Recent Activities of the Fifth Generation Mobile Communications Promotion Forum (5GMF) in Japan

– Towards Realization of Crossover Collaboration for 5G Eco-society –

Susumu Yoshida, Kohei Satoh and Yoshinori Ohmura

5GMF, Japan
E-mail: susumu.yoshida.t25@kyoto-u.jp; satoh@arib.or.jp;
y-ohmura@arib.or.jp

Abstract

This article describes recent activities of the Fifth Generation Mobile Communications Promotion Forum (5GMF) and gives an outline of its major outcomes.

Keywords: Fifth Generation Mobile Communications, 5G, IMT for 2020, Global 5G Event, Eco-society.

1 Introduction

The Fifth Generation Mobile Communications Promotion Forum (5GMF) was established in September 2014, prompted by the Interim Report of the Ministry of Internal Affairs and Communications (MIC), "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
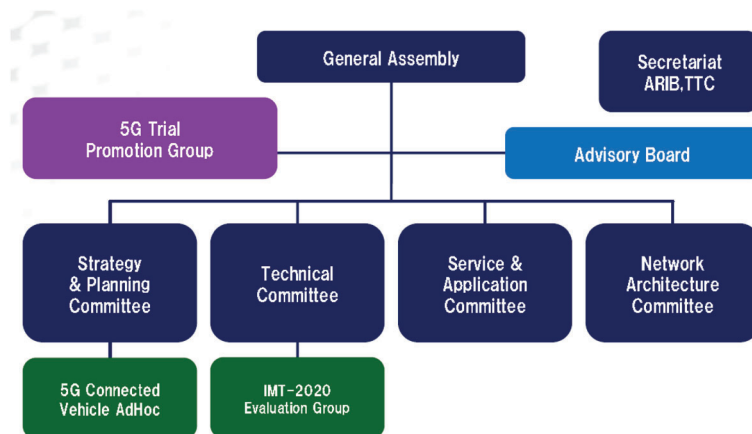
Figure 1 Organizational Structure of 5GMF.

organizations. 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 establishment, 5GMF had four study committees. It established the "5G Trial Promotion Group (5G-TPG)" to promote research activities on the comprehensive verification testing for 5G systems in January 2016 and the "5G Connected-Vehicle Ad Hoc" to study automotive applications in 5G systems in December 2017 as shown in Figure 1. As of the beginning of February 2018, there were 137 members. The secretariat of 5GMF is being handled by the Association of Radio Industries and Businesses (ARIB) and the Telecommunications Technology Committee (TTC).

This article describes recent activities of 5GMF and gives an outline of its major outcomes, e.g. the "5GMF White Paper" and "5G-TPG Report".

2 Overview of 5GMF Activities

This highest decision making body in 5GMF is the annual 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 executives. The Advisory Board currently includes professors from universities and those with other academic research experience, and from communications operators, manufacturers, related organizations and the MIC,

totalling 30 people. In advisory board meetings, these members actively exchange ideas regarding overall 5GMF activities. The main activities of the 5GMF are outlined below.

2.1 5GMF White Paper

An important 5GMF task since its establishment has been the creation of the first edition of the White Paper, "5G Mobile Communications Systems for 2020 and Beyond" (in English). It is a result of the research activities of the four committees and was published on the 5GMF Web-site (http://5gmf.jp/en/) in July 2016. Executive summaries in Japanese and English were also published.

In September 2017, this white paper was revised to Version 1.1 based upon recent activities in Technical, Application and Network Committees, and 5G-TPG.

2.2 Studying Comprehensive Verification Trial Plans for 5G Systems and 5G-TPG Report

A special meeting was held in January 2016 to study plans and frameworks for performing "Comprehensive verification trials for 5G systems" starting in FY2017, and the "5G-TPG" was formed. The group gathered proposals for trial projects from members of each committee and group, totalling more than 40 proposed projects. These projects were categorized into 6 use cases; (1) Entertainment, (2) Safe and secure society prevented from crime and natural disasters, (3) Logistics, agricultural and fisheries, offices, factories, (4) Remote controlled and managed devices such as robots and drones, (5) Connected cars, autonomous and remote driving and (6) High data-rate and reliable communications for high speed mobile such as train, bus and helicopter.

