IoTs – Overview of the Ecosystem

Training on Planning Internet of Things (IoTs) Networks

Bandung - Indonesia
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Aamir Riaz
International Telecommunication Union – Regional Office for Asia and the Pacific
aamir.riaz@itu.int

Scope

- IoTs?
- Design and Planning requirements
- IMT and IoT
- Going forward

Internet of Things – IoTs?

IoT? (Some Industry Definitions)

- *A network connecting (either wired or wireless) devices, or 'things', that is characterized by autonomous provisioning, management, and monitoring. The IoT is innately analytical and integrated* **(IDC)**

- *IoT is the next evolution of the Internet, connecting the unconnected people, processes, data, and things in your business today* **(Cisco)**

- *IoT devices as those capable of two-way data transmission (excluding passive sensors and RFID tags). It includes connections using multiple communication methods such as cellular, short range and others.* **(GSMA)**

- *Sensors & actuators connected by networks to computing systems. These systems can monitor or manage the health and actions of connected objects and machines. Connected sensors can also monitor the natural world, people, and animal"* **(McKinsey)**

IoT?

- **Resolution ITU-R 66** *(recognizing "**c**")*

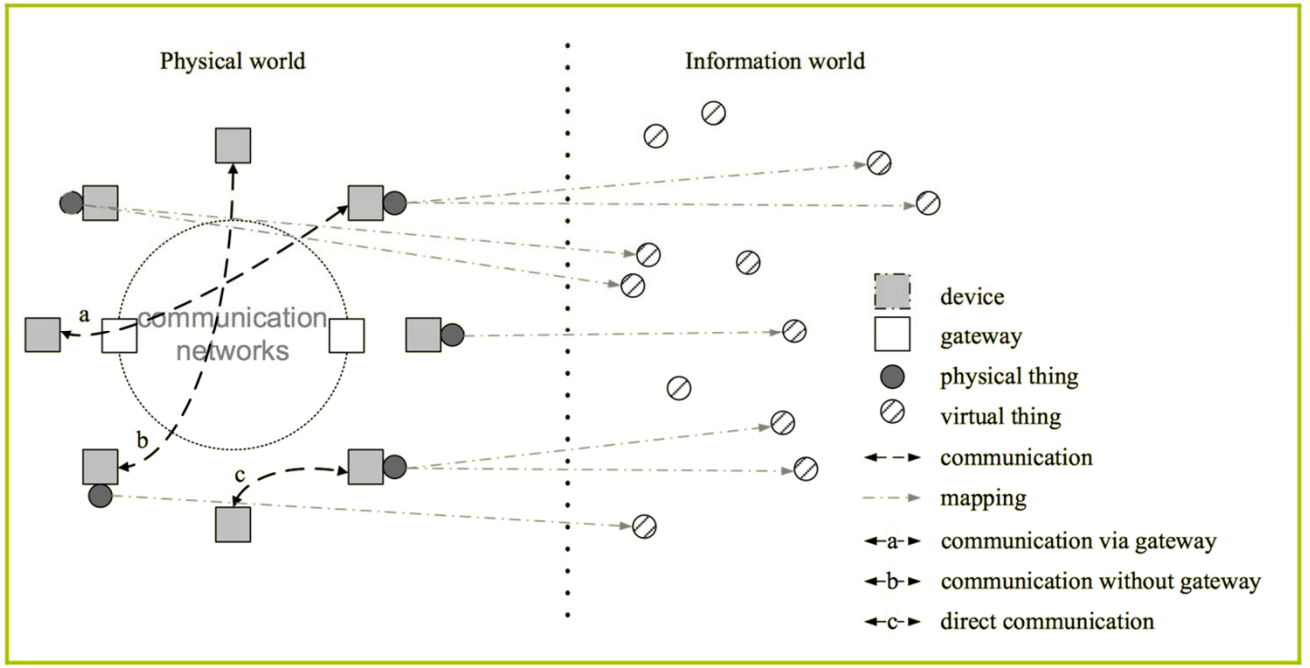
IoT is a concept encompassing various platforms, applications, and technologies implemented under a number of radio communication services

- **ITU-T Recommendation [Y.2060 renamed as Y.4000]**

A global infrastructure for the information society, enabling advanced services by interconnecting (physical & virtual) things based on existing and evolving interoperable information and communication technologies

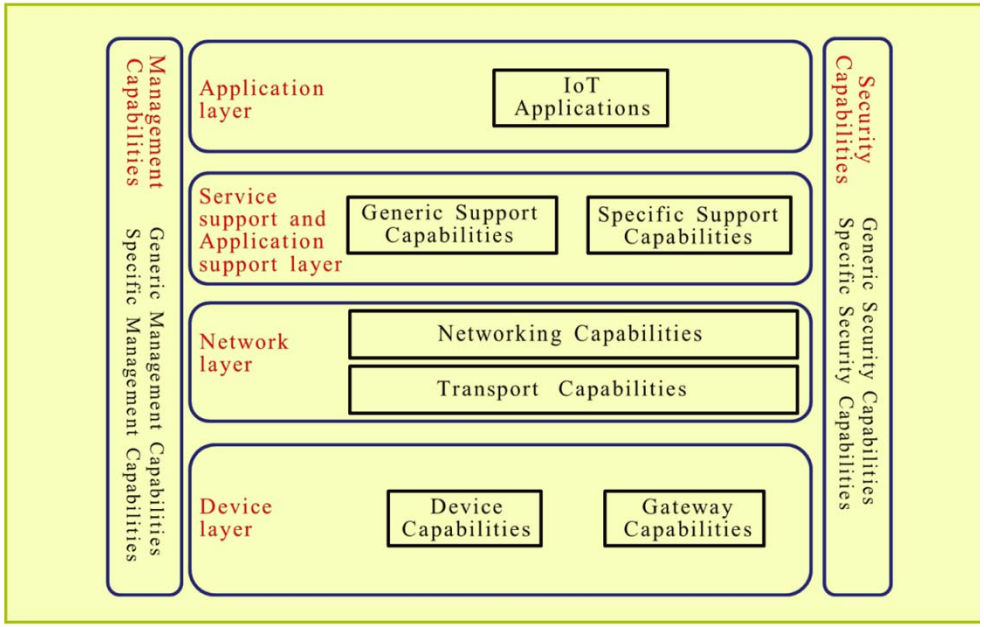
Internet of Things - ITU Definition

- **Physical things**
  - Exist in the physical world and are capable of being sensed, actuated and connected.
  - Examples: industrial robots, goods and electrical equipment.
- **Virtual things**
  - Exist in the information world and are capable of being stored, processed and accessed.
  - Examples: Multimedia content, application software.

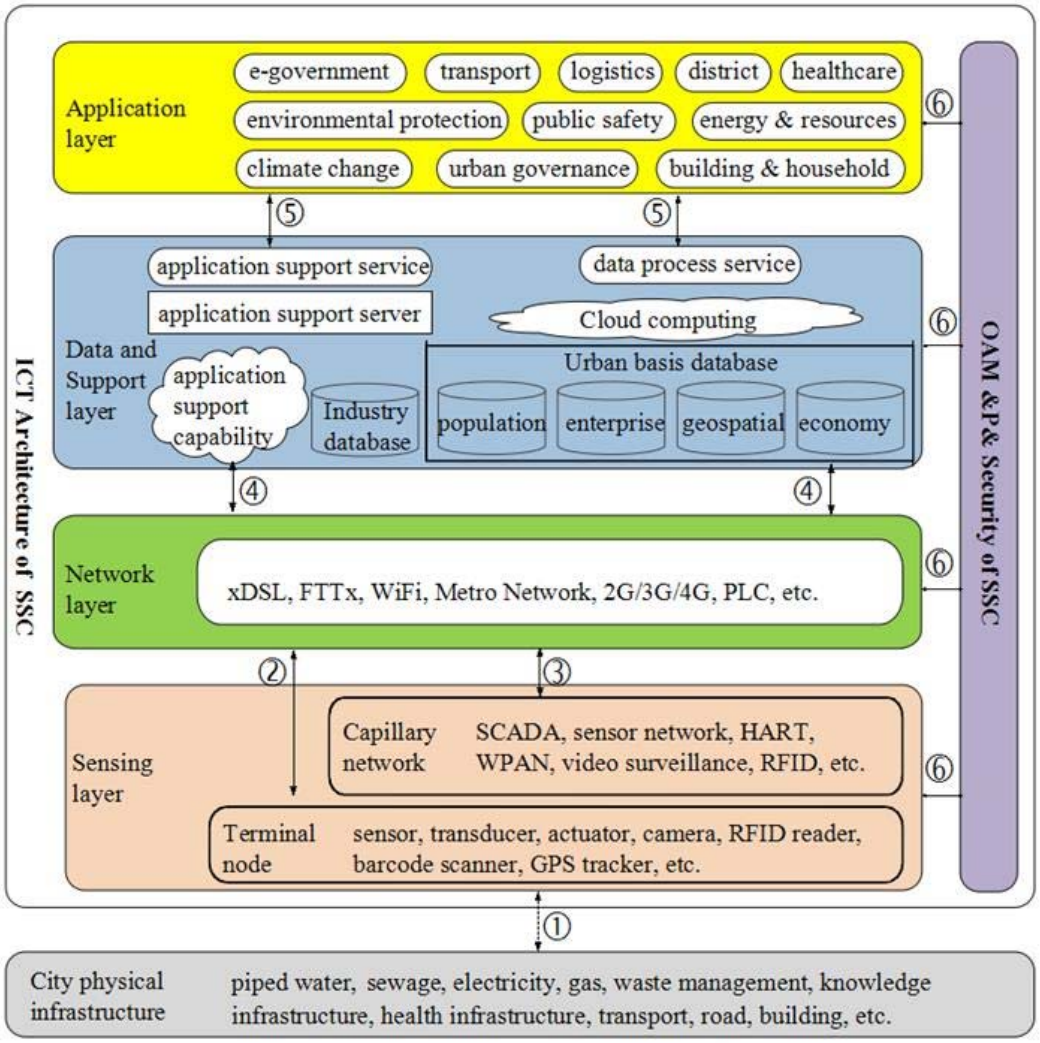


Source: Recommendation **ITU-T Y.2060**

IoT reference model

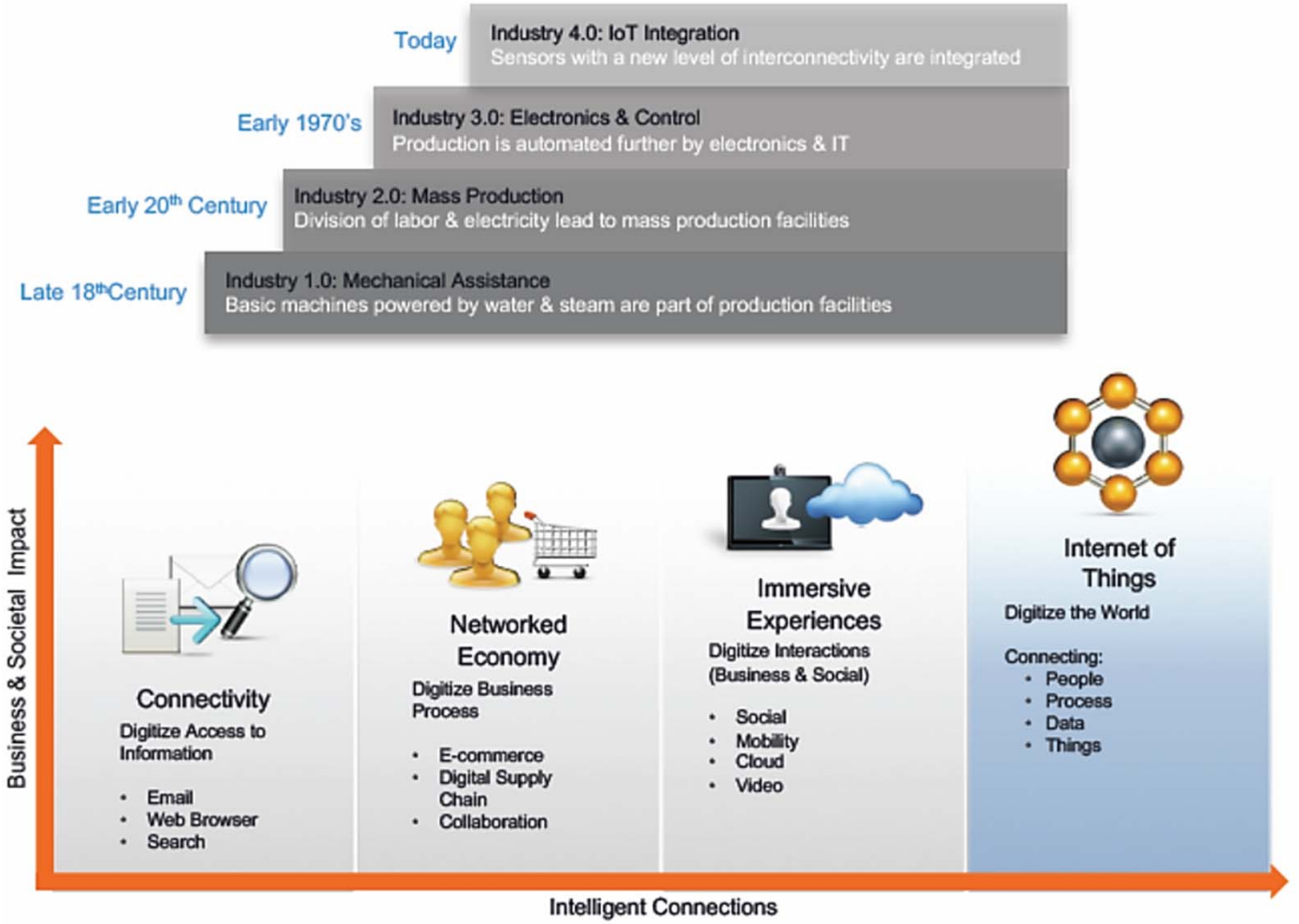


Source: Recommendation **ITU-T Y.2060**



A multi-tier SSC (smart sustainable city) ICT architecture from communication view
Source: ITU-T Focus Group on Smart Sustainable Cities: *Overview of smart sustainable cities infrastructure*

IoTs and Industry 4.0



IoT & Standards-based protocols are helping IT and OT converge and drive new economic value streams

The Convergence of IT and OT

- **Information Technology** (IT) supports connections to the internet along with related data and technology systems and is focused on the secure flow of data across and organization
- **Operational Technology** (OT) monitors and controls devices and processes on physical operational systems (assembly lines, utility distribution networks, production facilities, roadway systems etc.

- Typically, IT does not get involved with the production and logistics of OT environments

Source: ITU CoE training on BB networks planning, Bangkok, Sep 2017

IoT?

