

5G: Spectrum International Regulatory Framework

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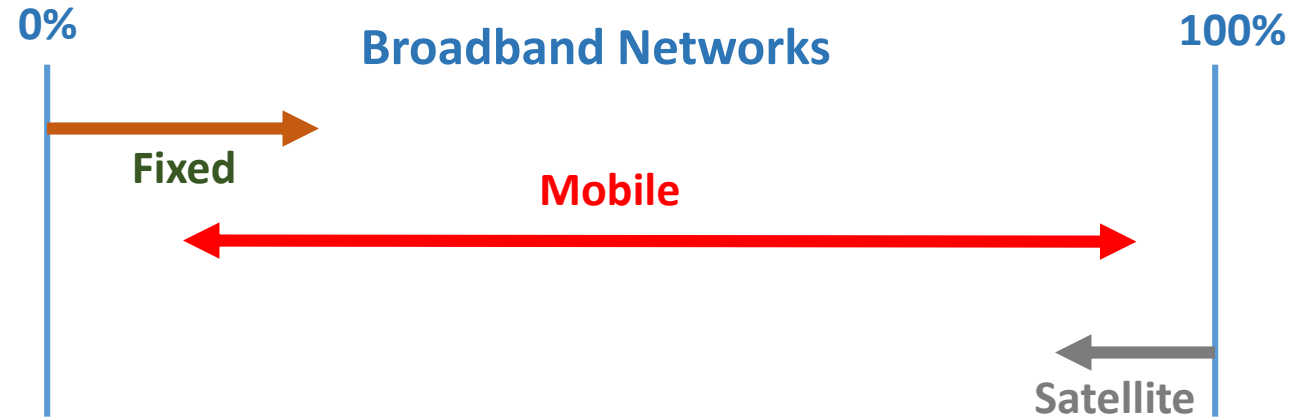
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International Telecommunications Union, ITU*

**Workshop on Economics, Finance and Business models for 5G and new Technologies
for Digital Africa (RED-AFR19)**

**Session 1: Regulatory aspects that will facilitate the deployment and use of the 5G
Lomé, Republic of Togo**

9-11 September 2019

Broadband Access: Fixed vs. Mobile

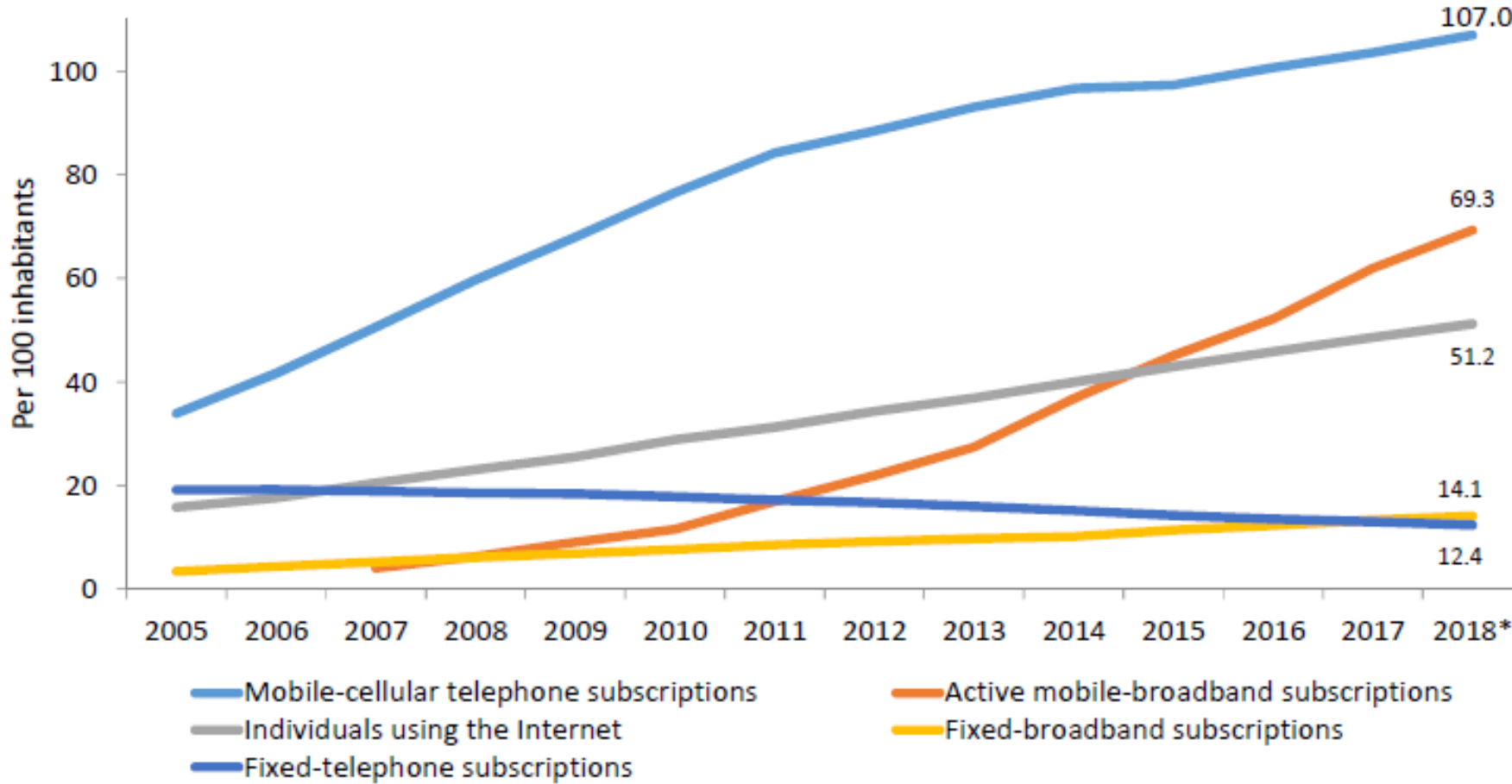


Broadband services infrastructure is based upon 3 types of final access networks (last km, last mile):

- Fixed: copper, coaxial, fiber
- Wireless (Terrestrial): cellular, Wi-Fi?
- Satellite

