

Recent Standardization Activities in the Terahertz Communication Field

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1. Introduction

In the Radio Regulation (RR), footnote No. 5.565 stated that the frequency band above 275 GHz can be used for experimentation with various passive services and active services, but in accordance with Resolution 950 (Rev.WRC-07), footnote No. 5.565 was revised in WRC-12 Agenda item 1.6 to add specific frequencies for use in passive service applications (earth exploration-satellite service (passive), space research service (passive), radio astronomy service), and to protect these passive services from harmful interference until the Table of Frequency Allocation for active services in the 275–1000 GHz band has been established.

On the other hand, the research and development of devices capable of operating at 275 GHz and above has made rapid progress recently, and advances are being made in the understanding of propagation characteristics in these frequency bands and the study of short-range high-capacity communication systems that can achieve data transfer speeds of 100 Gbps and above. In particular, in the field of short-range radiocommunication, it is expected that IEEE802.15.3d (standard for Wireless Personal Area Network (WPAN) systems) will be completed in the next few years. It is envisaged that this standard will be applied to systems that transmit data at 1–100 Gbps using frequency bands of 60 GHz or more in four use cases including kiosk and tollgate downloading systems.

To reflect these R&D and standard activities towards using the spectrum above 275 GHz in ITU-R studies, ITU-R WP 1A has already started a preliminary study aimed at facilitating sharing and compatibility with passive services in frequency bands above 275 GHz. This report overviews the current activity of

ITU-R WP1A and discusses possible allocation of active services in the bands above 275 GHz.

2. Efforts of ITU-R WP 1A (Spectrum engineering)

2.1 New Study Question

Since other international standardization organizations have also been studying spectrum usage above 275 GHz, it is essential that the ITU-R study of spectrum use in various services clarifies issues such as the technical and operational characteristics of active services operating in the bands from 275 GHz to 1000 GHz, and the conditions whereby services for which frequencies have already been identified in RR footnote No. 5.565 can coexist in these frequency ranges without causing interference. Therefore, to address the research of the frequency spectrum above 275 GHz, at the ITU-R WP 1A meeting held in June 2012, Japan proposed a new study Question relating to the technical and operational characteristics of active services in the 275–1000 GHz band. This study Question involves studying the technical characteristics and operational characteristics required of active services using frequencies in the 275–1000 GHz band, and the need for sharing and compatibility studies on such issues. Information about this new study Question was provided to the other related WPs (Working Parties), and documents requesting the following information were sent out.

- (1) Propagation data required for the planning of active services operating above 275 GHz
- (2) Technical and operational parameters and the characteristics of active services operating above 275 GHz
- (3) Sharing studies required for active services operating above 275 GHz

As a result, since information on Recommendations ITU-R P.676, P.838 and P.840 was provided from WP3M, and Report ITU-R RA.2189 from WP7D, a new study Question reflecting this information was submitted by Japan to WP 1A in June 2013, and was adopted by SG1 after its approval by WP 1A. Then, after it had been circulated to the ITU member states for approval, final approval was given in November 2013.

2.2 Preliminary draft new Report ITU-R SM.[THZ.TREND]

In June 2013, while a new study Question was being prepared, Japan submitted to ITU-R WP 1A a working document towards preliminary draft new Report ITU-R SM.[THZ.TREND] introducing technical trends of active services in the band above 275 GHz (focusing on technical trends such as terahertz wireless communication, sensing and imaging). At this meeting, the document proposed by Japan was carried forward to the next meeting as an attachment to the chairman's report.

At the meeting in June 2014, Japan made the following additional proposals.

- Revising the constitution of the Report with terahertz communication as a major theme, and revising the preamble based on the current state of affairs, including the presence of Resolution 118 (Marrakesh, 2002), changes to RR footnote No. 5.565 by Resolution 950 (Rev.WRC-07), approval of a new study Question regarding terahertz spectrum issue and the state of progress of IEEE802.15.3d.
- Adding a new section containing RR information from RR footnote No. 5.565 amended by WRC-12 Agenda item 1.6.

- Adding 300 GHz band transceiver technology and terahertz communication use cases, which resulted from the Ministry of Internal Affairs and Communications R&D program for the expansion of spectrum resources (“Research and development program on multi-Gbps wireless communication technology at subterahertz frequencies”).
- Adding terahertz cameras, which resulted from an NICT funded project (“R&D of terahertz-wave technology for making society safe and secure with ICT”).
- Adding other key terahertz technology trends — light sources capable of emitting terahertz light, material analysis trends, and non-contact evaluation methods.

The above additional proposals were agreed upon, but a new section on initial studies relating to sharing with passive services was provided as a trigger for future sharing studies. Since the contents were significantly updated, requests for comments were issued as liaison statements to the terahertz-related working groups ITU-R WP7C & WP7D, and to IEEE802. Japan also submitted a proposal for upgrading the working document to the preliminary draft Report, and the preliminary draft Report was attached to the chairman's report.

3. Efforts of the APT Wireless Group (AWG)

Frequency bands above 275 GHz are characterized by having shorter propagation distances due to attenuation, but it is possible to secure a wide bandwidth, as shown in Table 1. Therefore, the ITU-R draft Report cites three large-capacity short-range radiocommunication systems as examples of terahertz communication.

Meanwhile, although one of the AWG Task Groups (TG-SRD; TG-Short Range Devices) is researching technologies related

■ **Table 1: Frequency range and contiguous bandwidth**

Frequency range (GHz)	Continuous bandwidth (GHz)	Attenuation (dB/km)
200–320	120	< 10
275–320	45	< 10
335–360	25	< 10
275–370	95	< 100
380–445	65	< 100
455–525	70	< 100
625–725	100	< 100
780–910	130	< 100

to short-range devices, a new work item for study of short-range radiocommunication systems operating in the band above 275 GHz was submitted to TG-SDR from Japan and presented at the AWG-17 meeting on September, 2014.

Assuming that active services such as short-range radiocommunication systems using frequencies above 275 GHz will become globally widespread in a few years, this proposal summarizes the technical trends of short-range radiocommunication systems operating in the band above 275 GHz that are currently being studied by NICT and other companies, and the activities at ITU-R and IEEE 802, and recommends the study of short-range radiocommunication systems operating in the band above 275 GHz within AWG. This proposal also encourages APT member countries to discuss a new frequency allocation for active services in the frequency band above 275 GHz.

4. Toward frequency identification and/or allocation above 275 GHz

Revisions to RR will be made at the World Radiocommunication Conference to be held in November 2015 (WRC-15), but since there is no WRC-15 Agenda item relating to the spectrum above 275 GHz, it will have to be approved during WRC-15 as a new Agenda item for WRC-19.

Usually when a new Agenda item is proposed for WRC, it is proposed to

the APT Conference Preparatory Group (APG) meeting, and then proposed to WRC as an APC (APT Common Proposal). Preparations and negotiation within APT member countries should be made in accordance with this procedure.

In the future, based on discussions in ITU-R WP1A and AWG, a new WRC Resolution for spectrum identification and/or allocation above 275 GHz will be proposed to APG and discussed through negotiations with the other Regions at WRC-15.

5. Conclusion

NICT has pioneered the use of new frequencies at millimeter wavelengths (including the 60, 70 and 90 GHz bands), but there is now an urgent need for the development of new frequencies due to recent demands for high-capacity communication on mobile devices. It is therefore not only necessary to develop spectrum resources to enable the use of new spectral bandwidth, but also to modify the provisions of Radio Regulations that can create new active services in the band above 275 GHz. NICT plans to conduct research and development of terahertz frequencies while taking these points into consideration.

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