- **Wireless Technologies**

- **Diversity of IoT application requirements:**
  - Varying bandwidth requirements (how much information is sent)
  - Long-range vs short-range
  - Long battery life
  - Various QoS requirements

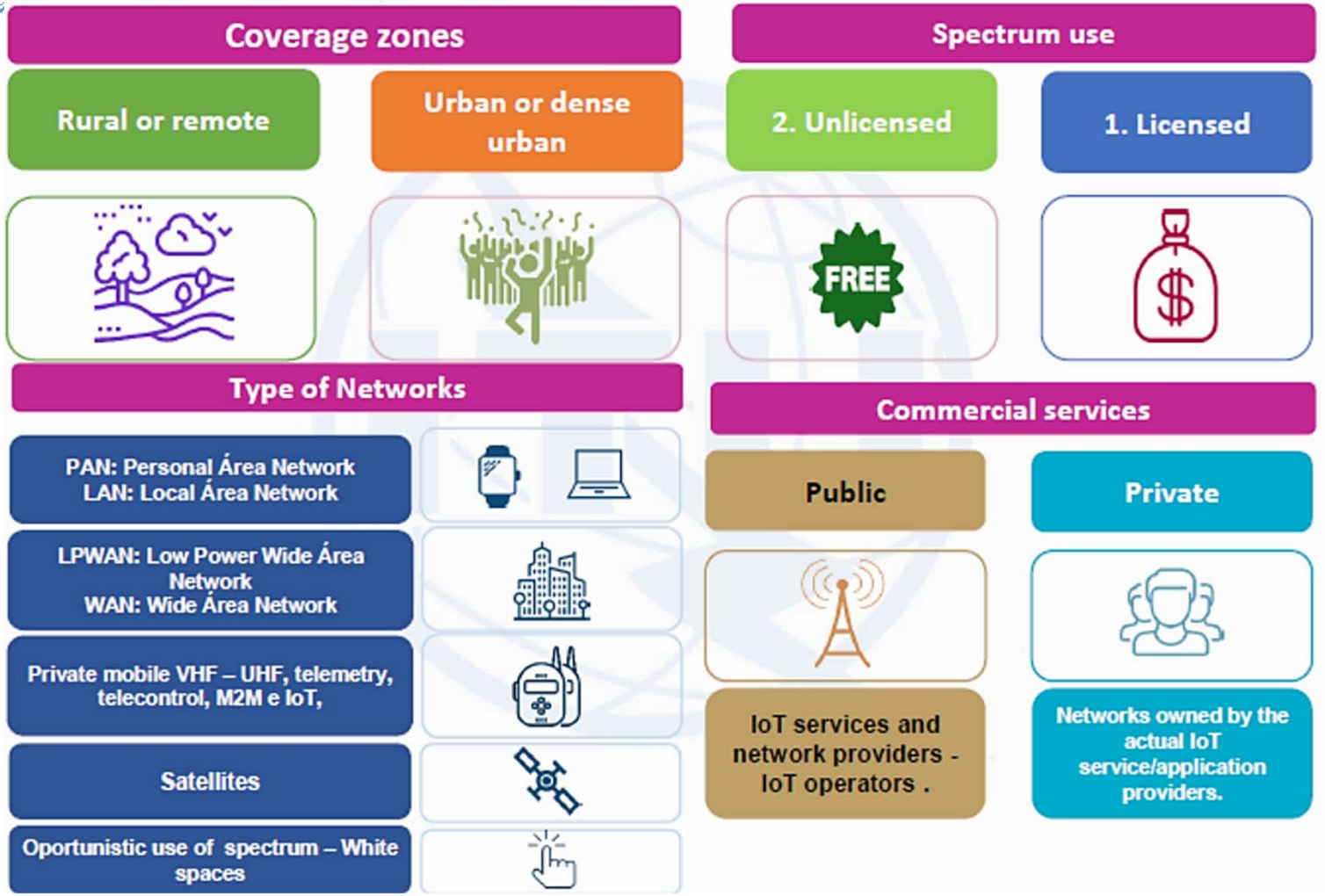
IoTs and cloud technologies and are the two unstoppable forces promoting digital capabilities

Spectrum needs to be made available in a range of frequency bands to cater for various cases

Why IoT?

- **Open platforms**
  - Designed to make building and deploying applications easier, faster, secure and more accessible for everyone.
- **Allows**
  - To create the low-power, wide-area sensor and/or actuator network (WASN) systems for Machine Type Communications (MTC), Smart cities and Ubiquitous Sensor Networks (USN) applications.
- **Contributes**
  - To socio economic development such as in Agriculture, health sector and many more.
- **Efficient Management**
  - Manage utilities efficiently such as smart power, water grids, and transport management

IoT Usage Cases



Source: ITU Workshop on Spectrum Management for Internet of Things Deployment, 22 November 2016, Geneva

IoT Usage Categories

Category	Sub-category	
Consumer IoT	Consumer electronics	Smart TVs, home entertainment (games consoles, speakers), personal entertainment (MP3 players, portable gaming devices), set-top boxes
	Smart home	Home appliances (fridges, washing machines), home infrastructure (routers), home security (alarms), energy monitoring (thermostats)
	Wearables	Fitness trackers (including personal health trackers), smart watches
	Smart vehicles	Connected cars, connected bikes, insurance telematics
	Consumer – others	Trackers for children, the elderly and pets, as well as drones and robots
Industrial IoT	Smart city	Public transport, surveillance, electric vehicle charging, street lighting, parking, waste management
	Smart utilities	Energy, water and gas smart metering, smart grid
	Smart retail	PoS, digital signage, vending machines, ATMs
	Smart manufacturing	Inventory tracking, monitoring and diagnostics, warehouse management
	Smart buildings	Heating and air con, security, lighting, hot desks, office equipment
	Health	Remote monitoring of medical devices, emergency vehicle infrastructure
	Enterprise – others	Fleet management, applications in agriculture, oil, mining, construction

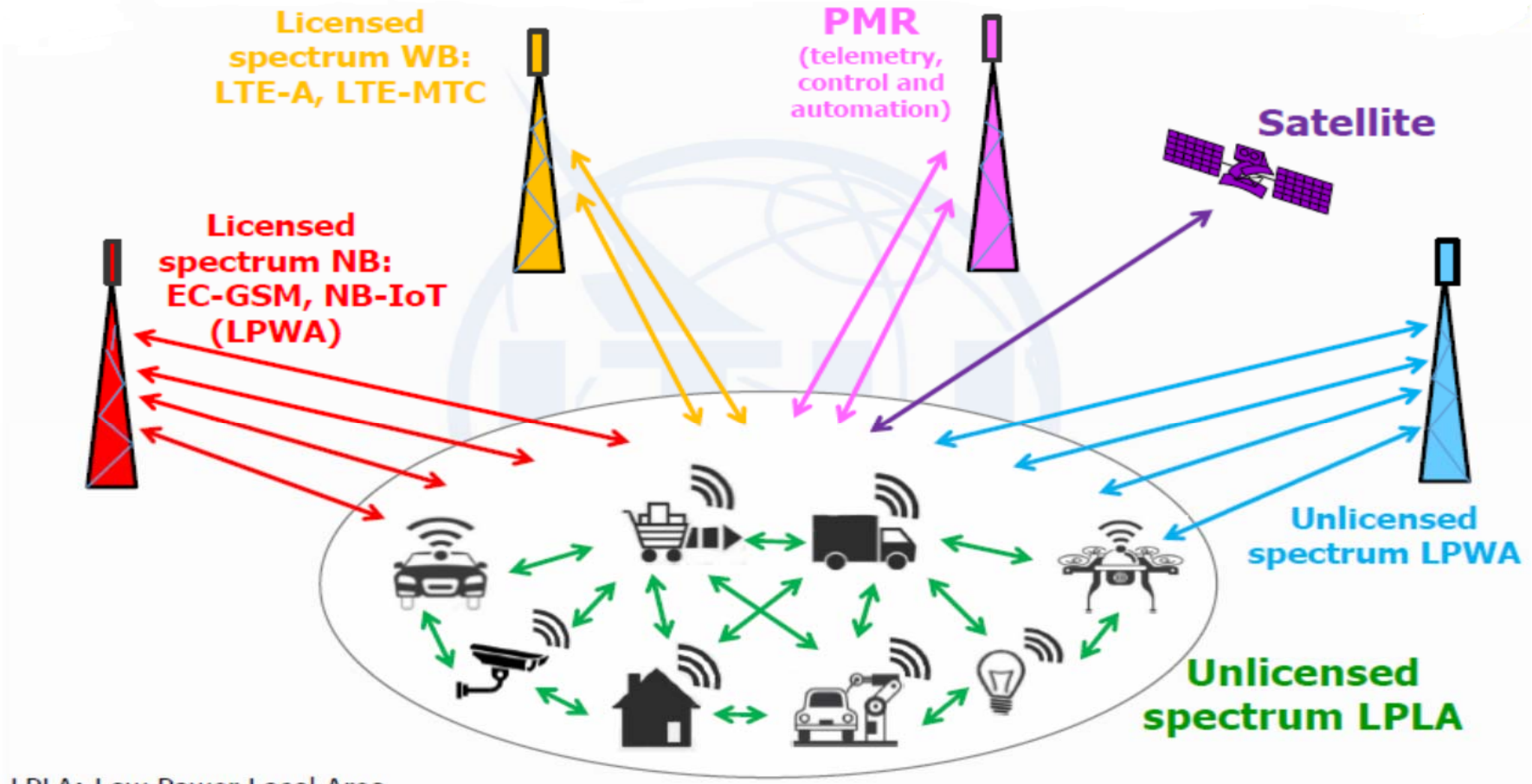
Source: GSMA Intelligence - IoT: the next wave of connectivity and services

IoT design requirements

IoT Network	Impact on IoT Systems Design
Scale	**Tens of thousand sensors in a given site; or millions distributed geographically** More pressure on application architectures, network load, traffic types, security, non-standard usage pattern
Heterogeneous end-points	**Vast array of sensors, actuators, and smart devices – IP or non-IP** Diverse data rate exchange, form factor, computing and communication capabilities, legacy protocols
Accessibility-Visibility of end-points	**May be deployed before activation, maybe or cannot-be accessed once deployed** Devices deliver services with little or no human control, difficult to correct mistakes, device management is key
Criticality of services	**Human life critical (Healthcare), Critical infrastructure (Smart Grid)** Stringent latency (10ms for SG) and reliability requirements, may challenge/exceed network capabilities of today
Intrusiveness	**Things with explicit intent to better manage end-users (eHealth, Smart Grid)** Issues of Privacy become major obstacles
Geography	**Movement across borders** Issues of numbering for unique identification

Source: ITU CoE training on BB networks planning, Bangkok, Sep 2017

IoT Connectivity Options



LPLA: Low Power Local Area
LPWA: Low Power Wide Area

Source: ITU Workshop on Spectrum Management for Internet of Things Deployment, 22 November 2016, Geneva

IoT network connectivity requirements

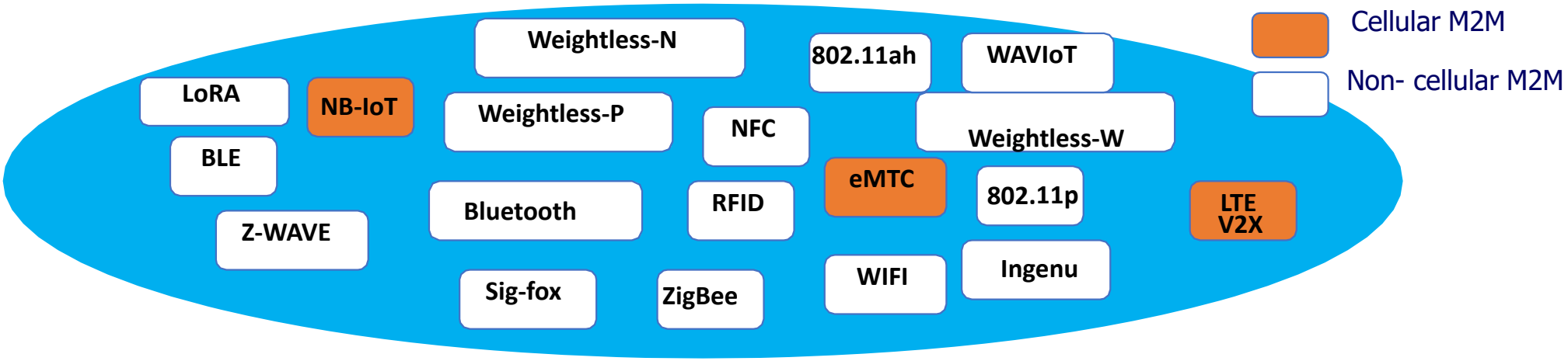
IoT Network	Impact on IoT Systems Design
Resource-constrained endpoints	**Severely resource constrained (memory, compute)** Cost motivation: compute/memory several orders of magnitude lower, limited remote SW update capability, light protocols, security
Low Power	**Some end-point types may be mostly 'sleeping' and awakened when required** Sensors cannot be easily connected to a power source, reduced interaction time between devices and applications
Embedded	**Smart civil infrastructure, building, devices inside human beings** Sensors deployed in secure or hostile operating conditions, difficult to change without impacting system, Security
Longevity	**Deployed for life typically, have to build-in device redundancy** Very different lifetime expectancy, rate of equipment change in IoT business domains much lower than ICT Industry

Source: ITU CoE training on BB networks planning, Bangkok, Sep 2017

IoT Technical Solutions

Study in ITU under **WRC-19 agenda item 9.1, issue 9.1.8** (Machine Type Communication - MTC)

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



IoT Technical Solutions

- **Fixed & Short Range**
  - RFID
  - Bluetooth
  - Zigbee
  - WiFi

- **Long Range technologies**
  - Non 3GPP Standards (LPWAN)
  - 3GPP Standards

Spectrum Needs of IoT

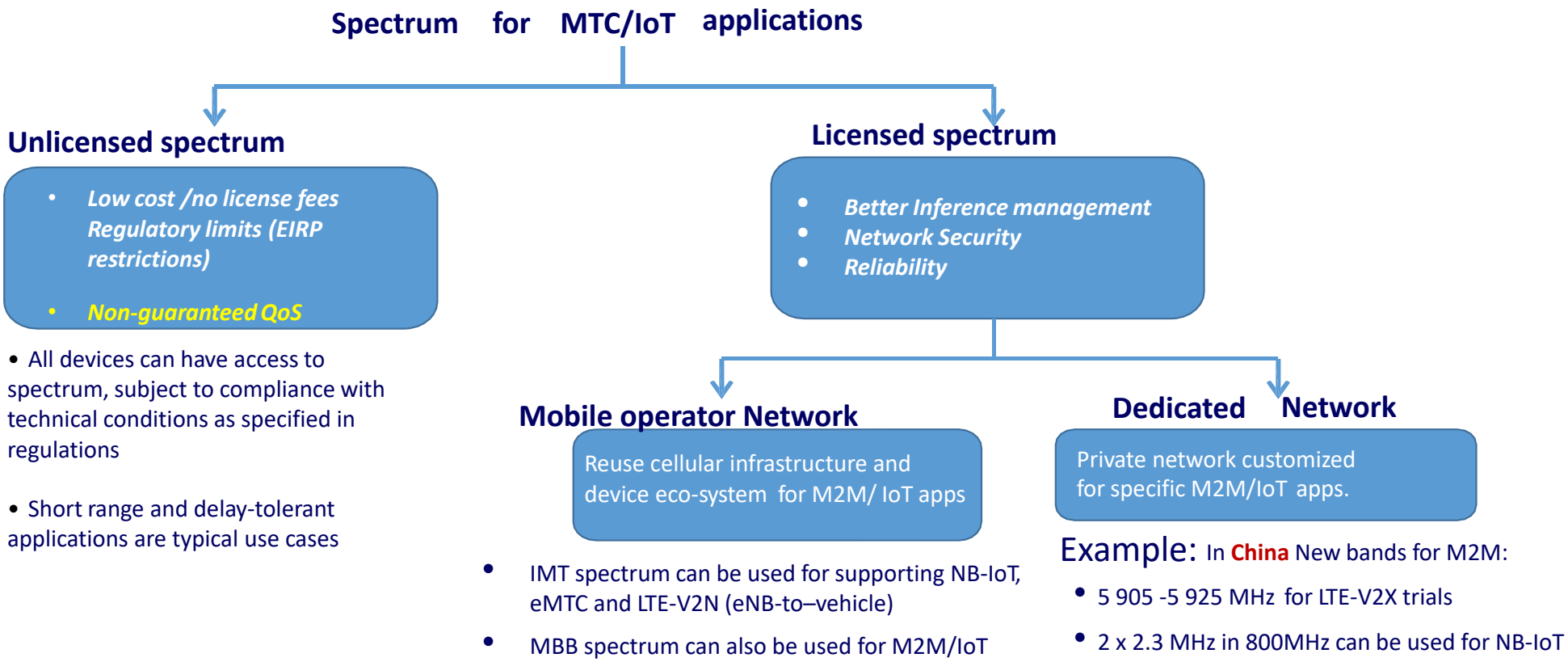
➢ What are the spectrum needs of IoT?