Broadband penetration is topped by the penetration of these networks

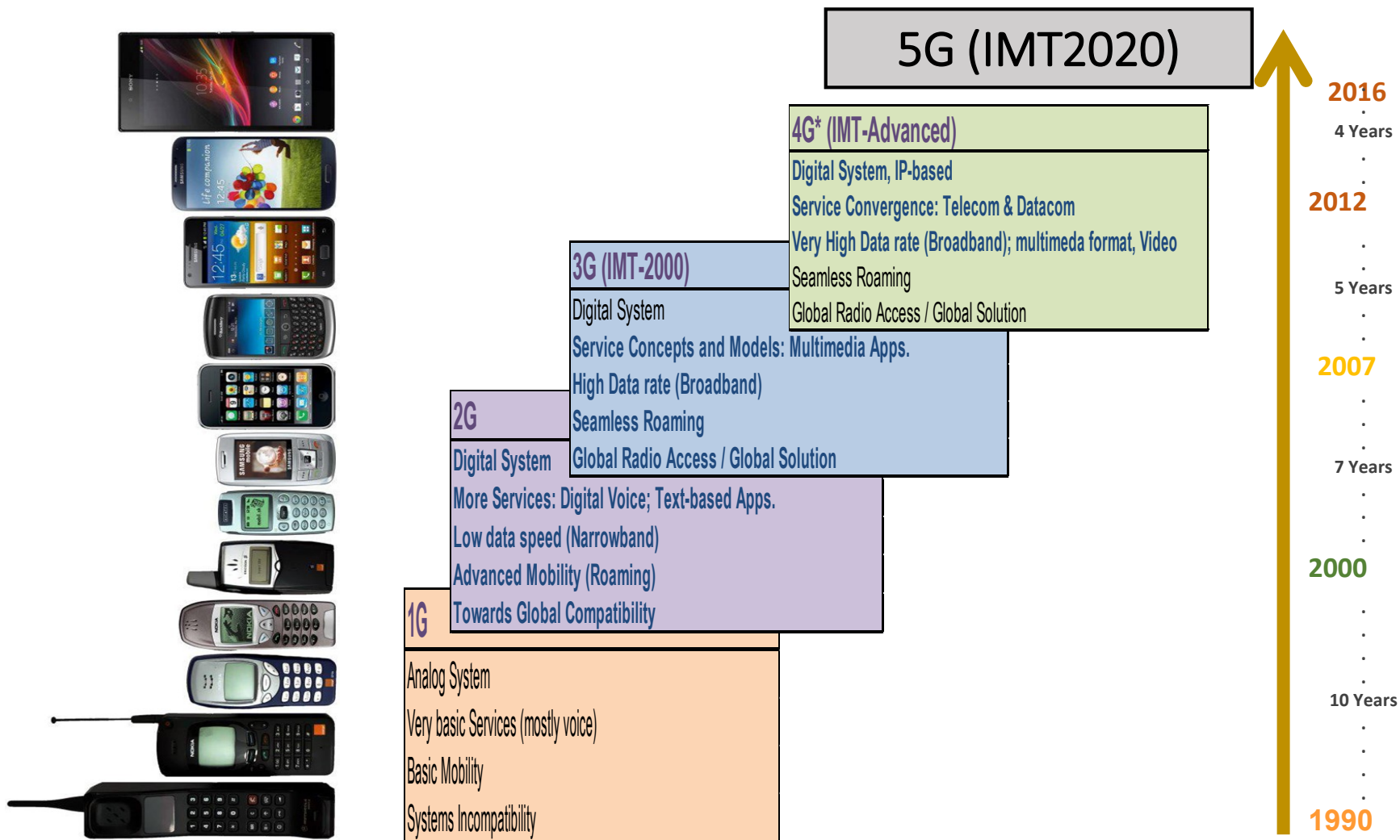
Broadband Access: Fixed vs. Mobile



	Region	% Prepaid
Developing	<i>Africa</i>	96%
	<i>Asia</i>	91%
	<i>Latinamérica</i>	89%
Developed	<i>Asia</i>	15%
	<i>Norteamérica</i>	22%
	<i>Europa</i>	33%

- Fixed Networks in slight decline
- Mobile Networks in high growth, near saturation
- increasing Gap between developed and developing world.
- Broadband Universal Service in developing world: **Mobile & Prepaid**

Mobile Networks Evolution



For over 30 years, ITU has been developing the standards and spectrum arrangements to support International Mobile Telecommunications (IMT)

First Generation (1G)

1G analogue systems provided two key improvements over the first radiotelephone services:

- the invention of the microprocessor; and
- digitization of the control link between the mobile phone and the cell site.



1970s

Frequencies for mobile services allocated
in the **Radio Regulations**

Second Generation (2G)

2G systems digitized not only the control link but also the voice signal - better quality and higher capacity at lower cost.

Regional/global operation was hampered by:

- multiple incompatible standards;
- different frequency bands and channels in different parts of the world.



1980s-1990s

ITU-R develops the international mobile telecommunication system (IMT) to address these issues – first global IMT frequencies identified at **WRC-92**

IMT-2000 – Third Generation (3G)

ITU's IMT-2000 global standard for 3G unanimously approved at the ITU Radiocommunication Assembly 2000 – digital voice and data.

Global standard and harmonized frequencies:

- global roaming;
- massive economies of scale;
- innovative applications and services.



