ITU-R studies in support of the Internet of Things

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The Internet of Things

The ITU Global Standards Initiative on Internet of Things defined the IoT as "the infrastructure of the information society“. It enables a wide range of devices to be sensed or controlled remotely and to exchange data through connection to the Internet network infrastructure.

The range of application of IoT is very broad – extending from smart clothing, to smart cities, to global monitoring systems. To meet these varied requirements, a range of access technologies, both wired and wireless, are required to provide access to the network.

While most current IoT applications use wired technologies and short-range wireless technologies, these are now being augmented by the deployment of low power wide area networks and optimized mobile cellular and satellite systems.

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Wireless access

The spectrum requirements and standards for IoT wireless access technologies and techniques are being addressed in ITU-R, including:

- protection of radio services from power line telecommunication system emissions
- harmonization of frequency ranges, technical and operating parameters used for the operation of short range devices
- standards for wide area sensor and actuator network systems
- spectrum to support the implementation of narrowband and broadband machine-type communication infrastructures
- support for massive machine-type communications within the framework of the standards and spectrum for IMT-Advanced (4G) and IMT-2020 (5G)
- use of fixed-satellite and mobile-satellite communications for IoT

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Resolution ITU-R 66: *Studies related to wireless systems and applications for the development of the Internet of Things*

- Different radiofrequency bands, many of which provide communication channels, infrastructure and capacity, could be used in IoT deployment with the aim of ensuring cost-effective deployment and efficient use of the radiofrequency spectrum
- IoT is a concept encompassing various platforms, applications, and technologies that are, and will continue to be, implemented under a number of radiocommunication services
- The implementation of IoT currently does not require specific regulatory provisions in the Radio Regulations

➢ ITU-R is invited to conduct studies on the technical and operational aspects of radio networks and systems for IoT

➢ Development of ITU-R Recommendations, Reports and/or Handbooks as appropriate, on the basis of the studies

Source: Resolution ITU-R 66 http://www.itu.int/pub/R-RES-R.66

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Studies on Power Line Telecommunication (PLT)

- **Question ITU-R 221-2/1 calls for studies of acceptable levels of radiation from telecommunication systems utilizing wired electrical power supply so as not to impair the performance of radiocommunication systems**

- **Reports ITU-R SM.2158 and ITU-R SM.2212 on Impact of PLT systems on radio systems operating below 80 MHz and in the VHF and UHF bands above 80 MHz**
  - ✓ Illustrates the potential for interference to various radiocommunication services in the presence of emissions/radiation from PLT systems and devices
  - ✓ Describes the radio-frequency emission/radiation characteristics of PLT systems as well as the characteristics and protection criteria of radiocommunication systems
  - ✓ Discusses potential methods for mitigating interference from PLT emissions

Sources: Question ITU-R 221-2/1 http://www.itu.int/pub/R-QUE-SG01.221
Report ITU-R SM.2158 http://www.itu.int/pub/R-REP-SM.2158
Report ITU-R SM.2212 http://www.itu.int/pub/R-REP-SM.2212

Studies mainly by ITU-R WP 1A

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Resolution ITU-R 54 on Short Range Devices (SRDs)

- **Achieve Harmonization for SRDs** for Economies of scale; Technological advances / Tuning ranges; Spectrum sharing; Integration in consumer products crossing borders
  - ✓ Harmonization of technical and operating parameters (use advanced technologies)
  - ✓ Measurement procedures to verify these parameters and ensure protection to radio services
  - ✓ Deployment in specific bands, harmonised globally or regionally (may ease the use of relevant frequency bands/tuning ranges, preferably on a global or regional basis)
  - ✓ Recognized role played by some SRDs in the Internet of Things (IoT)

- Technical & operating parameters and spectrum use for SRDs (Rep. ITU-R SM.2153)
- Frequency ranges for global/regional harmonization of SRDs (Rec. ITU-R SM.1896)
- Other on-going studies on global harmonization of SRD Categories & for IoT Deployment

