IMT-2030 status: spectrum and technology

Ven Sampath (Vice-Chair, SG5 & acting Vice- Chair, WP5D – ITU-R)

Glenn Parsons (Chair, SG15 – ITU-T)

ITU Workshop: The Evolution of Transport and Access Networks to Support IMT 2030/6G

Montreal, Canada, 7th July 2024

The WRC Process (2023 example)

(WRC-23 Docs)

APT (Doc. 62)

ASMG (Doc. 100)

ATU (Doc. 87)

CEPT (Doc. 65)

CITEL (Doc. 44)

RCC (Doc. 85)

Coordinated common proposals

Regional preparation
Resolution 72 (Rev.WRC-07)

Agenda: draft in WRC Res & final in Council Res

Informal Group
(Structure & Chairmanship)

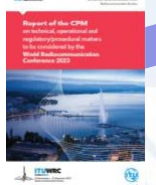
Proposals

Proposals

Member States

RA

RA Report
(Doc. 217)



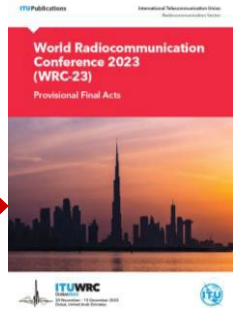
CPM Report
(Doc. 3)

Director's Report
(Doc. 4)

WRC

ITUWRC DUBAI 2023

Conference Secretariat (BR & GS)



Final Acts

Radio Regulations (CS89)

WRC outcome and common terms

- The RRs represent an International Treaty (effectively legal document)
- RRs constituted by four Volumes
  - First Volume defines (Article **1**) services and stations
  - First Volume also defines (Article **5**) frequency allocations
- The term "*allocation*" has a special regulatory meaning
  - ➢Primary service in that band – other services cannot cause interference
- Under a service, there could be different applications
  - ➢Applications can be "*identified (designated)*" in a band, with associated conditions

Spectrum

WRC-23 outcome: AI 1.7

Description:

- to consider studies on sharing and compatibility and develop technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz taking into account existing primary services operating in these, and adjacent, frequency bands, in accordance with Resolution **256 (WRC-23)**;

Responsible party is WP 5D; several contributing parties

Operative part of RES **256 (WRC-23)**:

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 the appropriate studies of technical, operational and regulatory issues pertaining to the possible use of the terrestrial component of IMT in the frequency bands listed in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference* 2, taking into account:

– evolving needs to meet emerging demand for IMT;

– technical and operational characteristics of terrestrial IMT systems that would operate in these specific frequency bands, including the evolution of IMT through advances in technology and spectrally efficient techniques;

– the deployment scenarios envisaged for IMT systems and the related requirements of balanced coverage and capacity;

– the needs of developing countries; and

– the time-frame in which spectrum would be needed;

2 sharing and compatibility studies, with a view to ensuring the protection of services to which the frequency band is allocated on a primary basis, including protection of stations operating in international waters or airspace which cannot be registered in the MIFR, without imposing additional regulatory or technical constraints on those services, and also on services in adjacent bands, for the frequency bands:

– 4 400-4 800 MHz;

– 7 125-8 400 MHz; and

– 14.8-15.35 GHz,

...

invites the 2027 world radiocommunication conference

to consider, based on results of studies, the identification of frequency band(s):

– 4 400-4 800 MHz, or parts thereof, in Region 1 and Region 3;

– 7 125-8 400 MHz, or parts thereof, in Region 2 and Region 3;