2000s

WRC-2000 and **WRC-07** identify additional frequency bands for IMT in the Radio Regulations

Fourth Generación (4G) – IMT Advanced

Multimedia

- **4G Systems**, provides:
 - IP based
 - Very high data speeds
 - Convergence of Services
 - Web access, television, videogames, videoconferences ...
 - IMT-Advanced Specifications were approved during Radio ITU Radio Assembly 2012
 - Mobile Broadband became the largest method to internet access



2010s

WRC-15 harmonized and identified several additional frequency bands for IMT on the **Radio Regulations**

		Real World (avg)		Theoretical (max)		Availability
		Download	Upload	Download	Upload	
2.5G	GPRS	32-48Kbps	15Kbps	114Kbps	20Kbps	Today
2.75G	EDGE	175Kbps	30Kbps	384Kbps	60Kbps	Today
	UMTS	226Kbps	30Kbps	384Kbps	64Kbps	Today
	W-CDMA	800Kbps	60Kbps	2Mbps	153Kbps	Today
3G	EV-DO Rev. A	1Mbps	500Kbps	3.1Mbps	1.8Mbps	Today
	HSPA 3.6	650Kbps	260Kbps	3.6Mbps	348Kbps	Today
	HSPA 7.2	1.4Mbps	700Kbps	7.2Mbps	2Mbps	Today
	WiMAX	3-6Mbps	1Mbps	100Mbps+	56Mbps	Today
Pre-4G	LTE	5-12Mbps	2-5Mbps	100Mbps+	50Mbps	End 2010
	HSPA+	-	-	56Mbps	22Mbps	2011
	HSPA 14	2Mbps	700Kbps	14Mbps	5.7Mbps	Today*
4G	WiMAX 2 (802.16m)	-	-	100Mbps mobile / 1Gbps fixed	60Mbps	2012
	LTE Advanced	-	-	100Mbps mobile / 1Gbps fixed	-	2012+

1G → 2G : Analog to Digital

2G → 3G : Narrowband to Broadband

3G → 4G : Broadband evolution (Multimedia)

4G → 5G : High Broadband to connect People and machines

IMT Definition

*From: Recommendation ITU-R M.1224**

International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based

IMT systems support low to high mobility applications and a wide range of data rates in accordance with user and service demands in multiple user environments. IMT also has capabilities for high quality multimedia applications within a wide range of services and platforms, providing a significant improvement in performance and quality of service.

IMT encompasses both IMT-2000 & IMT-Advanced, ...and IMT-2020

* 1st release ITU-R M.1224-0 (02-97); current version ITU-R M.1224-1 (03-12)

IMT Key Features

From: Recommendation ITU-R M.1224

1. A high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
2. Compatibility of services within IMT and with fixed networks;
3. Capability of interworking with other radio access systems;
4. High quality mobile services;
5. User equipment suitable for worldwide use;
6. User-friendly applications, services and equipment;
7. Worldwide roaming capability;
8. Enhanced peak data rates to support advanced services and applications.

These features enable IMT to address evolving user needs and the capabilities of IMT systems are being continuously enhanced in line with user trends and technology developments

IMT Requirements

From: Recommendation: ITU-R M.1822-0 (10/2007)

1. Seamless connectivity
2. Mobility management
3. Interoperability
4. Constant connection
5. Application scalability
6. Security
7. Prioritization
8. Location
9. Broadcast/multicast
10. Presence
11. Usability
12. Voice recognition
13. User-friendly human-to-machine interface
14. Support for a wide range of services

IMT and Mobile Labels

- **IMT**: Devised within ITU through the work of *ITU Study Groups* (worldwide participation, amongst all stakeholders: Regional Organizations, Regulators, operators, manufactures, universities and R&D Centers,, etc.)

Unique set of Definitions and Specifications (through ITU-R publications)

IMT encompasses all its versions: IMT2000, IMT-Advanced, IMT 2020

- **xG**: Devised by operators and mobile community.

There is no unique set of definitions and specifications.

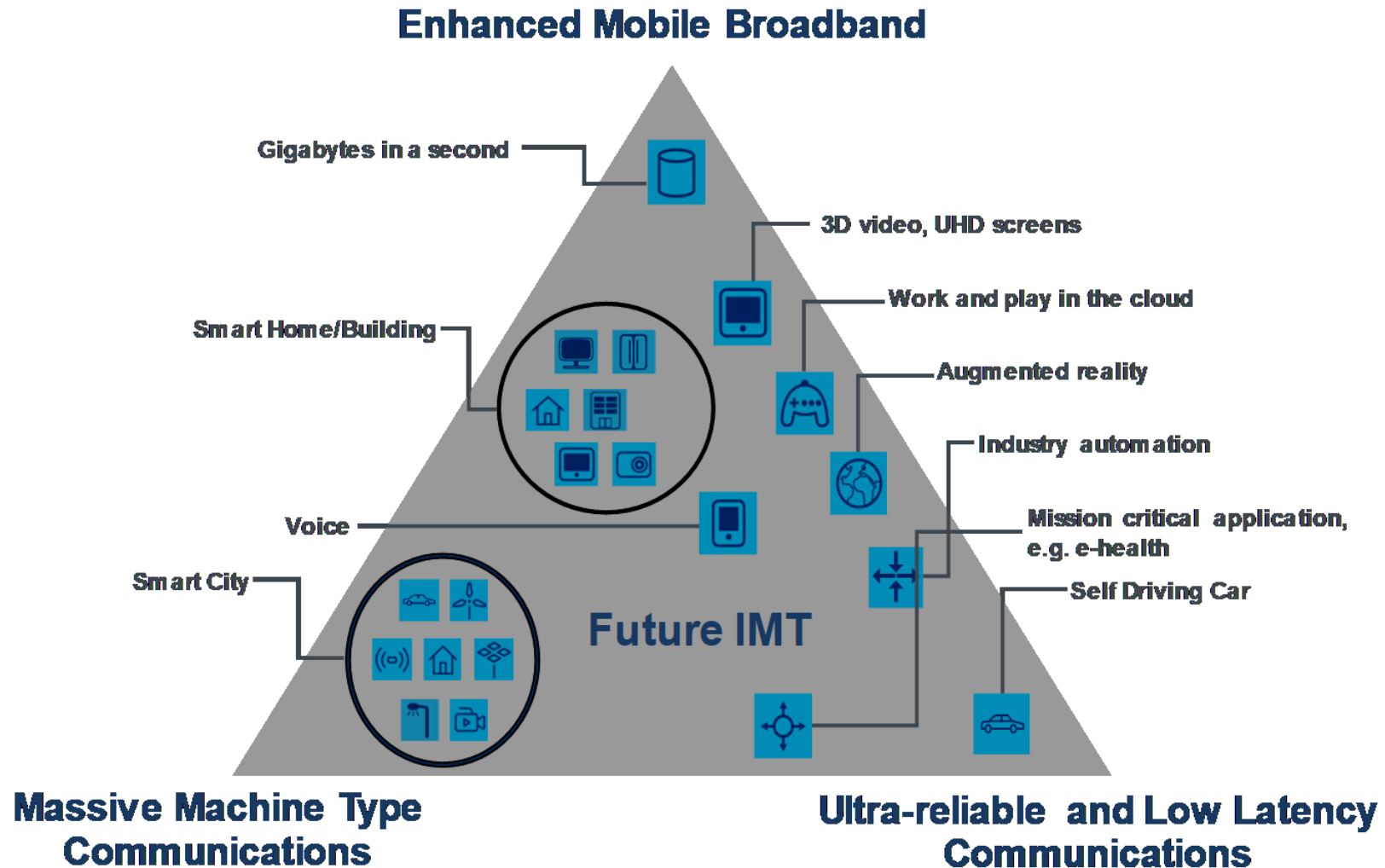
- **IMT-2000 and 3G**: there was consensus about matching both these concepts and associated specifications.

