Recent Activities of ITU-R Study Group 5

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Abstract

Radiocommunication systems such as mobile communication systems and fixed wireless communication systems play important roles in telecommunication networks. Mobile communication systems have become widespread, as represented by smartphones, and fixed wireless communication systems provide flexible and resilient communication in times of disasters. The International Telecommunication Union - Radiocommunication Sector (ITU-R) is one of the organizations responsible for developing standards for these important systems. Towards the end of 2015, the ITU-R will hold two very important meetings: the Radiocommunication Assembly (RA) and the World Radiocommunication Conference (WRC). This article introduces recent activities and contributions from NTT and NTT DOCOMO to ITU-R Study Group 5, which deals with terrestrial radiocommunication systems.

Keywords: ITU-R, Study Group 5, terrestrial radiocommunication service

1. Introduction

The International Telecommunication Union - Radiocommunication Sector (ITU-R) is the ITU sector that develops regulations and standards for radiocommunication systems. The structure of ITU-R is depicted in **Fig. 1**.

The Study Groups (SGs) work on developing technical, operational, and procedural bases for efficient use of the radio spectrum and the geostationary-satellite orbit and develop ITU-R Recommendations and Reports. They also carry out studies and provide solutions called *Methods* that are required in discussions at the World Radiocommunication Conference (WRC) on revising the Radio Regulations (RR)[*1].

The structure and scope of the six SGs in the ITU-R [1] are listed in **Table 1**. The scope of SG 5 is terrestrial services, and Dr. Akira Hashimoto of NTT DOCOMO has been the chairman of this SG for the last two study periods (2007–2012 and 2012–2015).

As listed in **Table 2**, SG 5 has four Working Parties (WPs); the participants in these WPs meet periodically to discuss ITU-R Recommendations. NTT members regularly attend WP 5A and WP 5C meetings, which deal respectively with land mobile services and fixed services, and NTT DOCOMO members regularly attend WP 5D meetings, which deal with International Mobile Telecommunications (IMT) systems[*2].

The ITU-R may also establish Task Groups (TGs) to deal with a specified theme for a short period, or Joint Task Groups (JTGs) to deal with a specific theme involving more than one SG. From 2012 through 2014, JTG 4-5-6-7 was established to discuss topics on WRC-15 agenda item 1.1, additional frequency bands for IMT. This article also introduces the activities of JTG 4-5-6-7.

2. Recent SG and WP activities

2.1 WP 5A

The scope of WP 5A is mainly land mobile radiocommunication systems excluding IMT. This WP

*1 Radio Regulations: The RR provide international rules and regulations for spectrum allocation to radio services, use of satellite orbits, and administrative and operational procedures for radio stations, all of which are needed for the use of radio waves.

*2 IMT systems: Includes 3rd generation mobile communication systems and beyond such as IMT-2000 and IMT-Advanced systems.