- Determined by each application's throughput requirements, but also latency
  - *For a given spectral efficiency (b/s/Hz), the lower the latency requirements the larger the bandwidth needed to send a given amount of data*
- While many IoT applications might not need high speed connections and/or have very stringent latency requirements, some do (e.g. remote surgery)

➢ In what frequency bands?

- Determined by each IoT application's range and coverage requirements, but also bandwidth needs of the applications
- Range and coverage requirements also depend on deployment scenarios
  - *Point-to-point, mesh, broadcast, multi-cast, etc.*

Spectrum Licensing for IoT



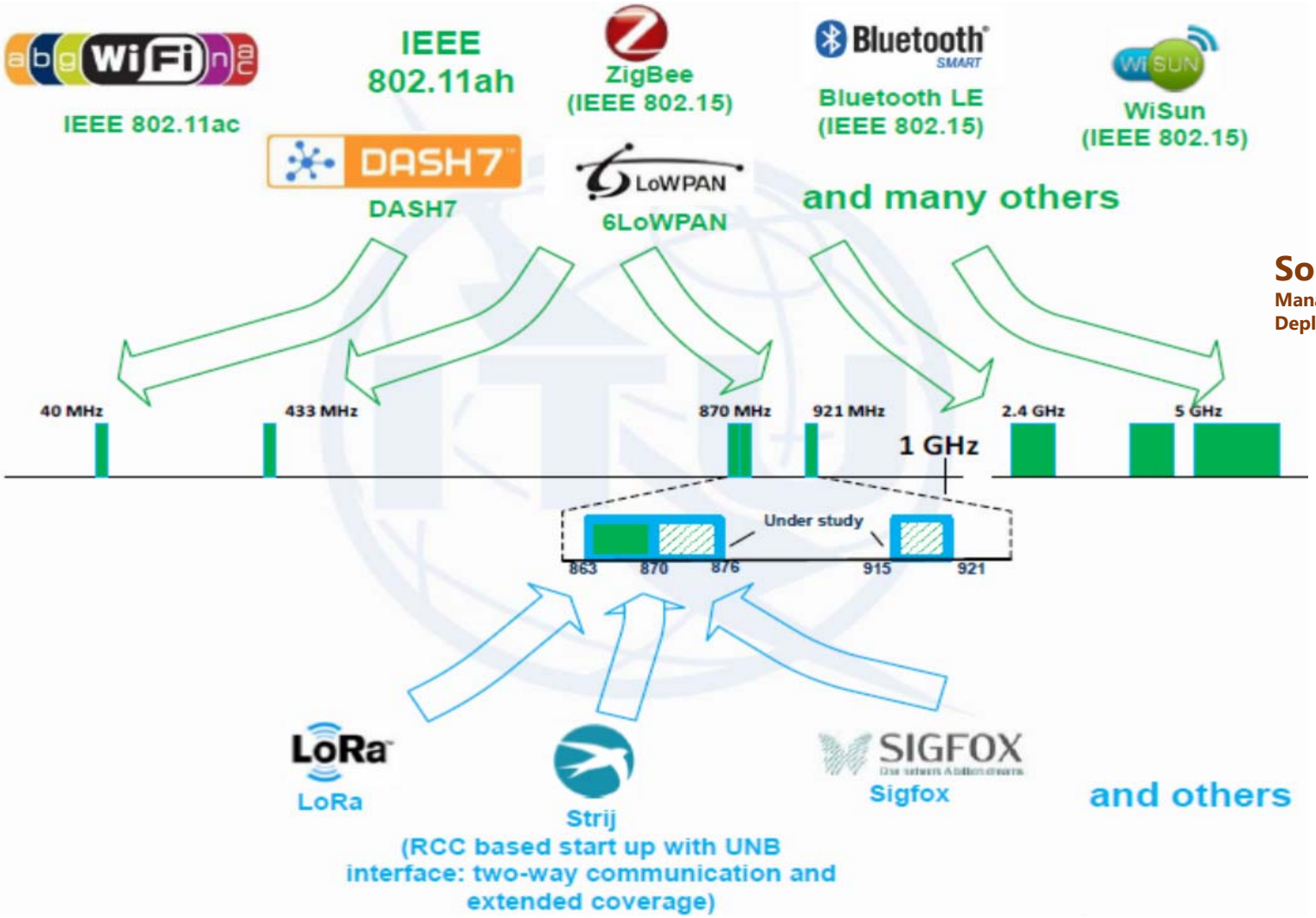
- All devices can have access to spectrum, subject to compliance with technical conditions as specified in regulations
- Short range and delay-tolerant applications are typical use cases

- IMT spectrum can be used for supporting NB-IoT, eMTC and LTE-V2N (eNB-to–vehicle)
- MBB spectrum can also be used for M2M/IoT

Example: In **China** New bands for M2M:

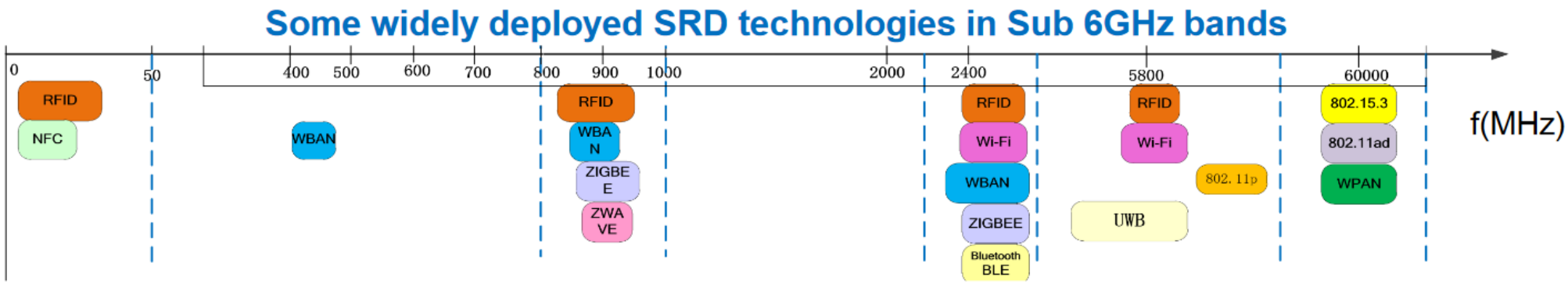
- 5 905 -5 925 MHz for LTE-V2X trials
- 2 x 2.3 MHz in 800MHz can be used for NB-IoT

Spectrum usage for IoT - SRDs



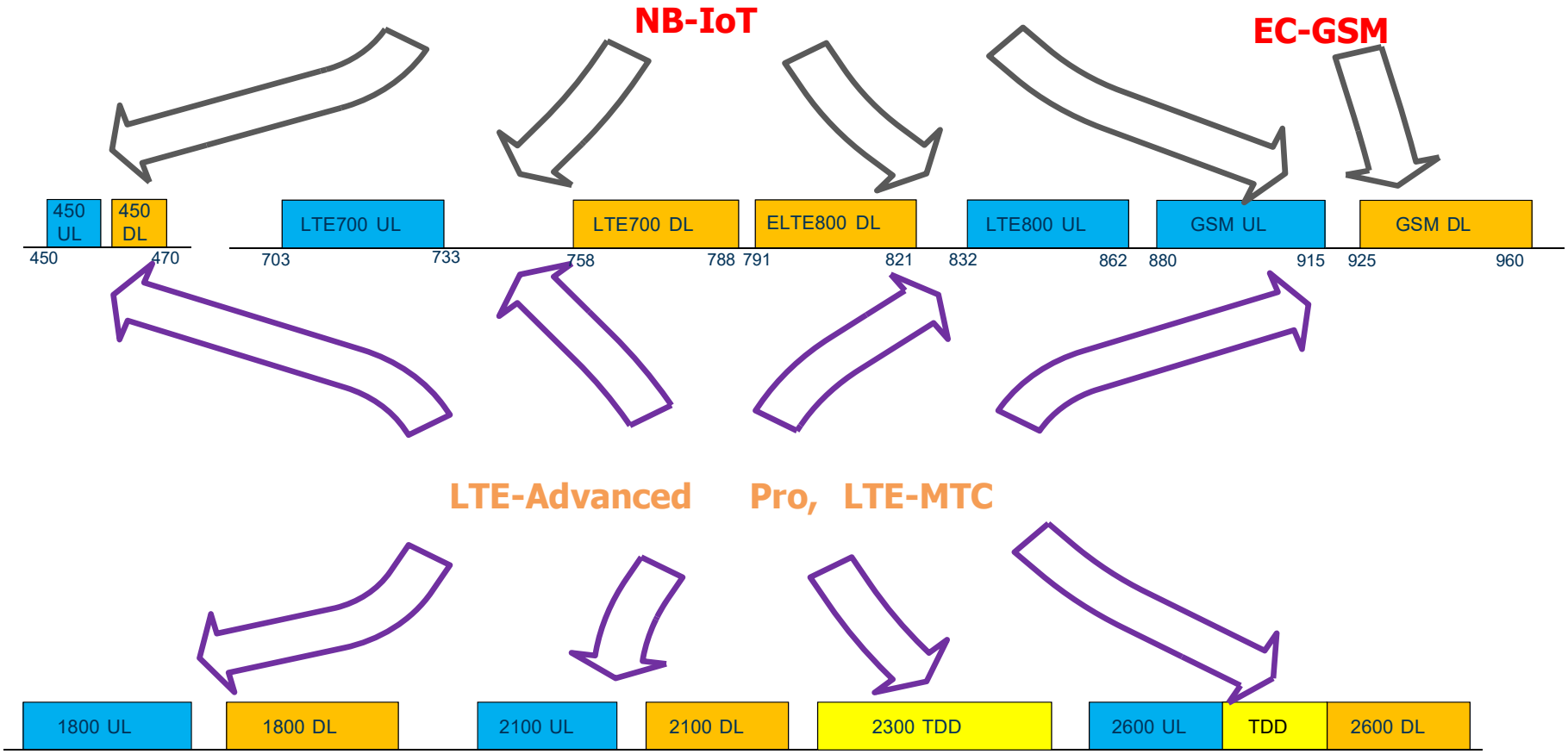
Source: ITU Workshop on Spectrum Management for Internet of Things Deployment, 22 November 2016, Geneva

Spectrum usage for IoT - SRDs



Source: ITU Workshop on Spectrum Management for Internet of Things Deployment, 22 November 2016, Geneva

IoT deployments in Licensed Spectrum - IMT



Spectrum Needs of IoT

M2M
Radiocommunication Technologies

Technology	Spectrum band
NB-IoT	MBB bands
eMTC	MBB bands
Sigfox	868MHz
LTE-V2X	MBB bands (Uu)
	5.8,5.9GHz (PC5)
Bluetooth	2.4GHz
ZigBee	868/2450MHz
RFID	13.56/27.12/433/ 860MHz …
NFC	13.56MHz
Z-WAVE	868 MHz
Ingenu	2.4GHz

Frequency range

- Sub-1 GHz band are most suitable for efficient provision of wide area coverage;

Authorization

- Sharing spectrum with unlicensed authorization to achieve low cost and low power requirements

- Licensed (exclusive) spectrum is more suitable for wide area coverage and/or higher reliability requirements for delay sensitive applications

IMT- Identified Spectrum

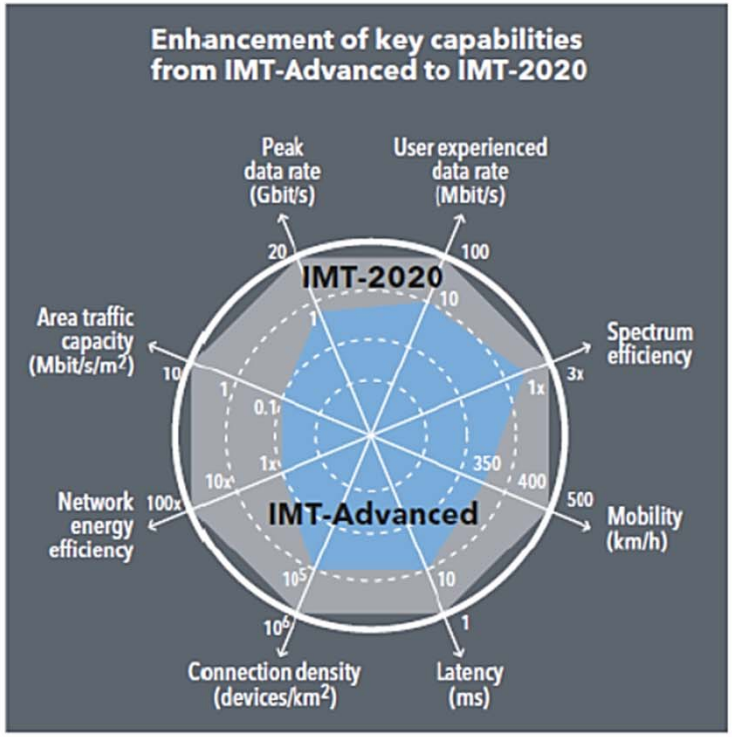
Definition

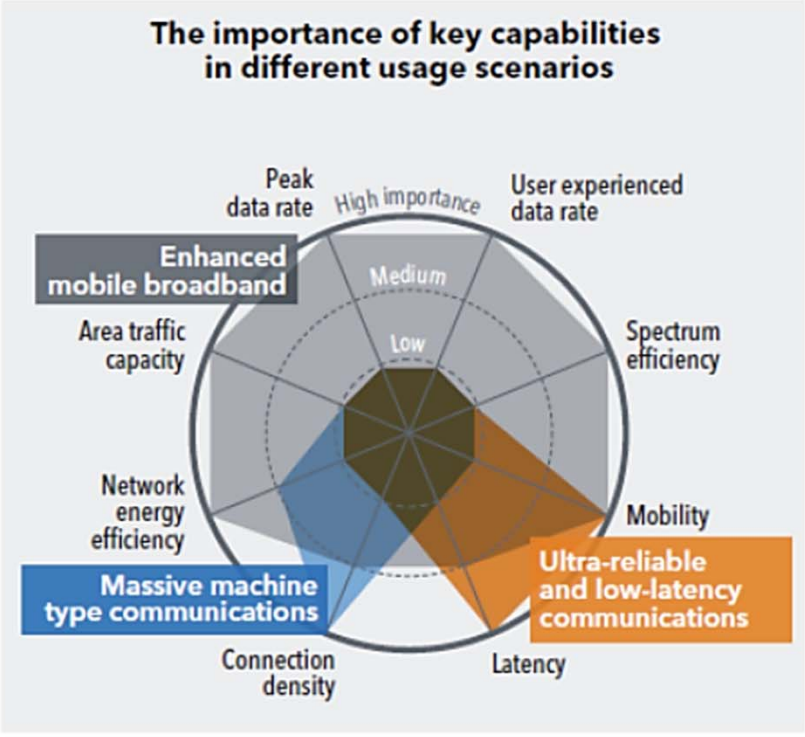
Res. ITU-R 56-1: *Naming for International Mobile Telecommunications*

Since ITU is the internationally recognized entity that has sole responsibility to define and to recommend the standards and frequency arrangements for IMT systems, with the collaboration of other organizations such as standard development organizations, universities, industry organizations and with partnership projects, forums, consortia and research collaborations, therefore the RA-15 debated especially on naming of IMT systems.