5G-TPG developed the first edition of its report including 5G trial concepts, contents and plans of "5G Utilization Projects" assessed in the group. The Report (Japanese edition) was completed in March 2017, and was translated into English in September 2017. These reports are also published on the 5GMF Web-site.

2.3 Supporting Collaboration and Events with 5G-related Organizations

5GMF has concluded a Memorandum of Understanding (MoU), Memorandum of Cooperation (MoC) or Letter of Intent (LoI) with eight overseas

5G-related organizations[1] to promote cooperative relationship. Various international workshops have been organized or jointly organized with them. In addition to the specific agreements, 5GMF organizes or co-hosts various international conferences/workshops on 5G in Japan and dispatches our experts or panellists to various oversea international conferences/workshops on 5G as part of collaboration with 5G-related organizations.

In October 2015, five organizations promoting 5G in China, Japan, Korea, Europe and USA concluded a multi-lateral MoU in Lisbon, Portugal. The Parties agreed to organize jointly two global 5G events per year called the "Global 5G Event" to rationalize the many different 5G events. The "Global 5G Event" is hosted on rotating basis between the signing organizations, each half year on a different continent between the Americas, Asia and Europe. The 1st Global 5G Event was held in May-June 2016 in Beijing, China organized by IMT-2020 Promotion Group, and the 2nd event was held in November 2016 in Rome, Italy organized by the 5G Infrastructure Association. The 3rd Global 5G Event was held in May 2017 in Tokyo, Japan organized by 5GMF. At the 3rd event, Telebrasil – Project '5G BRASIL' signed an accession agreement to the multilateral MoU for Global 5G Event. Then, Telebrasil joined the 5G signatories. The 4th Global 5G Event was held in November 2017 in Seoul, Korea organized by 5G Forum.

3 Overview of 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.

3.1 Overall Concept

Study for this white paper was made with reference to advanced research in the White Paper on the "Mobile Communications Systems for 2020 and beyond" published at the end of September 2014, by the "2020 and Beyond AdHoc Group," which was established in September 2013 by the Advanced Wireless Communications Study Committee in ARIB. In creating the white paper, study was conducted with an awareness of differences in user environments,

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[1]MoU with 5G PPP (EU), 5G Forum (Korea), Wireless World Research Forum, Indonesia 5G Forum and IMT-2020 PG (China); MoC with IMT Sub-WG 5G of Malaysian Technical Standards Forum and 5GTR Forum (Turkey); LoI with 5G Forum on Field Trial.

Chapter	Chapter
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 Access Technologies
4. Traffic Trends	12. Network Technologies for 5G
5. Cost Implications	13. 5G Trial
6. 5G Key Concept	14. Conclusion
7. Typical Usage Scenarios of 5G	Annex Future Businesses and Services

5GMF White Paper
5G Mobile Communications Systems for 2020 and beyond

Version 1.1
September 29, 2017

http://5gmf.jp/en/whitepaper/

Figure 2   Content of 5GMF White Paper.

implemented services, system performance and other aspects of 4th generation communications systems such as IMT-Advanced, and earlier systems.

3.2 5GMF White Paper organization

The white paper is composed of the Scope chapter, 14 chapters of content and an Annex, as shown in Figure 2. These chapters are outlined below:

3.2.1 Introduction and Objectives (Chapters 1 and 2)
The introduction discusses social background necessitating the study of 5G and outlines the content in Chapter 3 and following. It identifies the main purpose of the white paper as clarifying the key concepts including the new concept "Crossover collaboration" and technologies required to realize 5G.

3.2.2 Market and User Trends (Chapter 3)
This chapter 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 (Chapters 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 the broad range of communication requirements must be met.

3.2.4 Key Concepts and key technologies (Chapter 6)

Two key concepts for 5G will be "Fulfilment of End-to-End Quality" 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 Recommendation ITU-R M.2083-0 ("IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond").

