5-Alive

5G: A Leadership Vision for Europe

D3.2 Recommendations for global positioning of the 5g infrastructure PPP

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Abstract

The D3.2 deliverable presents an analysis of the current worldwide 5g landscape along with a set of recommendations for 5GPPP positioning on the global level

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Executive Summary

The present deliverable analyzes the current worldwide 5G landscape, with a focus on the state of the art as far as global initiatives on 5G are concerned, followed by some recommendations on how to position the European 5G PPP initiative at the forefront of the worldwide 5G activities.

As per the analysis of the worldwide 5G landscape, the starting point is the presentation of standardization roadmaps: at the present moment in time, standardization bodies are starting to invest significant resources in the definition of 5G roadmaps. Taking ITU-R and 3GPP roadmaps as a reference, detailed timeline and process for IMT 2020 in ITU-R are presented, from which we can extract relevant information about dates regarding IMT 2020 submission deadlines, and in particular about the 3GPP submission of the system specifications at 5D meeting #32 in June 2019. Another crucial date is September 15, 2015, date of the RAN#69 meeting, which will open the discussion on important items, both for below and above 6 GHz radio interface elements. Considering the regulatory scenario, two WRC conferences are coming up: WRC-15 and WRC-19. It is foreseen that new spectrum allocations below 6 GHz for cellular will be discussed at WRC-15. On the other hand, it is not expected that discussion of spectrum above 6 GHz will occur at WRC-15: it will all be postponed to WRC-19, which may actually be too late for 5G to start in 2020. It should be noted that WRC-15 will discuss and decide the agenda for WRC-19, and therefore it will in any case be essential to reach a strategic position on both below and above 6 GHz spectrum by November 2015.

An overview of the worldwide relevant bodies working on 5G such as IMT-2020 5G Promotion Group for China, 5GMF, ARIB, TTC for Japan, 5G Forum for Korea and 4G Americas for USA is then presented, extracting considerations from the conclusions of their whitepapers on 5G, followed by short description of European activities at national level as well, such as the 5GIC at University of Surrey (UK) and 5G Lab Germany at Technische Universität of Dresden (Germany). A section is dedicated to 5G-related activities within the European Commission, with reference to FI-PPP. The crucial point is that the interactions between the PPPs are still an on-going issue to be discussed, since the problem appears to be the difficult exchange of strategic information across initiatives.

In the second part of this deliverable, the recommendations for 5G positioning are developed starting from the awareness related to the technology disruption brought by the trend towards software defined networking: 5G will lead to a radical revolution of the industrial ecosystem of communication infrastructures and services, and new players and new business models will appear. There is a significant risk for Europe to be overwhelmed in this transformation by “web giants”, which are mainly USA headquartered. It is vital for Europe to master this disruption: to move beyond traditional places (3GPP, GSMA, etc.) to build 5G technology and to open the right interfaces, those that will create value for Europe industry champions and SMEs. Along with the European challenge, achieving a global consensus on global vision and requirements on 5G is crucial, as well as on the deployment timing and drivers of 5G. The preparation of WRC-19 will be a major challenge to develop a common European position on additional frequency spectrum and frequency bands. Different industries like broadcast, mobile and wireless communications

and the satellite sectors have different interests. In addition, other incumbent spectrum users like security services and military are using significant parts of frequency bands of interest. ITU-R is working on vision recommendation as input to the preparation of WRC-19. As far as application of 5G by international organizations is concerned, different regions have different focus areas: China is more focused on vertical sectors applications; Japan is looking to mobile broadband but also at the support of vertical sectors; Korea is mainly focused on mobile broadband, which is driven by high-quality video transmission; USA supports an approach similar to the European one.

Clearly, the main recommendation is to build a strong European push towards 5G, and in this regard this document reports what has already been done in terms of 5G PPP positioning: a section is dedicated to the documents of the Memoranda of Understanding between 5G PPP and Chinese IMT-2020 (which is currently a draft version), Japanese 5GMCP (signed), Korean 5G Forum (signed), and USA's 4G Americas (signed). Another action in terms of positioning is that of organizing of a 5G Global Event, which can be considered as strategically essential in order to coordinate and collect all the global experiences, challenges and results of the 5G world. At present 5G PPP foresees the organization of this major event hopefully within 2016.

In conclusion, it should be reminded that, even though 5G PPP will not directly contribute to global standardisation and the regulatory process, its "indirect" contributions will be submitted by project partners, who are also members of respective standards and regulatory bodies. 5G PPP can be used as a consensus-building machine in Europe, where achieved positions can be exploited in decision-making bodies.

List of Authors

Organisation	Authors	Main organisations' contributions
Eurescom	David Kennedy	Inputs for 5G PPP-FI PPP relationship
Nokia	Werner Mohr	Inputs from 5G Infrastructure Association
Orange	Jean- Sébastien Bedo	Inputs for positioning
University of Bologna	Giovanni E. Corazza	Roadmapping and positioning
University of Bologna	Alessandro Vanelli Coralli	White papers comparison
University of Bologna	Sara Martello	Editorial work

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Abbreviations

3GPP: 3rd Generation Partnership Project

5G-PPP: 5G Public Private Partnership

FI-PPP: Future Internet Public Private Partnership

ITU-R: ITU Radiocommunication sector

NGMN: Next Generation Mobile Networks

MoU: Memorandum of Understanding

RAN: Radio Access Network

WRC: World Radiocommunication Conference

1 INTRODUCTION

The D3.2 deliverable is structured in two parts: the first presents an analysis of the current worldwide 5G landscape, while the second offers recommendations for 5G PPP positioning on a global level.

As per the first part, the first section of this deliverable presents a short description of the approach of standardization bodies to 5G development, reporting specific roadmaps from ITU-R and 3GPP. A short discussion on the regulatory medium term scenario, which includes WRC-15 and WRC-19 conferences, is then carried out in the following section.

Attention is then focused on the activities related to 5G in specific areas of the world: the analysis considers the most important 5G organizations at global level (5G Forum - Korea, IMT2020 (5G) Promotion Group - China, 5GMF - Japan, ARIB2020 - Japan, TTC Ad hoc Group on Future Mobile Networking - Japan, 4GAmericas-USA) followed by an overview of the most significant sections of selected white-papers produced by these bodies. A section is dedicated to significant 5G activities in the rest of the world, followed by an analysis of European activities at national level (UK and Germany in particular). The following section presents a description of other 5G-related activities within the European Commission, with specific reference to FI-PPP activities.

The second part of the deliverable offers a set of recommendations for 5G PPP positioning, including the description of the challenges to be faced and the presentation of what has already been achieved in terms of joint activities with international parties, such as the Memorandum of Understanding with relevant bodies in Korea, China, Japan, and USA.

2 ANALYSIS OF THE WORLD-WIDE 5G LANDSCAPE

2.1 Standardization roadmaps

At the present moment in time, standardization bodies are starting to invest significant resources on the definition of 5G roadmaps. In the following, we report the available roadmaps from ITU-R and 3GPP.

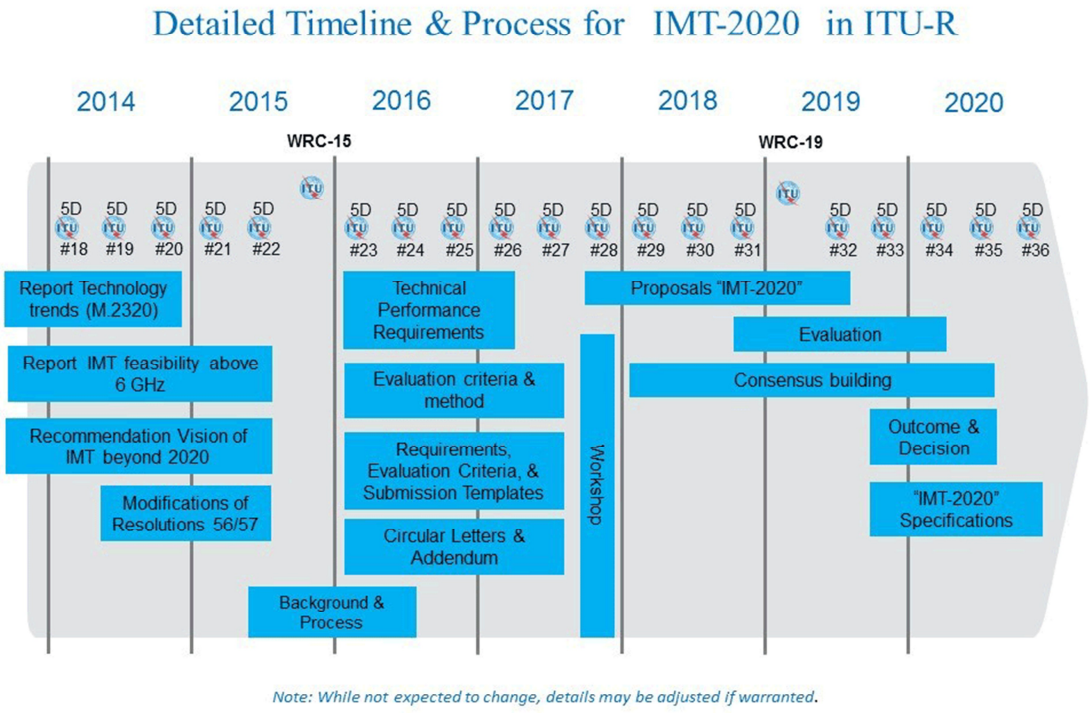


Figure 1 – ITU-R 5G Roadmap

From Figure 1, we can extract the following fundamental dates regarding IMT 2020 submission deadlines:

- Initial technology submission
  - Deadline: Jun. 2019 (5D #32)
  - Expected input: high-level description of the technology
- Detailed specification submission
  - Deadline: Oct. 2020 (5D #36)
  - Expected input: actual stage-3 specifications

As clarified by the ITU-R AH, 3GPP should submit the final specs at the 5D meeting in Feb 2020, based on functionally frozen specs by Dec 2019. As a consequence, 3GPP is defining an internal roadmap to be ready for contributions, as reported in the following figure.

