International Telecommunications Union (ITU) Recommendations and Challenges for Future Wireless Technologies in mm and THz Waves

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Herning

Short Profile of Dr. Ashok Chandra

- PhD in Electronics and Doctorate of Science (D.Sc.) in Radio Mobile Communications. Joined the Ministry of Communications, Government of India in the year 1977.
- Former Wireless Adviser to the Government of India (Head of the Indian Spectrum Management Authority). More than 35 years of experience. Responsible for spectrum planning & management, regulatory affairs for future technologies, auction of spectrum for IMT Applications etc.
- Was Director of WB Project on 'National Radio Spectrum Management Monitoring System.'
- Served as a Vice-Chairman of ITU's Study Group 5.
- Was Guest Scientist, Aalborg University, Aalborg, Denmark.
- Was Guest Scientist on DAAD Fellowship at the Institute of High Frequency Technology, Technical University (RWTH), Aachen, Germany and at Bremen University, Bremen (Germany).
- Was Adjunct Professor, Indian Institute of Technology (IIT), Bombay, India.
- Currently, International Telecommunications Union (ITU) Expert on "Radio Spectrum Management".
- Guest Scientist, Department of Business Development & Technology, Aarhus University, Herning.

Outline of Presentation

- ITU's Statistics on use of ICT applications including Broadband (BB).
- Radio Spectrum (RS) Requirements for BB.
- International Telecommunications Union (ITU).
- Role of ITU in RS Management.
- World Radio Conferences (WRCs).
- Salient Agenda Items for WRC-2019.
- Status of mm bands for BB.
- Sharing Studies.
- ITU's Plan for THz Band.
- A Study Question.

Statistics of ICT Applications

- As per ITU's statistics on the ICT applications, more than 830 million young people are using the Internet, which is about 80 per cent of the youth in more than 100 countries.
- In countries like China and India, more than 300 million young generations are using the Internet. Use of the Internet by youths in the Least Developed Countries (LDCs) is upto 35 per cent.
- During the last five years, LDCs have witnessed a very high growth rate. The mobile broadband users are likely to reach more than 5 billion globally by the end of this year. This trend will grow many folds in the coming 5-10 years' period.
- Today, the developing countries generate about 40 per cent of the globe's telecommunication revenues.
- The Wireless communications technologies are the economical way for the development of ICT adding to sizable GDP of a country.

Radio Spectrum (RS)

- The wireless-based technology uses radio frequency spectrum. The fastest increasing proliferation of new/future wireless technologies shall surely require additional radio frequency spectrum bandwidths that need to be effectively and efficiently utilized.
- More so, the commercial exploitation of the radio-based services namely mobile, broadcasting, satellite etc plays a significant role, making radio spectrum so precious.
- As per, ITU, the Radio Frequency Spectrum (RFS) allocations ranges between Myriametric waves (3 KHz) to millimetric (mm) waves (30-300 GHz) and Decimillimetric waves (300-3000 GHz, i.e. THz). Frequency Table goes from 8.3 KHz to 275 GHz (more than 140 pages).
- RS is the “Life Line” of all the 41-radiocommunication services, which are broad: Mobile, Fixed, Land Mobile, Fixed Satellite, Mobile Satellite, Broadcasting, Aeronautical, Maritime, radio-navigation, and safety etc.
- The applications of RFS can be broadly categorized for societal (public at large), commercial, security, and safety.

ITU and World Radio Conference (WRC)

ITU

- ITU, a specialized agency of the United Nations for all global ICT, sets out high-level guidance to the national bodies in setting more detailed policy on the management of RS and develop national frequency plans.
- The Radiocommunications Sector of ITU-(ITU-R) through the World Radio Conferences (WRCs), held typically in 3-4 years, conducts the critical parts of radio spectrum management.
- WRCs are attended by a large number of delegates ranging from spectrum managers (National Governments), technology developers, academicians and users from all over the world.

International Telecommunications Union (ITU)

- ITU works through Plenipotentiary conferences, Council, World conferences on International Telecommunications and General Secretariat.