3.2.5 Typical Usage Scenarios (Chapter 7)

Various usage scenarios in the four categories of (1) entertainment, (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 (Chapters 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 "Stage 1: from a use-case and technical perspective; Stage 2: from a perspective of interoperating and coexisting with current systems and Stage 3: from an international collaboration perspective". The results of studies in Stages 1 to 3 are given that a part of or whole of the following bands are preferred for initial use from the view point of global/regional harmonization, considering the information obtained at this point of time:

- 24.25–27.5 GHz;
- 27.5–29.5 GHz;
- 31.8–33.4 GHz;
- 37.0–40.5 GHz;
- 40.5–42.5 GHz;

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

3.2.7 5G Trial (Chapter 13)

5GMF has published "5G system integrated verification Trial Report – 5G Utilization Project Plan" in September 2017 as described in Section 2.2. This section summarizes the 5G System Integrated Verification Trial Report.

3.2.8 Conclusion and Future Business Prospects (Chapter 14 and Annex)

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

The Annex discusses possible future business and services based on current trends in the study of 5G systems including new illustrations of use cases.

4 Overview of the 5G-TPG Report

5GMF is publishing this report in order to provide information on the desired test contents and plans of the upcoming 5G Systems Integrated Verification Trial in Japan. The 5G-TPG was formed in order to further study these points. The results published here represent the outcome of their work.

More than 40 proposals from the 5G Utilization Project, generated mainly from members of the 5G-TPG were summarized into the following six broad categories that were decided upon after discussions by the 5G-TPG:

1. Entertainment (see Figure 3)
2. Safe and secure society prevented from crime and natural disasters (see Figure 4)
3. Logistics, agricultural and fisheries, offices, factories (see Figure 5)
4. Remote controlled and managed devices such as robots and drones (see Figure 6)
5. Connected cars, autonomous and remote driving (see Figure 7)
6. High data-rate and reliable communication for high speed mobile (see Figure 8)

5 Crossover Collaboration

At the opening session of the third Global 5G Event held in May 2017 in Tokyo, 5GMF proclaimed its recognition of progress in 5G development which stepped forward from its initial 'Concept building phase' to the next

■ **Entertainment exploiting 5G for stadium, theme park, event site, sightseeing area, etc.**
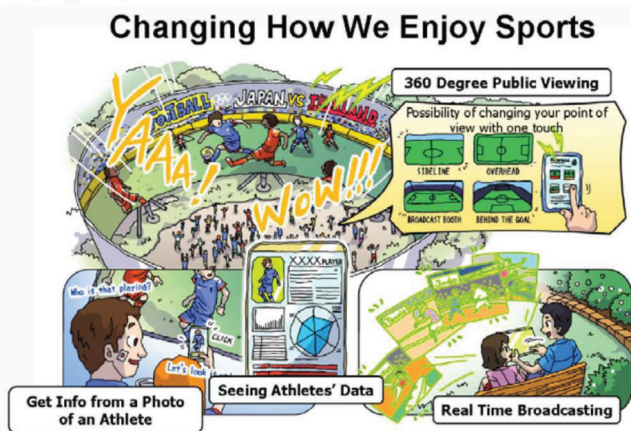

Figure 3   Use Case: Entertainment.

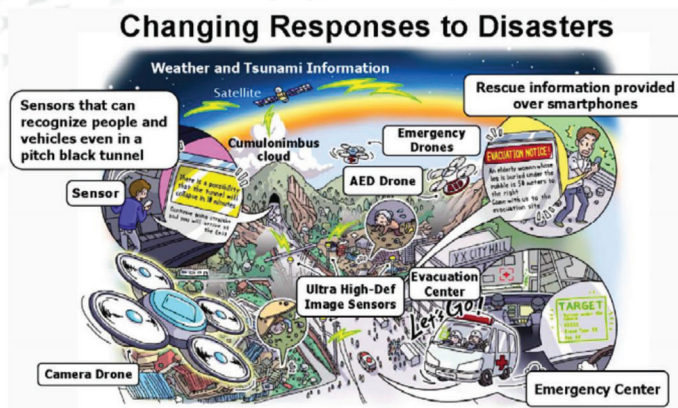■ **5G surveillance and security system to realize safe and secure society**

Figure 4   Use Case: Safe and secure society prevented from crime and natural disasters.

stage, 'Realization' of the concept. While focusing on the vision/concept and requirements and basic research and development on 5G so far, the focus area has been shifted to spectrum harmonization, international standardization activities and field trials. It was also declared that 5GMF believed 'Crossover Collaboration' was a key to maximize the true value of the enhanced and