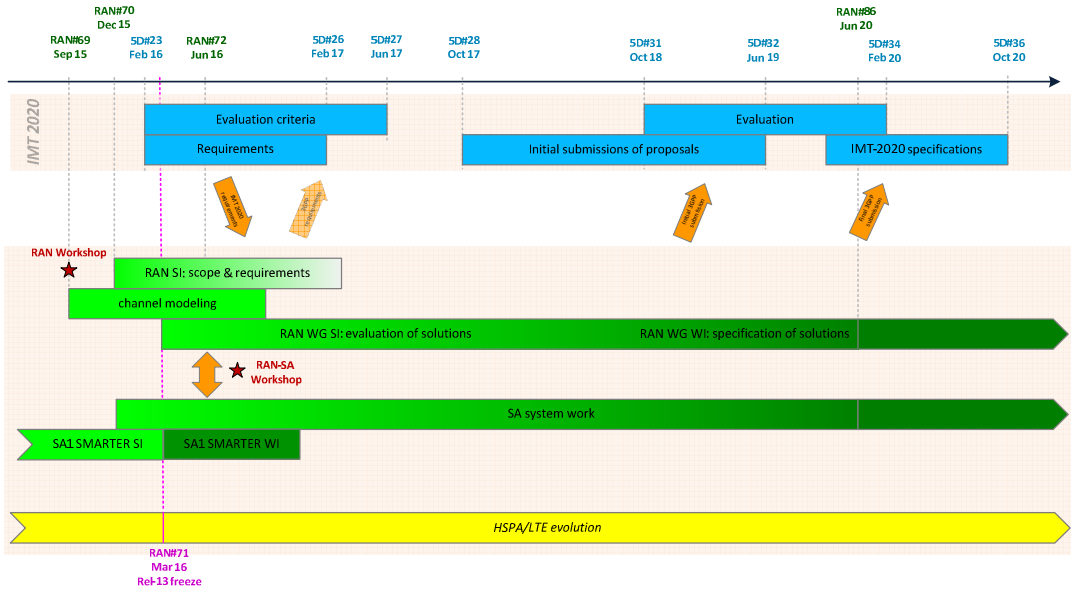


Figure 2 – 3GPP 4G evolution/5G Roadmap

In particular, there will be an important meeting on September 15, 2015, RAN#69, which will open the discussion on all important items, both for below and above 6 GHz radio interface elements. A more readable version of the 3GPP timeline is reported below.

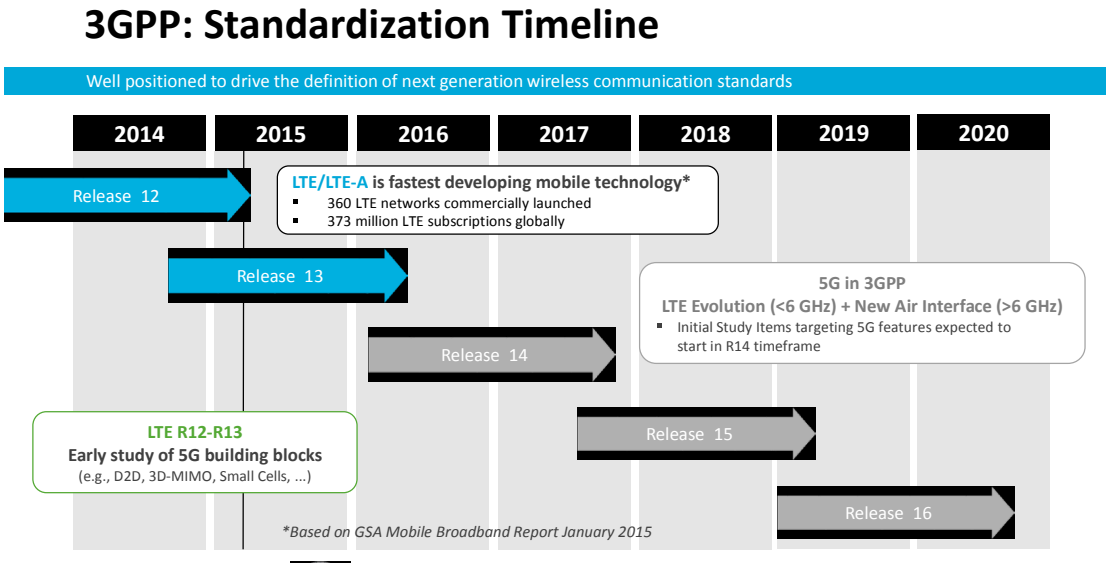


Figure 3 – Simplified 3GPP Roadmap

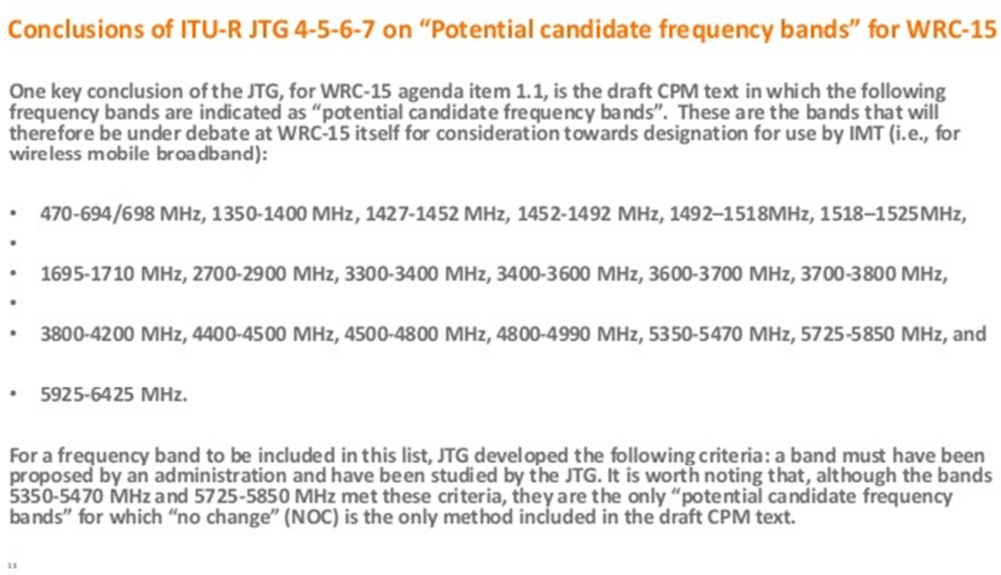
Source: InterDigital [1]

It is also important to note that by October 2017, the window for proposal submissions will be opened, and therefore companies will have essentially defined their approach:

from there on, room for wide scoped research will be consistently restricted, and the emphasis will shift to comparative evaluation of the competing alternative technologies.

2.2 Regulation scenario

As reported in Figure 1, two WRC conferences are coming up: WRC-15 and WRC-19. It is foreseen that new spectrum allocations below 6GHz for cellular will happen at WRC-15. On the other hand, it is not expected that discussion of spectrum above 6 GHz will occur at WRC-15: it will all be postponed to WRC-19, which may actually be too late for 5G to start in 2020. The ITU-R has set up Joint working groups in preparation for WRC-15, and the figure below reports some of the main conclusions.


Conclusions of ITU-R JTG 4-5-6-7 on "Potential candidate frequency bands" for WRC-15

One key conclusion of the JTG, for WRC-15 agenda item 1.1, is the draft CPM text in which the following frequency bands are indicated as "potential candidate frequency bands". These are the bands that will therefore be under debate at WRC-15 itself for consideration towards designation for use by IMT (i.e., for wireless mobile broadband):

- 470-694/698 MHz, 1350-1400 MHz, 1427-1452 MHz, 1452-1492 MHz, 1492–1518MHz, 1518–1525MHz,
- 1695-1710 MHz, 2700-2900 MHz, 3300-3400 MHz, 3400-3600 MHz, 3600-3700 MHz, 3700-3800 MHz,
- 3800-4200 MHz, 4400-4500 MHz, 4500-4800 MHz, 4800-4990 MHz, 5350-5470 MHz, 5725-5850 MHz, and
- 5925-6425 MHz.