- **IMT-Advanced and 4G**: no consensus was reached:

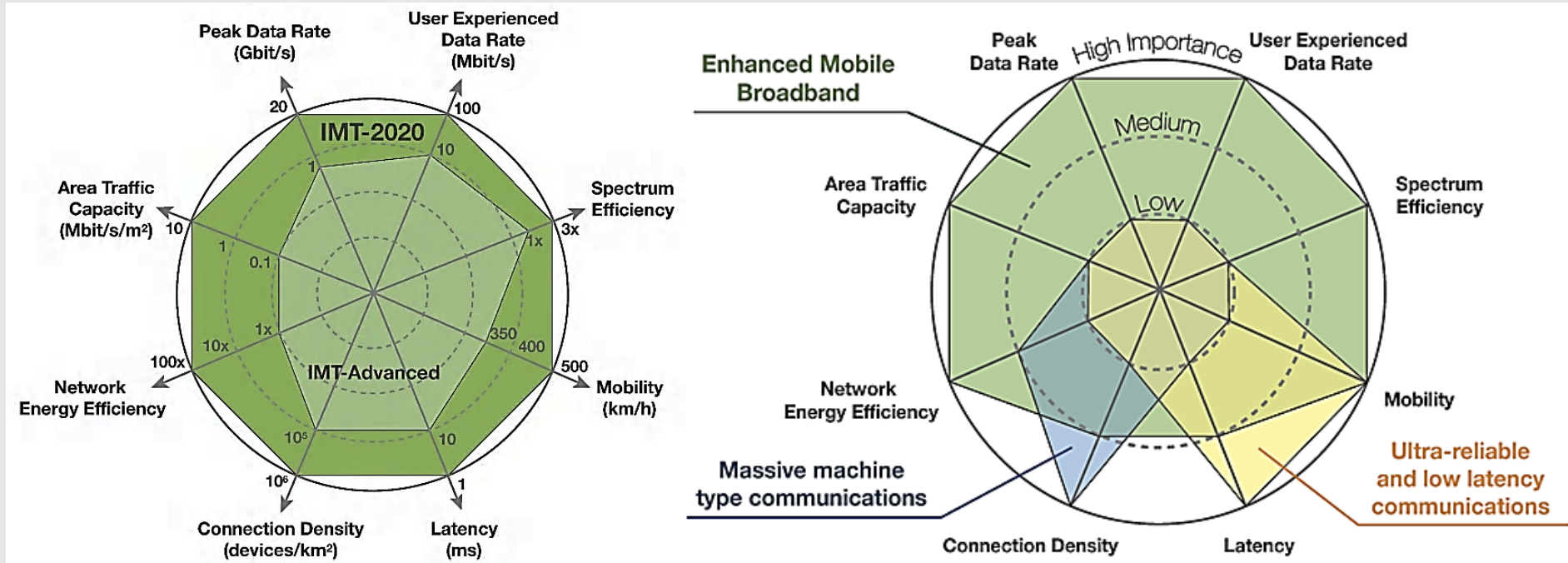
- Some Regulators demanded that a 4G brand must comply with IMT-Advanced specifications.
- Other Regulators recognized 4G as those technologies providing an enhanced performance in comparison to IMT-2000 Specifications.

IMT-2020 and 5G: consensus achieved

5G Usage scenarios



5G Capability Perspectives from the ITU-R IMT-2020 Vision Recommendation



Enhancement of key capabilities from IMT-Advanced to IMT-2020

The importance of key capabilities in different usage scenarios

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 (Recommendation ITU-R M.2083)



IMT-2020



- ITU-R Study Group 5 Process
- IMT-2020 Vision, overall requirements, radio interface specifications
- ITU membership, other standard making bodies
- Industry driven

- ITU WRC Process
- Mobile spectrum allocations and IMT identifications
- ITU membership, ITU-R Study Groups, Regional Groups, International organisations
- Member States driven

World Radiocommunication Conference (WRC)

Radiocommunication Assembly (RA)



- WP 1A
- WP 1B
- WP 1C

- WP 3J
- WP 3K
- WP 3L
- WP 3M

- WP 4A
- WP 4B
- WP 4C

- WP 5A
- WP 5B
- WP 5C
- WP 5D
- TG 5/1

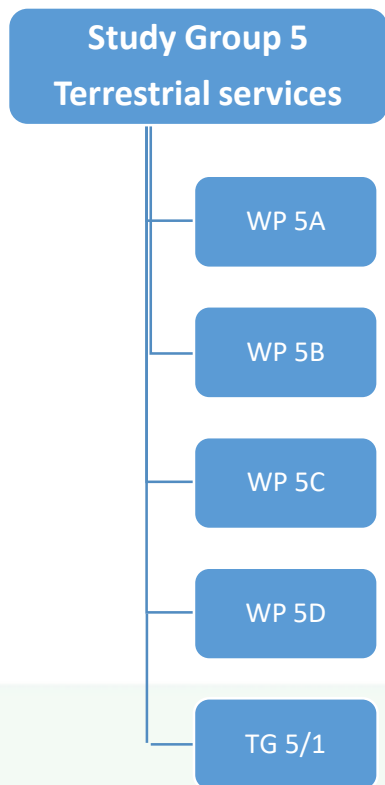
- WP 6A
- WP 6B
- WP 6C

- WP 7A
- WP 7B
- WP 7C
- WP 7D

ITU-R Study Group 5 – Terrestrial Services

Scope

Systems and networks for fixed, mobile, radiodetermination, amateur and amateur-satellite services.