ITU does:

- ⇨ International regulations and plans
- ⇨ Management of radio frequency spectrum
- ⇨ Standards and recommendations
- ⇨ Assistance to developing countries

Key priorities

- ❑ *Radio spectrum*
- ❑ *International standard*
- ❑ *Emergency communications & climate change*
- ❑ *Digital divide*
- ❑ *Cyber security*

The ITU Sectors

Three Core Sectors of ITU

- ITU-R: Radio Communication Sector;
- ITU-D: Development Sector; and
- ITU-T: Standardization Sector.

ITU Overview

193 Member States
+700 Sector Members

ITU

Helping the World Communicate

ITU-T

Telecommunication standardization of network and service aspects

ITU-D

Assisting implementation and operation of telecommunications in developing countries

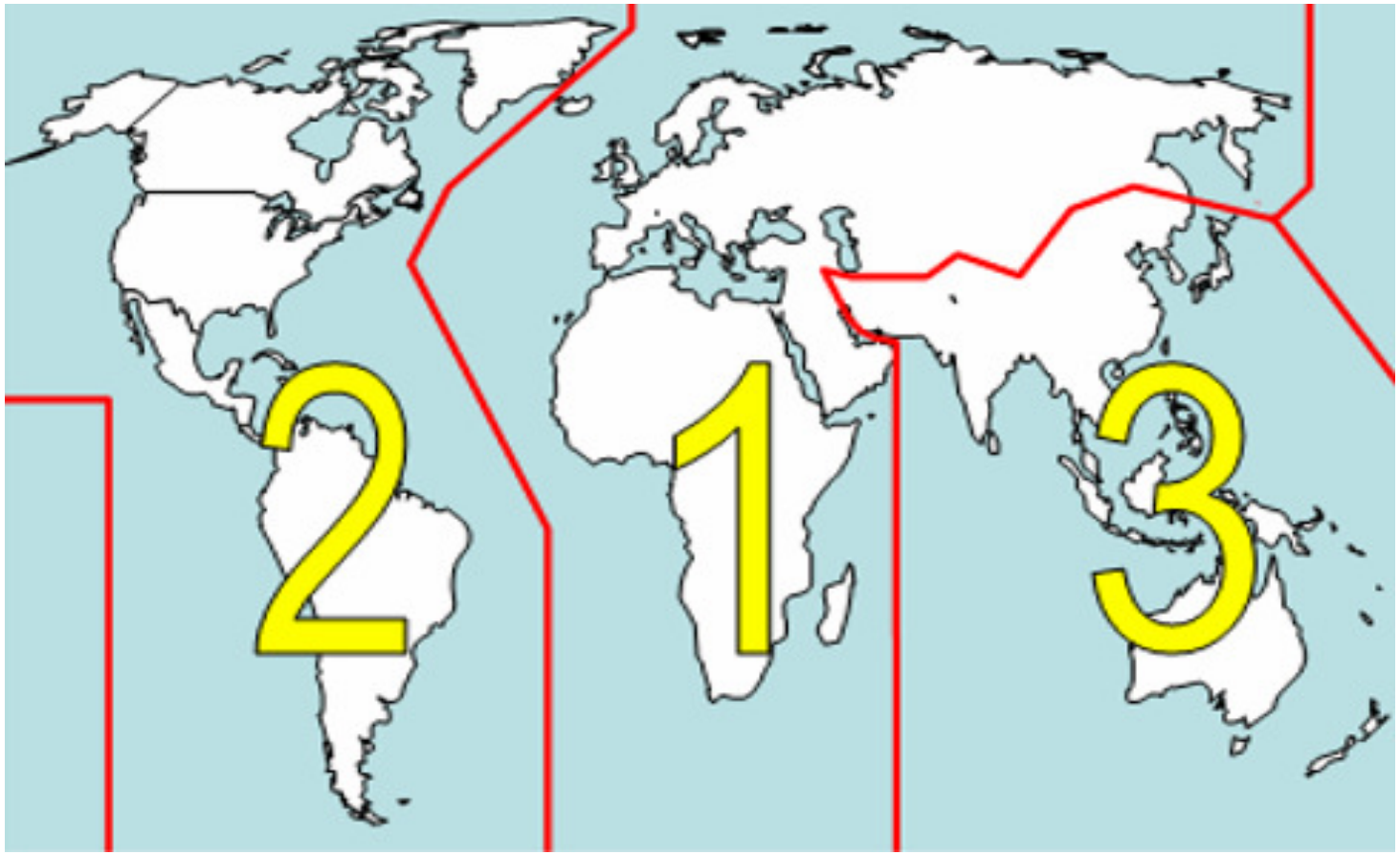
ITU-R

Radiocommunication standardization and global radio spectrum management

Regions of ITU

- For the sake of better spectrum allocations/management, ITU has divided the world into three Regions. Region 1, 2 and 3.
- Region1 includes the whole Europe, Africa, Middle East and northern part of Asia.
- Region 2 covers the Americas.
- Region 3 covers the southern part of Asia, Australia and Oceania.

ITU Regions



Region 1 includes the whole Europe, Africa, Middle East and northern part of Asia.
Region 2 covers the Americas, and
Region 3 – the southern part of Asia, Australia and Oceania.

World Radio Conference (WRC)

- Supreme body in worldwide management and regulation of the radio frequency spectrum.

- The body authorized to revise Radio Regulation (RR). Latest version RR-2016 is effective from January 1, 2017.

- Held normally every four years, based on the national studies and the work of Study Groups reports.

- *The ITU-R study Groups performs:*