- *the existing term* **IMT-2000** *continues to be relevant and should continue to be utilized;*
- *the existing term* **IMT-Advanced** *continues to be relevant and should continue to be utilized;*
- *However for systems, system components, and related aspects that include new radio interface(s) which support the new capabilities of systems beyond IMT-2000 and IMT-Advanced, the term "***IMT-2020***" be applied*
- *In addition it was resolved that the term "IMT" would be considered the root name that encompasses all of IMT-2000, IMT-Advanced and IMT-2020 collectively.*

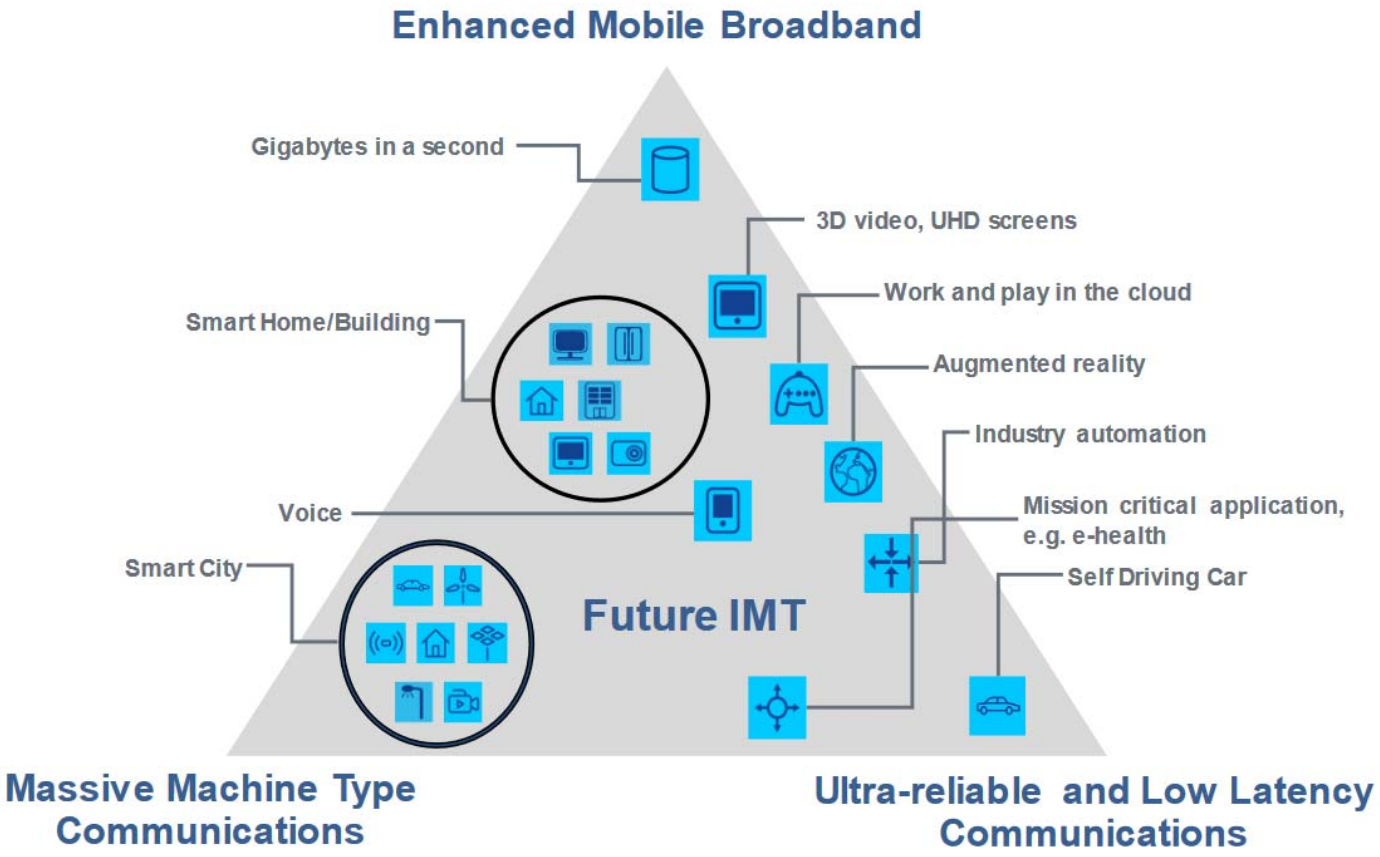
IMT





The values in the figures above are targets for research and investigation for IMT-2020 and may be revised in the light of future studies. Further information is available in the IMT-2020 Vision ***(Recommendation ITU-R M.2083)***

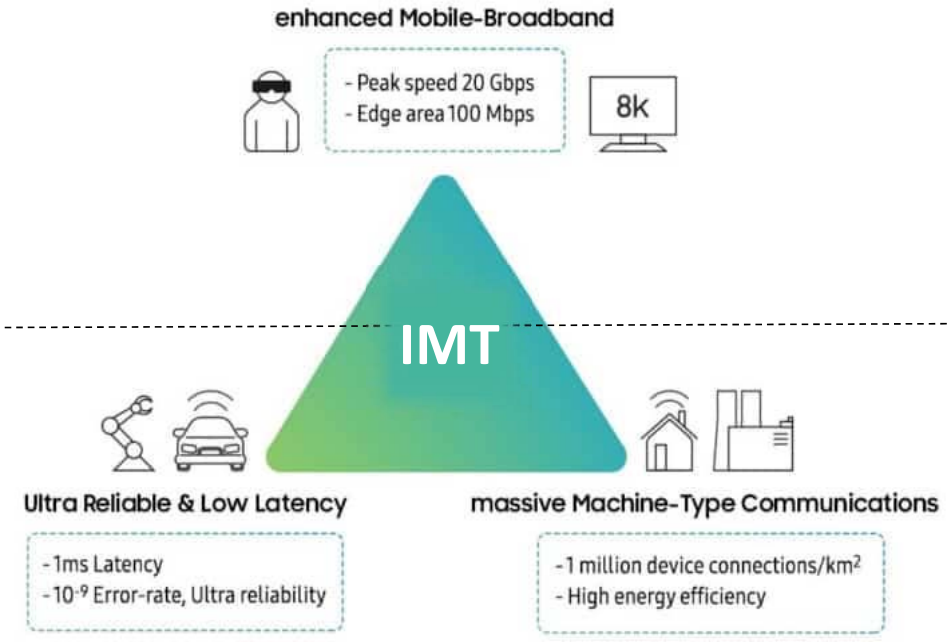
IMT Supports IoT



IMT-2020 standardization process

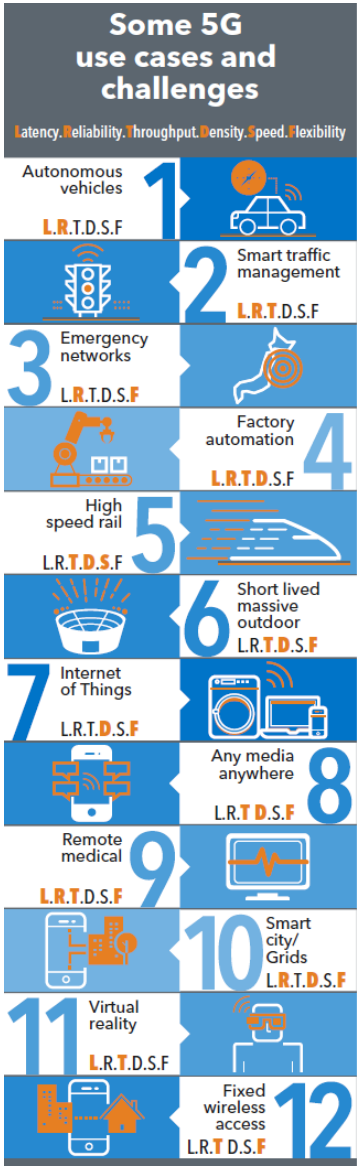
Source: Forging paths to IMT-2020 (5G), Stephen M. Blust, Chairman, ITU Radiocommunication Sector (ITU–R) Working Party 5D, Sergio Buonomo, Counsellor, ITU–R Study Group 5, ITU News, 02/2017

Understanding IMT applications



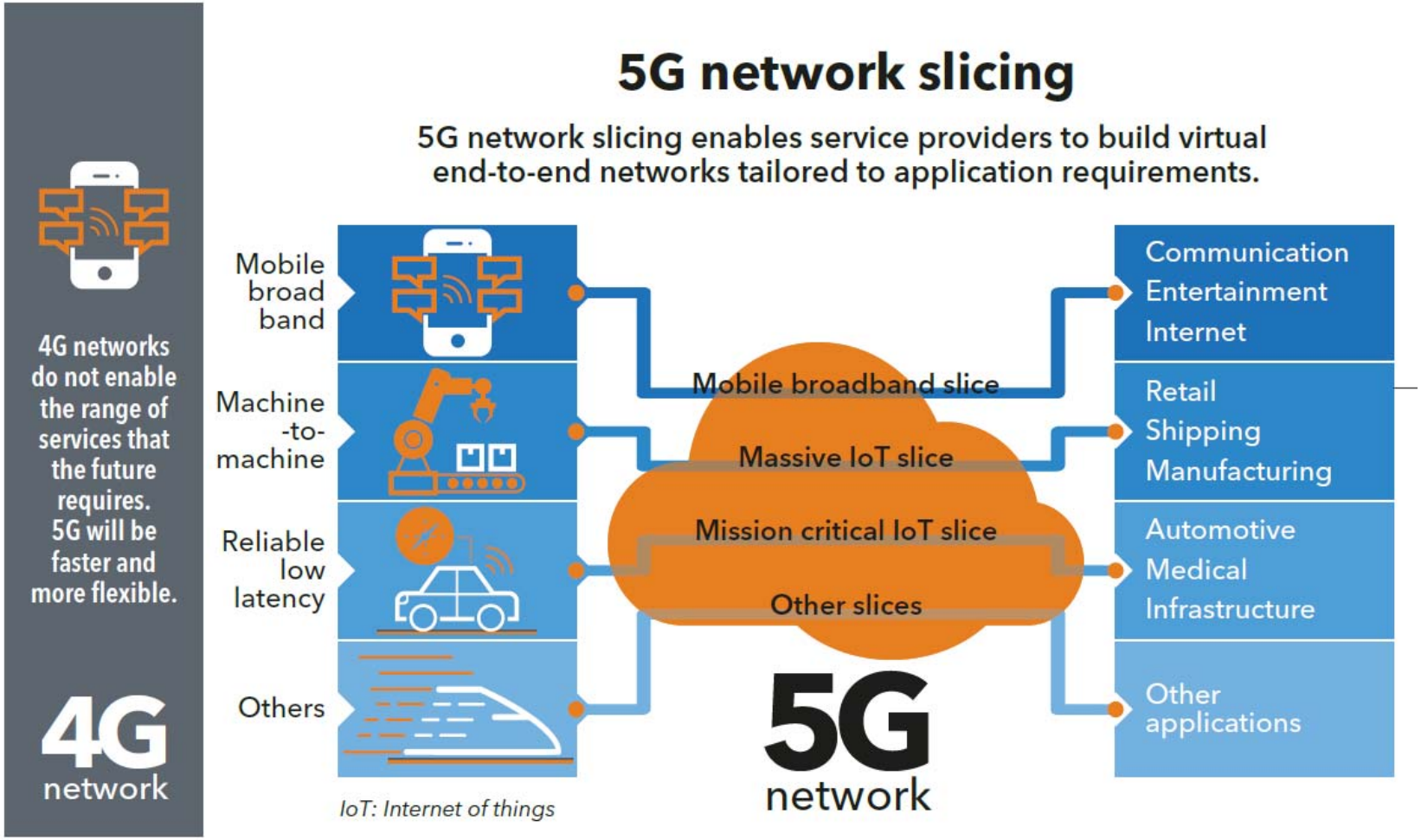
Consumer – Fixed wireless

Business



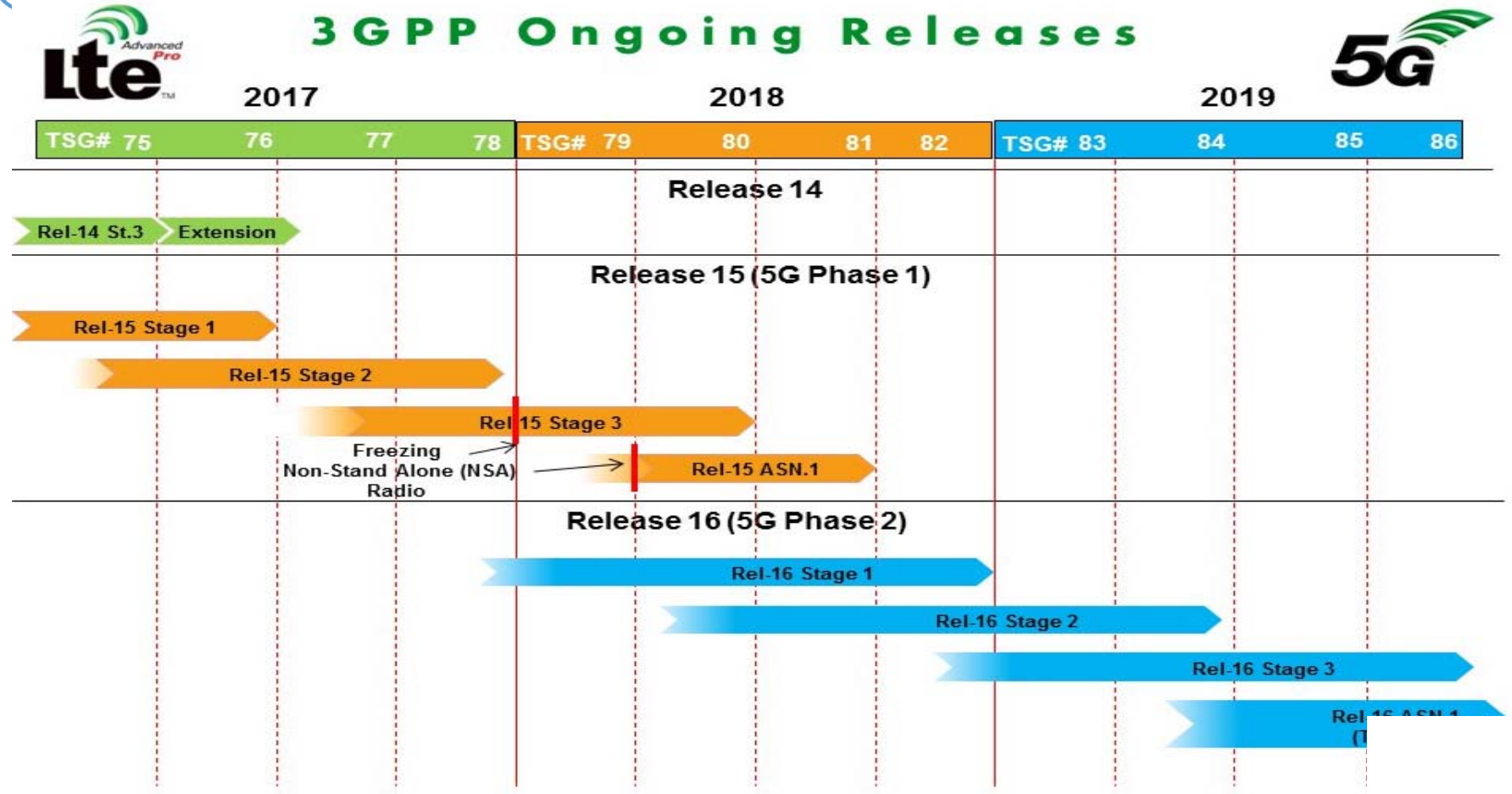
Source: Forging paths to IMT-2020 (5G), Stephen M. Blust, Chairman, ITU Radiocommunication Sector (ITU–R) Working Party 5D, Sergio Buonomo, Counsellor, ITU–R Study Group 5, ITU News, 02/2017