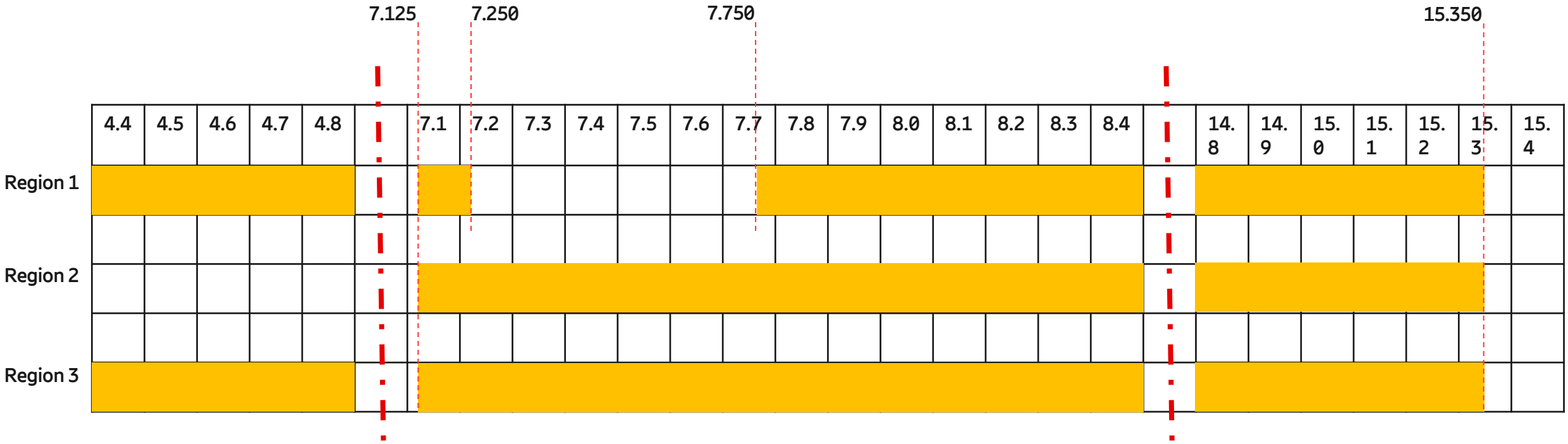
– 7 125-7 250 MHz and 7 750-8 400 MHz, or parts thereof, in Region 1;

– 14.8-15.35 GHz,

for the terrestrial component of IMT.