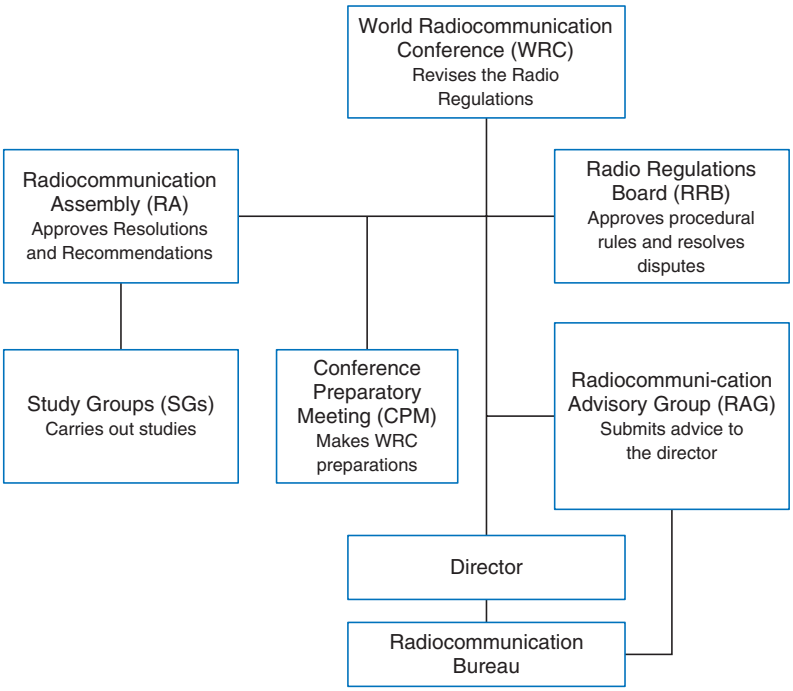


Fig. 1. Structure of ITU-R.

Table 1. Structure of ITU-R SGs.

	Scope of work
SG 1: Spectrum management	Spectrum management principles and techniques, general principles of sharing and spectrum monitoring
SG 3: Radiowave propagation	Propagation of radio waves in ionized and non-ionized media, and the characteristics of radio noise
SG 4: Satellite services	Systems and networks for fixed-satellite, mobile-satellite, broadcasting-satellite, and radiodetermination-satellite services
SG 5: Terrestrial services	Systems and networks for fixed, mobile, radiodetermination, amateur, and amateur-satellite services
SG 6: Broadcasting service	Radiocommunication broadcasting including vision, sound, multimedia, and data services principally intended for delivery to the general public
SG 7: Science services	Systems for space operation, space research, earth exploration and meteorology; systems for remote sensing including passive and active sensing systems, radio astronomy, and standard frequency and time signals

*Note that there is no SG 2.

carries out studies on wireless access systems (WAS) including wireless local area networks (WLANs) and public protection and disaster relief (PPDR) systems. It also studies new technologies for land mobile radiocommunication systems and develops ITU-R Recommendations and Reports on these topics.

At the October/November 2014 WP 5A meeting, work was completed on an ITU-R Report on cognitive radio systems (CRS)[*3]. These systems are

*3 Cognitive radio system: A radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge, and to learn from the results obtained.

Table 2. Structure of WPs in SG 5.

	Scope of Work
WP 5A	Land mobile service above 30 MHz (excluding IMT); wireless access in fixed services; amateur and amateur-satellite services
WP 5B	Maritime mobile service including Global Maritime Distress and Safety System (GMDSS); aeronautical mobile service and radiodetermination service
WP 5C	Fixed wireless systems; HF and other systems below 30 MHz in fixed and land mobile services
WP 5D	IMT systems

HF: high frequency

expected to improve efficient use of the spectrum allocated to land mobile communication systems.

This WP also carries out standardization activities on intelligent transport systems (ITS). One of the agenda items to be discussed at WRC-15 that concerns ITS is "Allocation of the band 77.5–78 GHz to the radiolocation service to support automotive short-range high-resolution radar operations," which is intended to achieve high resolution automotive radar for more precise collision avoidance by using the entire 77–81 GHz frequency range. In cooperation with WP 5B, which deals with radar, WP 5A has completed sharing and compatibility studies with other existing radiocommunication systems and provided solutions to achieve co-existence with these systems. These activities are in line with Japan's position of supporting new allocations for the 77.5–78 GHz frequency band.

2.2 WP 5B

The scope of WP 5B is the maritime mobile service, aeronautical mobile service, and radiodetermination service (e.g., radar), and this WP deals with a lot of topics discussed at WRCs. Although telecom operators have made few contributions to this WP, the NTT Group addresses these topics via liaison statements from other WPs that reflect the Group's opinions.

2.3 WP 5C

The scope of WP 5C is mainly fixed wireless systems (FWSs). This WP is developing ITU-R Recommendations and Reports on transport/trunking wireless network systems, fixed wireless access (FWA) systems, mobile backhaul (MBH) for land mobile radiocommunication, and systems for temporary use in disaster relief.