IMT-2020 (5G) Network slicing to Supports IoT



Source: Forging paths to IMT-2020 (5G), Stephen M. Blust, Chairman, ITU Radiocommunication Sector (ITU–R) Working Party 5D, Sergio Buonomo, Counsellor, ITU–R Study Group 5, ITU News, 02/2017

5G and 3GPP Releases evolution



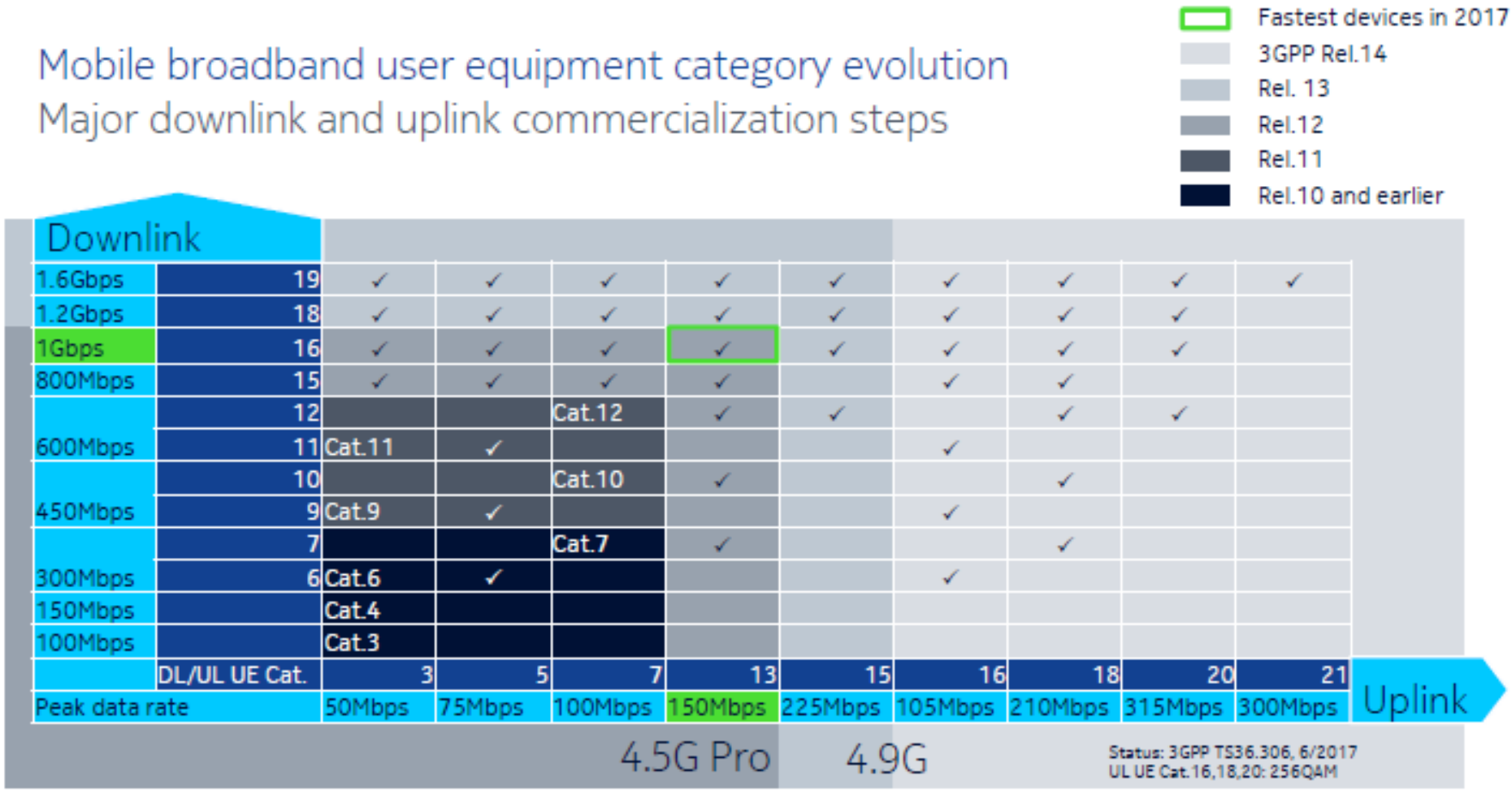
Source: http://www.3gpp.org/images/articleimages/ongoing_releases_900px.JPG

3GPP Release overview

LTE-Advanced Pro - Major WI/SI in 3GPP Releases

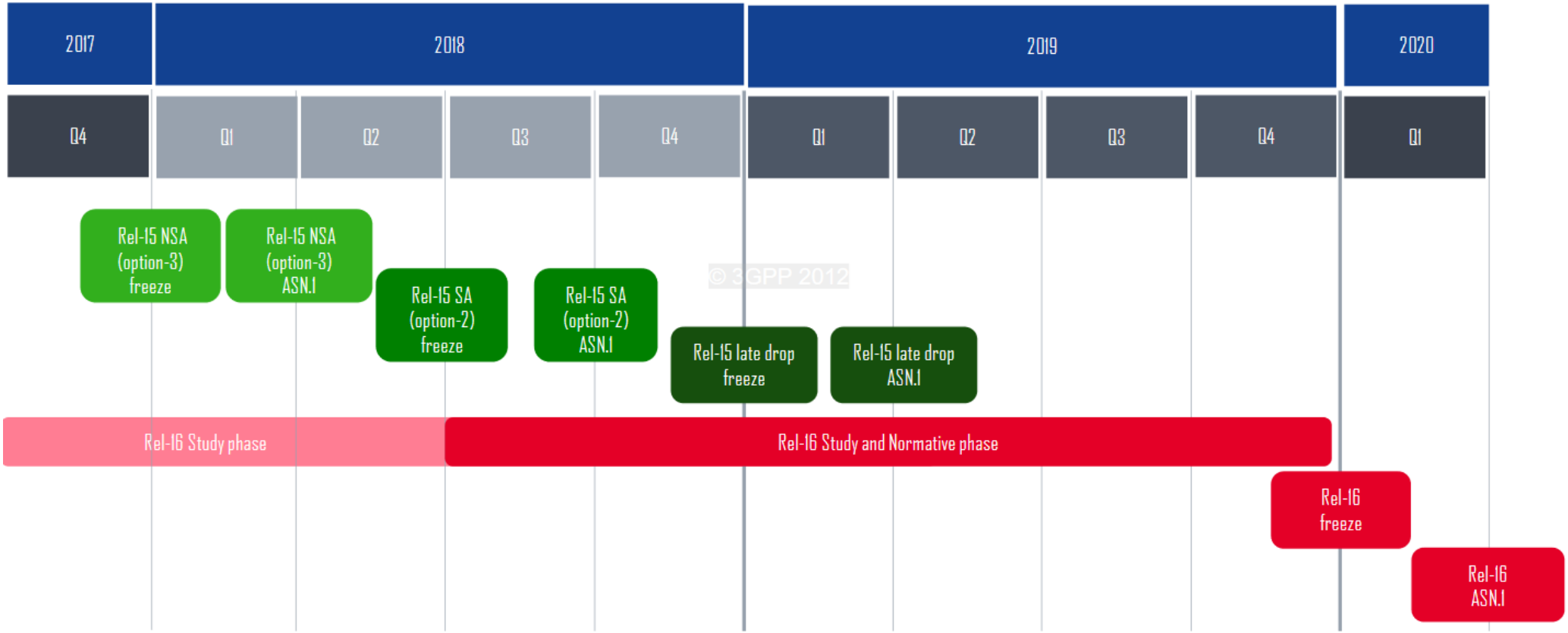
Release 13		Release 14		Release 15
LTE-U aka LAA fair co-existence of LAA and WiFi	**LTE-M** NB-IoT, low complex UE eMTC 1.4MHz operation Coverage improvement	**LTE efficiency** eFD-MIMMO UL enhancements VoLTE/video enhancements Mobility and latency	**LTE-U** Offload to Unlicensed eLAA with UL enhancements LTE-WLAN aggregation with Dual Connectivity	**5G NextGen** **SA2** **Next Generation architecture** **Start: Dec.2016**
CA frame for up to 32cc including unlicensed bands device capabilities	**FD-MiMO** Antenna arrays with Elevation Beamforming (3D) and up to 16ports (R'13) (up to 64ports in R'14)	**Verticals** V2V services V2x feasibility D2D for consumers	**LTE** service delivery Content awareness with MEC like character	**5G NR** **RAN** **New Radio specifications** **start: March 2017**
LTE D2D OoC discovery, MCPTT Consumer applications		**RF/Performance** Multi-band RFM testing High speed use cases LTE bandwidth flexibility	**HSPA-LTE** Joint Operation study for parallel CS-PS service	**SI / WI** . **Continuation of previous Rel.13/14**
2015-2016		2016-2017		2017-2018

Mobile broadband user equipment category evolution
Major downlink and uplink commercialization steps



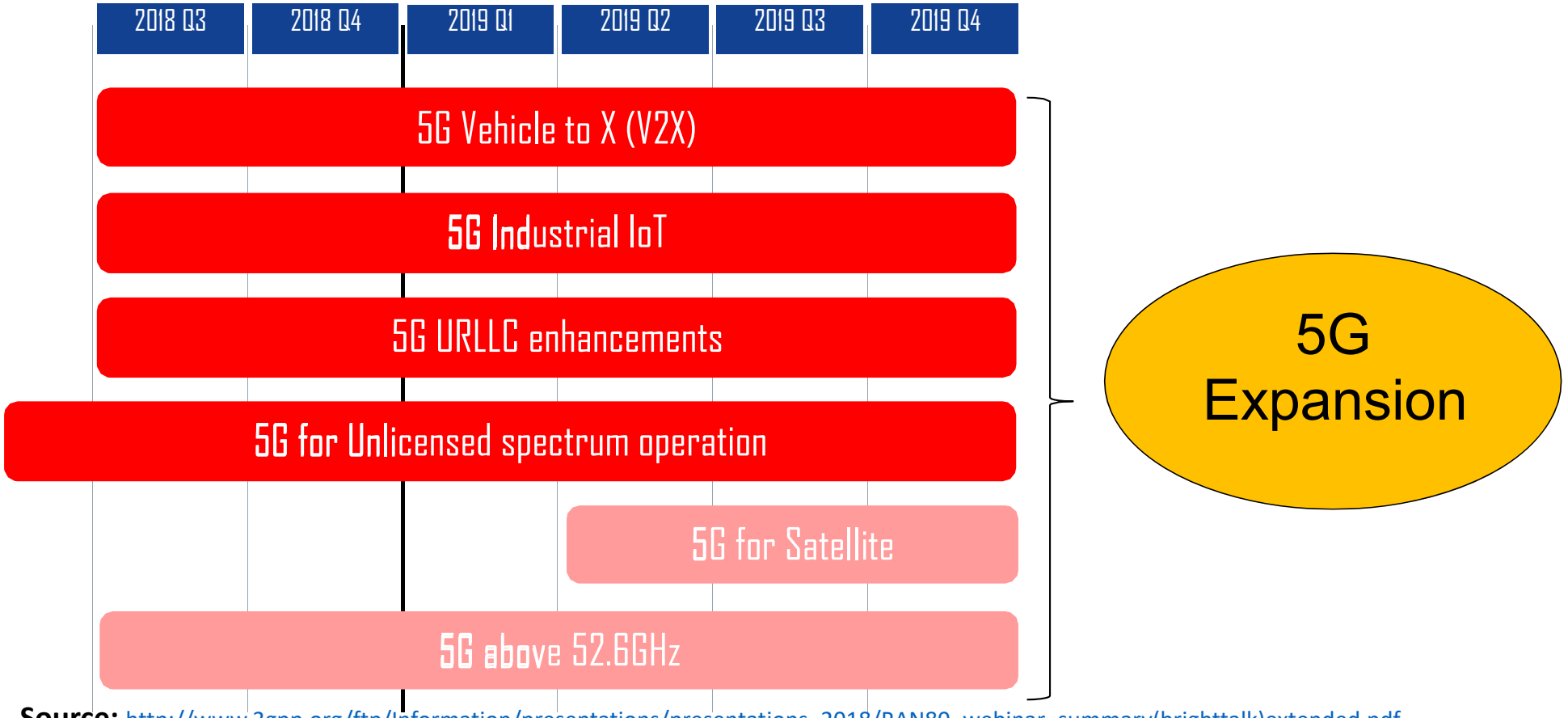
NOKIA

3GPP Release 16 - Timeline



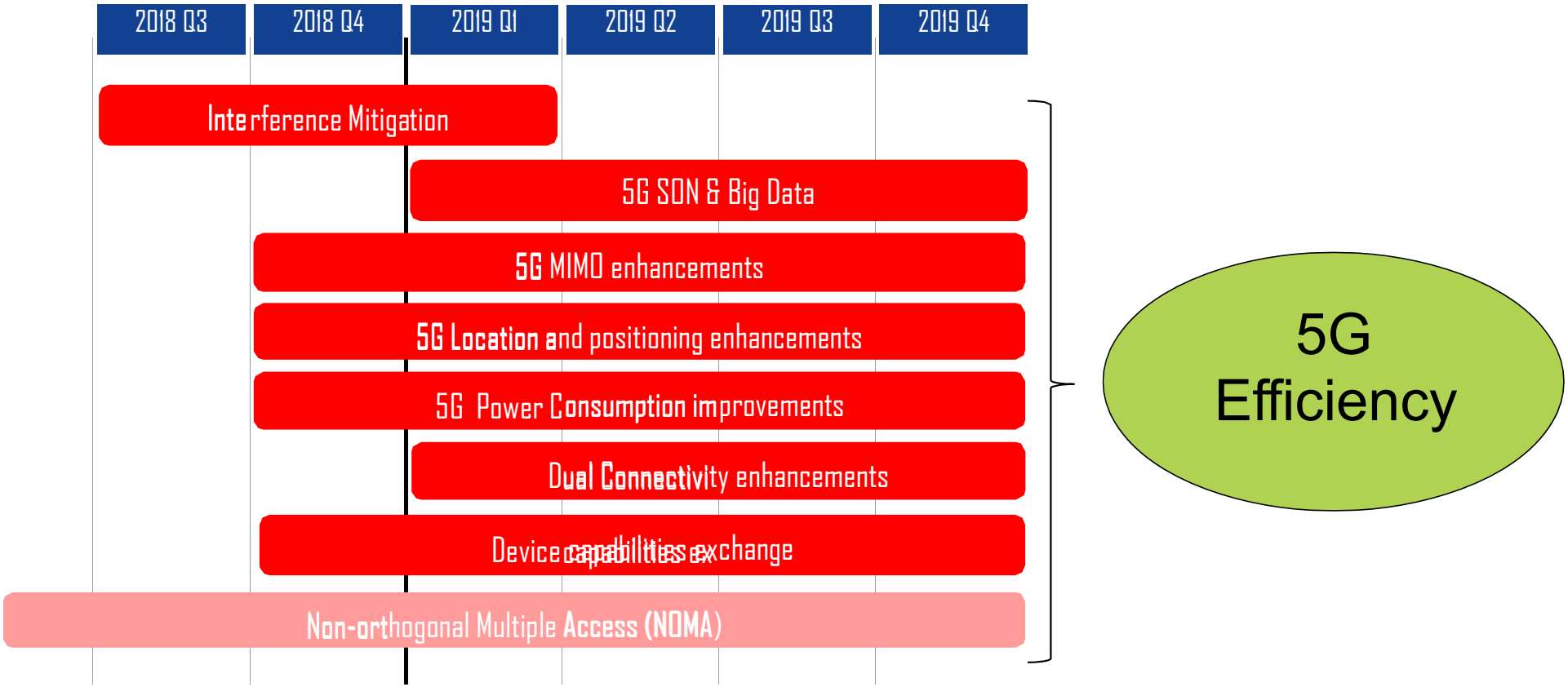
Source: http://www.3gpp.org/ftp/Information/presentations/presentations_2018/RAN80_webinar_summary(brighttalk)extended.pdf