Spectrum

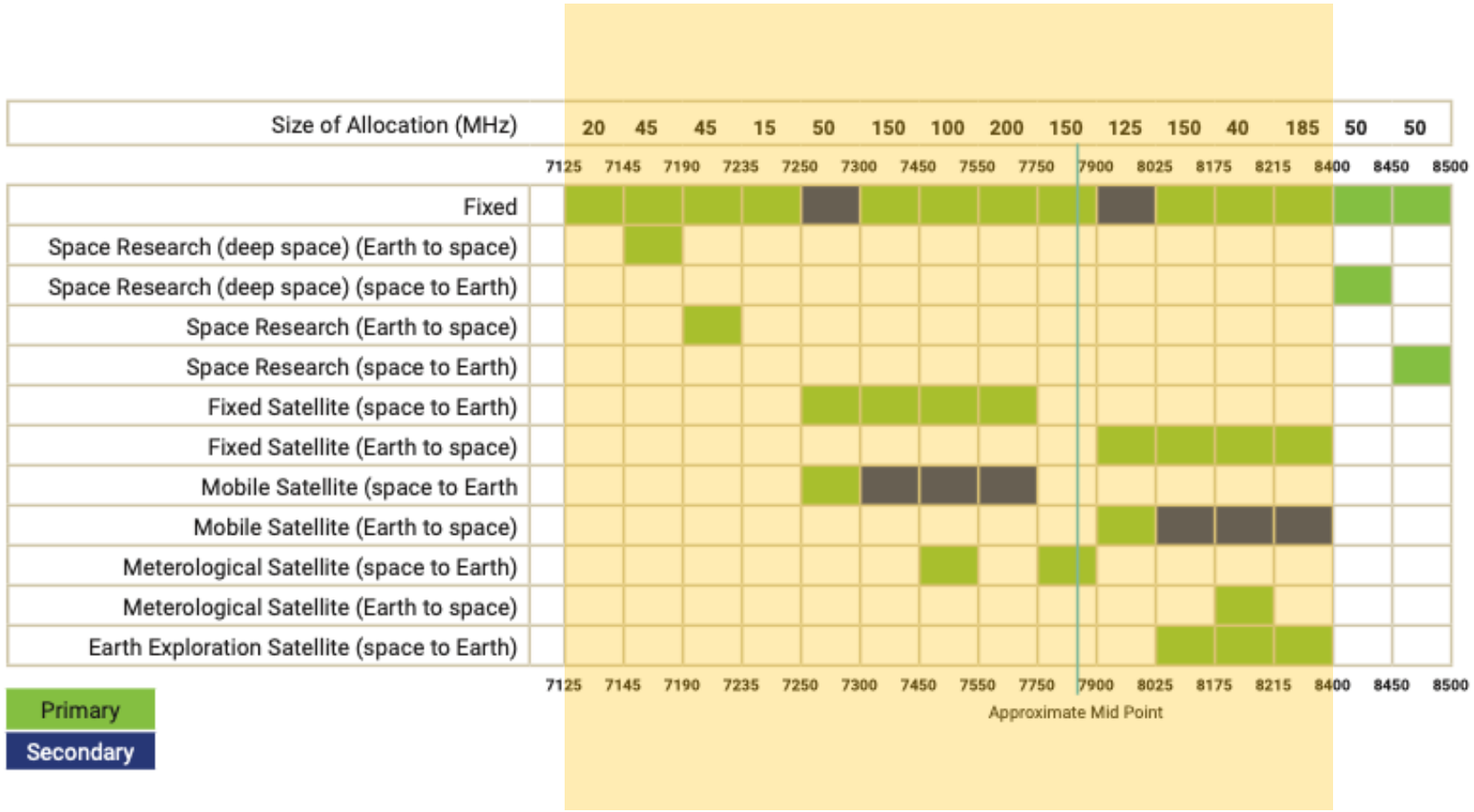
WRC-23 outcome: AI 1.7



Spectrum

WRC-23 outcome: AI 1.7

Region 2: Frequency range 7.125-8.400 GHz



Examples of sharing and compatibility studies that might be carried out between Jul'25 and Mar-Apr'27 (CPM27-2)

Spectrum

WRC-23 outcome: AI 1.13

Description:

- to consider studies on possible new allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage, in accordance with Resolution **253 (WRC-23)**;

Responsible party is WP 4C;
5D is between resp & contrib;
several contributing parties

Operative part of RES **253 (WRC-23)**:

resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference

1 studies on possible allocations to the MSS in the frequency range between 694/698 MHz and 2.7 GHz, taking into account the IMT frequency arrangements addressed in the most recent version of Recommendation ITU-R M.1036;

2 studies on spectrum requirements and on technical, operational and regulatory matters related to the implementation of the mobile-satellite service for direct connectivity to the IMT user equipment to complement the terrestrial IMT network coverage,

further resolves

1 to conduct studies on sharing and compatibility between incumbent services, including in adjacent frequency bands, ensuring the protection of incumbent services in accordance with the Radio Regulations;

2 to study possible technical and operational measures to ensure that the stations in the MSS do not cause harmful interference to, or claim protection from, stations operating in the mobile service,