For a frequency band to be included in this list, JTG developed the following criteria: a band must have been proposed by an administration and have been studied by the JTG. It is worth noting that, although the bands 5350-5470 MHz and 5725-5850 MHz met these criteria, they are the only "potential candidate frequency bands" for which "no change" (NOC) is the only method included in the draft CPM text.

Figure 4 – Conclusions from ITU-R JTG 4-5-6-7 on candidate new bands for mobile broadband, to be discussed at WRC-15

It should be noted that WRC-15 will discuss and decide the agenda for WRC-19, and therefore **it will in any case be essential to reach a strategic position on both below and above 6 GHz spectrum by November 2015**.

We now turn the attention to activities carried out in specific parts of the world.

2.3 China

In the framework of Chinese activities towards 5G, the main actor is the "*IMT-2020 (5G) Promotion Group*": established as a non-profit association, founded under Chinese law, has its seat in Beijing, China, with a financial and organizational structure, with a brand and a web-site (http://www.imt-2020.cn/). *IMT-2020 (5G) Promotion Group* is willing to collaborate with international bodies focusing on

- 5G mobile communication networks and/or
- enabling wireless and network technologies

and bodies working on

- 5G research & development,
- pre-standardization activities,
- spectrum issues and
- technical trials.

The purpose of *IMT-2020 (5G) Promotion Group i*s:

- Major objectives
  - To propose 5G strategy of China
  - To promote 5G research and development in China
  - To facilitate international collaboration in the field of 5G
- Scope
  - 5G vision and requirements
  - 5G concept, roadmap and architecture
  - 5G wireless and network technologies
  - 5G spectrum demand and candidate bands
  - 5G pre-standardization for international standard organizations

Considering the white paper [2] on 5G Concept, we extract the Technology Roadmap and Conclusions:

"5G Technology Roadmap

By analyzing the technical features, standard evolution, and industry development, the 5G technology roadmap can be identified. It consists of two technology routes: New air interface and 4G evolution.

The new air interface targets new scenarios and new frequency bands, especially for IoT services and high frequency bands. This requires a totally new air interface design and innovative technologies without the need to consider backward compatibility with 4G. It can fulfil the service requirements and challenges that 4G evolution cannot support.

The 4G evolution will introduce new enhanced technologies on the basis of 4G framework. It will further improve the performance of 4G systems with backward compatibility. The requirements of 5G scenarios and services can be met to some extent by this route.

In addition, wireless local area network (WLAN) has become an important supplement of mobile communications, which mainly provides data offloading in hot-spot areas. The standardization of the next-generation WLAN standard (802.11ax) was launched in early

2014 and is expected to be completed in 2019. Looking towards 2020 and beyond, the next-generation WLAN will be tightly integrated with 5G, to jointly provide services to end users. Currently, developing globally unified 5G standards has become a common voice for industry worldwide. The ITU has already initiated the research work for 5G standards, and set up the work plan for IMT-2020 (5G). The pre-standard research for 5G is scheduled to be completed in mid-2015, and the technical performance requirements and evaluation methodology research will start in 2016. The call for 5G standard proposals will be kicked off in late 2017. The 5G specification is expected to be completed by the end of 2020.

As the major international standard organization in the field of mobile communications, 3GPP will take charge of the development of 5G technical specifications. 3GPP Release 14 is considered to be the best time to initialize the study items for 5G standards, and the 5G standard work items can be launched in Release 15. The enhancement and optimization of 5G standards can be carried out in Release 16 and beyond.

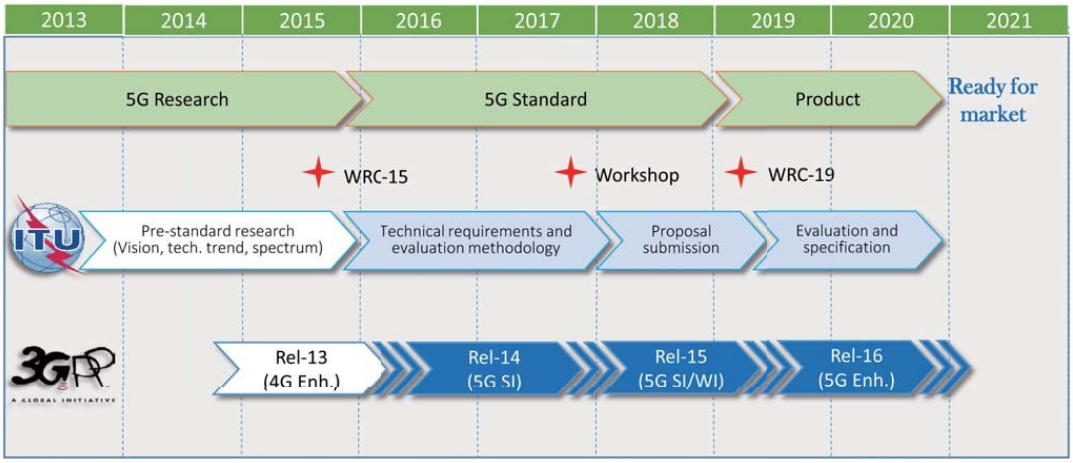


Figure 5 – 5G Time Plan from IMT-2020 Promotion Group (China)

2.4 Japan

In the framework of Japanese activities towards 5G, the main actor is the "*The Fifth Generation Mobile Communications Promotion Forum*"(5GMF), established as a non-profit association, founded under Japanese law, with its seat in Tokyo, Japan, with a financial and organizational structure with a brand and a web-site (http://5gmf.jp). *The Fifth Generation Mobile Communications Promotion Forum* is an open and independent organization and is open for collaboration to international bodies focusing on

- 5G communications systems, networks, services and applications and/or
- particular technologies

and bodies working on

- 5G research,
- pre-standardization activities,
- regulatory issues and
- 5G frequency concepts and future frequency bands.

The purpose of *The Fifth Generation Mobile Communications Promotion Forum* is:

- Major objectives
  - To conduct research and development concerning 5G Mobile Communications Systems and research and study on its standardization
  - To collect information relating to 5G Mobile Communications Systems and exchange thereof with other organizations
  - To correspond and coordinate with related organizations concerning 5G Mobile Communications Systems
  - To conduct dissemination and enlightenment pertaining to 5G Mobile Communications Systems
- Scope
  - 5G mobile communications systems and networks
  - 5G mobile communications services and applications
  - Related research activities
  - Contributions to the preparation of future global standards
  - Contributions to regulatory discussions including future frequency bands

In addition, standardization bodies such as ARIB and TTC are defining their Vision on 5G, and producing White Papers [3][4].

We extract from ARIB's document on "Mobile Communications Systems for 2020 and beyond" [3] the Conclusions:

"This white paper entitled ―Mobile Communications Systems for 2020 and beyond‖ was developed by ―2020 and Beyond Ad Hoc (20B AH)‖ of Association of Radio Industries and Businesses (ARIB), Japan, in order to describe the terrestrial mobile communications systems to be commercialized in 2020 and beyond.

The paper addressed the socio-economic environment surrounding 5G, including market and user trends, traffic trends, cost and spectrum implications, as well as the framework and capability aspects of 5G. Based on the examination on the development road towards 5G', it was concluded that the radio access network (RAN) for IMT for 2020 and beyond as

a whole will be realized by the complementary interworking of its constituent Radio Access Technologies (RATs), i.e., Enhanced IMT-Advanced and New RAT(s), which satisfy all the requirements foreseen for mobile radio communications in the year 2020 and beyond. As for the framework, "Typical User Throughput' is considered one of the most important measures to characterize IMT for 2020 and beyond, focused on user experience in the wide range of user density.

