Fifth Generation Mobile Communications Promotion Forum (5GMF) White Paper

— *Realizing 5G mobile communication systems for 2020 and beyond* —

Secretariat of The Fifth Generation Mobile Communications Promotion Forum

Association of Radio Industries and Businesses
The Telecommunication Technology Committee

1. Introduction

The Fifth Generation Mobile Communications Promotion Forum (5GMF) was established in September 2014, prompted by the MIC interim report, "Radio policy vision round-table," to accelerate study of 5th generation mobile communications systems (5G) in Japan and to facilitate collaboration with other countries, and contribution to international standardization at the ITU-R and other organizations. The 5GMF began its activities bringing together participants from industry, academia and government, promoting cooperation and collaboration among specialists in a wide range of fields not limited to information and communications.

At its inception the 5GMF had four committees, and in January 2016 it established the "5G Trial Promotion Group" to promote research activities (Figure 1). As of August 19, 2016 there were 101 members. The executive office of 5GMF is being handled by the Association of Radio Industries and Businesses (ARIB) and the Telecommunications Technology Committee (TTC).

This article introduces 5GMF activities and gives an outline of the "5GMF Whitepaper, 1st Ed. (English)," which is a result of those activities. It was written by the 5GMF Secretariat.

2. Overview of 5GMF activities

This highest decision making body in the 5GMF is the general meeting, held once every fiscal year and including reports of the year's activities, plans and settlement of budgeting, setting regulations and electing the executive. The advisory currently includes persons with university or other academic research experience, and from communications operators, manufacturers, related organizations and the Ministry of Internal Affairs and Communications, totaling 30 people. In advisory meetings, these members actively exchange ideas regarding overall 5GMF activities. The main activities are outlined below.

2.1 Creation of the white paper

An important 5GMF task from its inception has been the creation of the first edition of the white paper, "5G Mobile Communications Systems for 2020 and Beyond" (English version). It is a result of the research activities of the four

■ **Figure 1: Organizational Structure of 5GMF**
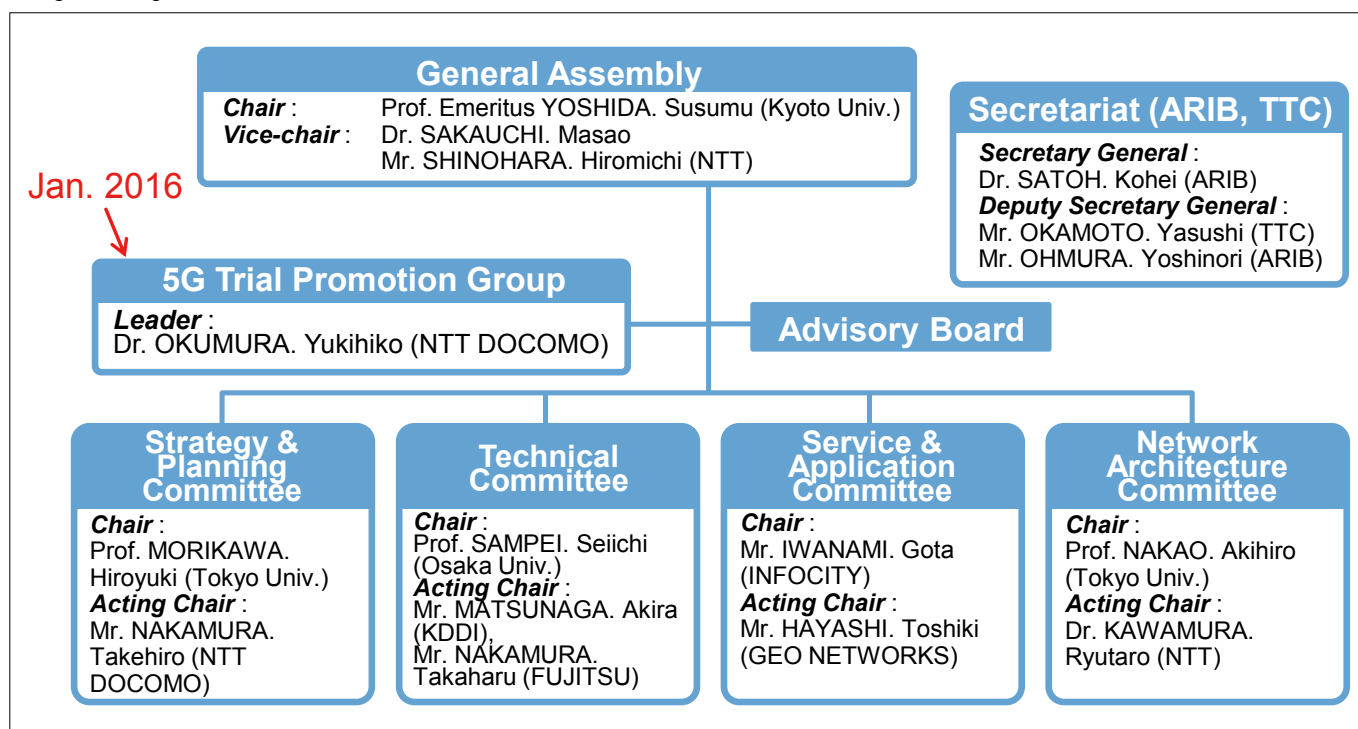
committees and was published on the 5GMF Web page (http://5gmf.jp/) at the end of May, 2016. Executive summaries in Japanese and English were also published.