  - ⇨ *develop ITU-R Recommendations on the technical characteristics of and operational procedures for radiocommunication services and systems*

  - ⇨ *draft the technical bases for radiocommunication conferences*

  - ⇨ *compile handbooks on spectrum management and emerging radiocommunication services and systems.*

RS for International Mobile Telecom (IMT) including Broadband (BB)Applications

- With the advent of GSM standard in mid-eighties, ITU had been allocating different frequency bands, under ‘Mobile (MO)’ Service category for IMT including Broadband (BB) applications.

- From time to time, until WRC-2015, the frequency bands allocated are: 806-960 MHz, 1710-1885 MHz, 2110–2200 MHz, 2300-2400 MHz, 2500-2690, 450–470 MHz, 470-694/698 MHz, 790–960 MHz, 1710–2025 MHz, 3300-3600 MHz, 1427-1518 MHz, etc

“RR’s” Table of Frequency Allocation of RS for Radio Services (Primary Mode)- A Typical Example

Table of Frequency Allocation 3300-3600 MHz		
Allocation to services (Primary Mode)		
Region 1	**Region 2**	**Region 3**
3 300-3 400 RADIOLO-CATION	3 300-3 400 RADIOLOCATION	3 300-3 400 RADIOLOCATION
3 400-3 600 FIXED FIXED- SATELLITE MOBILE	3 400-3 500 FIXED FIXED- SATELLITE MOBILE	3 400-3 500 FIXED FIXED-SATELLITE
	3 500-3 600 FIXED FIXED- SATELLITE MOBILE	3 500-3 600 FIXED FIXED-SATELLITE MOBILE

- It can be seen that the band 3300-3400 MHz is allocated for RADIOLOCATION service only for all the three regions.
- However, in 3400-3500-3600 MHz bands, besides MOBILE service, FIXED and FIXED-SATTELITE services do exist in the entire three regions except in the 3400-3500 MHz for Region 3.
- Hence, while making use of these bands for IMT applications, series of co-existence studies would need to be carried out with other radio services in those bands.