Topics of particular interest:

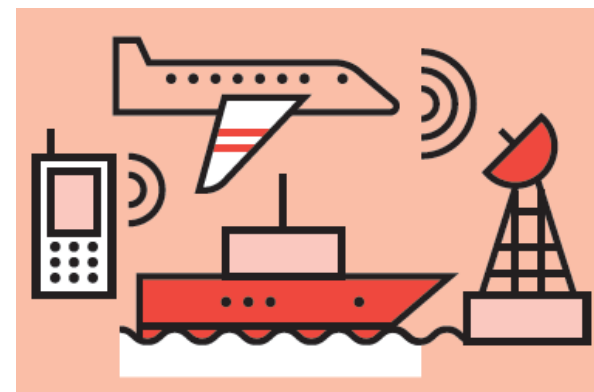
Radio Local Access Networks (WAS/RLAN)

High Altitude Platforms (HAPS)

International Mobile Communications (IMT)

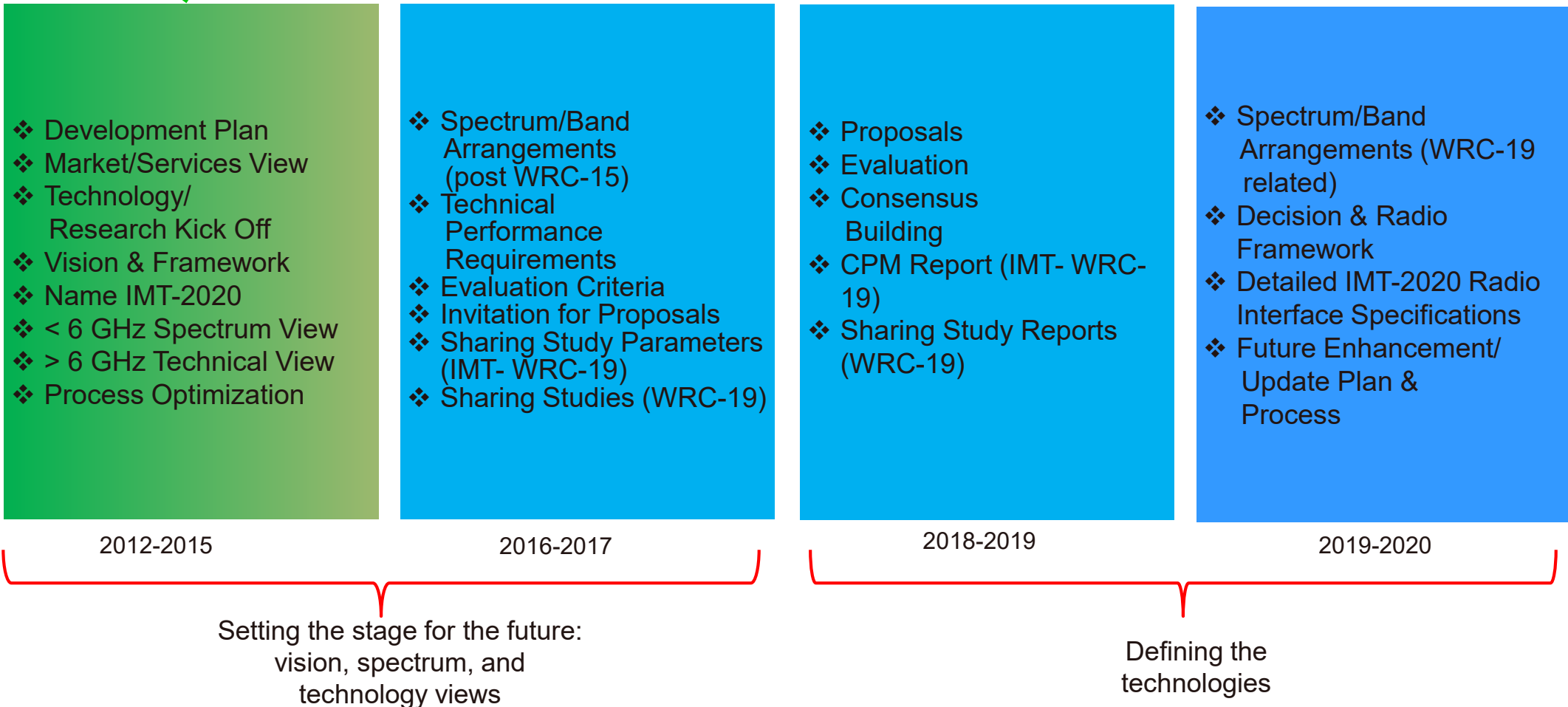
Amateur radio service

Maritime and aeronautical services



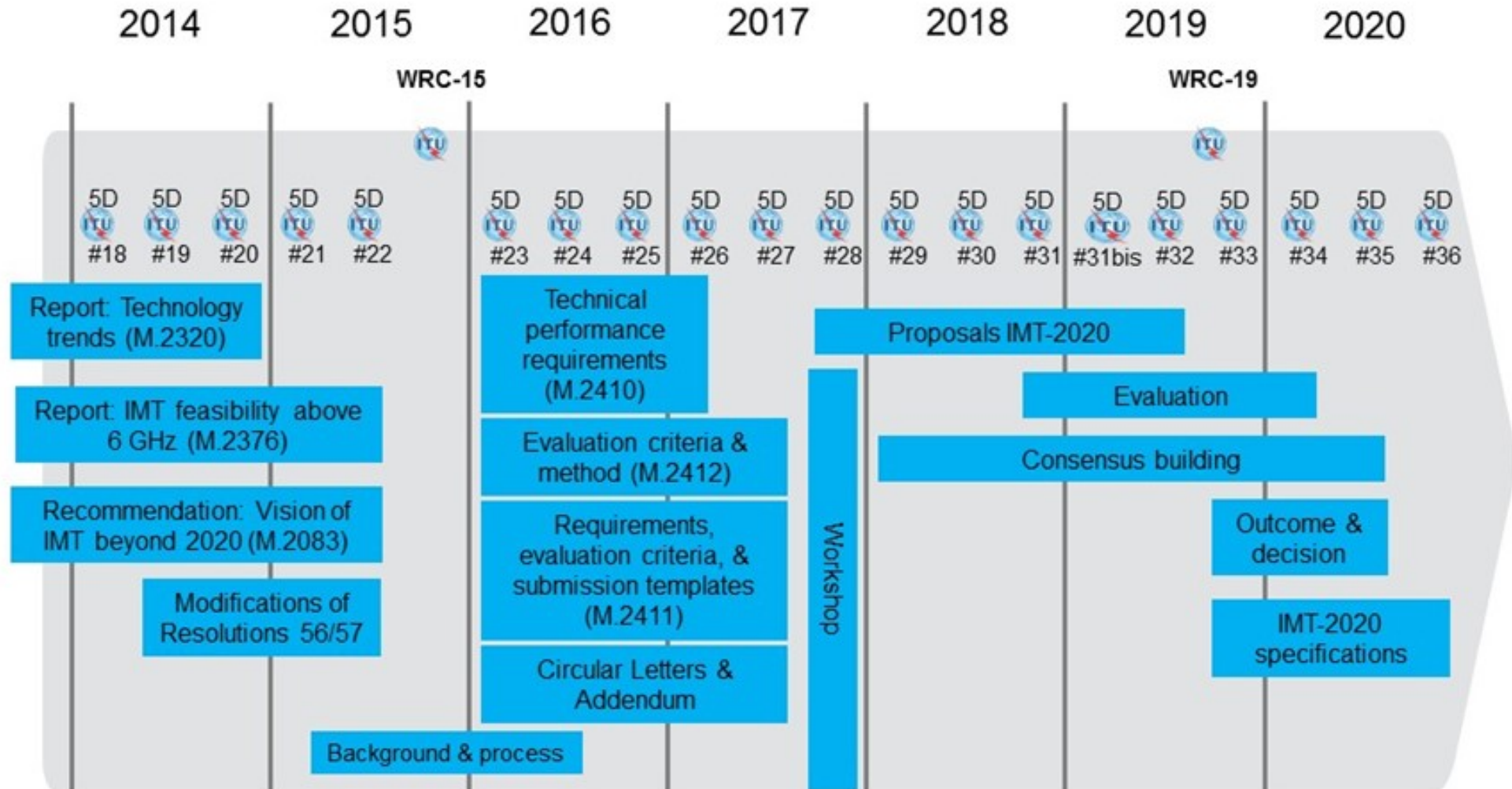
Chairman: Mr. Martin FENTON
Counsellor SG 5 and WP 5A, 5C and 5D:
Mr. Sergio BUONOMO
Counsellor WP 5B: Mr. Vadim Nozdrin
Counsellor TG 5/1: Mr. David Botha

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





IMT-2020 standardization process



Technical performance for IMT-2020

Target values for user experienced data rate in the Dense Urban eMBB:

- Downlink user experienced data rate is **100 Mbit/s**

Minimum user plane latency:

- 4 ms for eMBB
- **1 ms for URLLC**

Minimum connection density in mMTC usage scenario:

- **1 000 000 devices** per km²

eMBB Enhanced mobile broadband
URLLC Ultra-reliable and low-latency communications
mMTC Massive machine type communications

IMT-2020 spectrum allocation process

WRC-19, AI 1.13: 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)**

TG 5/1

- Conduct sharing and compatibility studies in accordance with Res. 238 (WRC-15)
- Develop draft CPM-text under WRC-19 AI 1.13

WP 5D

- Spectrum/band arrangements (post WRC-15)
- Spectrum/band arrangements (WRC-19)



CPM 19-2

- CPM 19-2: 18 – 28 February 2019
- Switzerland, Geneva

WRC-19

- WRC-19 28 October to 22 November 2019
- Egypt, Sharm el-Sheikh
- Spectrum allocation