Source: Resolution ITU-R 54-2 http://www.itu.int/pub/R-RES-R.54

Studies mainly by ITU-R WP 1B

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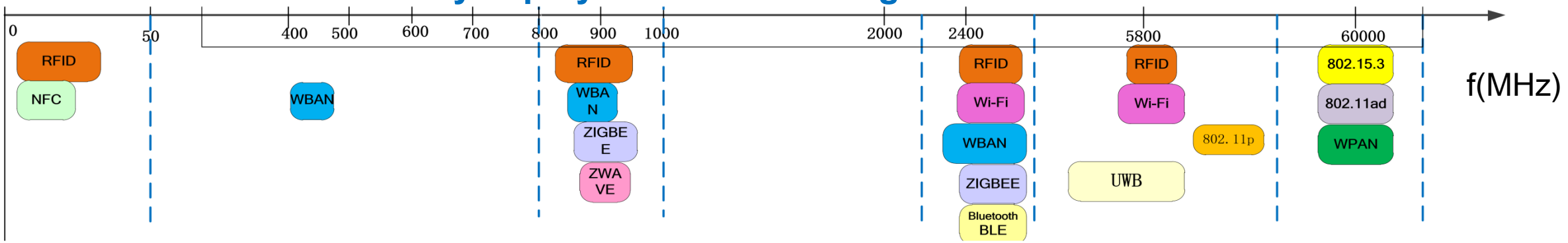
Typical applications supported by SRDs

Class	Applications	Technologies
Personal Area Networks (PANs)	Headsets, device links (e.g. medical/sport to iPhone)	Bluetooth®(2.4 GHz)
Home Area Networks (HANs)	Alarms, Home Automation, Smart Lighting (sub GHz)	ZigBee® (2.4 GHz), KNX® (868-870 MHz), Wideband Networking such as IEEE 802.11ah (sub GHz)
RFID (See Report ITU-R SM.2255)	Tag reading, Ticketing, payment cards, car tolls	Sub GHz (4-channel plan) and 2.4 GHz
Metropolitan Area Networks (MANs)	Sensing and control applications	Low Power Wide Area Networks (LPWAN – LoRa™ and SigFox) (sub GHz); Wi-SUN (sub GHz) Low speed metering networks (169 MHz)
Satellite M2M	Truck tracking, remote sensor reading	Under study at 862-863 MHz

Some widely deployed SRD technologies in Sub 6 GHz bands



Source: Presentations at the ITU Workshop on Spectrum Management for IoT Deployment (www.itu.int/go/ITU-R/RSG1SG5-IoT-16)

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Studies on Wide-area Sensor and Actuator Network (WASN) Systems

Wide-area sensor and/or actuator network (WASN) systems support machine-to-machine communications to a large number of sensors and/or actuators.

- Recommendation ITU-R M.2002 "*Objectives, characteristics and functional requirements of wide-area sensor and/or actuator network (WASN) systems*". The key objective of WASN systems is to support machine-to-machine service applications irrespective of machine location.
- Report ITU-R M.2224 "*System design guidelines for wide area sensor and/or actuator network (WASN) systems*". The Report provides detailed information for system design policy, the wireless applications and examples of WASN systems for information sharing.