Numerous technologies in various categories identified as effective 5G RAT(s) technologies are summarized in the following Table:"

Table.A.1-1 Correlation between 5G RAT and 5G RAN features, capabilities

Radio Access Technology \ Feature, Capability	Coverage [8.2 (i)]	User Throughput [8.2 (ii)]	Peak Data Rate [8.3.1]	Mobility [8.3.1]	Capacity [8.2 (iii), 8.3.1]	Connected devices [8.3.1]	Latency [8.3.1]	Energy [8.3.1]	Availability / Reliability [8.3.1]	Lifeline connection [8.3.2]	QoE [8.3.2]	Application diversity [8.3.2]	Virtualization [8.3.2]
A.2 Technologies to enhance the radio interface													
A.2.1 Advanced modulation, coding and multiple access schemes	x	x	x		x	x			x	x	x		
A.2.2 Multi-antenna and multi-site technologies	x	x	x	x	x			x					
A.2.3 Network densification		x		x	x			x	x				x
A.2.4 Flexible spectrum usage	x	x	x	x	x						x	x	
A.2.5 Simultaneous transmission and reception (STR)	x	x	x		x		x		x				
A.2.6 Other Technologies to enhance the radio interface	x	x						x		x	x		
A.3 Technologies to support wide range of emerging services													
A.3.1 Technologies to support the proximity services				x					x		x	x	
A.3.2 Technologies to support M2M						x	x	x	x	x	x	x	
A.4 Technologies to enhance user experience													
A.4.1 Cell edge enhancement	x	x			x	x							
A.4.2 Quality of service enhancement		x					x				x		
A.4.3 Low latency							x				x		
A.4.4 High reliability									x	x			
A.4.5 Radio Local Area Network (RLAN)interworking	x			x	x								
A.4.6 Context Aware											x	x	
A.4.7 Mobility Enhancement with Linear Cell				x								x	
A.5 Technologies to improve energy efficiency													
A.5.1 Network-level power management					x			x					
A.5.2 Energy-efficient network deployment								x					
A.5.3 Other item					x			x					
A.6 Terminal Technologies													
A.6.1 Advanced receiver	x	x	x	x	x	x			x		x		
A.7 Network Technologies													
A.7.1 Technologies to enhance network architectures								x	x		x	x	x
A.7.2 Technologies to support ease of deployment and increase network reach	x			x						x		x	
A.7.3 Novel RAN architecture	x	x		x	x	x							
A.7.4 Cloud-RAN (C-RAN)		x						x			x		x
A.7.5 RAN sharing enhancement		x		x	x	x					x		
A.8 Technologies to enhance privacy and security											x	x	
A.9 Technical studies on millimeter wave and centimeter wave		x	x		x	x							

Figure 6 – ARIB2020 effective categories of 5G RAT(s) technologies (Japan)

Considering on the other hand the White Paper by TTC Ad Hoc Group on Future Mobile Networking [4], we extract the Conclusion and Proposal:

"This document's compilation of the various technical issues that will need to be addressed with the current core network and the mobile front/backhaul is based on the following scenarios that have been drawn up for 2020 and beyond:

- Data traffic will continue to increase in the years leading up to 2020 and beyond
- In line with the rapid increase in the number of M2M/IoT terminals, the number of connections will continue to increase.
- Traffic levels will fluctuate widely from hour to hour due to variety in the types of services that will be on offer.
- There will be a need to accommodate a greater variety of access technologies.
- The advent of ultra low latency real-time control services such as tactile communication, V2X, AR, and M2M can be anticipated. It will be noted that 5G research and pre-standardization activities within the relevant domestic and global organizations are ongoing. A survey of the main technologies that are candidates for inclusion in the 5G platform has been carried out by the relevant standards development organizations (SDOs) and research organizations of countries that have been playing a leading role in this effort, and useful insights into key technical issues and technologies have been obtained. Although it will also be noted that the definition or interpretation of "5G" differs depending on the organization; as such, there is not yet a unified definition of 5G. This study has gathered information on the following important technologies and key technical issues.

(1) Based on a monolithic network architecture, the current mobile network has passed through the eras of 2G, 3G and 4G and the core network has steadily evolved by adding the functions needed to accommodate the changing requirements of services and radio access technologies. However, as discussed in this white paper, in the future the network side will need the capability to efficiently accommodate a greater variety of traffic and connect with a wide variety and huge number of M2M/IoT terminals.

(2) In the core network, a new setup will be necessary to efficiently accommodate multiple architectures that are optimized each for specific needs and conditions, and further efforts to integrate network and component technologies based on the promising NFV and SDN technologies will need to be made.

(3) Currently, the main communication services on offer are voice, multimedia services such as video, and SNS and other types of messaging services, while in mobile communications IMS is utilized for both fixed and mobile networks for the commercial provision of IP multi-media services. This technical survey has not uncovered any new study activities in Japan or other countries focusing on communication services for 2020 and beyond or new systems required for such services.

(4) Regarding the mobile front/backhaul, this study has identified a number of technical issues associated with the rising traffic volumes in the U-plane. While it has been essential to have ultra large capacity for both the mobile fronthaul and the mobile backhaul, this requirement will need to be mitigated through the continued enhancement of

transmission technologies, and studies will need to be conducted that take the entire network into account when examining topics such as the appropriate layout of functions. It also has become clear that power consumption is becoming a serious issue for the mobile fronthaul because of the increase in capacity and the introduction of small cells, and it will be necessary to study new technology and architecture to resolve this.

(5) Taking the network management point of view, it is commonly known that relatively new technologies such as SDN, NFV, and virtualization are to be deployed on a large scale, and that scalable and flexible network management technologies are indispensable to the mitigation of network management costs associated with short service life-cycles and the handling of excessively large amounts of management data. These issues are acknowledged both domestically and globally. Network security issues will also need to be studied due to the complexity of a network architecture that utilizes virtualization and other technologies.

TTC has prepared this summary of the technical issues related to mobile networks for 2020 and beyond, and has done a domestic and international survey of potential solutions. Based on the results of this study, TTC will continue to study these issues in collaboration with the relevant organizations, and is considering activities such as the following:

- A quantitative assessment of the issues identified in this document
- The application of the component technologies discussed here
- Discussion and study of a complete new end-to-end architecture, including the radio system and the requirements for the entire system TTC would like to emphasize that it will be much more important for a study of a unified network management approach for future mobile networks to be done from a comprehensive standpoint that considers not only radio system technologies but also the core network, the transmission network and the service network. TTC also wishes to affirm that it will continue to actively monitor trends in domestic and international 5G activities. TTC would like not only to accelerate the pace of global standardization activities related to5G, but also be a main driver in promoting research into the types of services, network architecture, and component technologies that society will need for 2020 and beyond. ”

2.5 Korea

In the framework of Korean activities towards 5G, the main actor is the 5G Forum:

“*5G Forum, Korea*” is established as a non-profit association, founded under Korean law, with its seat in Seoul, Korea, with a financial and organizational structure with a brand and a website (http://www.5gforum.org). *5G Forum, Korea* is an open and independent organization and is open for collaboration to international bodies with a vision of

- Globally leading and promoting 5G toward 2020

and bodies working on

- Developing visions for 5G
- Study Technology and spectrum issues

- Global collaboration

The purpose of *5G Forum, Korea* is:

  - Develop Vision and services
  - Study spectrum aspects
  - Identify potential technology
  - Collaborate for global harmonization
  - Bridge between industries and government

Considering the white paper [1] on 5G Vision, we extract the Concluding Remarks:

"According to 5G service trends, there are two major services, mobile internet and IoT (Internet of Things) services. Considering both mobile internet and IoT, moreover focusing on user centric network, we set up the Technology Vision as '1Gbps/user anytime anywhere in 2020s'. In IoT service, massive connections and energy efficient technologies are needed more than the capacity increase technologies. With the vision, we have drawn Technology Requirements and Candidate Technologies for 5G intentionally aligned with global harmonization activity such as ITU-R 5G process.

In this white paper, we divided technology into two categories, Core Network and Wireless Network. With high level requirements about service transferred from 5G Forum Service Sub- committee, we set up Core and Wireless Network requirement accordingly. Through these requirements, we extracted 11 KPI needed for 5G. The candidate technologies satisfying the requirements and KPI are selected first focusing on the 5G innovative concept such as flat and distributed network, mmWave band, large scale antenna, advanced dense small cell, etc. Then evolution technologies from 4G which can be 5G technology are also included in the 5G enabling technologies. We hope this white paper would be a reference to ITU-R and would be helpful with understanding 5G technologies which are expected to be firstly shown in PyeongChang Winter Olympic Games and considered to be commercialized from 2020."

The mention of the 2018 Olympic Games is particularly important, as it may be a driver to accelerate commercial development ahead of schedule.

2.6 USA

In the framework of American activities towards 5G, the main actor is "*4G Americas*", which is established as a Limited Liability Corporation, founded under U.S. law, with its location in Bellevue, Washington USA, with a financial and organizational structure with a brand and a web-site (www.4GAmericas.org). *4G Americas* unifies the Americas through mobile broadband technology and is an independent organization that welcomes collaboration with international bodies focusing on 5G and mobile broadband technical and regulatory issues and opportunities. 4G Americas is a prominent wireless industry association for the Americas providing important 5G technical recommendations and leadership for the region.

The mission of *4G Americas*:

4G Americas will advocate for and foster the advancement and full capabilities of LTE mobile broadband technologies, including LTE-Advanced and beyond to 5G, throughout the ecosystem's networks, services, applications and wirelessly connected devices in the Americas.