Agenda Items for WRC-2019 (Scheduled from October 28-November 22, 2019)

Agenda Item Number	Title
1.11	to evolve harmonized frequency bands for railway radiocommunication systems between train and trackside within existing mobile service allocations.
1.12	to consider possible global or regional harmonized frequency bands, for the implementation of Intelligent Transport Systems (ITS) under existing mobile-service allocations.
1.13#	to identify the frequency bands for the future International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis.
1.15	to identify frequency bands for the land-mobile and fixed services applications operating in the frequency range 275-450 GHz (a sub-band in THz).
Without Number	As regards the radio spectrum aspects of IoT, the study should be primarily on the possible harmonized use of spectrum to support the implementation of narrow-band and broadband machine-type communication

- **#** Carry out studies to determine the spectrum needs for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz. More precisely, 24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz, 81-86 GHz, 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz.
- Further, the sharing and compatibility studies shall be conducted related to adjacent bands, considering the protection of services to which the band is allocated on a primary basis.
- In order to develop draft text, a Task Group (TG) 5/1 was constituted by ITU. TG had six meetings, and concluded its studies, on the spectrum needs, technical and operational characteristics including protection criteria for the existing services allocated in the same and/or adjacent bands by considering different propagation models and technical parameters.

- For the sake illustrations, we present an overview of studies conducted by different Study Groups of ITU-R, in the frequency bands namely 24.25-27.5 GHz, 66-76 GHz and 81-86 GHz. These bands are proposed for IMT-2020, i.e. 5G applications.

- The allocations of radio services for three regions in these frequency bands are enumerated in the next slides.

Frequency Band 24.25-27.5 GHz

24.25-24.45 **FIXED**	**24.25-24.45** **RADIONAVIGATION**	**24.25-24.45** **RADIONAVIGATION** **FIXED** **MOBILE**
24.45-24.65 **FIXED** **INTER-** **SATELLITE**	24.45-24.65 INTER-SATELLITE RADIONAVIGATION	24.45-24.65 FIXED INTER- ATELLITE MOBILE RADIONAVIGATION
24.65-24.75 **FIXED** **FIXED-** **SATELLITE** **INTER-** **SATELLITE**	24.65-24.75 INTER-SATELLITE RADIOLOCATION- SATELLITE	24.65-24.75 FIXED FIXED- SATELLITE- INTER SATELLITE MOBILE
24.75-25.25 **FIXED** **FIXED-** **SATELLITE**	24.75-25.25 FIXED-SATELLITE	24.75-25.25 FIXED FIXED-SATELLITE MOBILE

25.25-25.5	**FIXED** **INTER-SATELLITE** **MOBILE**
25.5-27	**EARTH EXPLORATION** **SATELLITE** **FIXED** **INTER-SATELLITE** **MOBILE** **SPACE RESEARCH**
27-27.5 **FIXED** **INTER-** **SATELLITE** **MOBILE**	27-27.5 FIXED FIXED-SATELLITE INTER-SATELLITE MOBILE

71-74 GHz	**FIXED** **FIXED-SATELLITE** **MOBILE** **MOBILE-SATELLITE**
74-76 GHz	FIXED FIXED-SATELLITE MOBILE BROADCASTING BROADCASTING-SATELLITE SPACE RESEARCH

81-84	**FIXED** **FIXED-SATELLITE** **MOBILE** **MOBILE-SATELLITE** **RADIO ASTRONOMY**
84-86	FIXED FIXED-SATELLITE MOBILE RADIO ASTRONOMY

- It can be seen that 25.25-27, 71-76 and 81-86 GHz, which are potentially good candidates for IMT applications for all the three regions uniformly subject to successful coexistence studies with the other radio services in those bands.
- Concisely, as enumerated for the above three frequency bands, it is amply clear that there is earmarking of more than one radio service in a band (s)/sub-band(s).
- Therefore, the respective application in a service area of operation (AoO) shall have to limit the number of frequencies to the minimum essential in order to provide a satisfactory existence of another service (s) by applying the latest technical advances and spectrum efficient techniques.
- It is required to setup a radio station(s) in such a way that they do not cause harmful interference to the other radio services or communications/applications.

