



Update from ITU-R on IMT-2030

Framework Recommendation
ITU-R M.2160 and ITS

3GPP Stage 1 Workshop on IMT2030 Use Cases

Rotterdam, NL
08 - 10 May 2024



Content

Organisation of ITU-R Study Group 5

IMT-2030

- **IMT-process and timeline**
- **Framework Recommendation ITU-R M.2160**
- **Usage scenarios and capabilities**

ITS

- **Activities within ITU - WPs 5A/5D and CITS**
- **WRC-23 to WRC-31 - Question ITU-R 264/5 & relevant meetings**

International Telecommunications Union (ITU)

The International Telecommunication Union (ITU) is the United Nations **specialized agency for information and communication technologies – ICTs**.

- **One of 15** special organizations which are legally and organizationally independent, but part of “UN-family”
- **Founded in 1865** to facilitate international connectivity in communications networks,

UN Specialized Organizations

FAO	ICAO	IFAD	ILO
IMO	ITU	IWF	UNESCO
UNIDO	UNWTO	UPU	WBG
WHO	WIPO	WMO	

We are responsible to

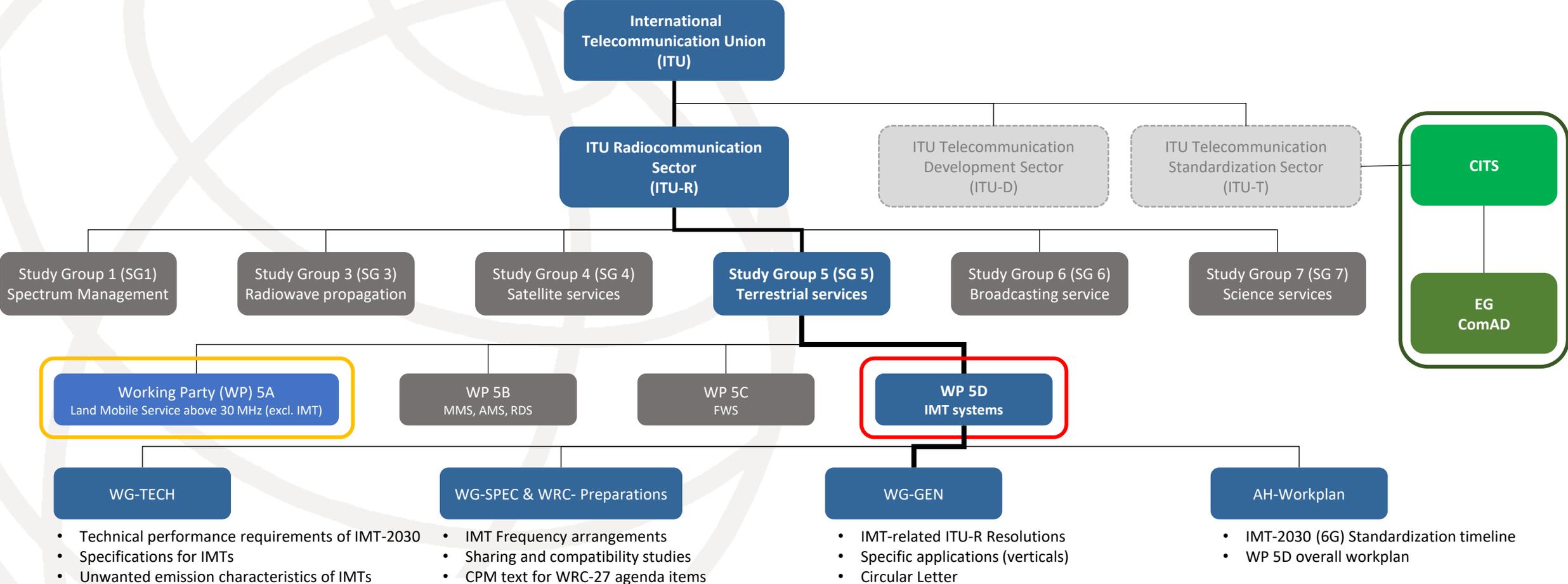
- **allocate global radio spectrum** for wireless services (terrestrial, maritime and aeronautical),
- **coordinate the world’s satellites** through the management of spectrum and orbits,
- **develop the technical standards** that ensure networks and technologies seamlessly interconnect, and strive to improve access to ICTs to **underserved communities worldwide**,
- helps support communications in the wake of **disasters and emergencies**.