One of the key goals of *4G Americas* is:

Provide and promote 5G technology recommendations that will benefit industry stakeholders and the mobile broadband ecosystem, providing organizational leadership in the development of next generation networks in 2020 and beyond for the Americas.

Considering the White Paper [5] on "4G Americas' Recommendations on 5G Requirements and Solutions", we extract the Conclusions and Recommendations:

"An end-to-end 5G system has to be architected to meet the expected demand in 2020 and beyond. Figure 2 illustrates a comprehensive view that must be considered in the initial planning process for 5G.

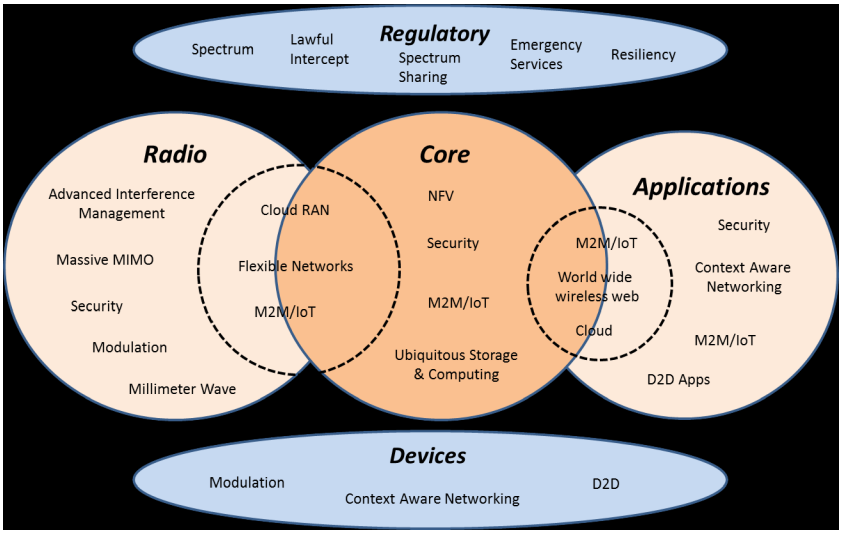


Figure 2. A Preliminary View of an End-to-End 5G Ecosystem.

Figure 7 – 4G Americas' preliminary view of and End-to-End 5G Ecosystem

The key 5G principles highlighted in this white paper are:

- As 5G is defined and requirements developed, it must include the entire 5G ecosystem (e.g., air interface, devices, transport, packet core).
- 5G development should provide global harmonization under a single framework and allow time for true advances of technology, feasibility studies, standardization and product development.
- It is critical that the countries of the Americas invest in 5G research.
- Avoid debate (at least initially) on what 5G is. 5G does not (yet) describe any particular specification in any official document published by any standardization body.
- 5G planning should consider all major technology advances on the road to 5G.
- Wherever feasible, features being discussed as 5G requirements should be implemented as LTE- Advanced extensions before the full 5G is available. This will also give time to recoup the investment in 4G.
- There are ongoing enhancements in LTE-Advanced that will continue through 2018. 5G is envisioned to have initial deployments around 2020. It must be recognized that significant breakthroughs in new radio transmission interfaces may be accompanied by a break in backward compatibility. ”

2.7 Rest of the World

Taiwan and Russia appear to be taking preliminary steps about 5G. At the present moment in time, the information we have is that Taiwan has started national research programs on 5G, while in Russia there is a private initiative but no major research activity on 5G is reported.

As known, NGMN acts internationally through its operators, therefore spreading the concepts about 5G to the rest of the World [7].

2.8 European activities at national level

As far as European activities at national level are concerned, several countries are launching initiatives for 5G. In particular, significant steps have been taken in UK and Germany.

2.8.1 UK

The 5GIC (5G Innovation Centre) at University of Surrey (http://www.surrey.ac.uk/5gic) is a research centre dedicated to the next generation of mobile communications. The 5GIC involves cooperation between academic experts and industry partners in order to define and develop the 5G infrastructure. The centre offers the UK's only large-scale testbed, which will be used to prototype technological solutions. It will also hosts dedicated specialist laboratories for network testing and management, and communications electronics.

2.8.2 Germany

The 5G Lab Germany (http://5glab.de/) at Technische Universität of Dresden is a research laboratory with more than 20 faculty members, more than 500 researchers and cooperation partners from industry.

The mission of 5G Lab Germany is:

- Understand and drive the holistic requirements and solutions of 5G
- Deliver technology breakthrough
- Be Opinion Leader in forming 5G
- Deliver lab examples and test beds
- Deliver business innovation through technology transfer and cooperation
- Simple one-stop shop for complex 5G research topics

2.9 5G-related activities within the European Commission

2.9.1 FI-PPP

The interactions between the PPPS is an on-going issue to be discussed, since the problem appears to be related to the hesitation by similar initiatives to share and be open to different views in the same subject of interest.

As far as the FI-PPP is concerned, it will have little impact on the 5G-PPP as it has been implemented using todays internet and therefore does not add to the 5G requirements.

Below are three figures (Fig. 8, Fig. 9, and Fig. 10) that graphically represent the current situation and related relationships.

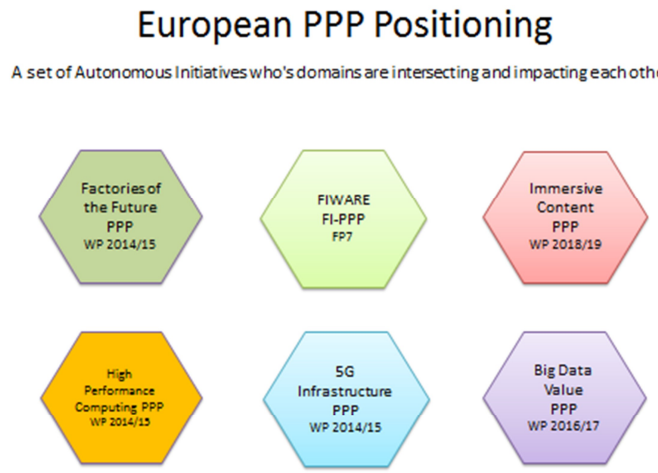


Fig.8 - European PPP Positioning - Autonomous initiatives

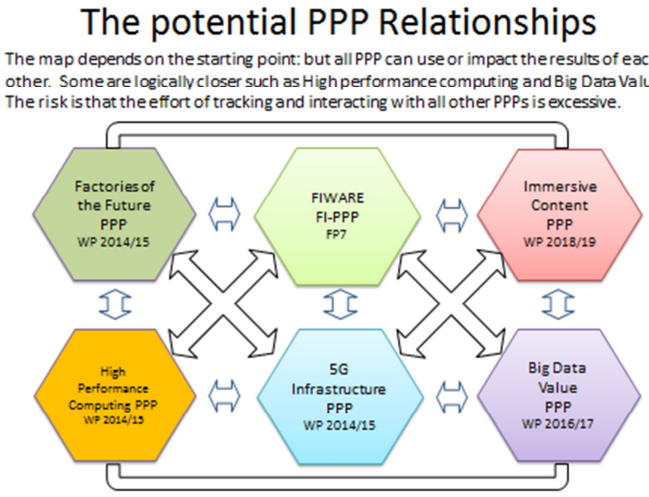


Fig.9 - Potential PPP relationships map

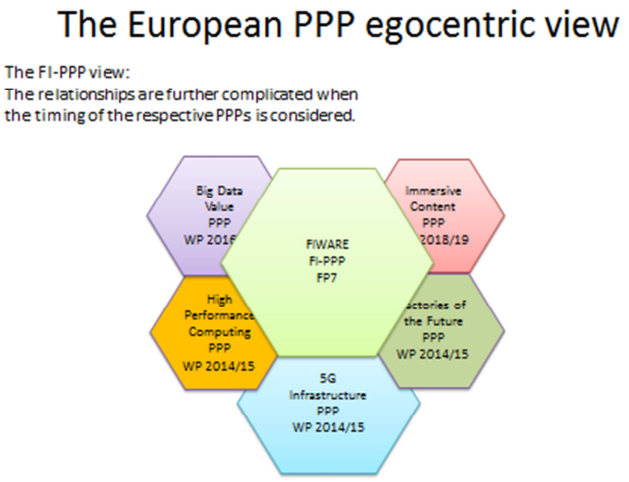


Fig.10 - European PPP view

3 RECOMMENDATIONS FOR 5G PPP POSITIONING

3.1 Positioning challenges

5G, with the technology disruption brought by the network softwarization, will lead to a deep revolution of the industrial ecosystem of communication infrastructures and services, and new players and new business models will appear. There is a high risk for Europe to be overwhelmed in this transformation by "web giants", which are mainly USA headquartered. It is vital for Europe to master this disruption: to move beyond traditional places (3GPP, GSMA, etc.) to build 5G technology and to open the right interfaces, those which will create value for Europe industry champions and SMEs. 5G PPP can help to build this industrial ambition and to spot the associated regulatory roadblocks which can go far beyond spectrum towards data portability or allocation of liability in vertical sectors use cases for example. Along with the European challenge, achieving a global consensus on global vision and requirements on 5G is crucial, as well as on the deployment timing and drivers of 5G. Indeed, if we follow South Korea pace, 5G standards will not be able to satisfy the major requirements for vertical sectors and the interest to invest will be low in Europe.