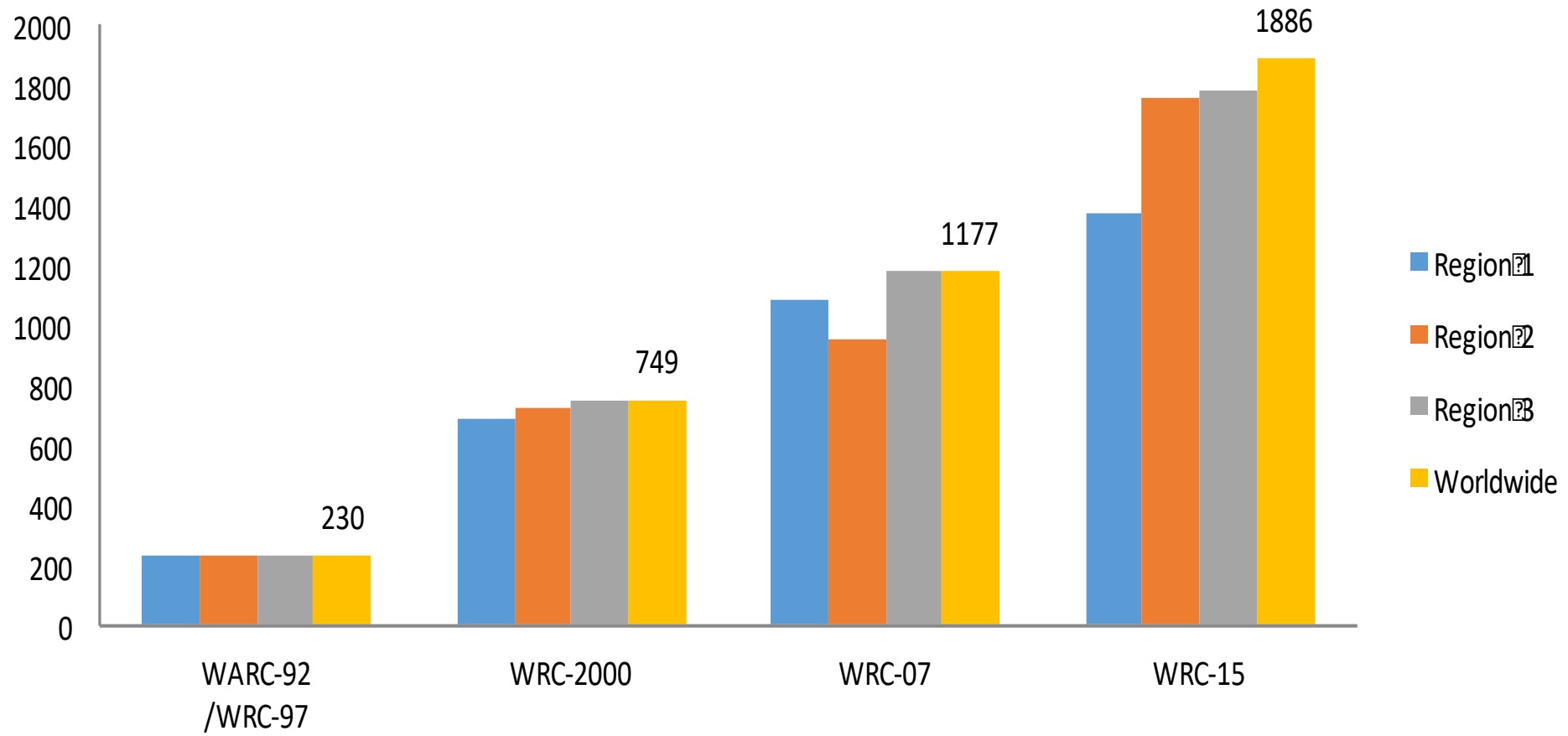
RADIO REGULATIONS: IMT Bands

	BW (MHz)	Band (MHz)	RR Footnote	Global?
< 1 GHz	20	450-470	5.286AA	100%
	228	470-698	5.295 5.296A 5.308A 5.317A	<5%
	262	698-960	5.313A 5.317A	~100%
1 GHz to 3 GHz	91	1427-1518	5.341A 5.341B 5.341C 5.346 5.346A	~100%
		1518-1710		
	315	1710-2025	5.384A 5.388	100%
		2025-2110		
	90	2110-2200	5.388	100%
		2200-2300		
3 GHz to 5 GHz	100	3300-3400	5.429B 5.429D 5.429F	~20%
	200	3400-3600	5.430A 5.431B 5.432A 5.432B 5.433A	>85%
	100	3600-3700	5.434	2%
		3700-4800		
	190	4800-4990	5.441A 5.441B	2%

All footnotes related to IMT indicates that:

the band X MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations

Total amount of spectrum identified for IMT (MHz)



IMT and Mobile Broadband

UHF band: 470-698 MHz

Identified by some Administrations

**DIGITAL
DIVIDEND**

700 MHz – Quasi-Global Harmonization

Except some Administrations in Region 3

L-Band: 1427-1518 MHz – Quasi-Global Harmonization

Except some Administrations in Region 1 in the 1452-1492 MHz band

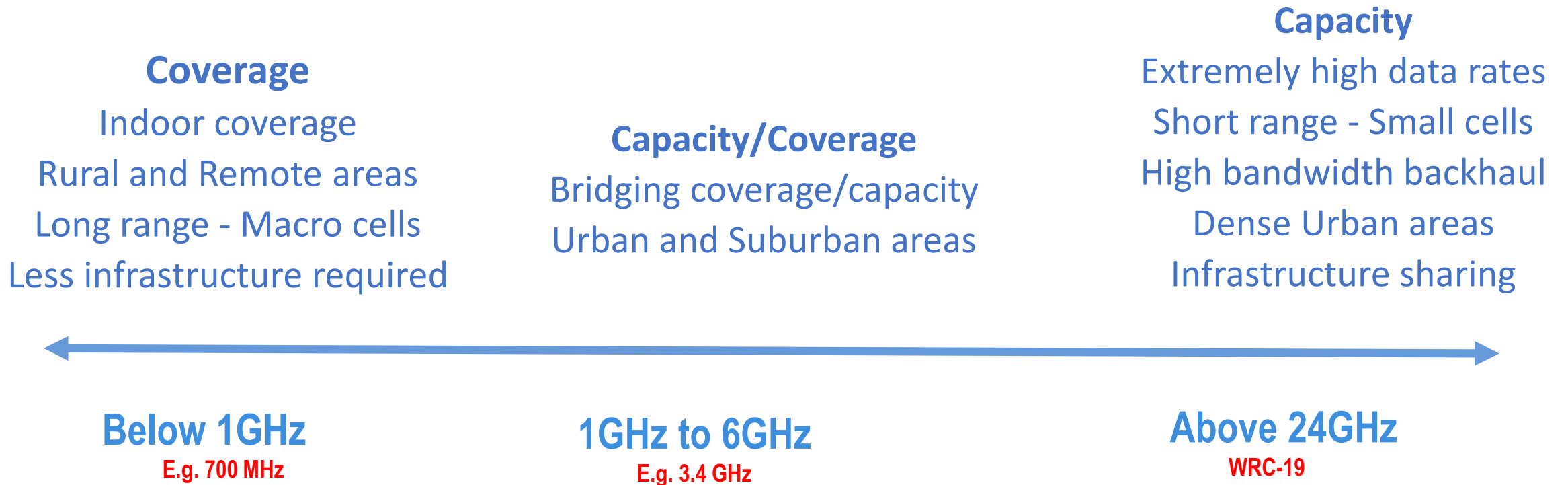
C-Band: 3400-3600 MHz – Quasi-Global Harmonization