Studies by ITU-R WP 5A

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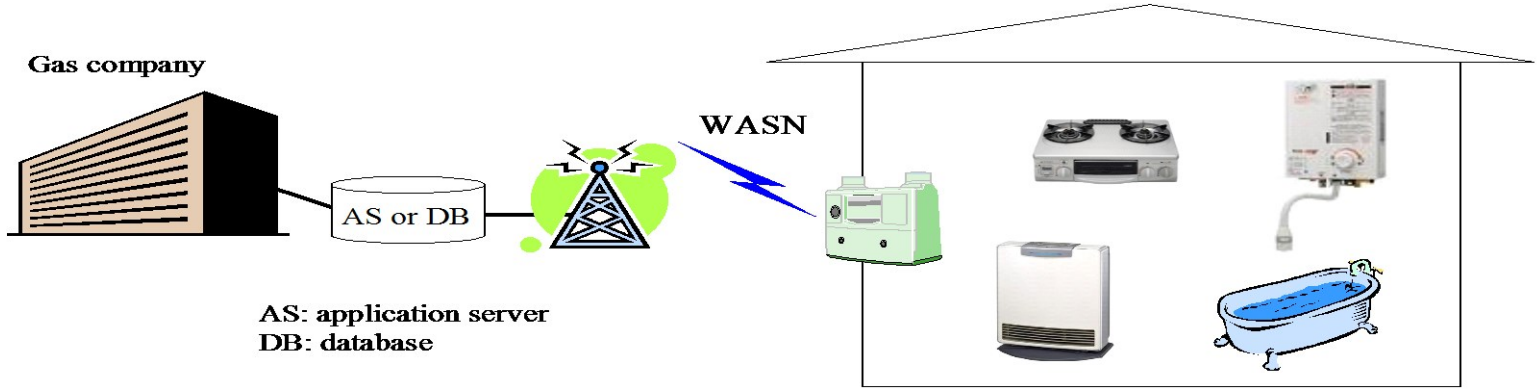
WASN – 2 main network functionalities

- *Automatic sensing and information collection*: automatically collect the information acquired by sensors and send it to application servers (ASs) or databases (DBs) via the core network.



- *Remote actuator control*: control actuators remotely using ASs via the core network.

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Resolution 958 (WRC-15) - Urgent studies required in preparation for WRC-19 – Annex item 3

- Studies on the technical and operational aspects of radio networks and systems, as well as spectrum needed, including possible harmonized use of spectrum to support the implementation of narrowband and broadband machine-type communication infrastructures, in order to develop Recommendations, Reports and/or Handbooks, as appropriate, and to take appropriate actions within the ITU Radiocommunication Sector (ITU-R) scope of work
  - WRC-19 agenda item 9.1 issue 9.1.8 (Reference: Circular Letter CA/226)

Responsible group: WP 5D
Contributing groups: WP 1B, WP 5A

Sources: Resolution 958 (WRC-15) https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A00000C0024PDFE.pdf

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IMT - International Mobile Telecommunications

IMT support for IoT:

- In the short term, the current IMT-Advanced 4G standard (Rec. ITU-R M.2012) is being enhanced to include support for IoT (e.g. NB-IoT systems).
- In the longer term, IoT is seen as an integral element of the IMT-2020 5G standard being developed in ITU – extending the benefits of the IMT massive economies of scale and globally harmonized frequencies and standards to all industry sectors.
- The framework and overall objectives of the future development of IMT for 2020 and beyond is detailed in Recommendation ITU-R M.2083.