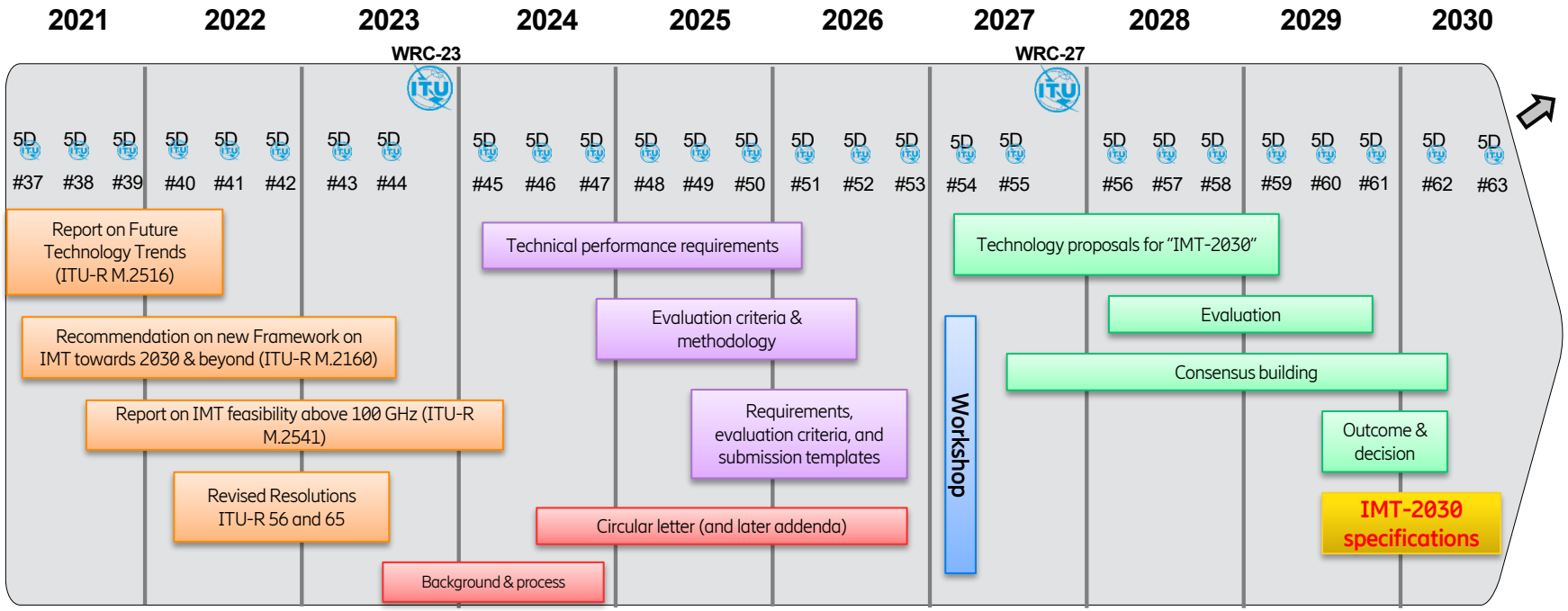
…

invites the 2027 world radiocommunication conference

to consider, based on the results of studies, the appropriate regulatory actions, including possible new allocations to the MSS for direct connectivity between space stations and IMT user equipment to complement terrestrial IMT network coverage..