- Efficient logistics supported by 5G massive connectivity (IoT)
- Same communication environment provided anywhere for future new work style by exploiting Heterogeneous Network
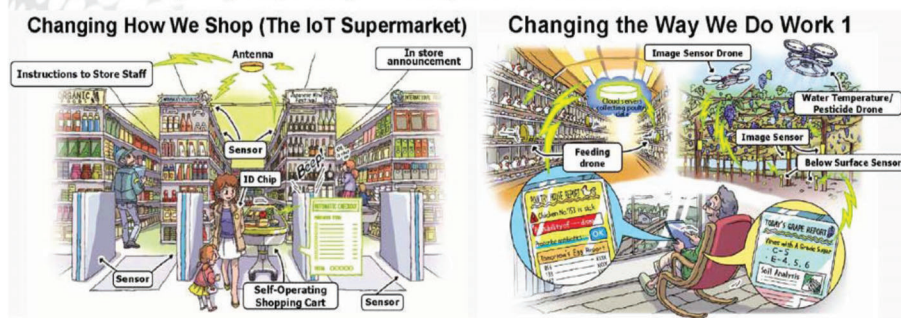
Figure 5 Use Case: Logistics, agricultural and fisheries, offices, factories.

- Remote control of drone, robot, machine, etc. and surveillance by machine with camera

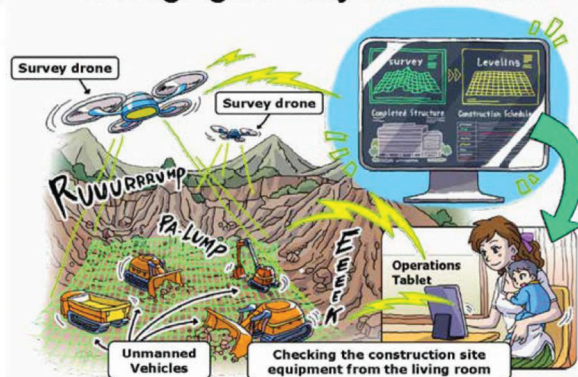**Figure 6** Use Case: Remote controlled and managed devices such as robots and drones.

excellent capabilities of 5G, and that the realization of 'Crossover Collaboration' is the shortest way to realize an eco-society spread by 5G. In this context, crossover collaboration means a barrier-less cooperation between various industries and 5G Mobile Communications should enable lowering of barriers through its enhanced capabilities as an infrastructure as shown in Figure 9.
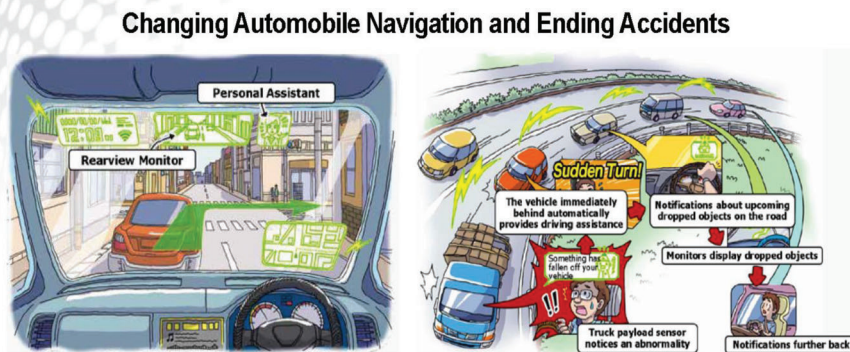
Figure 7   Use Case: Connected cars, autonomous and remote driving.
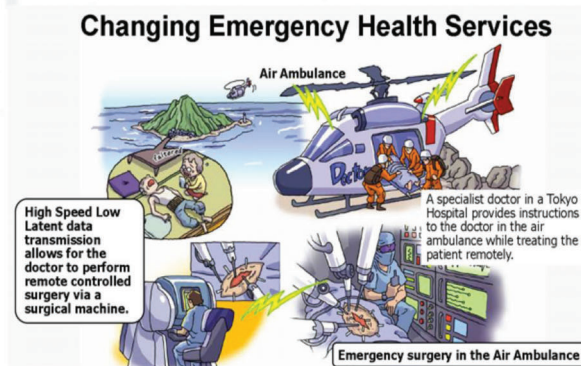

Figure 8   Use Case: High data-rate and reliable communication for high speed mobile.