Studies by ITU-R WP 5D

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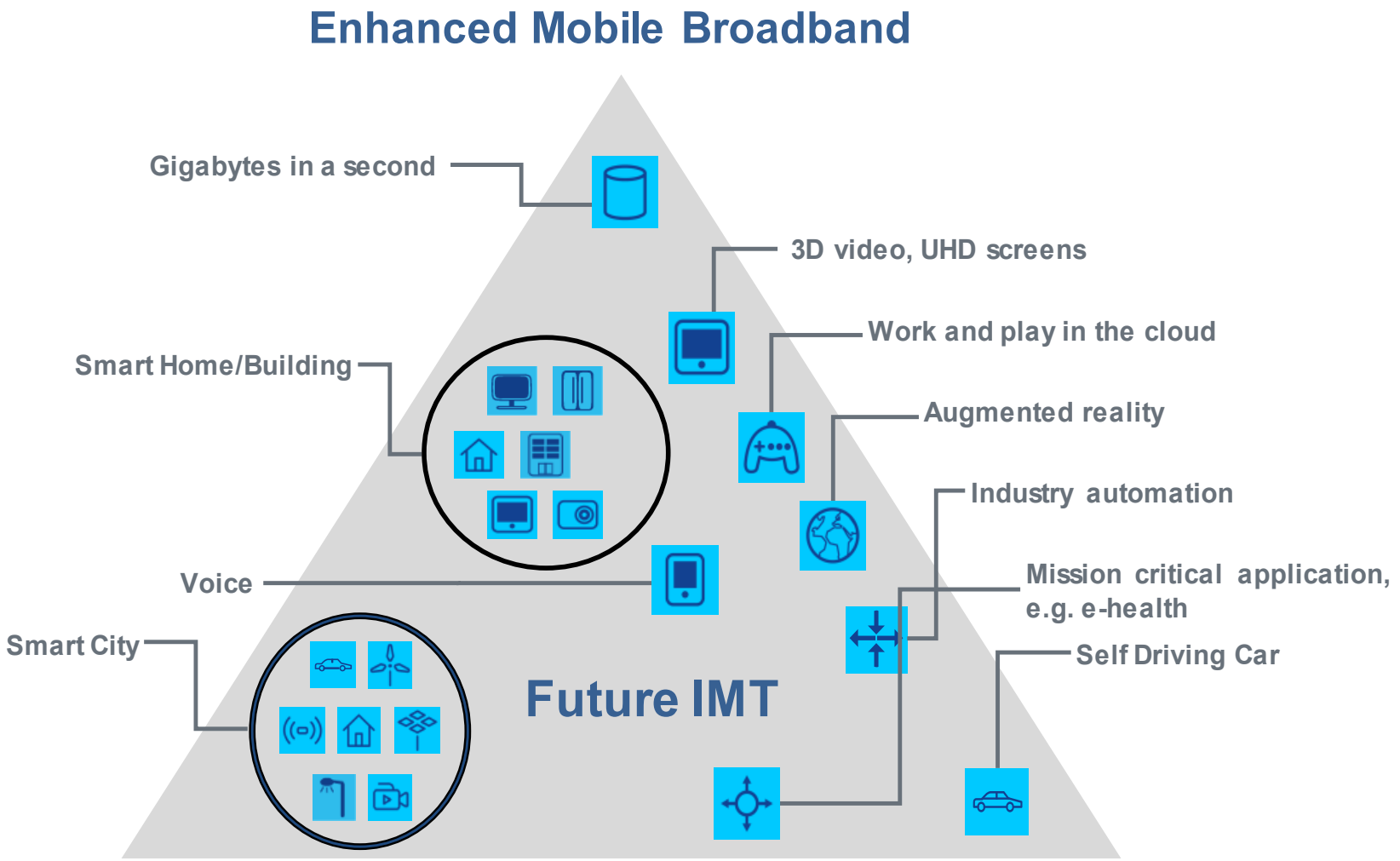
5G usage scenarios



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Integration of satellite systems into Next Generation Access Technologies

- Satellites cover a wide area with high capacity and can instantaneously connect any place within their footprint, allowing rapid connection of cities, villages, businesses and homes with a predictable quality of service.

- In addition, satellite networks are less vulnerable to natural disasters and similar incidents than their terrestrial counterparts – an intrinsic property that makes them the preferred delivery method for highly secure and mission-critical services.

- Satellites may help to accelerate the commercially viable development of Next Generation Access Technologies anywhere in the world, provided a number of satellite-specific issues are considered.

- Both geostationary and non-geostationary satellite networks have their specific benefits for integration of satellite-based solutions into Next Generation Access Technologies.