Technology

IMT-2030 process & timeline



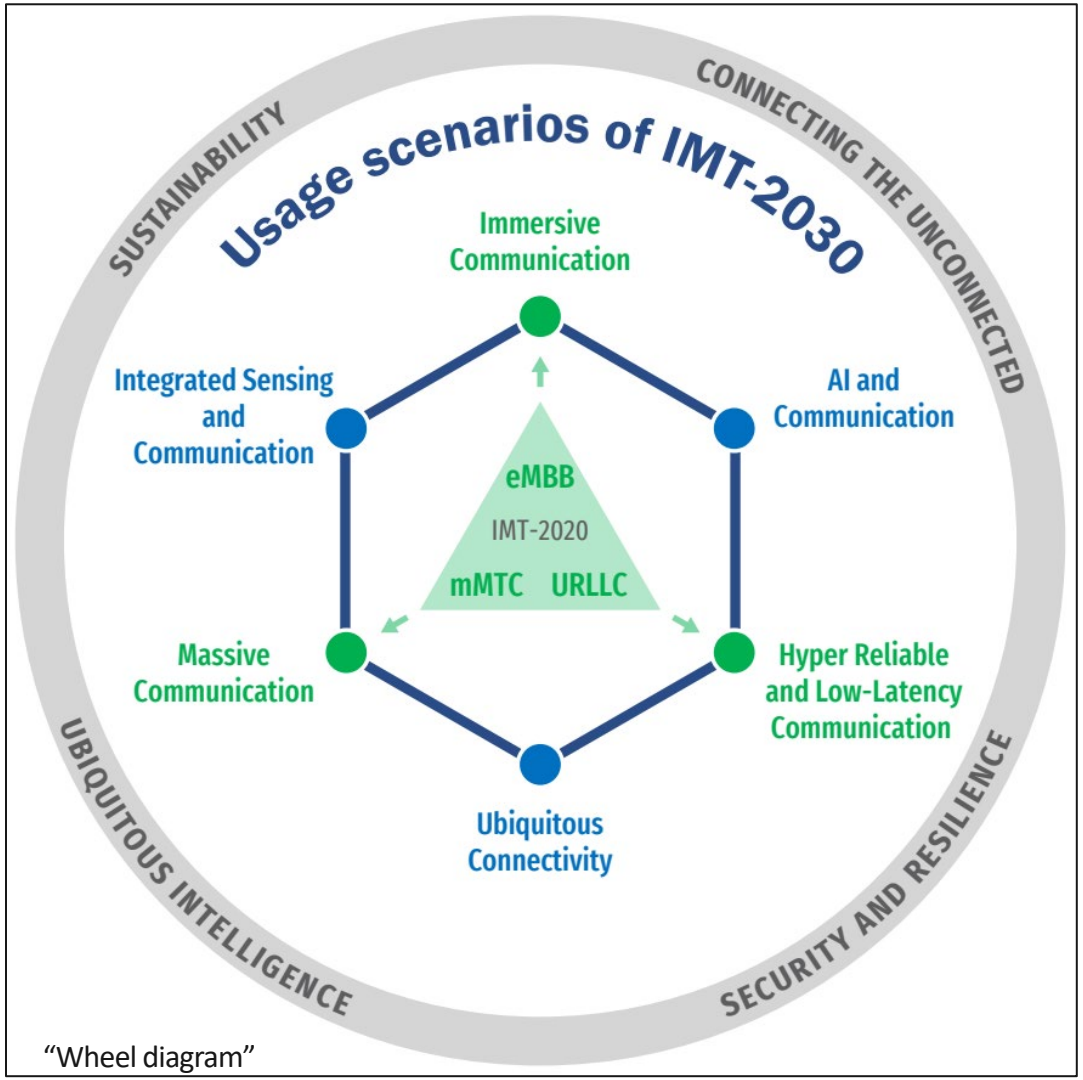
Note 1: WP 5D #59 will additionally organize a workshop involving the Proponents and registered Independent Evaluation Groups (IEGs) to support the evaluation process

Note 2: While not expected to change, details may be adjusted if warranted. Content of deliverables to be defined by responsible WP 5D groups

Framework → Requirements and Evaluation criteria → Evaluation and Consensus building → Specifications → Adoption and Approval

Technology: Usage Scenarios

ITU-R M.2160 (IMT.FRAMEWORK)



"Wheel diagram"

6 Usage scenarios

Extension from IMT-2020 (5G)

- eMBB ➡ Immersive Communication
- mMTC ➡ Massive Communication
- uRLLC ➡ HRLLC (Hyper Reliable & Low-Latency Communication)

New

- Ubiquitous Connectivity
- AI and Communication
- Integrated Sensing and Communication