At the October/November 2014 WP 5C meeting, work was finalized on a new ITU-R Report on fixed service use and future trends [2]. The details of this ITU-R Report are described later in this section.

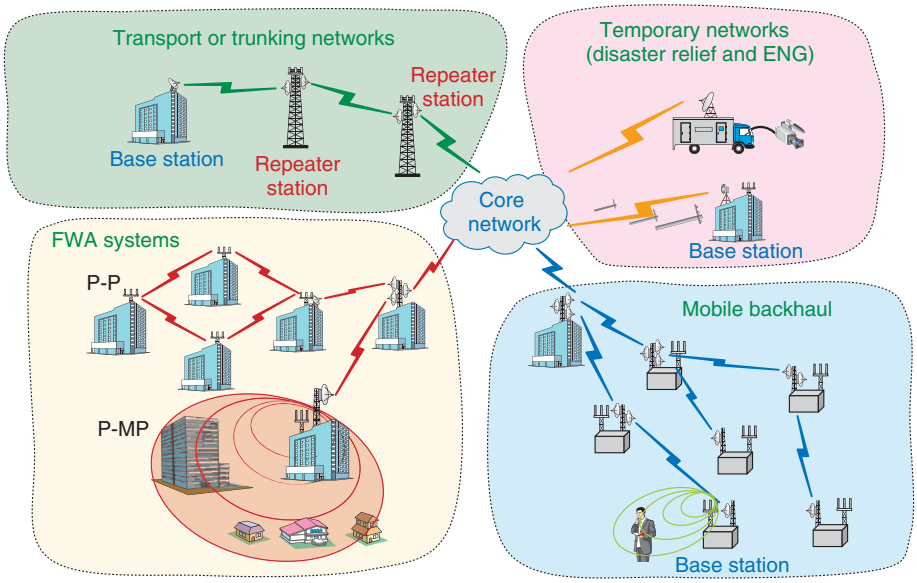
One study currently being carried out in WP 5C is aimed at developing a new ITU-R Report on technical characteristics for MBH such as frequency bands, network topologies, and required capacity. The WP has been developing this report through liaison statements in cooperation with WP 5D and ITU-T SG15, which deal respectively with IMT and fiber-optic transport networks.

In this section, we summarize the abstract of the new ITU-R Report on the aforementioned fixed service use and future trends. FWSs are used in telecommunication networks in various situations. FWSs are used for transport/trunking networks, MBH networks, FWA systems, and temporary networks, as shown in **Fig. 2**. The demand for MBH capacity in such networks is increasing with the explosive increase in traffic in mobile communication systems due to the introduction of smartphones.

To fulfill this demand, studies on FWSs using millimeter-wave bands (above 30 GHz) are being carried out, since a broader bandwidth is available in these bands than in the frequency bands below 30 GHz. Report ITU-R F.2323, "Fixed service use and future trends," is aimed at providing guidance on the future development of fixed services by taking into account the evolution of current use and technology development, application trends for FWSs, and future requirements for FWSs. This Report covers the following areas: (1) FWS use in telecommunication networks, (2) FWS band usage, (3) FWS technologies and trends, and (4) spectrum aspects and requirements. It was NTT that led the way in developing the report and that made a lot of contributions to it. These contributions included applications making use of FWA technologies as follows: (1) an example of an MBH network to provide Internet access service for passengers in trains on the Tsukuba Express Line in Japan, (2) home network systems in the 60-GHz frequency band as an extension of FWA systems, and (3) gigabit millimeter-wave links in the 120-GHz frequency band. The above contributions were reflected in this ITU-R Report.

2.4 WP 5D

The scope of WP 5D is IMT, and this WP deals with IMT radio interfaces, IMT frequency arrangements (frequency use within the ranges identified for IMT), sharing and compatibility studies between IMT and other radiocommunication systems, and the



ENG: electronic news gathering
P-P: point to point
P-MP: point to multipoint

Fig. 2. Applications of FWS.

development process for and concepts of future IMT (fifth generation (5G) of mobile communications). This WP develops ITU-R Resolutions, ITU-R Recommendations, and ITU-R Reports on these topics. The WP has been the recipient of many NTT DOCOMO contributions including studies on 5G. The following is a review of the studies currently being carried out on 5G, which is expected to be introduced around the year 2020.