6 Conclusion

This article summarized recent activities of 5GMF and gave an outline of its major outcomes. 5GMF understand that the practical implementation of 5G has started, moving towards initial 5G commercialization in 2020. In other words, 5GMF was focusing on vision/concept, requirements and basic research and development on 5G at the early stage of its activities, but
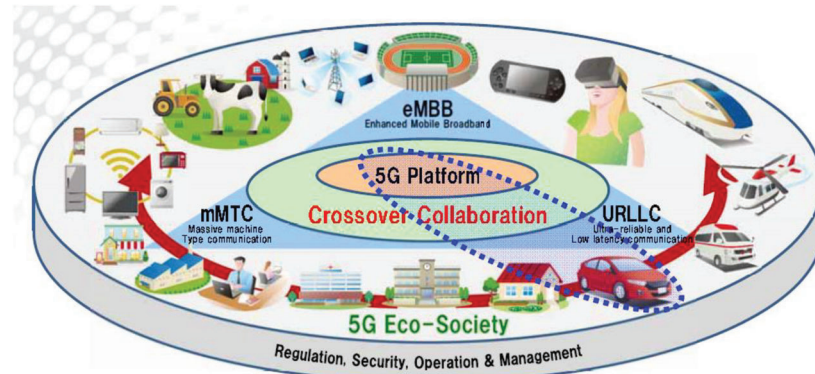
Figure 9 Concept of Crossover Collaboration.

5GMF's focus area has been shifted to spectrum harmonization, international standardization activities and field trials.

5GMF will continue promotional activities for the use of 5G leading to the 5G eco-society. 5GMF will support and cooperate with 5G field trials, will lead R&D and international standardization activities and will contribute to international activities through the collaboration with overseas 5G-related organizations. 5GMF hopes for continued cooperation, expanding and invigorating these activities toward practical implementation of 5G eco-society in 2020 and beyond.

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Biographies

Susumu Yoshida received the B.E., M.E. and Ph.D. degrees all in electrical engineering from Kyoto University, Kyoto, Japan in 1971, 1973 and 1978, respectively. Since 1973, he had been with the Faculty of Engineering of Kyoto University and was a full professor there until his retirement, i.e., from March 1992 till March 2013. He is currently a Professor Emeritus, Kyoto University.

During his 40 years career at Kyoto University, he had been mainly engaged in the fundamental research and education of mobile radio communication techniques.

He served as a President of the Institute of Electronics, Information and Communication Engineers (IEICE). Currently, he is a chairman of 5GMF as well as members of Science Council of Japan and Radio Regulatory Council of Ministry of Internal Affairs and Communications of Japan.

He received several awards including the IEICE Best Paper Award, IEICE Distinguished Achievement and Contributions Award, Radio Day Ministerial Commendations, Ministry of Internal Affairs and Communications, Ericsson Telecommunications Award and Okawa Prize.

Kohei Satoh joined the Electrical Communication Laboratories, Nippon Telegraph and Telephone Public Corporation (NTT), Japan, in 1975, and transferred to NTT Mobile Communications Network, Inc. (NTT DOCOMO) in 1992. Since 1975, he has been engaged in the research on radio propagation for satellite communication systems, research and development of mobile satellite communications and mobile communications systems. After 1985, he has been also engaged in standardization activities of mobile satellite services in ITU-R and international alliance activities for IMT-2000.

In July 2002, he moved from NTT DoCoMo to the Association of Radio Industries and Businesses (ARIB). He is now an Executive Manager on Standardization of ARIB, and his current job is to promote R&D and standardization activities for the 5th Generation Mobile Communications System. And, he is Chairman of APT Wireless Group and Secretary General of the 5th Generation Mobile Communications Promotion Forum (5GMF).

Dr. Satoh is a member of the IEEE and the Institute of Electronics, Information, and Communication Engineers of Japan, and a Fellow of Wireless World Research Forum.

Yoshinori Ohmura joined KDD Co. Ltd. (currently KDDI Corporation) in 1981 and was engaged in the applied technology planning of mobile communications, and management of mobile joint venture in the overseas business field.

He is currently engaged in the promoting to realize the new generation mobile systems in ARIB (Association of Radio Industries and Businesses). He also serves as Deputy Secretary General of 5GMF (The 5th Generation Mobile Communications Promotion Forum) in Japan.