2.2 Studying comprehensive verification test plans for 5G systems

A special meeting was held in January 2016 to study plans and frameworks for performing "comprehensive verification testing for 5G systems" starting in FY2017, and the "5G System Comprehensive verification test promotion group" was formed.

The group gathered testing projects from members of each committee and group, totaling more than 30 projects (as of July 2016). Most of the projects involved (1) entertainment systems at stadiums and other event venues, (2) mobile monitoring and security systems for safety and security in society, (3) high-speed, highly-reliable communication for mobile situations such as high-speed trains, or (4) support for remote control, monitoring and automatic operation of robots or vehicles. In the future, with reference to materials such as the MIC report from the "Radio policy 2020 council," projects that need to be done will be selected and decisions made for creating concrete plans and frameworks for carrying them out.

2.3 Supporting collaboration and events with 5G organizations

Memorandums of Understanding (MoU) have been reached with six overseas 5G promotion organizations, and various workshops have been held. Lecturers have been actively sent from 5GMF to 5G-related workshops and other events within and outside of Japan, presenting results of our activities. 5GMF has also conducted activities such as co-hosting workshops during CEATEC JAPAN, Wireless Technology Park (WTP) and other events, for the benefit of general attendees.

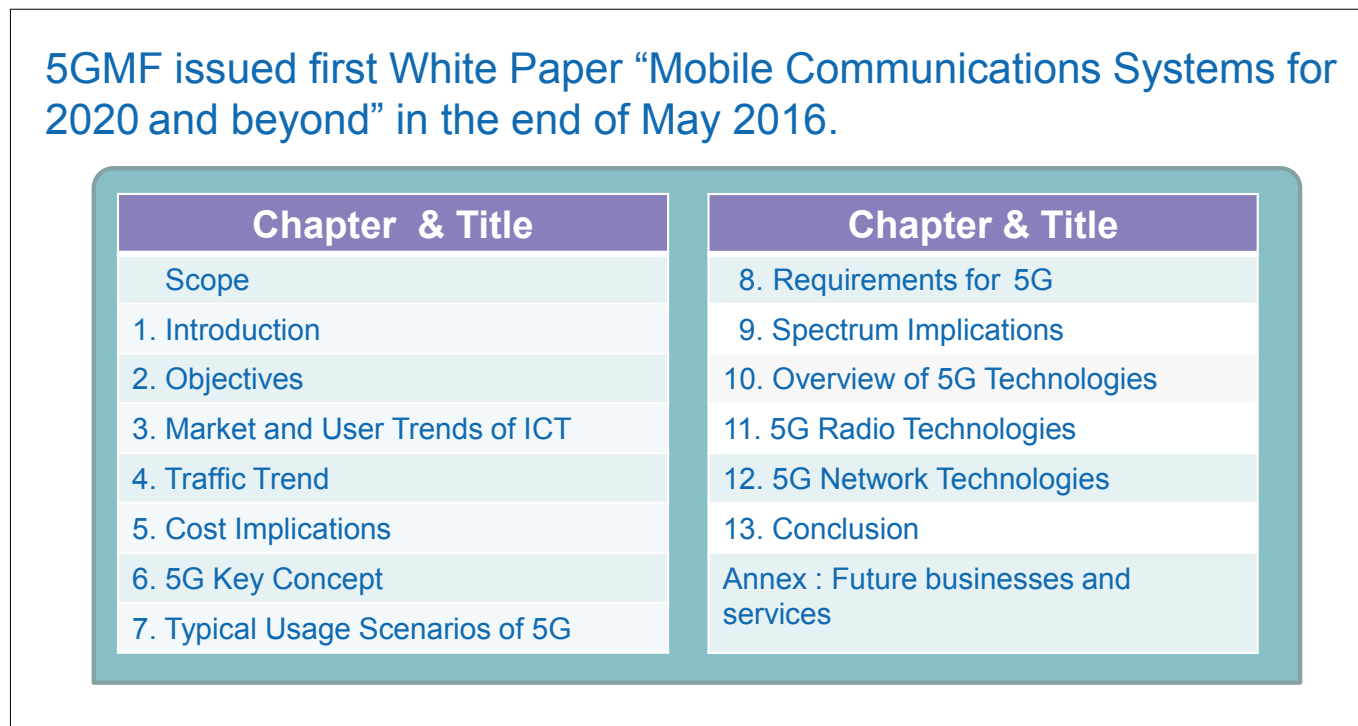## 3. Introduction to the 5GMF white paper

The 5GMF white paper gives a comprehensive summary of studies of 5G concepts and implementation issues, in the hope of promoting use of 5G in industry, creating new business markets and expanding businesses overseas. The four committees worked closely together in creating the white paper. Final editing was completed by an editorial task force gathering together representatives from each of the committees.