Except some Administrations in Region 3

3300-3400 MHz, 3600-3700 MHz, 4800-4990 MHz Bands

Identified by some Administrations

IMT-2020 spectrum bands

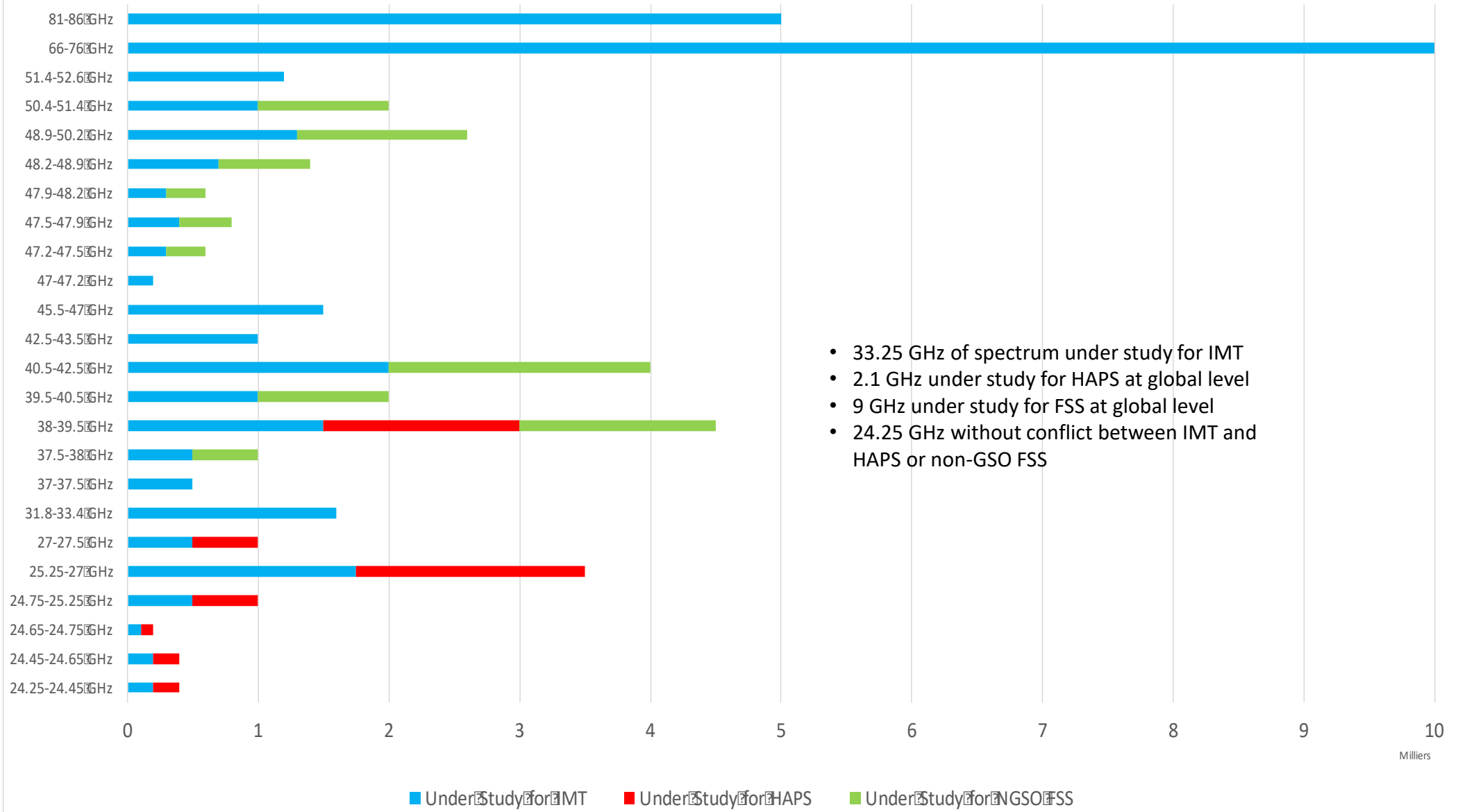


New spectrum: Bands under study for WRC-19

BW (GHz)	Existing mobile allocation	No global mobile allocation	Gaps
3.25	24.25 GHz – 27.5 GHz		
			27.5-31.8 GHz
1.6		31.8 – 33.4 GHz	
			33.4-37 GHz
3.5	37 – 40.5 GHz		
2		40.5 – 42.5 GHz	
			42.5-45.5 GHz
1.5	45.5 – 47 GHz		
0.2		47 – 47.2 GHz	
3	47.2 – 50.2 GHz		
			50.2-50.4 GHz
2.2	50.4 – 52.6 GHz		
			52.6-66 GHz
10	66 – 76 GHz		
			76-81 GHz
5	81 – 86 GHz		

WRC-19 Challenges

Spectrum (GHz) under study for IMT identification by WRC-19



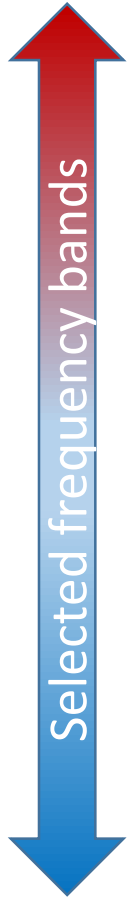
WRC-19 AI 1.13 sharing & compatibility studies

Mobile service
IMT-2020



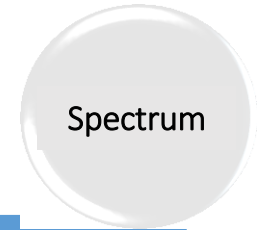
Incumbent services
Mobile-satellite Radionavigation-satellite service
Fixed-satellite Broadcasting-satellite
Radio astronomy
Space research Earth exploration-satellite
Inter-satellite
Earth exploration-satellite (passive) Space research (passive)
Fixed
Mobile – Multiple gigabit wireless systems
Aeronautical mobile Radiodetermination

24.25 GHz



86 GHz

Frequency bands under study for WRC-19



	Frequency bands (GHz) mentioned in Resolution 238 (WRC-15) in which studies are focused/prioritized											
	24.25-27.5	31.8-33.4	37-40.5	40.5-42.5	42.5-43.5	45.5-47	47-47.2	47.2-50.2	50.4-52.6	66-71	71-76	81-86
CEPT	X			X	X					X		
ASMG	X	X		X	X							
RCC	X	X		X						X		
APT	X	X	X	X	X					X	X	X
ATU	X		X	X	X							
CITEL												

Reference docs:

<https://www.itu.int/en/ITU-R/conferences/wrc/2019/Pages/reg-prep.aspx>

APT: indication in grey reflects the views of some administrations with regards to studies /identification

ATU: frequency bands as priority candidates for IMT identification

Thank you