The preparation of WRC-19 will be a major challenge to develop a common European position on additional frequency spectrum and frequency bands. Different industries like broadcast, mobile and wireless communications and the satellite sectors have different interests. In addition, other incumbent spectrum users like security services and military are using significant parts of frequency bands of interest. ITU-R is working on vision recommendation as input to the preparation of WRC-19.

As far as application of 5G by international organizations is concerned, different regions have different focus areas:

- China has a similar focus on vertical sectors like Europe
- Japan is looking on mobile broadband but also at the support of vertical sectors
- Korea is mainly focused on mobile broadband, which is driven by high-quality video transmission
- USA supports a similar approach as in Europe

5G PPP will not directly contribute to global standardisation and the regulatory process. Contributions will be submitted by project partners, who are also members of respective standards and regulatory bodies.

5G PPP can be used as a consensus building machine in Europe, where achieved positions can be exploited in other bodies. Here follows a figure (Fig.8) that graphically represents exploitation of results by 5G PPP association.

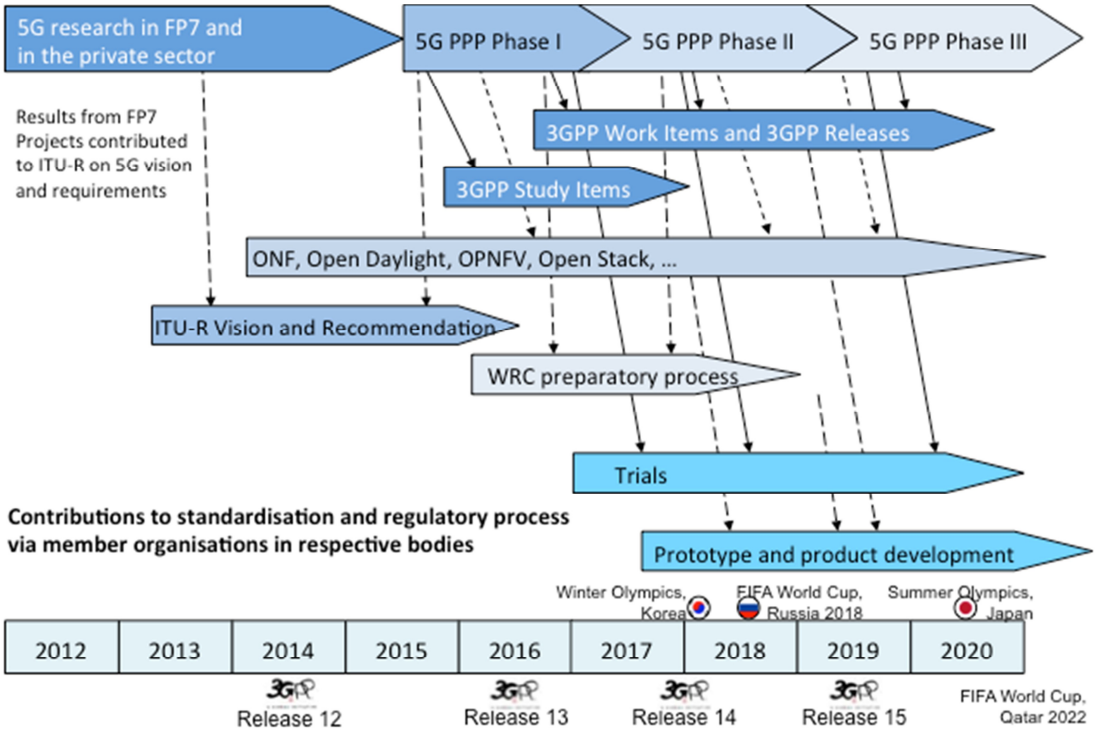


Figure 8 – Exploitation of results by 5G PPP Association

Source: 5G infrastructure association [8]

In the next section we present what has been done in terms of collaboration between 5GPPP and relevant international bodies to face these new challenges.

3.2 Memorandum of Understanding with relevant bodies

In this section we present the current situation about MoU documents (collected in Annex section of the present document) between 5G Infrastructure Association and the relevant bodies mentioned in section 2.

- Korea: An MoU was signed with 5G Forum in Korea on June 17, 2014 after the signature of a Joint Declaration between the EU Commission and the Korean government. 5G Infrastructure Association contributed to the Horizon2020 work program on a joint call EU – Korea. (see Annex A.1)

- China: A draft MoU was negotiated with the IMT-2020 Promotion Group in China. The EU Commission is currently discussing a joint declaration with the Chinese government. (see Annex A.2)

- Japan: An MoU was signed with The Fifth Generation Mobile Communications Promotion Forum in Japan on March 25, 2015. The EU Commission and the Japanese government signed a joint declaration on May 27, 2015. (see Annex A.3)

- USA: An MoU was signed with 4G Americas on March 2, 2015. 4G Americas developed 5G white papers on the view of industry in the Americas. (see Annex A.4)

3.3 Organisation of a 5G Global Event

The organisation of a 5G Global Event is to be considered as strategically essential in order to coordinate and collect all the global experiences, challenges and results of the 5G world. At present we foresee the organization of this major event within 2016.

References

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[3] IMT-2020, IMT-2020 (5G) Promotion Group on 5G Concept "5G Concept", 2015 (downloadable at http://www.imt-2020.cn/en/documents/listByQuery?currentPage=1&content=)

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[7] NGMN, "NGMN 5G White Paper", 2015 (downloadable at https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf)

[8] 5G Infrastructure association website (https://5g-ppp.eu/wp-content/uploads/2015/07/5G-Infrastructure-Association-5G-PPP-overview_EuCNC-2015.pdf)

ANNEX A MEMORANDA OF UNDERSTANDING

A.1 MoU 5G Infrastructure Association and IMT2020 (draft) - China

Memorandum of Understanding

Between "*The 5G Infrastructure Association*" and "*IMT-2020 (5G) Promotion Association*"

Considering that:

"*The 5G Infrastructure Association*" is established as an international non-profit association, under Belgian law, with its seat in Gent, Belgium, with a financial and organizational structure with a brand and a web-site (http://5g-ppp.eu/). *The 5G Infrastructure Association* is an open and independent organization and is open for collaboration to international bodies focusing on

- 5G communication systems and networks and/or
- particular technologies

and bodies working on

- 5G research,
- pre-standardization activities,
- regulatory issues and
- 5G frequency concepts and future frequency bands.

The purpose of *The 5G Infrastructure Association* is:

- Major objectives
  - To enter into the 5G PPP Contractual Arrangement with the EU Commission.
  - To promote R&D in the networks industry in order to strengthen the networks industry in the European Union.
  - To endorse the Strategic Research and Innovation Agenda as developed by the NetWorld2020 European Technology Platform and the industry roadmap as developed by the 5G Infrastructure PPP competent body.
  - To foster technology skills in Europe by attracting students.
  - To increase the competitiveness of the European industry by providing new tools and capabilities for manufacturing in Europe.
- Scope
  - 5G communication systems and networks.
  - Related research activities.
  - Contributions to the preparation of future global standards.
  - Contributions to regulatory discussions including future frequency bands.

"IMT-2020 (5G) Promotion Association" is established as a non-profit association, founded under Chinese law, with its seat in Beijing, China, with a financial and organizational structure with a brand and a web-site (http://www.imt-2020.cn/). *IMT-2020 (5G) Promotion Association* is willing to collaborate with international bodies focusing on

- 5G mobile communication networks and/or
- enabling wireless and network technologies

and bodies working on

- 5G research & development,
- pre-standardization activities,
- spectrum issues and
- technical trials.

The purpose of *IMT-2020 (5G) Promotion Association i*s:

- Major objectives
  - *To propose 5G strategy of China.*
  - *To promote 5G research and development in China.*
  - *To facilitate international collaboration in the field of 5G.*
- Scope
  - *5G vision and requirements.*
  - *5G concept, roadmap and architecture.*
  - *5G wireless and network technologies.*
  - *5G spectrum demand and candidate bands.*
  - *5G pre-standardization for international standard organizations.*

The parties agree therefore to the following:

1. The *5G Infrastructure Association* and *IMT-2020 (5G) Promotion Association* may exchange information as they may deem fit free of charge, regarding programs of work in areas of mutual interest in the field of 5G communication systems and networks.
2. The two parties agree to explore collaboration opportunities on
   - Vision of 5G communication systems and networks.
   - Requirements on 5G communication systems and networks.
   - Discussions on basic system concepts.
   - Frequency spectrum in order to support the global regulatory process.
   - Preparation of future global standards by identification of common interest and consensus building.