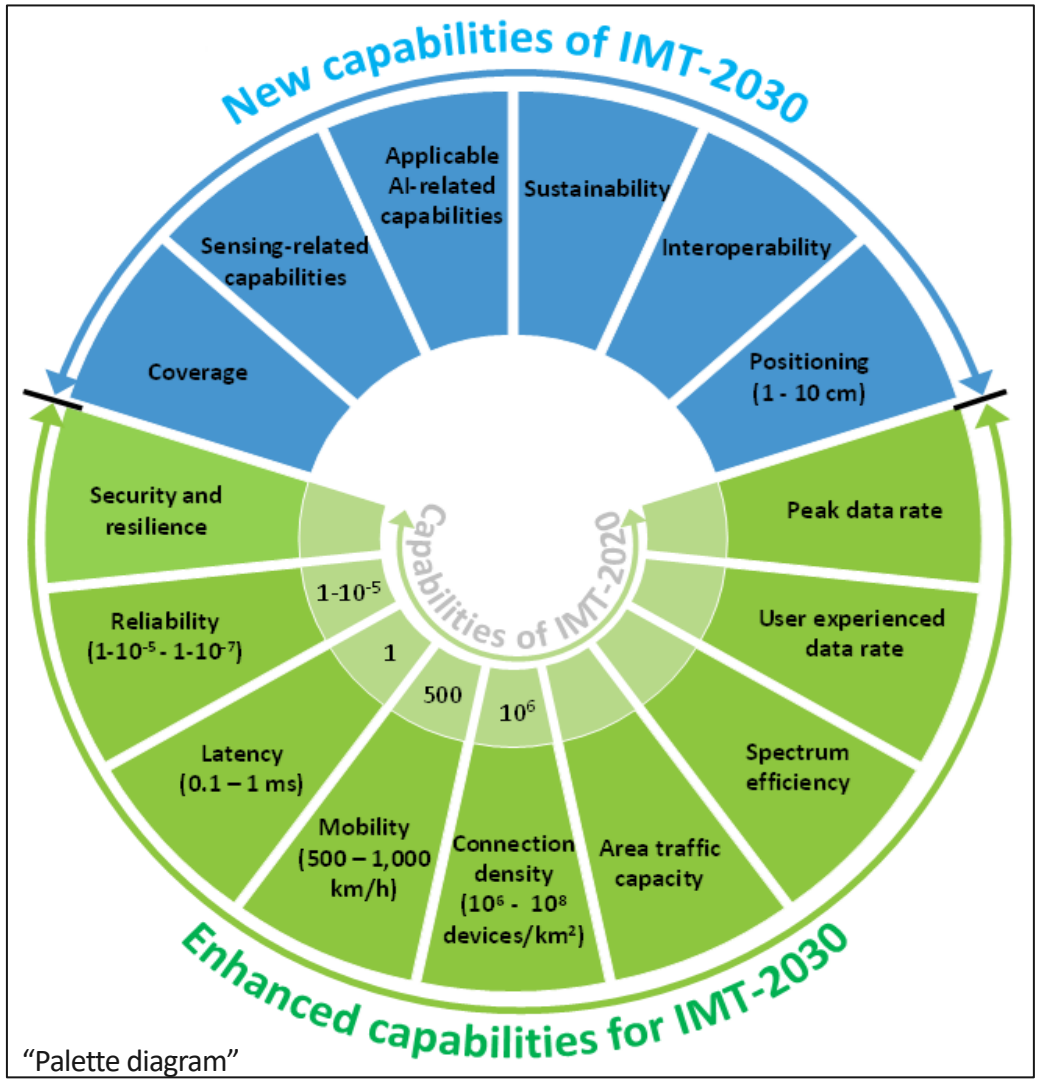
4 Overarching aspects

act as design principles commonly applicable to all usage scenarios

- Sustainability
- Connecting the unconnected
- Ubiquitous intelligence
- Security / resilience

Technology: Capabilities

ITU-R M.2160 (IMT.FRAMEWORK)



"Palette diagram"

- The Framework Recommendation identifies **15 capabilities** for IMT-2030 technology
  - Nine of those capabilities are derived from existing IMT-2020 systems
- **The range of values given for the capabilities constitute estimated targets for research and investigation of IMT-2030**
  - All values in the range have equal priority in research and investigation
  - For each usage scenario, a single (or multiple) value(s) within the range would be developed in future in other ITU-R Recommendations/Reports
- IMT-2030 is also expected to help **address the need for increased environmental, social and economic sustainability,** and also support the goals of the Paris Agreement of the United Nations Framework Convention on Climate Change