3GPP Release 16 – 5G expansion



Source: http://www.3gpp.org/ftp/Information/presentations/presentations_2018/RAN80_webinar_summary(brighttalk)extended.pdf

3GPP Release 16 – 5G Efficiency



Source: http://www.3gpp.org/ftp/Information/presentations/presentations_2018/RAN80_webinar_summary(brighttalk)extended.pdf

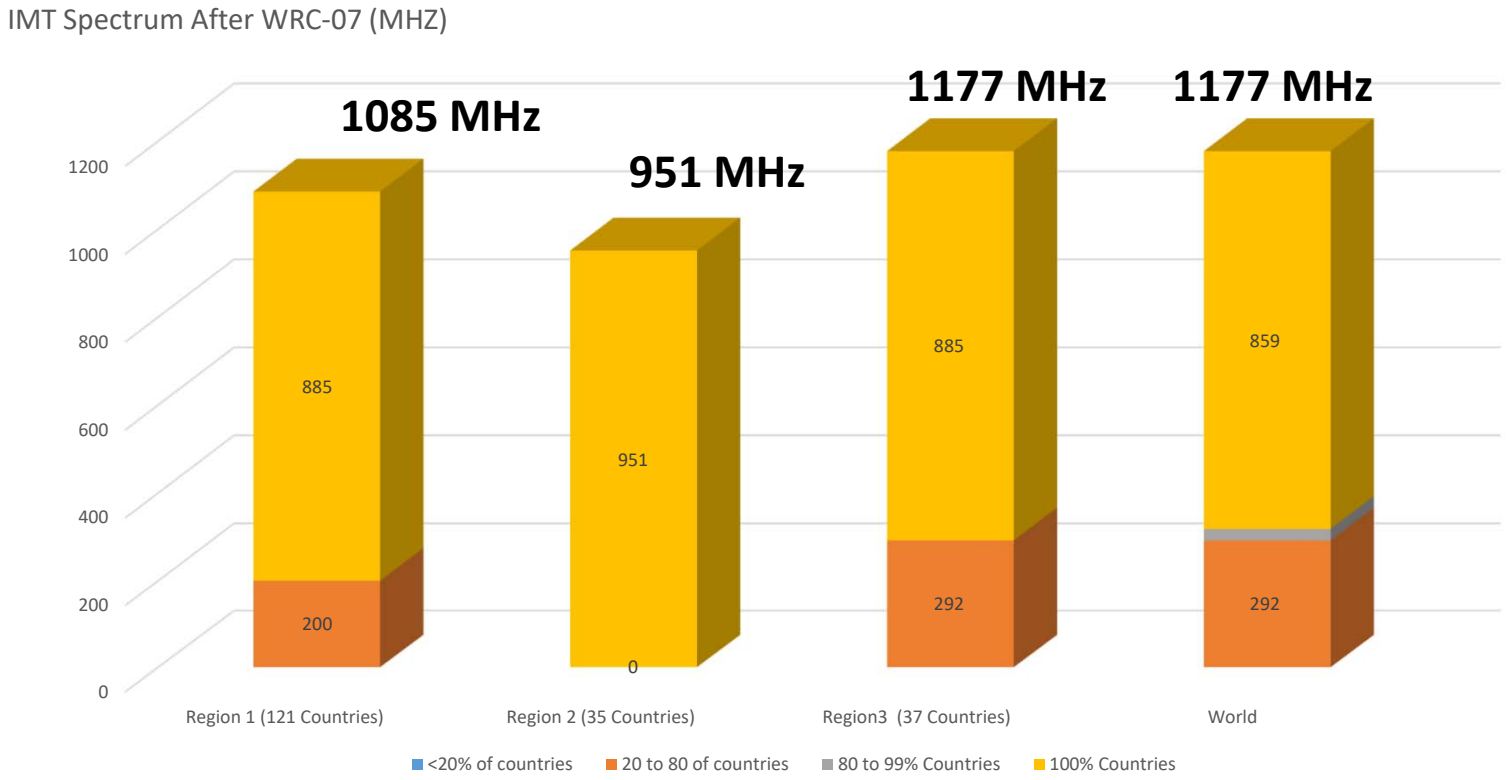
Recalling WRC-15 outcomes

Outcomes of WRC-15

Mobile Broadband (MBB)

(agenda Item 1.1 and 1.2)

IMT Spectrum after WRC-07



Outcomes of WRC-15

➢ Need for More spectrum

User density	Total requirement by 2020 (MHz)	Region 1		Region 2		Region 3	
		Already identified (MHz)	Additional demand (MHz)	Already identified (MHz)	Additional demand (MHz)	Already identified (MHz)	Additional demand (MHz)
Low	1 340	981-1 181	**159** – 359	951	389	885 - 1 177	163 – 455
High	1 960		779 - 979		1 009		783 - **1 075**

Estimated additional spectrum requirements by 2020 ranged from 159 to 1075 MHz depending on Region and user density)

Source: CPM-15 report (Additional Spectrum Requirements)

Outcomes of WRC-15

➢ New spectrum Identified

WRC - 15

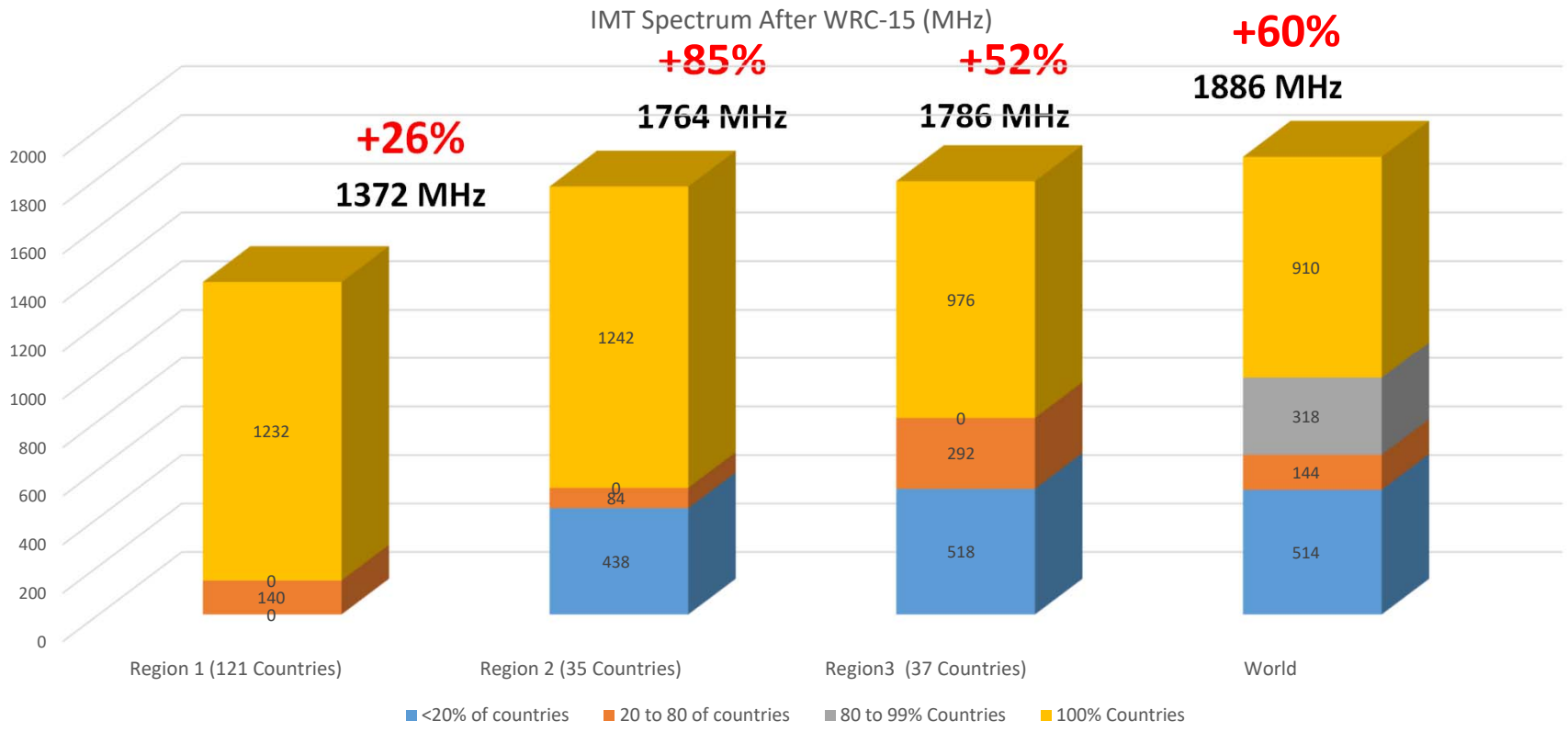
Band (MHz)	Bandwitdh (MHz)	R1	R2	R3
470 – 608	138		some	
608 – 698	84		some	
1427 – 1452	25	any	any	any
1452 – 1492	40	some	any	any
1492 – 1518	26	any	any	any
3300 – 3400	100	some	some	some
3600 – 3700	100		some	
4800 – 4990	190		some	some
	New BW 709			

Outcomes of WRC-15

➢ Spectrum for IMT

Band (MHz)	Footnotes identifying the band for IMT			Bandwidth
	Region 1 or parts thereof	Region 2 or parts thereof	**Region 3 or parts thereof**	
450-470		**5.286AA**		20
470-698	-	5.295, 5.308A	**5.296A**	228
694/698-960	5.317A	5.317A	**5.313A, 5.317A**	262
1 427-1 518	5.341A, 5.346	5.341B	**5.341C, 5.346A**	91
1 710-2 025		**5.384A, 5.388**		315
2 110-2 200		**5.388**		90
2 300-2 400		**5.384A**		100
2 500-2 690		**5.384A**		190
3 300-3 400	5.429B	5.429D	**5.429F**	100
3 400-3 600	5.430A	5.431B	**5.432A, 5.432B, 5.433A**	200
3 600-3 700	-	5.434	-	100
4 800-4 990	-	5.441A	**5.441B**	190
Total Bandwidth	**1,886** *(Regional allocations vary and therefore totals can be different for a specific region)*			

IMT Bands after WRC-15



WRC-15 (Follow up)

- **WRC-15 Final ACTs available at:**
  - www.itu.int/pub/R-ACT-WRC.12-2015 *(ITU CL-16/22 of 17 May 2016)*

- **Radio Regulation 2016 edition available at:**
  - http://www.itu.int/pub/R-REG-RR/en

2016 ***New!*** Publication Notice with Order Form

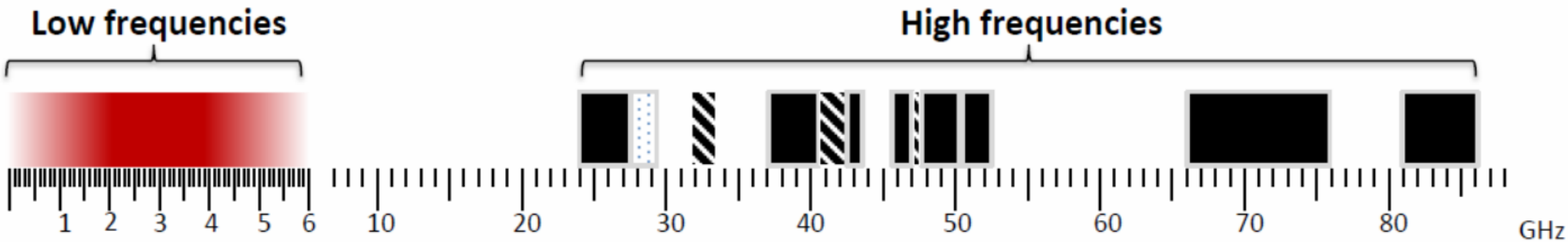
The Radio Regulations, edition of 2016, contains the complete texts of the Radio Regulations as adopted by the World Radiocommunication Conference (Geneva, 1995) (WRC-95), subsequently revised and approved by the World Radiocommunication Conference (Geneva, 1997) (WRC-97), the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000), the World Radiocommunication Conference (Geneva, 2003) (WRC-03), the World Radiocommunication Conference (Geneva, 2007) (WRC-07), the World Radiocommunication Conference (Geneva, 2012) (WRC-12) and the World Radiocommunication Conference (Geneva, 2015) (WRC-15), including all Appendices, Resolutions, Recommendations and ITU-R Recommendations incorporated by reference. Available: end-October 2016

Available in

Other editions: 2012 Edition of 2008 Edition of 2004 Edition of 2001 Edition of 1998

Going Forward

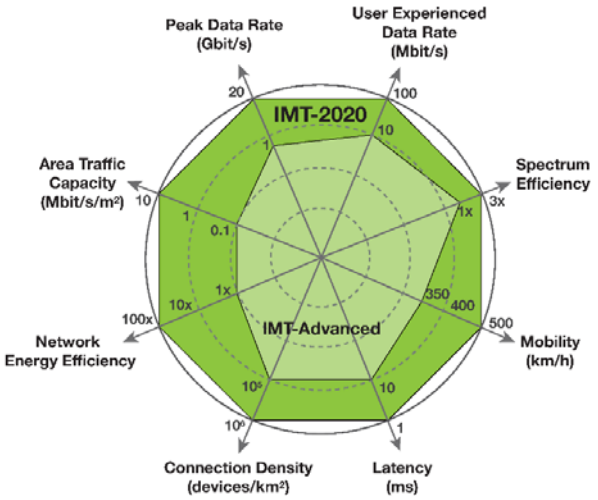
IMT spectrum requirements and WRC-19



BB applications in MS

(WRC-19 Agenda item 1.13 and 1.16)

