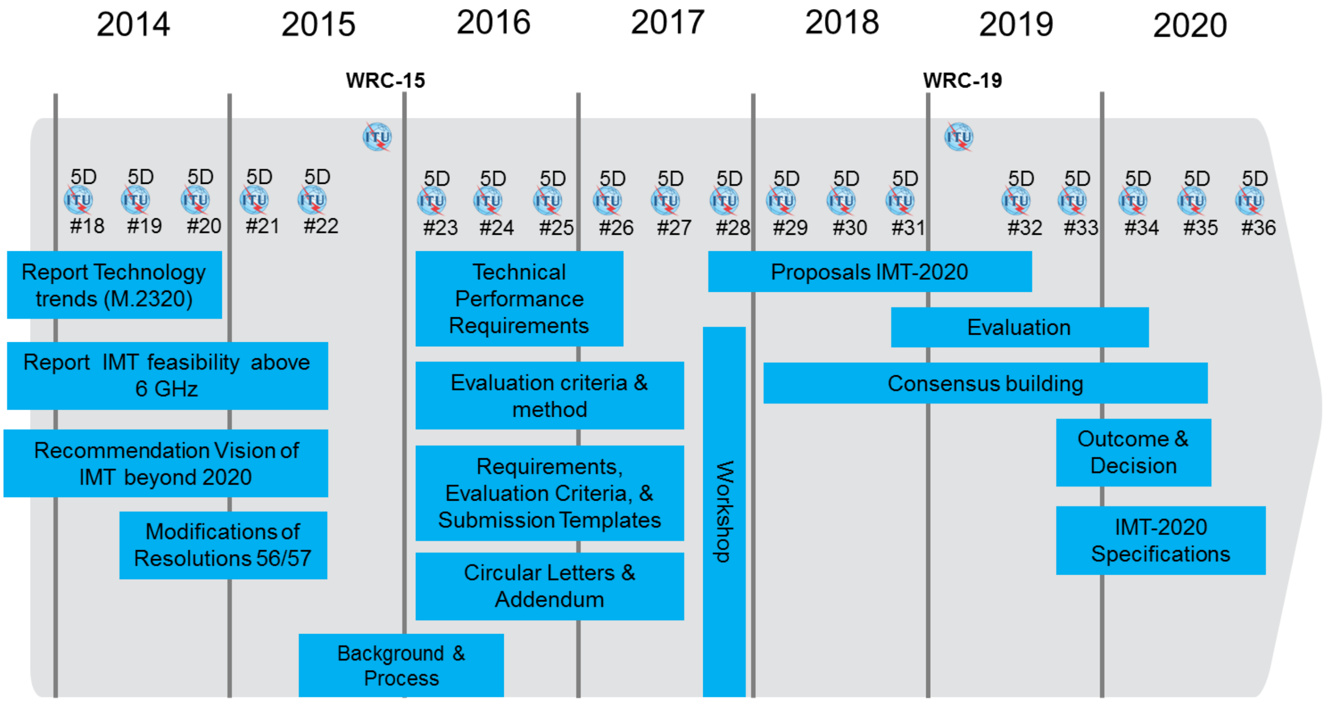

Figure 6: Detailed Timeline & Process For IMT-2020 in ITU-R

In 3GPP, work is undergoing to define 5G stage one requirements under the SMARTER study item. A RAN workshop is scheduled for mid-September, with the intention of starting study items for architectural and radio aspects in December 2015. The work, aiming at defining the requirements on 5G as the basis for the 3GPP standardisation work programme, is targeting completion by 2019 in order to meet IMT 2020 deadlines; it is expected that the work will span over 3GPP's releases Rel-14 and Rel-15 to deliver an initial specification set.

8. Implications for Spectrum

To enable sufficient performance across a range of mobile environments, to provide coverage in urban/suburban areas and to support outdoor-to-indoor coverage scenarios, it will be necessary to have access to a range of frequency bands above 6 GHz.