Technology

IMT-2030: emerging requirements

Capabilities \ Usage Scenario		Ubiquitous Communi-cations	Immersive Communi-cations	Massive Communi-cations	Hyper Reliability and Low Latency Communication	Artificial Intelligence and Communication	Integrated Sensing and Communication
Peak data rate		[No]	[Yes]	[No]	[No]	[TBD]	[TBD]
User experienced data rate		[TBD]	[Yes]	[No]	[No]	[TBD]	[TBD]
Spectrum efficiency	Average	[TBD]	[Yes]	[No]	[No]	[TBD]	[TBD]
	Peak	[No]	[Yes]	[No]	[No]	[TBD]	[TBD]
	5th percen-tile	[Yes]	[Yes]	[No]	[No]	[TBD]	[TBD]
Area traffic capacity		[TBD]	[Yes]	[No]	[No]	[TBD]	[TBD]
Connection Density		[TBD]	[No]	[Yes]	[No]	[TBD]	[TBD]
Mobility		[Yes]	[Yes]	[No]	[No]	[TBD]	[TBD]
Latency		[No]	[Yes]	[No]	[Yes]	[Yes]	[Yes]
Reliability		[No]	[No]	[Yes]	[Yes]	[Yes]	[Yes]
Coverage		[Yes]	[Yes]	[Yes]	[Yes]	[Yes]	[Yes]
Positioning		[TBD]	[No]	[No]	[No]	[TBD]	[Yes]
Sensing-related capabilities		[TBD]	[No]	[No]	[No]	[TBD]	[Yes]
Applicable AI-related capabilities		[TBD]	[No]	[No]	[No]	[Yes]	[TBD]
Security and resilience		[Yes]	[Yes]	[Yes]	[Yes]	[Yes]	[Yes]
Sustainability		[Yes]	[Yes]	[Yes]	[Yes]	[Yes]	[Yes]
Interoperability		[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]

Capabilities	Usage Scenarios						Not defined
	Immersive Communication	Hyper Reliable and Low Latency Communication	Massive Communication	Ubiquitous Connectivity	AI and Communication	Integrated Sensing and Communication	
Peak data rate	G						
User experienced data rate	G I	I		I			
Spectrum efficiency (average)	G I	I		I			
Spectrum efficiency (5th percentile)	G I	I		I			
Area traffic capacity	G						
Connection density			G				
Mobility	G I R		I				
Latency	G	G					
Reliability		G					
Security and resilience							G
Coverage							
Positioning							
Sensing-related capabilities							
Applicable AI-related capabilities					C		
Sustainability							
Interoperability							G

Capability	Possible technical performance indicator	Evaluation type	Comments
Sensing-related	Accuracy of sensing (positioning, velocity, etc.) estimate	Quantifiable	Performance indicators could be assessed by quantifiable, analytical or inspected manner. Most of the RAN's power consumption is due to the active antenna units (AAUs) in gNBs, energy-saving should
	Confidence level	Quantifiable	
	Missed detection probability	Quantifiable	
	False alarm probability	Quantifiable	
	Max sensing service latency	Quantifiable	
	Refreshing rate	Quantifiable	
AI-related	Performance enhancement (in terms of throughput, accuracy, etc.)	Quantifiable	
	Inference latency	Quantifiable	
	Computational complexity	Analytical	

Capability	Possible technical performance indicator	Evaluation type	Comments
	Capability of providing inference as a service	Inspection (Y/N)	be assessed on the gNB side.
	Capability of automation (in terms of RAN configuration, OAM, performance enhancement, etc. with no or reducing human intervention)	Inspection (Y/N)	
Sustainability	Energy consumption per symbol or slot (in non-sleep mode)	Quantifiable	
	Controllability of power states (sleep, active DL, active UL, cell shutdown, etc.)	Quantifiable or Inspection (Y/N)	
Interoperability	Availability of open and standardized interfaces and protocols	Inspection (Y/N)	
	Availability of reference components for enhancing transparency and facilitating interoperability	Inspection (Y/N)	