Means of exploring collaboration opportunities are exchange of information, documents, meetings and workshop when mutually agreed.

3. This Memorandum of Understanding shall enter into force on the date it is signed by duly authorized representatives of both parties. This Memorandum of Understanding shall last for three years and may be renewed by mutual consent. This Memorandum

of Understanding may be terminated by either Party before the expiry date with three months notice.

4. Any difficulties arising shall be agreed wherever possible at the working level between the relevant Working Groups and Technical Bodies of both organizations. Matters which cannot be resolved at working level shall be subject to discussion between the two parties at the level of the Chair of the Board of *The 5G Infrastructure Association* and the Chair of *IMT-2020 (5G) Promotion Association*.

5. The contact persons for the application of this Memorandum of Understanding will be Werner Mohr, Chair of the Board of *The 5G Infrastructure Association* and Ms. CAO Shumin, Chair of *IMT-2020 (5G) Promotion Association*.

6. General

   6.1 Notwithstanding any other provision or clause in the present MoU, the signature of this MoU can in no way be construed as an obligation to engage into certain activities or projects with legally binding commitments, or as a restriction for the Parties in their activities in any other way.

   6.2 In principle Parties will not exchange confidential information in the context of the MoU. If the Parties want to exchange certain confidential information for specific purposes, they will have to enter into a specific non-disclosure agreement.

   6.3 The existence of the present MoU and the content thereof will not be considered as confidential information. However each communication by either Party that will refer to the other Party will be subject to the prior approval of the latter.

   6.4 Either Party shall bear its own costs, fees or other expenses incurred during the term and in connection with this MoU.

   6.5 This MoU shall not be construed so as to create any legally binding commitments or any liabilities between the Parties, and the Parties shall not be under any obligation to pay any damages under this MoU. However, should such exclusion of liability not be enforceable under the applicable law, any liability or damages which any Party may face as between it and the other Parties, however caused or arising and irrespective of the specific theory of liability giving rise to or supporting such liability or damages, shall not in any case (even in case of gross negligence) exceed the amount of 5.000 € in the aggregate.

Done at yyy on xxx xx, 201x

Dr. Werner Mohr	Ms. CAO Shumin
Chair of the Board of	Chair of
The 5G Infrastructure Association	*IMT-2020 (5G) Promotion Association*

A.2 MoU 5G Infrastructure Association and 5GMCP - Japan

Memorandum of Understanding

Between "*The 5G Infrastructure Association*" and "*The Fifth Generation Mobile Communications Promotion Forum*"

Considering that:

"*The 5G Infrastructure Association*" is established as an international non-profit association, under Belgian law, with its seat in Gent, Belgium, with a financial and organizational structure with a brand and a web-site (http://5g-ppp.eu/). *The 5G Infrastructure Association* is an open and independent organization and is open for collaboration to international bodies focusing on

- 5G communication systems and networks and/or
- particular technologies

and bodies working on

- 5G research,
- pre-standardization activities,
- regulatory issues and
- 5G frequency concepts and future frequency bands.

The purpose of *The 5G Infrastructure Association* is:

- Major objectives
  - To enter into the 5G PPP Contractual Arrangement with the EU Commission.
  - To promote R&D in the networks industry in order to strengthen the networks industry in the European Union.
  - To endorse the Strategic Research and Innovation Agenda as developed by the NetWorld2020 European Technology Platform and the industry roadmap as developed by the 5G Infrastructure PPP competent body.
  - To foster technology skills in Europe by attracting students.
  - To increase the competitiveness of the European industry by providing new tools and capabilities for manufacturing in Europe.
- Scope
  - 5G communication systems and networks.
  - Related research activities.
  - Contributions to the preparation of future global standards.
  - Contributions to regulatory discussions including future frequency bands.

"*The Fifth Generation Mobile Communications Promotion Forum*" is established as a non-profit association, founded under Japanese law, with its seat in Tokyo, Japan, with a financial and organizational structure with a brand and a web-site (http://5gmf.jp/index_en.html). *The Fifth Generation Mobile Communications Promotion Forum* is an open and independent organization and is open for collaboration to international bodies focusing on

- 5G communications systems, networks, services and applications and/or
- particular technologies

and bodies working on

- 5G research,
- pre-standardization activities,
- regulatory issues and
- 5G frequency concepts and future frequency bands.

The purpose of *The Fifth Generation Mobile Communications Promotion Forum* is:

- Major objectives
  - To conduct research and development concerning 5G Mobile Communications Systems and research and study on its standardization
  - To collect information relating to 5G Mobile Communications Systems and exchange thereof with other organizations
  - To correspond and coordinate with related organizations concerning 5G Mobile Communications Systems
  - To conduct dissemination and enlightenment pertaining to 5G Mobile Communications Systems
- Scope
  - 5G mobile communications systems and networks.
  - 5G mobile communications services and applications.
  - Related research activities.
  - Contributions to the preparation of future global standards.
  - Contributions to regulatory discussions including future frequency bands.

The parties agree therefore to the following:

7. The *5G Infrastructure Association* and The *Fifth Generation Mobile Communications Promotion Forum* may exchange information as they may deem fit free of charge, regarding programs of work in areas of mutual interest in the field of 5G communication systems and networks.
8. The two parties agree to explore collaboration opportunities on
   - Vision of 5G communication systems and networks.
   - Requirements on 5G communication systems and networks.
   - Basic system concepts.
   - Technologies for 5G communication systems and networks.
   - Frequency spectrum in order to support the global regulatory process.
   - Preparation of future global standards by identification of common interest and consensus building.

Means of exploring collaboration opportunities are exchange of information, documents, meetings and workshop when mutually agreed.

9. This Memorandum of Understanding (MoU) shall enter into force on the date it is signed by duly authorized representatives of both parties. This Memorandum of Understanding shall last for three years and may be renewed by mutual consent. This Memorandum of Understanding may be terminated by either Party before the expiry date with three months notice.

10. Any difficulties arising shall be agreed wherever possible at the working level between the relevant Working Groups and Technical Bodies of both organizations. Matters which cannot be resolved at working level shall be subject to discussion between the two parties at the level of the Chair of the Board of *The 5G Infrastructure Association* and the Chair of *The Fifth Generation Mobile Communications Promotion Forum*.

11. The contact persons for the application of this Memorandum of Understanding will be Werner Mohr, Chair of the Board of *The 5G Infrastructure Association* and Susumu Yoshida, Chairman of *The Fifth Generation Mobile Communications Promotion Forum*.

12. General

    6.1 Notwithstanding any other provision or clause in the present MoU, the signature of this MoU can in no way be construed as an obligation to engage into certain activities or projects with legally binding commitments, or as a restriction for the Parties in their activities in any other way.

    6.2 In principle Parties will not exchange confidential information in the context of the MoU. If the Parties want to exchange certain confidential information for specific purposes, they will have to enter into a specific non-disclosure agreement.

    6.3 The existence of the present MoU and the content thereof will not be considered as confidential information. However each communication by either Party that will refer to the other Party will be subject to the prior approval of the latter.

    6.4 Either Party shall bear its own costs, fees or other expenses incurred during the term and in connection with this MoU.

    6.5 This MoU shall not be construed so as to create any legally binding commitments or any liabilities between the Parties, and the Parties shall not be under any obligation to pay any damages under this MoU. However, should such exclusion of liability not be enforceable under the applicable law, any liability or damages which any Party may face as between it and the other Parties, however caused or arising and irrespective of the specific theory of liability giving rise to or supporting such liability or damages, shall not in any case (even in case of gross negligence) exceed the amount of 5.000 € in the aggregate.

Done at Frankfurt on March 25, 2015

Dr. Werner Mohr	Dr. Susumu Yoshida
Chair of the Board of	Chairman of
The 5G Infrastructure Association	*The Fifth Generation Mobile Communications*
	Promotion Forum

A.3 MoU 5G Infrastructure Association and 5G Forum - Korea

Memorandum of Understanding

Between "*The 5G Infrastructure Association*" and "*5G Forum – Korea*"

Considering that:

"*The 5G Infrastructure Association*" is established as an international non-profit association, under Belgian law, with its seat in Gent, Belgium, with a financial and organizational structure with a brand and a website (http://5g-ppp.eu/). *The 5G Infrastructure Association* is an open and independent organization and is open for collaboration to international bodies focusing on

- 5G communication systems and networks and/or
- particular technologies

and bodies working on

- 5G research,
- pre-standardization activities,
- regulatory issues and
- 5G frequency concepts and future frequency bands.