(1) Current studies toward 5G

Studies on IMT-2000[*4] (3G) and IMT-Advanced[*5] (4G) radio interfaces have been completed by WP 5D (and by former WP 8F, the predecessor of WP 5D), which has also adopted numerous technical specifications proposed by external standards developing organizations. The WP will complete the development of specifications for IMT-2020[*6] radio interfaces by the year 2020. In addition, it is actively discussing ITU-R Resolutions for the future development process of IMT, including IMT-2020, and an ITU-R Recommendation (Recommendation on Vision) on use cases, applications, requirements, and technology trends of IMT-2020. Studies on IMT-2000 and IMT-Advanced were conducted following the same process. However, for IMT-2020 the duration from initial studies to deployment is projected to be reduced to 8 years (as opposed to 15 years for IMT-2000), as shown in **Fig. 3**.

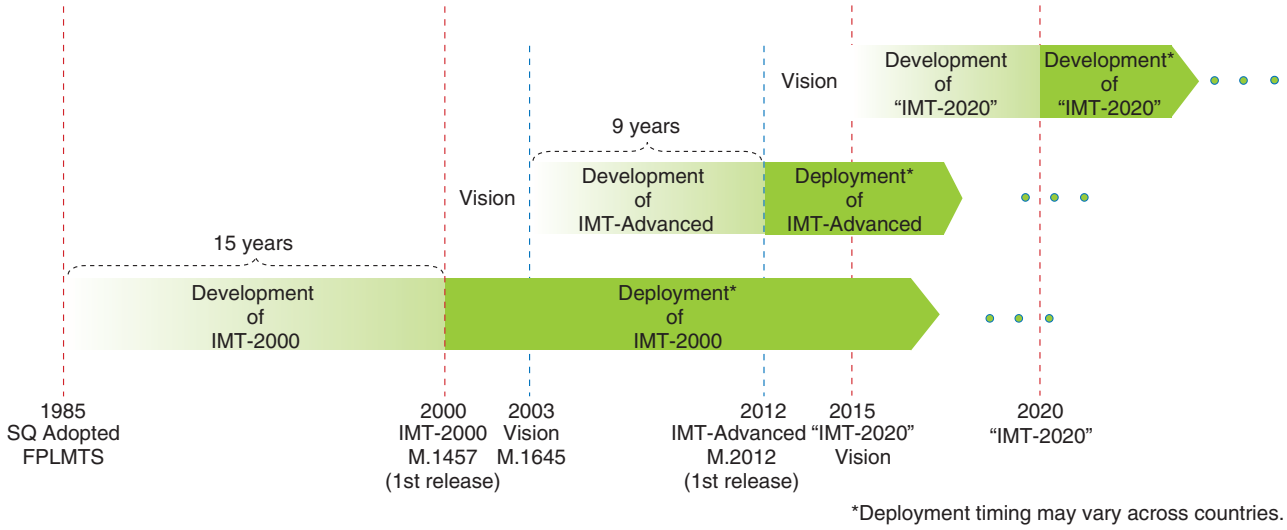
(2) Recommendation on 5G Vision

Three main use cases are assumed for IMT-2020 in the Recommendation on Vision. One is for further enhancement of mobile broadband devices such as smartphones (Enhanced Mobile Broadband). Another is for communications involving a massive number of mobile terminals in the era of Internet of Things (IoT) and Internet of Everything (IoE) (massive machine-type communications). The other is for communications required for high reliability such as vehicle to vehicle (V2V) communication and public safety communication systems (ultra-reliable and low latency communications). The Recommendation on Vision contains considerations for eight parameters for the basic requirements, while Recommendation ITU-RM.1645 [3] on the Vision of IMT-2000 and

*4 IMT-2000: W-CDMA (Wideband Code Division Multiple Access), HSPA (High-Speed Packet Access), and LTE (Long Term Evolution) are included as radio interfaces.