Spectrum below 20 GHz exhibits propagation characteristics that can readily facilitate better area coverage with relatively simple antenna. Generally speaking, the potential bandwidth available in these frequencies may be limited for some 5G capabilities, especially for the possibility to deliver extremely high data rate services.

Spectrum between around 20 GHz to around 40 – 45 GHz exhibits more challenging propagation characteristics but these may with further research be overcome by using more complex antenna array technologies. In this range, there are potential bands that offer very wide contiguous bandwidth suitable for the delivery of very high data rates. Complex antenna arrays can realistically be implemented in the limited space in handheld devices and component and sub-system technology is available to efficiently and cost-effectively deliver services in an outdoor mobile environment.

Spectrum above around 45 GHz and up to the 70 GHz region can also be used for certain scenarios through the application of advanced antenna technology. A key driver is the possibility for very wide frequency ranges (several GHz) that can support extremely high giga-bit services especially delivering high user quality of experience more suited to hot spot areas, in particular for indoor scenarios.

Based on the information above, conclusions may be drawn regarding spectrum requirements for 5G:

- Traditional cellular frequency bands (below 6 GHz) will play a key role for 5G but will not provide sufficient bandwidth for all applications that will use 5G.
- It is technically feasible to use spectrum above 6 GHz for mobile services.
- Propagation and technology characteristics vary considerably from one frequency band to another, indicating that different bands may be used for different deployment scenarios. Spectrum above 6 GHz may be used in conjunction with spectrum below 6 GHz in order to provide very high bit rates and total throughput as well as guaranteed QoS/coverage.
- Peak bit rates are expected to be in the range of 10 Gbps or more, corresponding to contiguous channel bandwidths of about 1 GHz. However, such bit rates are not necessary for all services or in all places, meaning that frequency bands of lower bandwidth, possibly in the order of 100 MHz, but with better coverage and lower complexity for equipment, should also be considered.
- Contiguous spectrum of sufficient bandwidth to deliver 5G services will simplify implementation considerably, although carrier aggregation, also with spectrum below 6 GHz, may be used to increase available bandwidth at the cost of increased complexity.
- Sufficient backhaul spectrum must be available to handle the increasing data rates and total traffic. Sharing between backhaul and access should be investigated.
- Spectrum management changes typically require long timescales and involve a wide range of international stakeholders. Therefore, it is important that operators are allowed and incentivized to "re-

farm” existing spectrum bands to 5G technology. This will enable improvements in spectrum efficiency and the introduction of new capabilities, as well as the planning of the required long-term investments.

- Licenses issued for high frequency bands should be flexible enough to allow the use of this spectrum for meeting both the network rollout demands and backhaul when/if appropriate.
- Harmonization of spectrum is needed for economies of scale, enabling roaming, reducing equipment design complexity, preserving battery life, improving spectrum efficiency and potentially reducing cross border interference.

9. Conclusions

Research and current trends indicate that communication via mobile networks will continue to increase beyond 2020, as a result of enhanced MBB and M2M communication. Technological developments enabling higher spectrum efficiency will also continue, but peak data rates in the order of 10 Gbps or more and general bit rates of 100 Mbps – 1 Gbps imply that spectrum allocations below 6 GHz, including potential additions at WRC-15, will not be sufficient to meet 5G requirements beyond 2020.

Consequently, new frequency bands are of paramount importance for the development of 5G systems. The identification of new frequencies is a topic with a long lead time. Preparations are already on-going for a WRC-19 agenda item for allocation and identification of spectrum for 5G in new higher frequency ranges. On-going research and development shows that it will be feasible to use such spectrum for mobile communications. Simulations, measurements and prototyping/test beds show that there are no technological obstacles to utilizing the bands above 6 GHz for IMT. In particular,

Different frequency ranges above 6 GHz have different propagation characteristics and, similarly, performance characteristics of e.g. antennas will vary with frequency. As a consequence, different frequency ranges may provide different opportunities for deployment; some may be used for urban/suburban and outdoor-to-indoor coverage whereas others may enable extremely high data rates but with a reduced coverage e.g. for small hot spot cells or indoor deployments.