- The following bands, which are already allocated to mobile, will be studied with a view to an IMT-2020 identification:
  - 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



- The following bands will also be studied, although they do not currently have global mobile allocations: Res. 238 (WRC-15)
  - 31.8 – 33.4 GHz
  - 40.5 – 42.5 GHz
  - 47 - 47.2 GHz

Overlapping Bands in WRC-19 Agenda Items

1.6 – NGSO FSS Res. 159 (WRC-15)	1.13 – IMT Res. 238 (WRC-15)	1.14 – HAPS Res. 160 (WRC-15)	9.1 (9.1.9) – FSS Res. 162 (WRC-15)
	24.25 - 27.5	24.25 - 27.5 (Reg. 2)	
37.5 - 39.5 (s-E*)	37 - 40.5	38 - 39.5 (globally)	
39.5 - 42.5 (s-E*)	40.5 - 42.5		
47.2 - 50.2 (E-s*)	47.2 - 50.2		
50.4 - 51.4 (E-s*)	50.4 - 52.6		51.4 - 52.4 (E-s*)

- **E-s: Earth-to-space; s-E: space-to-Earth.**
- **All bands in GHz**

Studies to **address mutual compatibility & sharing feasibility** among the **services/applications** for which **allocation/identification is envisaged** under the corresponding Res. relating to the AI in the overlapping bands

Future Spectrum need estimation for IMT

(24.25 GHz - 86 GHz)

	Examples	Associated conditions for different examples (For details, please see the corresponding sections in the Annex A)	Spectrum needs in total (GHz)	Spectrum needs (GHz) per range
Application-based approach ITU-R M.1651	1	Overcrowded, Dense urban and Urban areas	**18.7**	➢ 3.3 (24.25-33.4 GHz range) ➢ 6.1 (37-52.6 GHz range) ➢ 9.3 (66-86 GHz range)
		Dense urban and Urban areas	**11.4**	➢ 2.0 (24.25-33.4 GHz range) ➢ 3.7 (37-52.6 GHz range) ➢ 5.7 (66-86 GHz range)
	2	Highly crowded area	**3.7**	➢ 0.67 (24.25-33.4 GHz range) ➢ 1.2 (37-52.6 GHz range) ➢ 1.9 (66-86 GHz range)
		Crowded area	**1.8**	➢ 0.33 (24.25-33.4 GHz range) ➢ 0.61 (37-52.6 GHz range) ➢ 0.93 (66-86 GHz range)

Source: Chairman's report TG 5/1 Annex 2: *Working document towards Draft CPM text for WRC-19 AGenda Item 1.13*

Future Spectrum need estimation for IMT

(24.25 GHz - 86 GHz)

	Examples	Associated conditions for different examples (For details, please see the corresponding sections in the Annex A)	Spectrum needs in total (GHz)	Spectrum needs (GHz) per range
Technical performance -based approach (Type 1) *Calculated on single technical performance requirement, i.e. user experienced data rate.*	1	User experienced data rate of 1 Gbit/s with N simultaneously served users/devices at the cell-edge, e.g., Indoor	➢ 3.33 (N=1), ➢ 6.67 (N=2), ➢ 13.33 (N=4)	Not available
		User experienced data rate of 100 Mbits/s with N simultaneously served users/devices at the cell-edge, for wide area coverage	➢ 0.67 (N=1), ➢ 1.32 (N=2), ➢ 2.64 (N=4)	Not available
	2	eMBB Dense Urban	➢ 0.83-4.17	Not available
		eMBB Indoor Hotspot	➢ 3-15	Not available
	3	With a file transfer of 10 Mbits by a single user at cell-edge in 1 msec	➢ 33.33 GHz (one direction)	Not available
		With a file transfer of 1 Mbit by a single user at cell-edge in 1 msec	➢ 3.33 GHz (one direction)	
		With a file transfer of 0.1 Mbits by a single user at cell-edge in 1 msec	➢ 333 MHz (one direction)	

Source: Chairman's report TG 5/1 Annex 2: *Working document towards Draft CPM text for WRC-19 Agenda Item 1.13*

Future Spectrum need estimation for IMT

(24.25 GHz - 86 GHz)

	Examples	Associated conditions for different examples (For details, please see the corresponding sections in the Annex A)	Spectrum needs in total (GHz)	Spectrum needs (GHz) per range
Technical performance-based approach (Type 2) *Calculated taking into account different technical performance requirements, i.e. user experienced data rate, peak data rate and area traffic capacity*	–	Dense urban micro	**14.8-19.7**	5.8-7.7 (24.25-43.5 GHz range)
		Indoor hotspot		9-12 (24.25-43.5GHz and 45.5-86 GHz range)
Information from some countries based on their national considerations	–	–	**7-16**	2-6 (24.25-43.5 GHz range) 5-10 (43.5-86 GHz range)

Source: Chairman's report TG 5/1 Annex 2: *Working document towards Draft CPM text for WRC-19 Agenda Item 1.13*

Note: The spectrum needs estimates of the different approaches and examples should be considered separately.

Future Spectrum need estimation for IMT

(24.25 GHz - 86 GHz)

Deployment scenarios	Indoor hotspot	Dense urban		Urban macro
		Micro	Macro	
Frequency range	24.25-86 GHz	24.25-43.5 GHz	<6 GHz	<6 GHz

Deployment scenario	Micro	Indoor hotspot
Total spectrum needs for 24.25-86 GHz	14.8-19.7 GHz*	
Spectrum needs for 24.25-43.5 GHz	5.8-7.7 GHz	9-12 GHz
Spectrum needs for 45.5-86 GHz	–**	

* *Considering the coexistence between multiple network operators (e.g. the guard band(s) may be required in the case of multiple network operators scenarios), the total spectrum needs are expected to be increased.*

** *The division in this table regarding frequency ranges and deployment scenarios is just an indicative example on how spectrum needs could be distributed for different spectrum sub-ranges within 24.25-86 GHz and different deployment scenarios. This table should not be understood nor used to exclude any possible IMT-2020 deployment options in the range 45.5-86 GHz.*

Source: WP 5D Liaison statement to Task Group 5/1

Some 5G Deployments strategies

Regulator	Low (1 GHz)	Medium (<6GHz)	High (mmWave)
FCC	600MHz auctioned – T-Mobile using for 5G	3.5GHz band to be shared under CBRS	28GHz available; 64GHz for unlicensed
Ofcom	700MHz spectrum available by 2020	3.5GHz cleared; 3.7GHz under consultation	26GHz to be repositioned for mobile data
MISP (KOR)	700MHz and 1.3GHz to be freed up in 2018	3.5GHz to be allocated	28GHz – 1GHz available; 38GHz to be allocated
MIIT (CHN)	800MHz for NB-IoT	3.3GHz, 3.5GHz, 4.4GHz, 4.9GHz being considered	26GHz and 40GHz reallocation underway
MIC (JPN)	700MHz assigned for LTE	3.4GHz & 4.4-4.9GHz under review, 3.5GHz done	27.5-29.5GHz to be reassigned for mobile BB
	For coverage – mobile BB and massive IoT	**3.5GHz has wide support – for eMBB and mission-critical apps**	**26 – 28GHz has wide support – high density and high capacity**

3.5GHz IMT vs FSS will be evaluated and coordinated with neighbouring countries

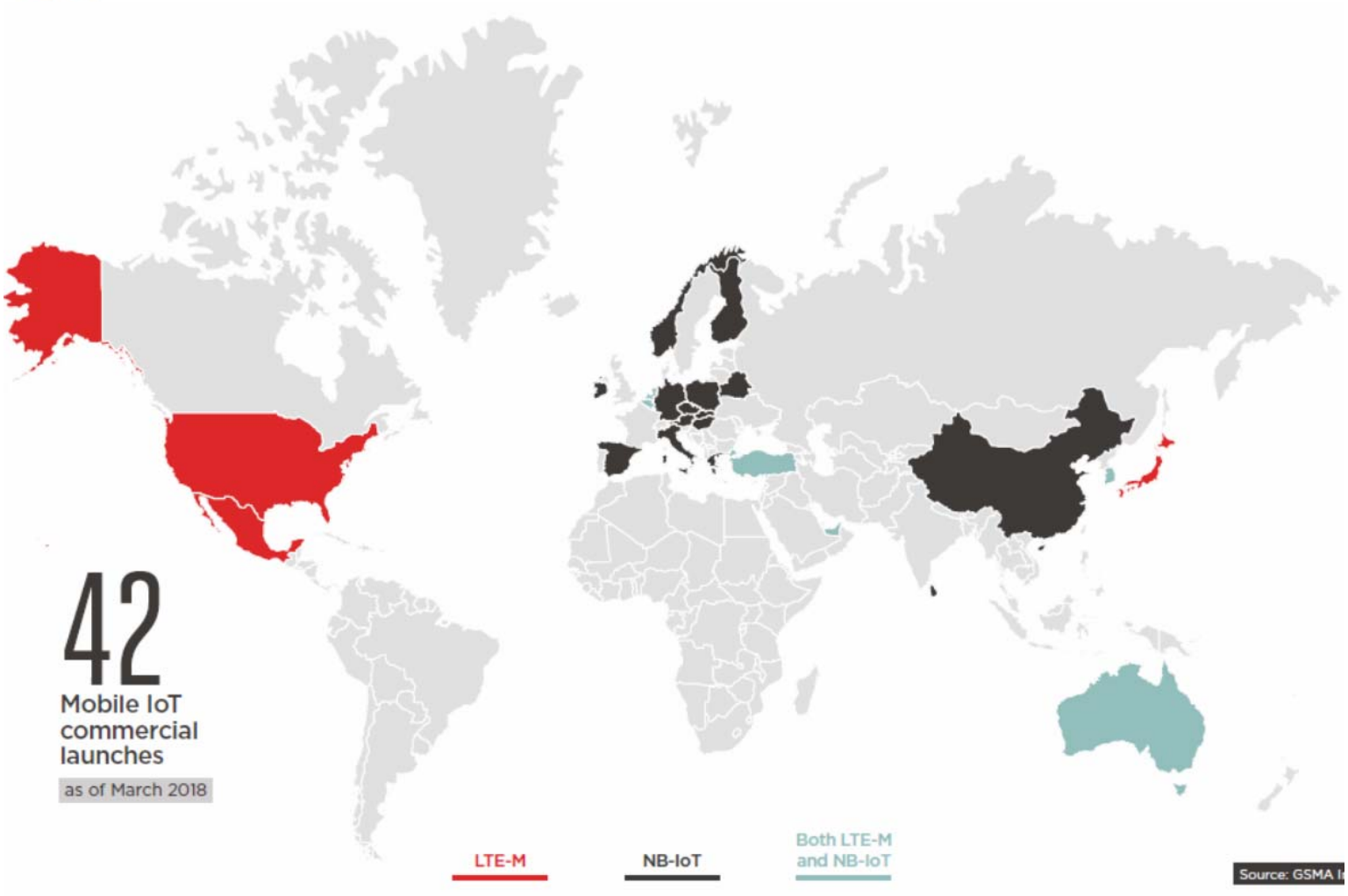
IoT and regulatory issues

- Licensed Vs Non Licensed spectrum
- Area of license
- Numbering
- Standardization
- Infrastructure sharing
- Access to data and open IOT platforms
- Data analytics
- Mobile data roaming
- Consumer protection
- Quality of Service
- USO
- Taxation

https://news.itu.int/one-world-one-global-sim/

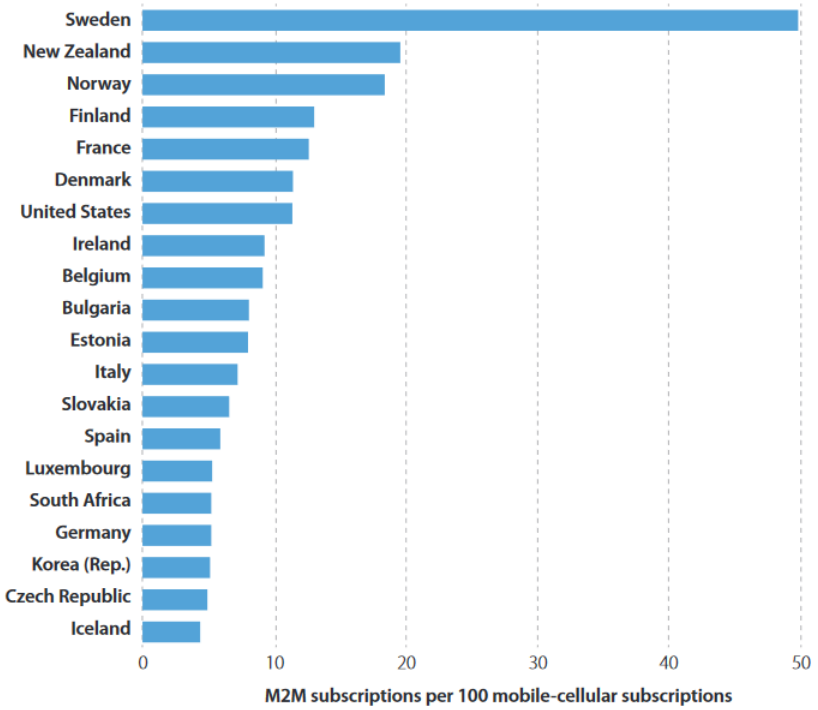
! Global International Mobile Subscriber Identity (IMSI) ranges are signified by the shared Mobile Country Code '**901**', a code without ties to any particular country.

Mobile IoT commercial Launches



Conclusion

- IoTs are in early stage of deployment
  - Some operators already provided services
- Spectrum requirements vary with usage cases
  - Could be Unlicensed or Licensed.
- IMT supports numerous applications including support for IMT services



Based on available data, there were 22 mobile-cellular subscriptions for each machine-to-machine (M2M) subscription worldwide at the beginning of 2015.