ITU-R Working Party 5D and 5A

WP 5D is responsible for the overall radio system aspects of the terrestrial component of International Mobile Telecommunications (IMT) systems, comprising IMT-2000, IMT-Advanced and IMT-2020 as well as IMT-2030.

WP 5A is responsible for Land mobile service (excluding IMT), amateur and amateur-satellite service



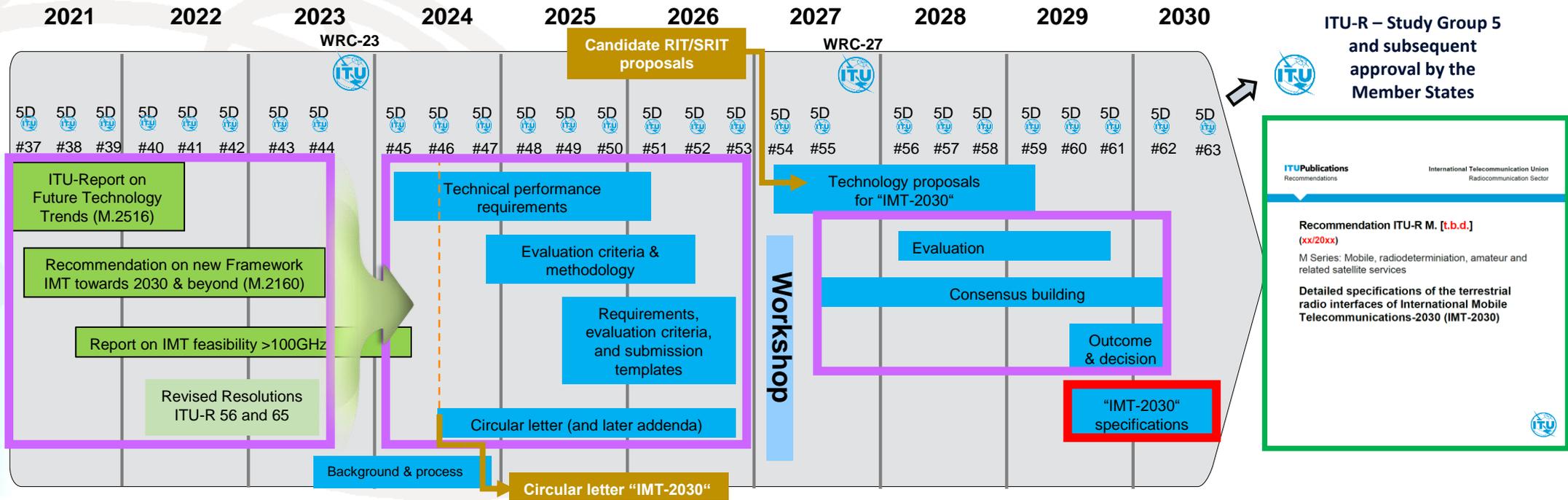
- Technical performance requirements of IMT-2030
- Specifications for IMTs
- Unwanted emission characteristics of IMTs

- IMT Frequency arrangements
- Sharing and compatibility studies
- CPM text for WRC-27 agenda items

- IMT-related ITU-R Resolutions
- Specific applications (verticals)
- Circular Letter

- IMT-2030 (6G) Standardization timeline
- WP 5D overall workplan

ITU-R Timeline and Process



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



Rep. ITU-R M.2516 – Future Technology Trends

- This new Report provides a broad view of **future technical aspects** of terrestrial IMT systems considering the timeframe up to 2030 and beyond, characterized with respect to **key emerging services, applications trends and relevant driving factors**.

Detailed inventory, see Annex

Emerging services
and applications

Drivers for future
technologies

Emerging technology
trends and enablers

Technologies
to enhance the radio
interface

Technology enablers
to enhance the radio
network

- The technology trends of terrestrial IMT systems described in Report ITU-R M.2516 **are applicable to radio interfaces, mobile terminals, and radio access networks** by considering the timeframe up to 2030 and beyond.