*5 IMT-Advanced: LTE-Advanced is included as a radio interface.

*6 IMT-2020: The term "3G" is used in ITU and in related organizations all over the world. However, the term "4G" is not used in ITU since there are certain ambiguities in how it was generated, likewise for the term "5G." The term "IMT-2020" is provisionally used in this article, but "IMT-2020 Connect" is also a candidate term. The formal name will be approved within ITU in October 2015.



FPLMTS: Future Public Land Mobile Telecommunication Systems
SQ: Study Question

Fig. 3. Overview of timeline for IMT development and deployment (derived from the Recommendation on Vision).

Table 3. Comparison of system requirements for IMT-2020 and IMT-Advanced.

	Rec. ITU-R M.1645 (IMT-2000/IMT-Advanced)	Rep. ITU-R M.2134 (IMT-Advanced)	Rec. on Vision (IMT-2020)
Year of approval	2003	2008	2015
Mobile terminal mobility	250 km/h	350 km/h	500 km/h
Peak transmission rate	0.1–1 Gbit/s	1 Gbit/s	20 Gbit/s
User throughput	–	10 Mbit/s	0.1–1 Gbit/s
Mobile terminal density	–	10^5/km^2	10^6/km^2
Radio link latency	–	10 ms	1 ms
Power efficiency (/bit)	–	–	100 times that of IMT-Advanced
Spectrum use efficiency	–	–	2–5 times that of IMT-Advanced
Area traffic capacity	–	0.1 Mbit/s/m^2	10 Mbit/s/m^2

IMT-Advanced specified only mobility and peak data rate[*7]. This shows that the uses of IMT are expected to become wider and more varied with the further development of IMT technologies (**Table 3**). It should be noted that the values shown in the table are tentative and will be discussed and finalized through discussions after completion of the Recommendation on Vision.

2.5 JTG 4-5-6-7

At the previous WRC (WRC-12), an agenda item on additional spectrum allocations and identifications for IMT was adopted and specified as Agenda Item 1.1 for WRC-15. Since this item covers a variety of candidate frequency ranges and involves a lot of existing services in those ranges, JTG 4-5-6-7 was established as the group responsible for it. In contrast, WP 5D studied the spectrum requirements for IMT and the parameters for sharing and compatibility studies between IMT and other radiocommunication systems. JTG 4-5-6-7 took the study results of WP 5D into account and carried out sharing and compatibility studies between IMT and other radiocommunication systems. It also compiled candidate frequency bands to be identified for IMT and provided draft

*7 Requirements were updated in 2008 in Report ITU-R M.2134 after Recommendation ITU-R M.1645 was developed.

texts for the revision of RR in the case of an IMT identification. As a result of these activities, the group was able to prepare draft texts for the Conference Preparatory Meeting (CPM).

(1) Spectrum requirements for IMT

It has been agreed that spectrum requirements for IMT in 2020 will be 1340 MHz and 1960 MHz for lower and higher user density settings, respectively. These values are based on a number of contributions NTT DOCOMO members made to WP 5D; NTT DOCOMO also took the lead in developing methodologies and tools for estimating spectrum requirements. These results were approved as Report ITU-R M.2290 [4] at the December 2013 SG 5 meeting.

(2) Candidate frequency bands for IMT

On the basis of contributions made from a number of countries, agreement has been reached on the following candidate frequency bands for IMT:

470–694/698 MHz, 1350–1400 MHz, 1427–1452 MHz, 1452–1492 MHz, 1492–1518 MHz, 1518–1525 MHz, 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, and 5925–6425 MHz.

It is expected that at WRC-15, some frequency bands will be identified for IMT from the above list, and it should be noted that the C-band (3400–4200 MHz and 4400–4900 MHz) and the L-band (1427.9–1462.9 MHz and 1475.9–1510.9 MHz), which are supported by Japan, are included in the candidate frequency bands.