3.1 Overall concept

Study for this white paper was done with reference to advanced research in the "Mobile Communications Systems for 2020 and beyond," white paper published at the end of September 2014, by the "2020 and Beyond Adhoc committee," which was established in September 2013 by the ARIB Advanced Wireless communications research committee.

In creating the white paper, study was conducted with an awareness of differences in user environments, implemented services, system performance and other aspects of 4th generation communications systems such as IMT-Advanced, and earlier systems.

■ Figure 2: Content of 5GMF White Paper

5GMF issued first White Paper "Mobile Communications Systems for 2020 and beyond" in the end of May 2016.

Chapter & Title	Chapter & Title
Scope	8. Requirements for 5G
1. Introduction	9. Spectrum Implications
2. Objectives	10. Overview of 5G Technologies
3. Market and User Trends of ICT	11. 5G Radio Technologies
4. Traffic Trend	12. 5G Network Technologies
5. Cost Implications	13. Conclusion
6. 5G Key Concept	Annex : Future businesses and services
7. Typical Usage Scenarios of 5G	

3.2 5GMF white paper organization

The white paper is composed of the Scope section, 13 sections of content, and an annex, as shown in Figure 2. These sections are outlined below.

3.2.1 Introduction and Objectives (Sections 1 and 2)

The introduction discusses societal background necessitating the study of 5G and outlines the content in Sections 3 and following. It identifies the main purpose of the white paper as clarifying the key concepts and technologies required to realize 5G.

3.2.2 Market and User Trends (Section 3)

This section discusses the sort of communications environment and services needed in the 5G era, as Internet use expands from PCs to smartphones and tablets and further to new devices such as sensors, robots and automobiles, and more diverse services are implemented.

3.2.3 Traffic Trends and Cost Implications (Sections 4 and 5)

The potential for new forms of communication as traffic increases in the future is identified, with object-to-object and other forms of communication. The importance of building 5G using technologies that are flexible and can be gradually extended is shown, in consideration of construction and operating costs, since such a broad range of communication requirements must be met.

3.2.4 Key Concepts and key technologies (Section 6)

As shown in Figure 3, two key concepts for 5G will be "Fulfillment of End-to-End Quality," able to satisfy users in all kinds of scenarios, and "Extreme Flexibility," so that this quality can be provided, adapting to all kinds of user scenarios with flexibility.

Key technologies for realizing 5G include "Advanced Heterogeneous Networks," and "Network Softwarization and Slicing."

Examples of typical use cases (ultra-high-reliability, ultra-low latency, large-scale communication, extended mobile broadband, etc.), and performance extensions needed to realize them, are also given, based on the vision recommended by the ITU-R in M.2083-0 ("IMTVision – Framework and overall objectives of the future development of IMT for 2020 and beyond").

3.2.5 Typical Usage Scenarios (Section 7)

Various usage scenarios in the four categories of (1) entertainment (Figure 4), (2) transportation, (3) industrial applications, and (4) disaster countermeasures are described and studied in detail. The importance of dynamically optimizing the network with changes in time, place and conditions in each of these usage scenarios is identified.

3.2.6 Radio and Network technologies (Sections 8 to 12)

The desirable frequency bands for 5G, particularly in the 6 to 100 GHz range were studied. This was done in three stages: from a use-case and technical perspective (Stage 1, Figure 5), from a