Studies by ITU-R WP 4B

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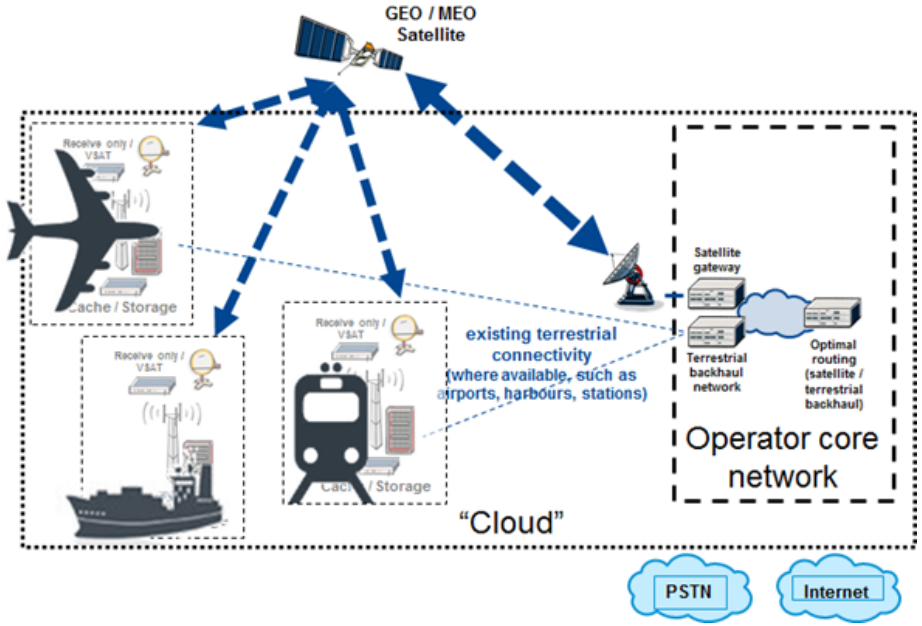
Example use case - Communications on the Move



- This use case is about high speed backhaul connectivity to individual planes, trains and vessels (including cruise ships and other passenger vessels), with the ability to multicast the same content (e.g. video, HD / UHD TV, as well as other non-video data) across a large coverage (e.g. for local storage and consumption). The same capability also allows for the efficient backhauling of aggregated IoT traffic from these moving platforms, for instance, IoT devices on containers (e.g. for tracking and tracing) connected via a Relay UE on a transport vehicle such as a ship, train or truck.

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Summary

- A variety of radio technologies will be used to implement the Internet of things, extending from short range devices to wide area sensor networks and global terrestrial IMT systems as well as satellite systems.

- The ITU-R Study Groups are developing technical and operational standards to facilitate the deployment of IoT on a global basis, including harmonized frequency spectrum and appropriate regulatory regimes.

- Associated aspects will also be addressed at the forthcoming World Radiocommunication Conference 2019 (WRC-19) agenda items 1.11, 1.12, 1.13, 1.16 and 9.1 (issues 9.1.5 & 9.1.8)

Your participation in these activities is more than welcome!

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Thank you!

ITU-R Study Groups: www.itu.int/ITU-R/go/rsg; Email: brsgd@itu.int

ITU-R Study Group 1 – Spectrum management
www.itu.int/ITU-R/go/rsg1 ; Email: rsg1@itu.int

ITU-R Study Group 4 – Satellite services
www.itu.int/ITU-R/go/rsg4 ; Email: rsg4@itu.int

ITU-R Study Group 5 – Terrestrial services
www.itu.int/ITU-R/go/rsg5 ; Email: rsg5@itu.int

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Additional information on relevant WRC-19 agenda items and issues