(3) Sharing and compatibility studies between IMT and other radiocommunication systems

A number of sharing and compatibility studies have been carried out by JTG 4-5-6-7 on IMT and other radiocommunication systems that use the candidate frequency bands. From the results, the group has identified sharing conditions such as separation distance, transmission power limit, interference mitigation techniques, and feasibility of sharing. The parameters (power, antenna height, and densities of base stations and mobile terminals) the group used in the studies were discussed in WP 5D on the basis of contributions made mainly by NTT DOCOMO and were approved as Report ITU-R M.2292 [5] at the December 2013 SG 5 meeting.

For the C-band, the main subjects have involved sharing issues between IMT and fixed-satellite systems. A number of contributions have been made by NTT DOCOMO regarding sharing studies and interference mitigation techniques such as the use of IMT base stations placed at low height with low transmission power and small cells. These contributions have helped to show how the interference into fixed-satellite systems from IMT systems can be mitigated.

For the L-band, one of the serious issues is unwanted emissions from IMT into Earth Exploration Satellite Service (EESS) using the 1400–1427 MHz band, which is adjacent to the L-band. Japan contributed the measured values of unwanted emissions from IMT base stations and mobile terminals already in operation in Japan. These values show that it is possible to deploy IMT without harmful interference to EESS operated in the adjacent frequency bands, and these results are properly reflected in the relevant documents.

3. Activities toward the 2015 meetings

ITU-R Resolutions on the name and development process of the 5th generation of IMT and the Recommendation on Vision will be adopted at the July 2015 SG 5 meeting. It is expected that the ITU-R Resolutions will be approved at RA-15 to be held in October 2015.

The results of considerations compiled by JTGs regarding Agenda Item 1.1 were finalized at the 2nd session of CPM (CPM15-2) as the CPM Report[*8]. Using this Report as a basis, WRC-15 will make decisions on the identification of frequency bands and associated conditions for IMT.

4. Future subjects

The ITU-R will soon hold the two most important meetings of 2015, RA-15 and WRC-15. During the latter meeting, discussions will be held on the agenda item most important to Japan, which regards additional IMT allocations and identifications. There will also be discussions on other agenda items for new allocations of the frequency bands that the NTT Group wireless systems use. It may be required that these frequency bands be shared with other wireless systems internationally.

Agenda items for the future WRC (expected to be held in 2019) will also be discussed at WRC-15. Additionally, NTT DOCOMO will propose a new agenda item regarding additional IMT allocations and identifications beyond the year 2020 under

*8 CPM Report: CPM Reports submitted to the WRC contain technical studies, solutions based on the studies, and examples of RR revisions. The reports are finalized during the CPM, which is held half a year before the WRC.

instructions from the Ministry of Internal Affairs and Communications. Since demand for spectrum is growing year by year, the future WRC is expected to see a variety of discussions on much wider frequency ranges.

This year and in years to come, NTT and NTT DOCOMO will continue to actively participate in ITU-R, always taking into account how best use of the frequencies can be made by the NTT Group.

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He received the B.E., M.E., and Ph.D. from Osaka University in 1993, 1995, and 1997, respectively. He joined NTT in 1997 and studied wireless access systems, wireless local area network systems, and wireless systems for Internet services in trains. During 2008–2011, he worked on studies and international standardization efforts in evolved packet core and services using IP (Internet protocol) multimedia subsystems at NTT Service Integration Laboratories. Since 2011, he has been with NTT Access Service Systems Laboratories, where he is engaged in studies on wireless local area networks and international standardization efforts. He is a member of the Institute of Electronics, Information and Communication Engineers (IEICE) and the Institute of Electrical and Electronics Engineers (IEEE).

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He received the B.E. in advanced chemistry and the M.E. in materials engineering from Hokkaido University in 1998 and 2000, respectively. He joined NTT DOCOMO in 2000. He is currently responsible for spectrum planning and coordination issues for IMT systems and ITU-R activities as well.