■ Figure 3: Potential 5G applications mapping
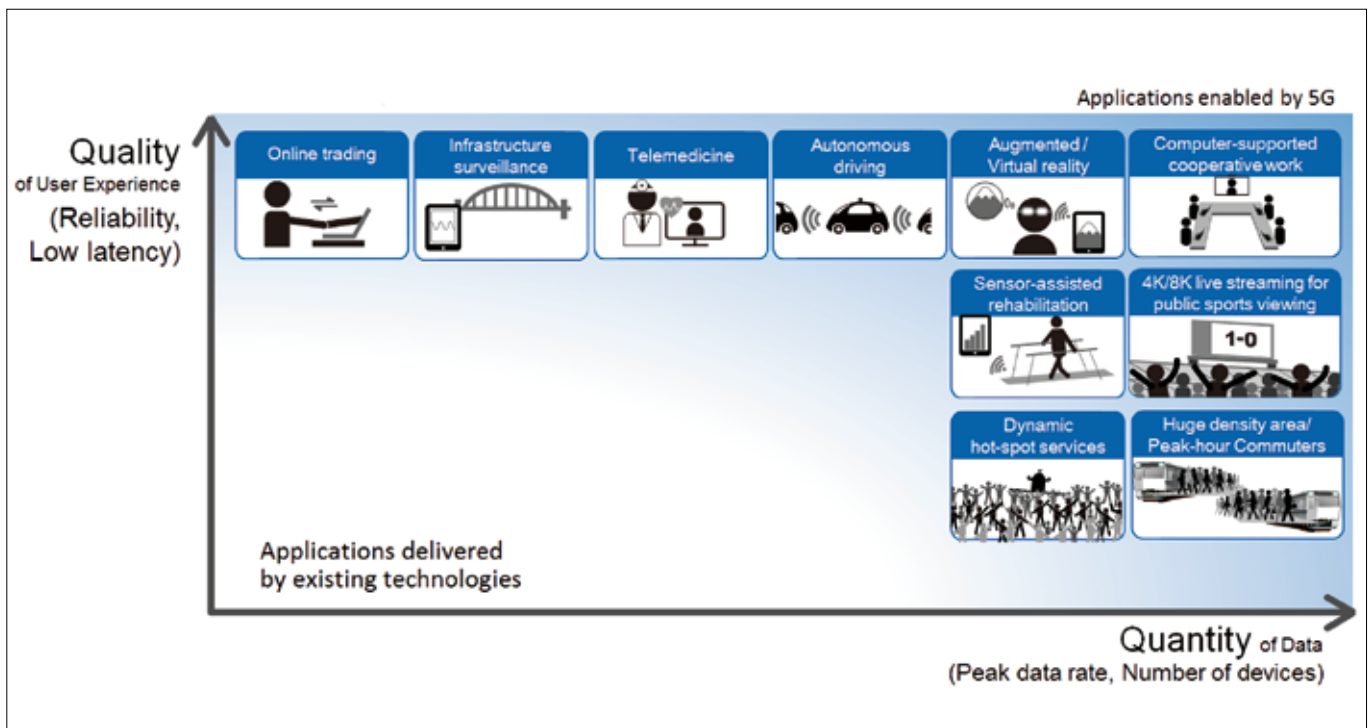
■ **Figure 4: Usage scenarios in entertainment**

■ **Figure 5: Stage 1, classification and evaluation of characteristics of frequency bands at or above 6 GHz**

Frequency range	Low（6-30GHz）	Middle（30-60GHz）	High（60-100GHz）
Desirable continuous bandwidth range (Note 1)	Approx. 300 MHz – 1.5 GHz	Approx. 1.5 GHz – 3 GHz	Approx. 3 GHz – 5 GHz
Coverage example (Note 2)	Hundreds of m – approx. 1 km	⟷	Dozens of m – approx. 100 m
Usage scenarios	Usable in diverse mobile communication scenarios (indoor, penetrating indoor from outdoor, hotspots, etc.)	⟷	Scenarios with higher bandwidth or density (indoor, hotspots, etc.)

(Note 1) These are desirable continuous bandwidth values determined with reference to existing 3GPP frequencies and bandwidths and assuming a fractional bandwidth of 5%, and do not necessarily represent required (or requested) bandwidths or bandwidths allocated by regulatory authorities. From the perspectives of spectral efficiency and implementation, it is desirable that these bands are continuous (Conversely, for 5G applications such as mobile broadband or M2M, bandwidth from hundreds of MHz to several GHz is desirable, but bandwidths usable for 5G in each range must each be considered individually).

(Note 2) Coverage values depend on radio propagation conditions, deployment scenarios and the radio technology used.

perspective of interoperating and coexisting with current systems (Stage 2), and from an international collaboration perspective (Stage 3). The results of Stage 2 of the study are given as a list of desirable frequency bands.

An overview of radio access technologies and network technologies studied for introduction of 5G systems, and associated issues, is also given.

3.2.7 Conclusion and Future Business Prospects (Section 13 and Annex)

5GMF has contributed the results of this study to international standardization activity at the ITU and 3GPP and is collaborating further with 5G organizations outside of Japan. It will continue its activities promoting introduction of 5G systems in 2020 and beyond.

The Annex discusses future business prospects based on current trends in the study of 5G systems.

3.3 Future prospects

The white paper provides a comprehensive study of 5G, and the next edition will be revised with new results from activities such as the comprehensive verification testing scheduled to begin in FY2017 and future studies of frequencies to be used for 5G.

4. Conclusion

The 5GMF will continue promotional activities for the use of 5G aimed at industry and the public, who are its users. We hope for continued cooperation, expanding and invigorating activity toward implementation of 5G in 2020 and beyond.