SHARING AND COMPATIBILITY STUDIES

- As mentioned that TG 5/1 undertook series of sharing studies in several frequency bands, required for co-existence of different services/applications.
- The studies reported by this Task Group have been briefly described in the three frequency bands in mm range by assuming some technical parameters of satellite and IMT networks.

➢ *Study of Interference Simulations from IMT Networks Towards GSO FSS Satellite in The Frequency Band 24.25-27.5 GHz;*

➢ *Sharing and Compatibility Studies of IMT Systems in The Frequency Band 71-76 GHz; and*

➢ *Sharing and Compatibility Studies of IMT Systems in The Frequency Band 81-86 GHz.*

Summary of Results of Interference Studies

- **Frequency Band 24.25-27.5 GHz**- the effect of aggregate interference from the IMT networks towards FSS is low with the average interference being far below the noise floor of the FSS receiver. The studies reveal that there is no harmful interference from IMT stations to FSS stations and hence sharing between both the applications is possible.
- **Frequency Band 71-76 GHz-** The results of the studies reveal that with a separation distance of 250 m between IMT BS and the FSS earth station, the aggregate interference level does not exceed the FSS interference threshold. This leads feasibility of coexistence between IMT and the FSS in the 71-76 GHz band.
- **Frequency Band 71-76 GHz-** The results show that IMT BS deployments do not exceed the FSS interference threshold. Further, the results reveal that with a separation distance of 250 m between IMT BS and FSS earth station, the aggregate interference level does not exceed the IMT BS interference threshold.

WRC-2019: Agenda Item No. 1.15

- To identify frequency bands for the land-mobile and fixed services applications operating in the frequency range 275-450 GHz (a sub-band in THz).
- It is also true that in Frequency Allocation Table (FAT) of RR, there are no allocations beyond 275 GHz. WRC-2015 on considering these facts have opened 275-450 GHz band for studies as an Agenda item of WRC-2019.
- As per existing RR, some portion of 275-450 GHz is identified for use for passive service applications, namely, radio astronomy service, Earth exploration-satellite service (passive) and space research service (passive). 450-1000 GHz can be used both for passive and active services.
- The use of this range of band by the passive services does not preclude use by the active services. For doing so, active service applicants should take all steps to protect passive services from harmful interference until the date when the Table of Frequency Allocations is established in the frequency band 275-450 GHz (likely in WRC-19).

An Important ITU's Study Question

- ITU-R has established a Study Question in developing propagation models in the frequency range from 300 MHz to 100 GHz range for the design of short-range wireless radio communication systems and wireless local area networks (WLAN) operating in indoors, outdoors, and indoor-to-outdoors.
- Also, to study (i) the effect of different building and furnishing materials in the indoor environment, (ii) effect of movement of persons & objects within room/corridors on propagation characteristics, and (iii) the effect of building structures and vegetation, in the outdoor environment.
- These studies are proposed to be completed by 2019 and results shall be included in Reports/Recommendations.
- A layout of Question is elucidated in next slide.

Continued…

The ITU ,

Considering that

a. many new short-range personal communication systems are being developed which will operate indoors as well as outdoors;

b. future mobile systems (e.g. IMT) will provide personal communications, indoors (office or residential) as well as outdoors;

c. there is a high demand for wireless local area networks (WLANs) and wireless private business exchanges (WPBXs), as demonstrated by existing products and intense research activities;

d.. short-range systems using very low power have many advantages for providing services in the mobile and personal environment;

e. there are only limited propagation measurements available in some of the frequency bands being considered for short-range systems;

Continued…

decides that the following Questions should be studied

a. What propagation models should be used for the design of short-range systems operating indoors, outdoors, and indoor-to-outdoors (operating range less than 1 km) including wireless communication, and WLANs etc.?

b. In the outdoor environment, what are the effect of building structures and vegetation as regards shadowing, diffraction, and reflection?

c. What effect does the movement of persons and objects within the room, possibly including the movement of one or both ends of the radio link, have on the propagation characteristics; and

d. What variables are necessary for the model to account for different types of buildings etc.

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Thanks for the Patience