Spectrum bands in ranges below 20GHz, between 20 and 30GHz, between 30 and 45GHz and above 45GHz will all have a part to play in satisfying the diverse range of 5G applications and usage scenarios.

The timing of spectrum availability is a critical issue. This needs to be aligned with consumer trends, research on and development of equipment, development of standards, etc. Considering developments in ITU-R and 3GPP, WRC-19 is a timely opportunity to ensure availability of new 5G spectrum.

An important objective for this process is to maximize the harmonization between different countries and regions so as to enable economies of scale and global equipment eco-systems.

To enable the 5G use cases and business models flexible spectrum management capabilities should be considered, ranging from exclusive use of spectrum to license-exempt and license-shared access of the frequencies. While the traditional ‘mobile’ spectrum will be at the foundation of 5G mobile services, many of these new services will require access to a range of spectrum bands with different characteristics terms of coverage, throughputs and latency. Cost efficient access to these additional bands will be of paramount importance to make effective use of the spectrum.

10. DIGITALEUROPE Recommendations

DIGITALEUROPE believes that Europe should be a centre of excellence for 5G research and development and recommends the following steps to make the appropriate spectrum available for 5G. European institutions and administrations should consider:

- Supporting an agenda item for WRC-19, through a European Common Proposal (ECP) for the allocation of additional spectrum for Mobile Services and identification for IMT to enable 5G.
- Supporting the conclusions of ITU-R WP5D documents (ITU-R. forthcoming a, b, c) as a basis for the further development of IMT technologies.
- Including the consideration of new spectrum bands below and above 6GHz for 5G in the second phase of the Radio Spectrum Policy Programme (RSPP).
- Developing a detailed investigation of spectrum within CEPT for spectrum above 6GHz covering all the existing Radio Services, their use and future needs and trends, in order to better understand the spectrum opportunities for 5G systems.
- Supporting harmonization of spectrum allocations, in order to enable economy-of-scale advantages for development of 5G systems.
- Making available spectrum for 5G deployment by 2020.
- Supporting studies in a range of high frequency bands for potential IMT identification that can satisfy the diverse range of 5G applications and usage scenarios. Spectrum bands in ranges below 20GHz, between 20 and 30GHz, between 30 and 45GHz and above 45GHz should be considered.
- Supporting studies in frequency ranges that are both relevant to the research and development activities that can be deployed across Europe in a timely fashion to support the aims of the Digital Agenda in the Europe 2020 strategy.

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12. List of Acronyms and Abbreviations

3GPP – 3G Public Private Partnership

5G NORMA - 5G NOvel Radio Multiservice adaptive network Architecture

5GPP – 5G Public Private Partnership

AI – Air Interface

ECP – European Common Proposal

FANTASTIC-5G - Flexible Air iNTerfAce for Scalable service delivery wiThin wIreless Communication networks of the 5th Generation

IMT - International Mobile Telecommunications

ITU-R – International Telecommunications Union Radiocommunication Sector

M2M – Machine-to-Machine

MBB – Mobile Broadband

METIS - Mobile and wireless communications Enablers for the Twenty-twenty Information Society

MIMO - Multiple Input Multiple Output

mmMAGIC - Millimetre-Wave Based Mobile Radio Access Network for Fifth Generation Integrated Communications

NGMN – Next Generation Mobile Networks

OFDM - Orthogonal Frequency-Division Multiplexing

QoS - Quality-of-Service

RSPP - Radio Spectrum Policy Programme

UHD – Ultra High Definition

WRC-15 – World Radio Conference 2015

WRC-19 – World Radio Conference 2019

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