WRC-19 agenda Item	Issue	WRC Resolution	Responsible Group(s)	Information from Responsible Group(s)
1.11		**Res. 236 (WRC-15)**	**WP 5A**	Doc. 5A/298 Sections 3.4, 3.7 & 4 and Annexes 6 (c), 7 (b) & 16
to take necessary actions, as appropriate, to facilitate global or regional harmonized frequency bands to support **railway radiocommunication systems** between train and trackside within existing mobile service allocations, in accordance with Resolution **236 (WRC-15)**;				
1.12		**Res. 237 (WRC-15)**	**WP 5A**	Doc. 5A/298 Sections 3.7 & 4 and Annexes 8 (c), 9 (b) & 30
to consider possible global or regional harmonized frequency bands, to the maximum extent possible, for the implementation of evolving **Intelligent Transport Systems (ITS)** under existing mobile-service allocations, in accordance with Resolution **237 (WRC-15)**;				
1.13		**Res. 238 (WRC-15)**	**TG 5/1**	Doc. 5-1/15 and its annexes
to consider identification of frequency bands for the future development of **International Mobile Telecommunications (IMT)**, including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution **238 (WRC-15)**;				
1.16		**Res. 239 (WRC-15)**	**WP 5A**	Doc. 5A/298 Sections 3.6 & 4 and Annexes 10 (c), 11 (b), 23, 24, 25, 26 & 27
to consider issues related to wireless access systems, including radio local area networks (**WAS/RLAN**), in the frequency bands between 5 150 MHz and 5 925 MHz, and take the appropriate regulatory actions, including additional spectrum allocations to the mobile service, in accordance with Resolution **239 (WRC-15)**;				
9.1	**9.1.5**	**Res. 764 (WRC-15)**	**WP 5A**	Doc. 5A/298 Annexes 12 (c) & 13 (b)
Consideration of the technical and regulatory impacts of referencing Rec. ITU R M.1638-1 and ITU R M.1849-1 in Nos. 5.447F and 5.450A of the RR				
9.1	**9.1.8**	**Res. 958 (WRC-15)**	**WP 5D**	Doc. 5D/530, Chapter 3, Attachments 3.10 (a), 3.11 (c), 3.12 (b), 3.16 & 3.17
Urgent studies required in preparation for WRC-19 - **Narrowband and broadband machine-type communication infrastructures**				

WRC-19 Agenda and relevant Resolutions

Source: www.itu.int/go/rcpm-wrc-19-studies

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SRDs Terms and Definitions

Short Range (radio or radiocommunication) Devices

- For the purpose of Report ITU-R SM.2153 the term SRD is intended to cover radio transmitters providing either unidirectional or bidirectional communication and which have low capability of causing interference to other radio equipment
- SRDs are permitted to operate on a non-interference and non-protected basis, subject to relevant standards or national regulations
- Simple licensing requirements may be applied, e.g. general licences or general frequency assignments or even licence exemption, however, information about the regulatory requirements for placing SRD equipment on the market and for their use should be obtained by contacting individual national administrations

Ultra-wideband technology (UWB): Technology for SRD, involving the intentional generation and transmission of radio-frequency energy that spreads over a very large frequency range, which may overlap several frequency bands allocated to radiocommunication services (see e.g. Rec. ITU-R SM.1755 & Rec. ITU-R SM.1756)

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SRDs use in many countries & regions

- Report ITU-R SM.2153 - Technical and operating parameters and spectrum use for SRDs
  - Provides SRD definitions and short description of different applications using SRDs, e.g.:
    Telecommand, Telemetry, Voice and video, Detecting avalanche victims, RLANs, Railway applications, Road transport and traffic telematics, Detecting movement and equipment for alert, Alarms, Model control, Inductive applications (e.g. car access), Radio microphones, RFID, ULP-active medical implant, Wireless audio applications (e.g. cordless loudspeakers), RF (radar) level gauges), among many others not listed
  - Indicates typical technical characteristics/limitations: Common frequency ranges; required radiated power or magnetic/electric field-strength values to allow satisfactory operation (for CEPT countries, USA(FCC)/B/CAN, J and KOR, etc.); Antenna requirements
  - Explains administrative requirements: certification and verification; licensing requirements; mutual agreements between countries/regions
  - Provides also useful information on national/regional rules (incl. technical and operational parameters and spectrum use)
- Report updated on regular basis

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On-going SRD harmonization activities (1/2)

- Rec. ITU-R SM.1896 – Frequency ranges for global/regional harmonization of SRDs
  - Frequency ranges appropriate for global harmonization:

    9-148.5 kHz; 3 155-3 400 kHz (low power wireless hearing aids, RR No. **5.116**);

    and following ISM bands listed in RR Nos. **5.138** and **5.150**:

    6 765-6 795 kHz; 13 553-13 567 kHz; 26 957-27 283 kHz; 40.66-40.7 MHz;

    2 400-2 500 MHz (up to 2 483.5 MHz in some countries); 5 725-5 875 MHz;

    24.00-24.25 GHz; 61.0-61.5 GHz; 122-123 GHz; 244-246 GHz

    [proposal under consideration for the addition of 3.7-4.8 GHz & 7.25-9 GHz (see note 1)]
  - Frequency ranges appropriate for regional* harmonization:

    (* bands entirely or just partly available in a Region or only in some countries)

    7 400-8 800 kHz (in Reg. 1 & 2 and some Reg. 3 countries);

    312-315 MHz (in Reg. 2 and some countries of Reg. 1 & 3);

    433.050-434.790 MHz (in Reg. 1 and some countries of Reg. 2 & 3);

    862-875 MHz (not in Reg. 2; in Reg. 1 and some Reg. 3 countries);

    875-960 MHz (in Reg. 2 as a tuning range but not available for SRDs in a number of countries due to the use by commercial mobile systems; in some countries of Reg. 1 & 3)

    [proposal under consideration for addition of 3.1-4.8 GHz & 6-9 GHz in some countries of Reg. 1 & 3 (see note 1)]

Note 1: Refer to UWB application for communication, location tracking, radio determination, see Annex 17 to Doc. 1B/123

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On-going SRD harmonization activities (2/2)

- PDN* Rec. ITU-R SM.[SRD–CATEGORIES] – Global harmonization of SRD categories
  - to facilitate the global harmonization process (e.g. global identification of freq. ranges)
  - benefits for end users, manufacturers and regulators (e.g. economies of scale)
  - Non-specific SRD applications (any, can avoid fragmentation of spectrum use and foster innovation)
  - SRD for **transport and traffic telematics** purposes (e.g. car-to-car, car-to-infrastructure)
  - SRD for **radio determination** purposes (e.g. equipment for detecting movement and alert)
  - SRD for **wireless alarms** (SRD applications incl. alarms for security and safety)
  - SRD for **model control** (equipment solely for purpose of controlling movement of the model, in the air, on land or over or under the water surface, e.g. flying models normally limited in weight & height above ground by national regulations)
  - Radio **microphone & audio applications** including aids for the hearing impaired under licence-exempt regulation
  - Radio Frequency Identification applications (**RFID**) (e.g. automatic article identification, asset tracking, waste management, personal identification, access control, proximity sensors, anti-theft systems, etc., often also described as the "internet of things" or "machine-to-machine communications")
  - Ultra low power active **medical** implant (**ULP-AMI** typically used to support and improve quality of people's lives, e.g. regulating heart rates, administering pharmaceuticals, treating neurological tremors, etc.)

* Preliminary draft new, see Annex 14 to Doc. 1B/123

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WASN applications

- automation and efficiency enhancement of business works such as remote meter-reading of utilities, i.e. water, gas, and electricity;
- meteorological observation such as air temperature and humidity measurement;
- environment observation, forecasting, and protection such as environmental pollution observation, including air, water, and soil;
- crime prevention and security, such as intrusion detection, child tracking;
- healthcare, medical applications, and welfare support such as monitoring of vital parameters (e.g. body temperature, weight, and heart rate);
- remote control and monitoring of plant facilities and goods distribution;
- disaster prevention and measures, such as disaster notification;
- smart homes and control commercial building, such as home and office appliance networking;
- intelligent transportation and traffic management systems;
- monitoring of avian species that may carry the avian influenza virus.

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IMT - International Mobile Telecommunications

- All of today's 3G and 4G mobile broadband systems are based on the ITU's IMT standards.
- ITU established the detailed specifications for **IMT-2000** and the first "3G" deployments commenced around the year 2000.
- In January 2012, ITU defined the next big leap forward in wireless cellular technology – **IMT-Advanced** – and these 4G systems are now being progressively deployed worldwide.
- The development of standards and identification of spectrum for **IMT-2020** is now well underway, once again using the highly successful partnership ITU-R has with the mobile broadband industry and the wide range of stakeholders in the 5G community.