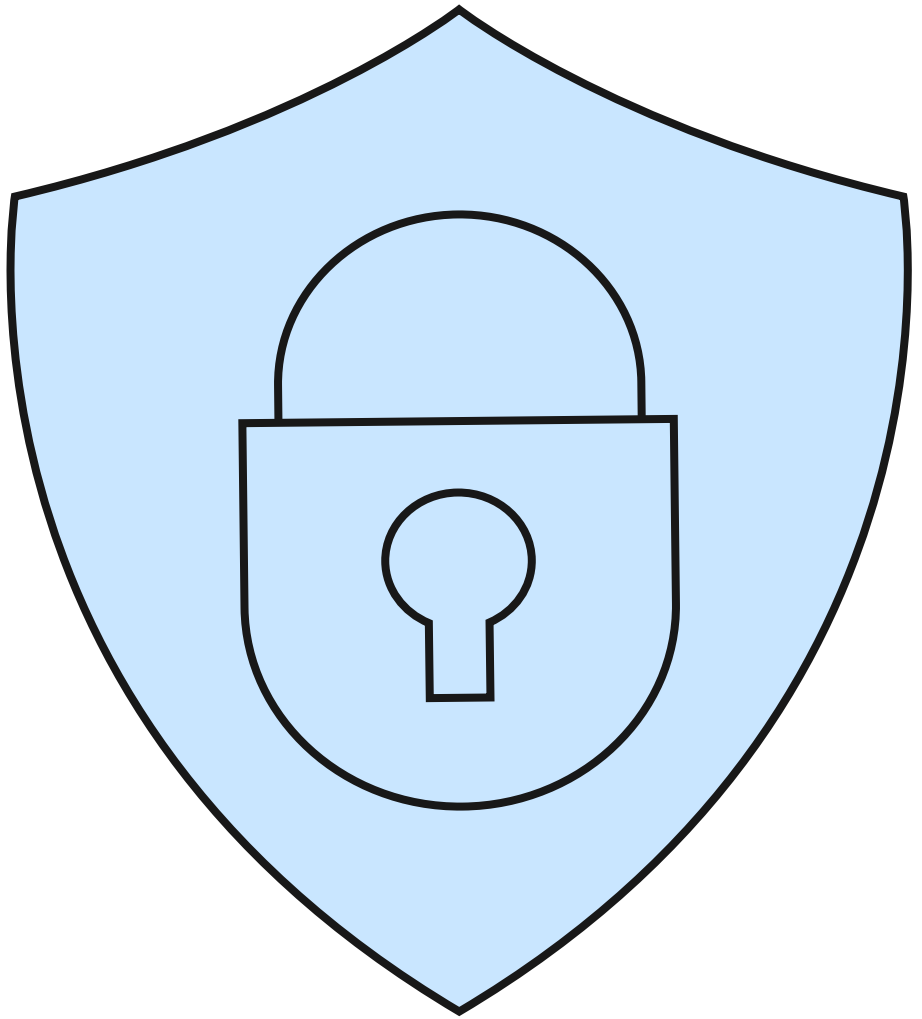
Technology: Security & Resilience

IMT-2030 system is expected to be **secure by design**. It is expected to have the ability to continue operating during and quickly recover from a disruptive event, whether natural or man-made. Making security and resilience as the key considerations in the design, deployment and operation of IMT-2030 systems is fundamental to achieving broader societal and economic goals.

Security and resilience is essential capability of IMT-2030 systems

In the context of IMT-2030:

- **Security** refers to preservation of confidentiality, integrity, and availability of information, such as user data and signalling, and protection of networks, devices and systems against cyberattacks such as hacking, distributed denial of service, man in the middle attacks, etc.
- **Resilience** refers to capabilities of the networks and systems to continue operating correctly during and after a natural or man-made disturbance, such as the loss of primary source of power, etc.



Transport network evolution to support 6G/IMT

- Enhanced requirements on transport from 6G RAN
  - Sensing-related capabilities (often called ISAC – Integrated sensing and communication)
  - Distributed MIMO for uniform coverage and high peak rate (comes with tight synchronization requirements)
  - Highly reliable networks NRAR – Network Reliability Availability and Resilience

- CRAN deployment will impact transport – with fronthaul and backhaul merging on the same infrastructure
  - Transport is a key enabler, and the transport technologies (especially for fronthaul) will need to evolve and become increasingly packet-based
  - RAN de-composition will lead to multipoint fronthaul networks
  - RAN-transport coordination and observability in the fronthaul network are important enablers

- Wireless transport
  - W- and D-band as compliment for E-band for multi-Gbps wireless links
  - Spectrum challenges
    - Other services in the same spectrum (e.g. Wi-Fi) require good co-existence solutions
    - Sharing solutions with IMT (e.g. cm-wave wave range and sub-THz)
  - Modern KPIs for wireless backhaul to avoid over dimensioning

- Automated management and network orchestration enabled by AI/ML
  - Allow for end-to-end performance guarantee and improve energy efficiency
  - Support differentiated QoS for multiple services concurrently
  - Simplify management, operations, and maintenance