Rec. ITU-R M.2160 “Framework for IMT-2030”

Main body (Preamble)	Annex
<p>Scope</p> <p>Keywords</p> <p>Abbreviations/Glossary</p> <p>Related documents</p> <p>The ITU Radiocommunication Assembly, <i>considering</i> <i>considering further</i> <i>recognizing</i> <i>recommends</i></p> <p>that the Annex should be considered as the framework and the overall objectives to guide the future development of IMT-2030.</p>	<p style="text-align: center;">Table of Contents</p> <ol style="list-style-type: none"> 1 Introduction 2 Trends of IMT-2030 <ol style="list-style-type: none"> 2.1 Motivation and societal considerations 2.2 User and application trends 2.3 Technology trends 2.4 Envisaged frequency bands 2.5 Spectrum harmonization 2.6 Studies on technical feasibility of IMT in bands above 100 GHz 3 Usage scenarios of IMT-2030 4 Capabilities of IMT-2030 5 Considerations of ongoing development <ol style="list-style-type: none"> 5.1 Relationships 5.2 Timelines 5.3 Focus areas for further study <div style="position: absolute; right: 0; top: 330px; width: 200px; background-color: #fff9c4; padding: 5px;"> <p>Why is IMT-2030 (6G) needed? IMT-2030 expected benefits</p> <p>Trend and prospect of 6G features/technology/spectrum in around 2030</p> </div> <div style="position: absolute; right: 0; top: 570px; width: 200px; background-color: #fff9c4; padding: 5px;"> <p>Guidance of 6G features</p> </div> <div style="position: absolute; right: 0; top: 630px; width: 200px; background-color: #fff9c4; padding: 5px;"> <p>Guidance of 6G capabilities to fulfil usage scenarios</p> </div> <div style="position: absolute; right: 0; top: 710px; width: 200px; background-color: #fff9c4; padding: 5px;"> <p>Relationship with existing IMTs and other access systems Roadmap for technology/standardization/deployment/spectrum</p> </div>

Rec. ITU-R M.2160 (§2) - Trends

§ 2.1 Motivation and societal considerations

IMT-2030 is expected to be an important enabler for achieving the following characteristics, among others:

- Inclusivity
- Ubiquitous connectivity
- Sustainability
- Innovation
- Enhanced and resilience
- Standardization and interoperability
- Interworking

§ 2.3 Technology trends

§ 2.3 Technology trends

“Summary of Future Technology Trends (FTT)”

- Emerging technology trends and enablers
- Technologies to enhance the radio interface
- Technology enablers to enhance the radio network

§ 2.6 IMT in bands above 100 GHz

The development of IMT for 2030 and beyond is expected to enable new use cases and applications with high data rate and low latency, which will benefit from large contiguous bandwidths of tens of GHz. This suggests the need to consider spectrum in higher frequency ranges above 92 GHz as a complement to the use of lower frequency bands.