Studies by ITU-R WP 5D

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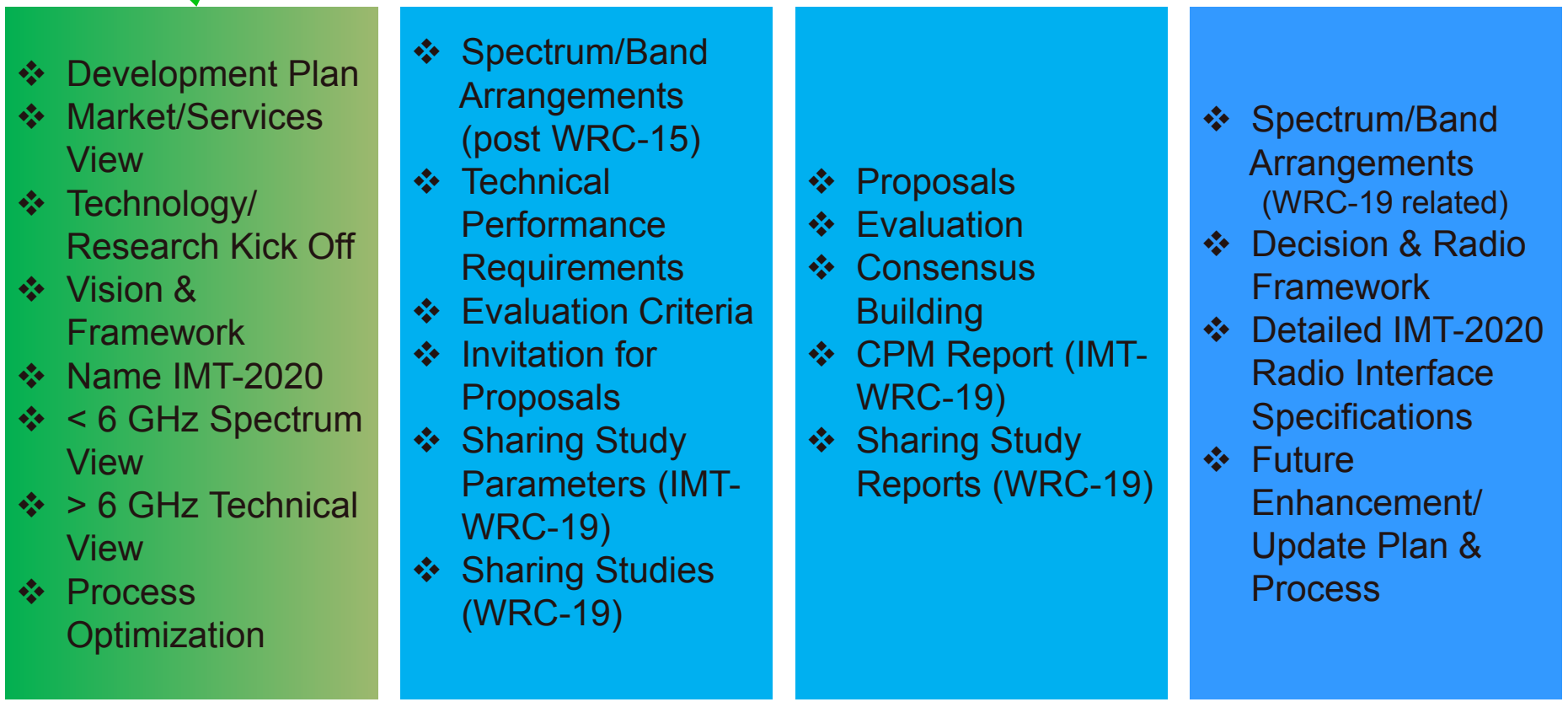
IMT-2020 Standardization Process – Where we are and what is ahead



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