The countries with the highest M2M penetration rates are highly industrialized, advanced economies, including the Northern European countries of Sweden, Norway, Finland and Denmark

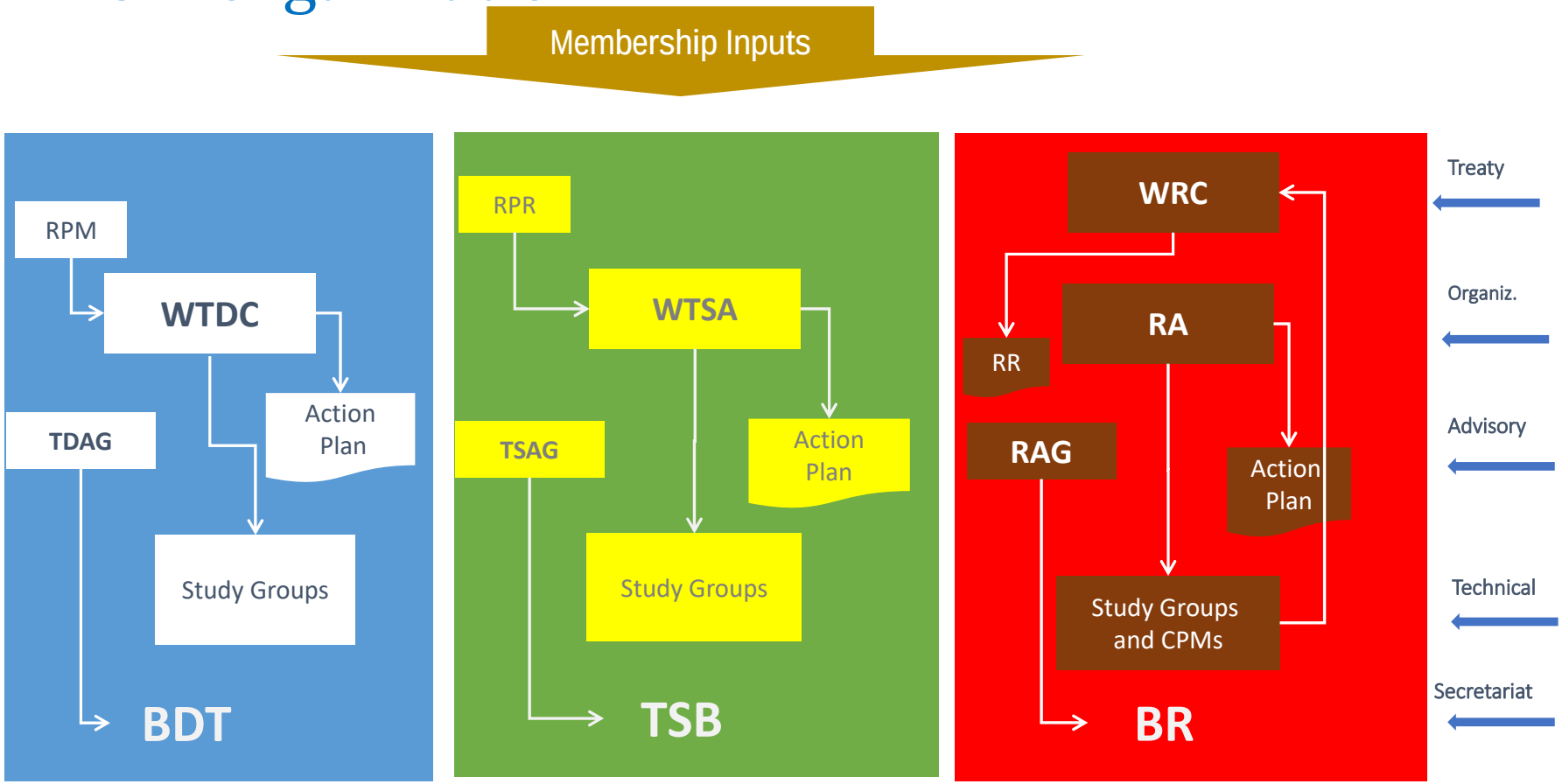
Source: ITU. Note: Data refer to early 2015.

I Thank U

"Committed to connecting the WORLD"

Further Information

ITU – Organization



Main Steps towards WRC-19

WRC-15: WRC-19 Agenda - Resolution 809 (WRC-15)

1st Session of Conference Preparatory Meeting: CPM19-1
30 Nov – 1 Dec. 2015; **Results** @CA/226 **of 23/12/2015**

C-16: WRC-19 agenda & dates in **Res. 1380** with **MOD** venue @ C-17

- **Agenda & dates approved, new venue** for consultation **of MS**

2nd Session of Conference Preparatory Meeting: CPM19-2
Planned dates at CICG in Geneva from 18 to 28 February 2019

Final meetings of regional groups
Member States' proposals to WRC-19

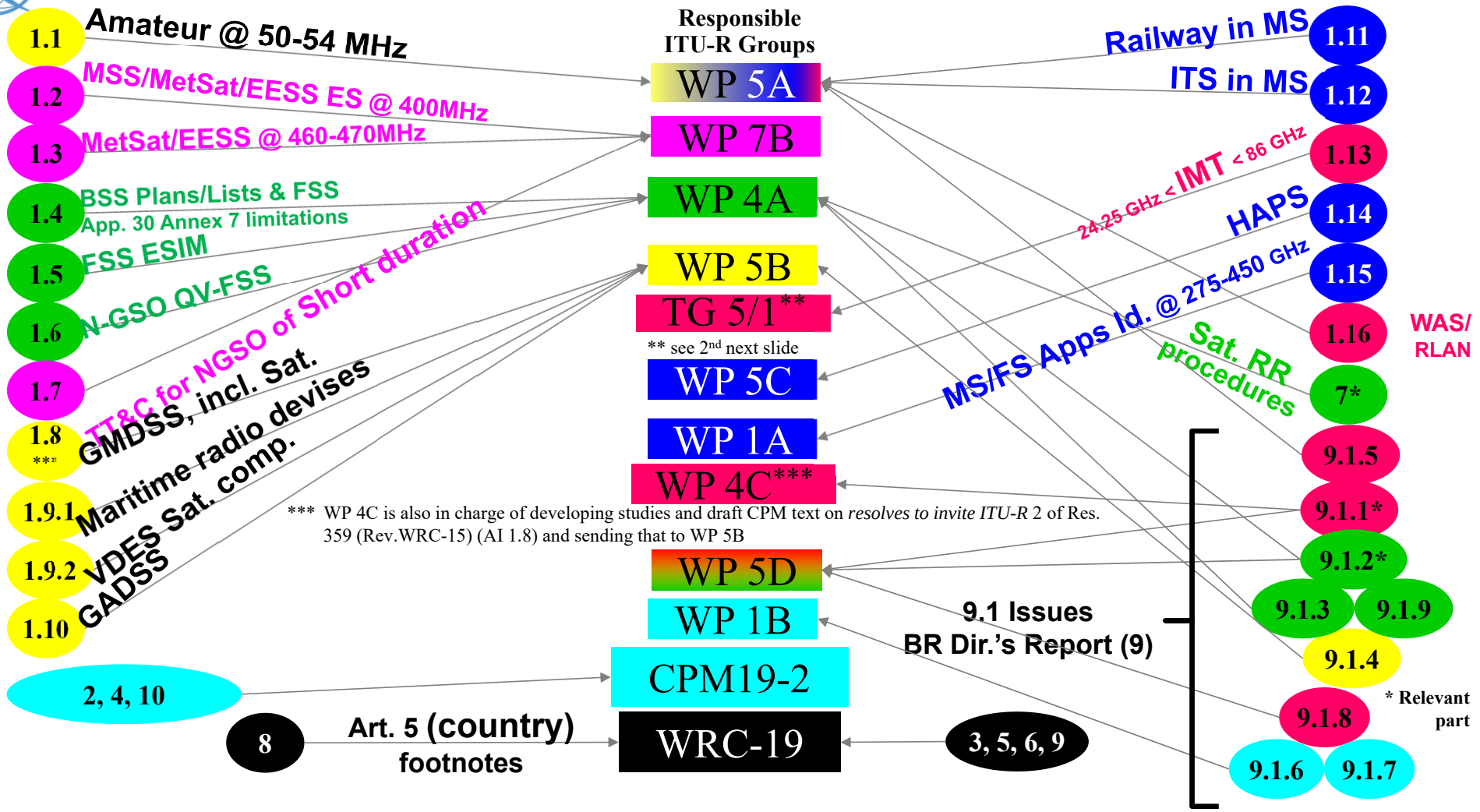
RA-19: **21 to 25 Oct. 2019 ;** WRC-19: **28 Oct. to 22 Nov. 2019**

Summary of AI

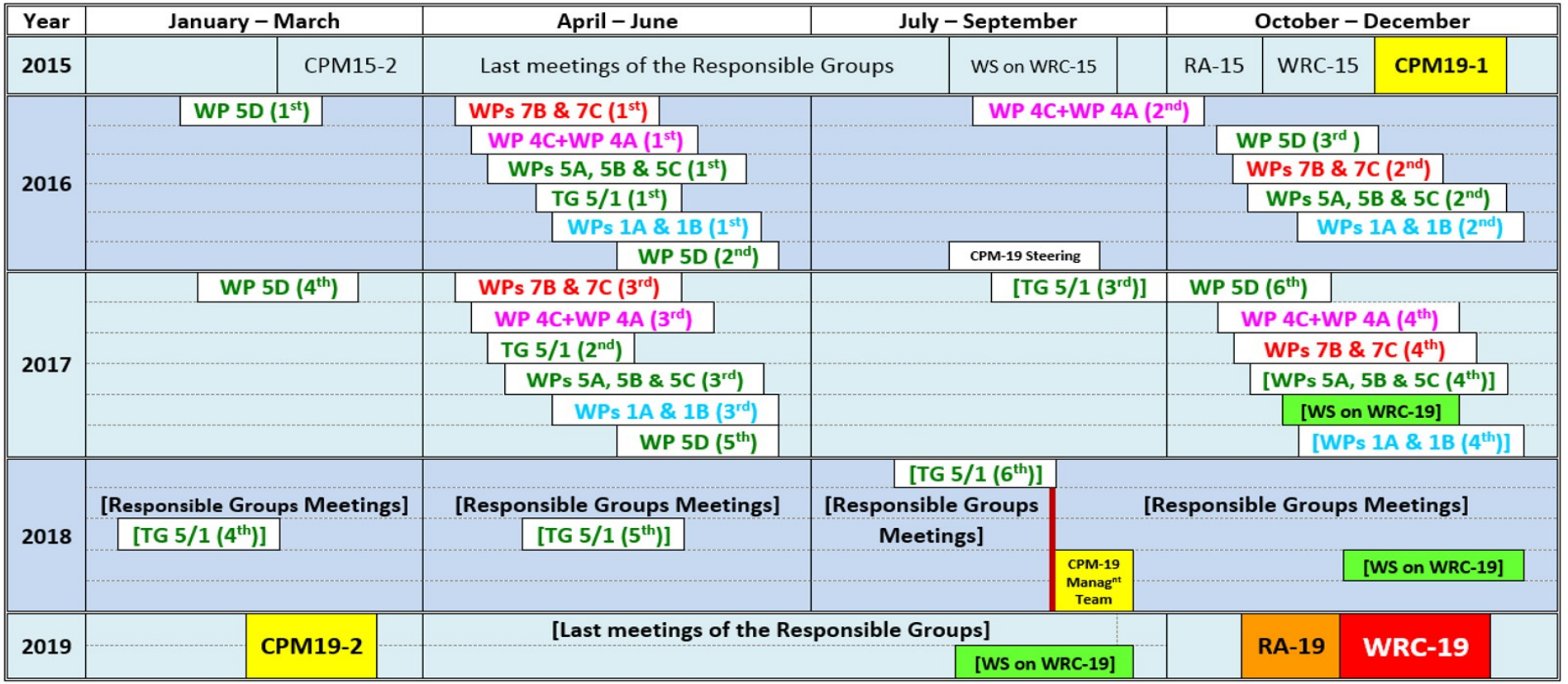
Agenda Item	Issues Covered	Chapter Number
1.1, 1.2, 1.3, 1.4	Mobile and Amateur	1
1.11, 1.12, 1.13, 1.14	Science	2
1.5,1.15, 1.16, 1.17, 1.18	Aeronautical, Maritime and Radiolocation Issues	3
1.6, 1.7, 1.8 , 1.9 (1.9.1 and 1.9.2), 1.10	Satellite Services, FSS	4
7, 9 (9.1, 9.2, 9.3)	Satellite Regulatory Issues	5
2 (2.1 and 2.2), 4, 9, 10	General Issues	6

Res. 809 (WRC-15): **17 specific and 6 standing Items**

WRC-19 agenda items & Resp. Groups



Overview of ITU calendar



[…] = planned meetings

WS on WRC-19 = ITU Inter-regional Workshop on WRC-19 Preparation

Up-to-date information online at: www.itu.int/en/events/Pages/Calendar-Events.aspx?sector=ITU-R

ITU preparatory studies for WRC-19

Resolution **809 (WRC-15)** contains the WRC-19 agenda.

WRC-19 agenda Item (Chapter)	Issue	WRC Resolution (*)	Responsible Group(s)	Information from Responsible Group(s) ITIES
1		-	-	-
1.1 (5)		Res. 658 (WRC-15)	WP 5A	Doc. 5A/298 Sections 3.3 & 4 and Annexes 4 (c), 5 (b), 14 & 15
1.2 (4)		Res. 765 (WRC-15)	WP 7B	Doc. 7B/170 Section 3.3.1 and Annexes 1 (c), 2 (b), & 18
1.3 (4)		Res. 766 (WRC-15)	WP 7B	Doc. 7B/170 Section 3.3.2 and Annexes 3 (c), 4 (b), & 19
1.4 (3)		Res. 557 (WRC-15)	WP 4A	Doc. 4A/196 Section 4.1.1 and Annexes 5 & 26 (b)
1.5 (3)		Res. 158 (WRC-15)	WP 4A	Doc. 4A/196 Section 4.1.2 and Annexes 16 to 20 & 27 (b)
1.6 (3)		Res. 159 (WRC-15)	WP 4A	Doc. 4A/196 Section 4.1.3 and Annexes 4, 8, 9 & 28 (b)
1.7 (4)		Res. 659 (WRC-15)	WP 7B	Doc. 7B/170 Section 3.1.6 and Annexes 5 (c), 6 (b), 7, 8, 9 & 20
1.8 (5)		Res. 359 (Rev.WRC-15)	WP 5B (1)	Doc. 5B/195 Sections 2.1.1 & 3.3.1.2 and Annexes 1 (c) & 2 (b) Doc. 4C/43 Sections 3.2.4 & 4.2
1.9 / 1.9.1 (5)		Res. 362 (WRC-15)	WP 5B	Doc. 5B/195 Sections 2.1.1 & 3.3.1.3 and Annexes 3 (c), 4 (b), 19, 23, 33 & 36 Circular Letter 5/LCCE/64
1.9 / 1.9.2 (5)		Res. 360 (Rev. WRC-15)	WP 5B	Doc. 5B/195 Sections 2.1.1 & 3.3.1.4 and Annexes 5 (c), 6 (b) & 26
1.10 (5)		Res. 426 (WRC-15)	WP 5B	Doc. 5B/195 Sections 2.1.1 & 3.2.1.1 and Annex 8
1.11 (1)		Res. 236 (WRC-15)	WP 5A	Doc. 5A/298 Sections 3.4, 3.7 & 4 and Annexes 6 (c), 7 (b) & 16

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

ITU inter-regional Workshops for WRC-19

1st Workshop [21-22] Nov. 2017***

- **To be scheduled halfway through the preparatory cycle**
  - *Presentation and review of the on-going preparatory studies of the ITU-R responsible groups for CPM-19*
  - *Presentation of the organization, preliminary views, draft priorities and positions of the regional groups*

2nd Workshop [Q4 2018]**

- **To be scheduled few months prior to CPM19-2**
  - *Presentation of the Draft CPM Report to WRC-19 (explanation of the draft Methods to satisfy the (WRC-19 agenda items)*
  - *Presentation and review of the regional groups' draft views, positions and common proposals*

3rd Workshop [Q3 2019]**

- **To be scheduled few months prior to WRC-19**
  - *Presentation of the CPM & Dir. Reports to WRC-19*
  - *Presentation and review of the regional groups' draft views, positions and common proposals*

* Subject to the confirmation of the dates of the ITU-R SG 5 meeting currently planned on 20 Nov. 2017

** Updated information on meeting dates to be provided later on at: www.itu.int/en/events/Pages/Calendar-Events.aspx?sector=ITU-R