The purpose of *The 5G Infrastructure Association* is:

- Major objectives
  - To enter into the 5G PPP Contractual Arrangement with the EU Commission.
  - To promote R&D in the networks industry in order to strengthen the networks industry in the European Union.
  - To endorse the Strategic Research and Innovation Agenda as developed by the NetWorld2020 European Technology Platform and the industry roadmap as developed by the 5G Infrastructure PPP competent body.
  - To foster technology skills in Europe by attracting students.
  - To increase the competitiveness of the European industry by providing new tools and capabilities for manufacturing in Europe.
- Scope
  - 5G communication systems and networks.
  - Related research activities.
  - Contributions to the preparation of future global standards.
  - Contributions to regulatory discussions including future frequency bands.

"*5G Forum, Korea*" is established as a non-profit association, founded under Korean law, with its seat in Seoul, Korea, with a financial and organizational structure with a brand

and a web-site (http://www.5gforum.org). *5G Forum, Korea* is an open and independent organization and is open for collaboration to international bodies with a vision of

- Globally leading and promoting 5G toward 2020

and bodies working on

- Developing visions for 5G
- Study Technology and spectrum issues
- Global collaboration

The purpose of *5G Forum, Korea* is:

- Major objectives and scopes
  - Develop Vision and services
  - Study spectrum aspects
  - Identify potential technology
  - Collaborate for global harmonization
  - Bridge between industries and government

The parties agree therefore to the following:

13. The *5G Infrastructure Association* and *5G Forum, Korea* may exchange information as they may deem fit free of charge, regarding programs of work in areas of mutual interest in the field of 5G communication systems and networks.
14. The two parties agree to explore collaboration opportunities on
    - Vision of 5G communication systems and networks.
    - Requirements on 5G communication systems and networks.
    - Discussions on basic system concepts.
    - Frequency spectrum (spectrum demand estimates and potential frequency spectrum ranges) in order to support the global regulatory process.
    - Preparation of future global standards by identification of common interest and consensus building.

Means of exploring collaboration opportunities are exchange of information, documents, meetings and workshop when mutually agreed.

15. This Memorandum of Understanding shall enter into force on the date it is signed by duly authorized representatives of both parties. This Memorandum of Understanding shall last for three years and may be renewed by mutual consent. This Memorandum of Understanding may be terminated by either Party before the expiry date with three months notice.
16. Any difficulties arising shall be agreed wherever possible at the working level between the relevant Working Groups and Technical Bodies of both organizations. Matters which cannot be resolved at working level shall be subject to discussion between the two parties at the level of the Chair of the Board of *The 5G Infrastructure Association* and the Chair of Steering Committee of *5G Forum, Korea*.

17. The contact persons for the application of this Memorandum of Understanding will be Werner Mohr, Chair of the Board of *The 5G Infrastructure Association* and Prof. HAN, Youngnam, Steering Committee chair, *5G Forum, Korea*.

18. General

    6.1 Notwithstanding any other provision or clause in the present MoU, the signature of this MoU can in no way be construed as an obligation to engage into certain activities or projects with legally binding commitments, or as a restriction for the Parties in their activities in any other way.

    6.2 In principle Parties will not exchange confidential information in the context of the MoU. If the Parties want to exchange certain confidential information for specific purposes, they will have to enter into a specific non-disclosure agreement.

    6.3 The existence of the present MoU and the content thereof will not be considered as confidential information. However each communication by either Party that will refer to the other Party will be subject to the prior approval of the latter.

    6.4 Either Party shall bear its own costs, fees or other expenses incurred during the term and in connection with this MoU.

    6.5 This MoU shall not be construed so as to create any legally binding commitments or any liabilities between the Parties, and the Parties shall not be under any obligation to pay any damages under this MoU. However, should such exclusion of liability not be enforceable under the applicable law, any liability or damages which any Party may face as between it and the other Parties, however caused or arising and irrespective of the specific theory of liability giving rise to or supporting such liability or damages, shall not in any case (even in case of gross negligence) exceed the amount of 5.000 € in the aggregate.

Done at Seoul on June 17, 2014

Dr. Werner Mohr	Prof. HAN, Youngnam
Chair of the Board of	Chair of Steering Committee,
The 5G Infrastructure Association	*5G Forum*

A.4 MoU 5G Infrastructure Association and 4G Americas - USA

Memorandum of Understanding

Between "*The 5G Infrastructure Association*" and "*4G Americas*"

Considering that:

"*The 5G Infrastructure Association*" is established as an international non-profit association, under Belgian law, with its seat in Gent, Belgium, with a financial and organizational structure with a brand and a web-site (http://5g-ppp.eu/). *The 5G Infrastructure Association* is an open and independent organization and is open for collaboration to international bodies focusing on

- 5G communication systems and networks and/or
- particular technologies

and bodies working on

- 5G research,
- pre-standardization activities,
- regulatory issues and
- 5G frequency concepts and future frequency bands.

The purpose of *The 5G Infrastructure Association* is:

- Major objectives
  - To enter into the 5G PPP Contractual Arrangement with the EU Commission.
  - To promote R&D in the networks industry in order to strengthen the networks industry in the European Union.
  - To endorse the Strategic Research and Innovation Agenda as developed by the NetWorld2020 European Technology Platform and the industry roadmap as developed by the 5G Infrastructure PPP competent body.
  - To foster technology skills in Europe by attracting students.
  - To increase the competitiveness of the European industry by providing new tools and capabilities for manufacturing in Europe.
- Scope
  - 5G communication systems and networks.
  - Related research activities.
  - Contributions to the preparation of future global standards.
  - Contributions to regulatory discussions including future frequency bands.

"*4G Americas*" is established as a Limited Liability Corporation, founded under U.S. law, with its location in Bellevue, Washington USA, with a financial and organizational structure with a brand and a web-site (www.4GAmericas.org). *4G Americas unifies the Americas through mobile broadband technology* and is an independent organization that welcomes collaboration with international bodies focusing on 5G and mobile broadband technical and regulatory issues and opportunities. 4G Americas is a prominent wireless industry association for the Americas providing important 5G technical recommendations and leadership for the region.

The mission of *4G Americas*:

4G Americas will advocate for and foster the advancement and full capabilities of LTE mobile broadband technologies, including LTE-Advanced and beyond to 5G, throughout the ecosystem's networks, services, applications and wirelessly connected devices in the Americas.

One of the key goals of 4G Americas is:

Provide and promote 5G technology recommendations that will benefit industry stakeholders and the mobile broadband ecosystem, providing organizational leadership in the development of next generation networks in 2020 and beyond for the Americas.

The parties agree therefore to the following:

19. The *5G Infrastructure Association* and *4G Americas* may exchange information as they may deem fit free of charge, regarding programs of work in areas of mutual interest in the field of 5G communication systems and networks.
20. The two parties agree to explore collaboration opportunities on
    - Vision of 5G communication systems and networks.
    - Requirements on 5G communication systems and networks.
    - Discussions on basic system concepts.
    - Frequency spectrum in order to support the global regulatory process.
    - Preparation of future global standards by identification of common interest and consensus building.

Means of exploring collaboration opportunities are exchange of information, documents, meetings and workshop when mutually agreed.

21. This Memorandum of Understanding shall enter into force on the date it is signed by duly authorized representatives of both parties. This Memorandum of Understanding shall last for three years and may be renewed by mutual consent. This Memorandum

of Understanding may be terminated by either Party for any reason before the expiry date with 30 days written notice.

22. Any difficulties arising shall be agreed wherever possible at the working level between the relevant Working Groups and Technical Bodies of both organizations. Matters which cannot be resolved at working level shall be subject to discussion between the two parties at the level of the Chair of the Board of *The 5G Infrastructure Association* and the President of *4G Americas*.

23. The contact persons for the application of this Memorandum of Understanding will be Werner Mohr, Chair of the Board of *The 5G Infrastructure Association* and Chris Pearson, President, *4G Americas*.

24. General

    6.1 Notwithstanding any other provision or clause in the present MoU, the signature of this MoU can in no way be construed as an obligation to engage into certain activities or projects with legally binding commitments, or as a restriction for the Parties in their activities in any other way.

    6.2 In principle Parties will not exchange confidential information in the context of the MoU. If the Parties want to exchange certain confidential information for specific purposes, they will have to enter into a specific non-disclosure agreement.

    6.3 The existence of the present MoU and the content thereof will not be considered as confidential information. However each communication by either Party that will refer to the other Party will be subject to the prior approval of the latter.

    6.4 Either Party shall bear its own costs, fees or other expenses incurred during the term and in connection with this MoU.

    6.5 This MoU shall not be construed so as to create any legally binding commitments or any liabilities between the Parties, and the Parties shall not be under any obligation to pay any damages under this MoU. However, should such exclusion of liability not be enforceable under the applicable law, any liability or damages which any Party may face as between it and the other Parties, however caused or arising and irrespective of the specific theory of liability giving rise to or supporting such liability or damages, shall not in any case (even in case of gross negligence) exceed the amount of 5.000 € in the aggregate.

March 2, 2015

Dr. Werner Mohr	Chris Pearson
Chair of the Board of	President
The 5G Infrastructure Association	*4G Americas*