§ 2.2 User and application trends

9 trends

Ubiquitous intelligence

Ubiquitous computing

Immersive multimedia and multi-sensory interactions

Digital twin and virtual world

Smart industrial applications

Digital health and well-being

Ubiquitous connectivity

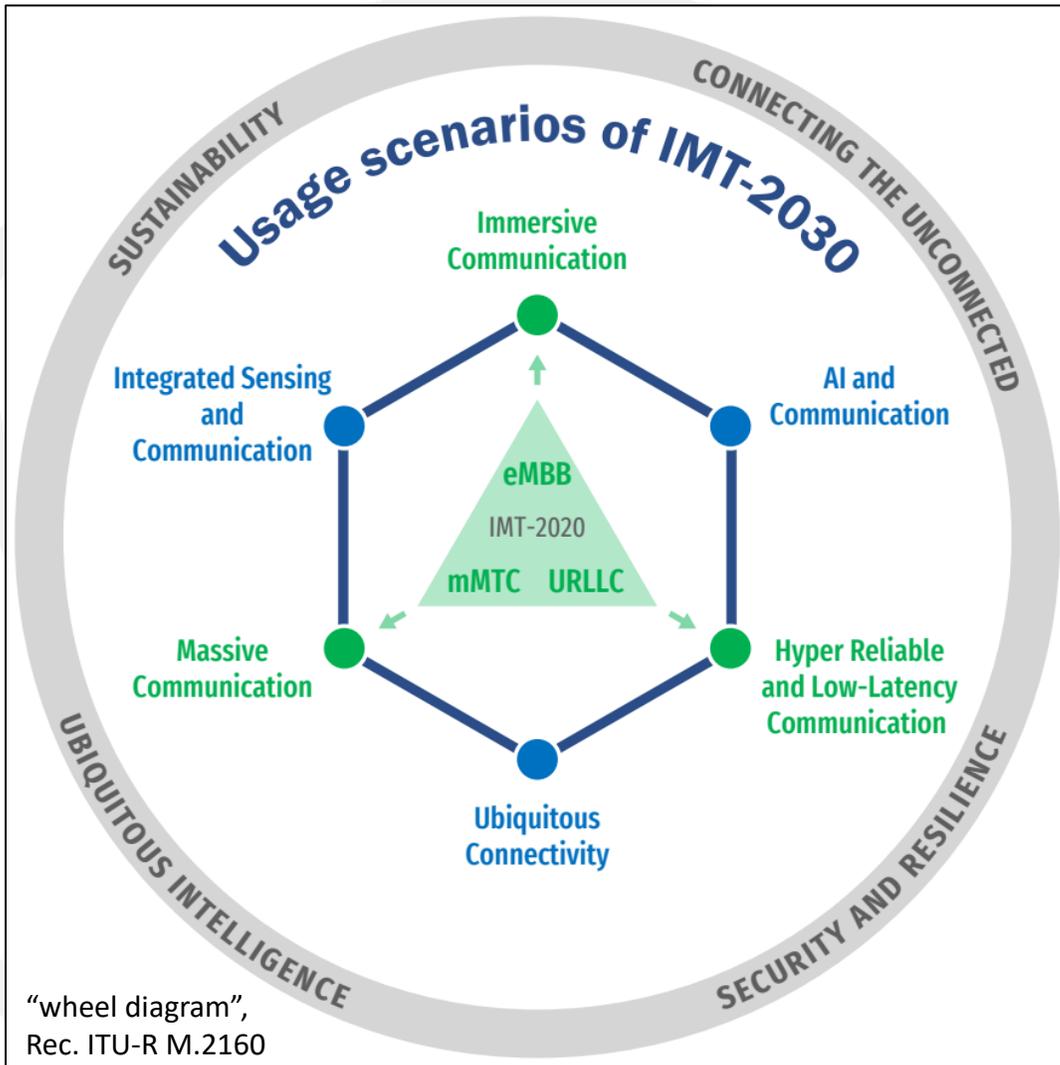
Integration of sensing and communication

Sustainability

§ 2.4 Envisaged frequency bands and § 2.5 Spectrum harmonization

- § 2.4. Multiple frequency ranges will be needed to meet the capacity and coverage requirements of IMT systems and to serve the emerging services and applications. New generations of IMT may expect new spectrum for increasing data rates, capacity, new applications and to provide for new capabilities. IMT-2030 is envisaged to utilize a wide range of frequency bands ranging from sub-1 GHz up to frequency bands above 100 GHz. Low bands will continue to be crucial to enable nationwide coverage, in particular addressing the digital divide and expanding coverage to unconnected areas.
- § 2.5. The benefits of spectrum harmonization include facilitating economies of scale, enabling global roaming, reducing complexity of equipment design, improving spectrum efficiency including potentially reducing cross border interference. Harmonization of spectrum for IMT would lead to increased commonality of equipment and is desirable for achieving economies of scale and affordability of equipment, thus promoting digital inclusion.

Rec. ITU-R M.2160 (§3) - Usage scenarios IMT-2030



“wheel diagram”,
Rec. ITU-R M.2160

6 Usage scenarios

Extension from IMT-2020 (5G)

eMBB → Immersive Communication

mMTC → Massive Communication

URLLC → HURLLC (Hyper Reliable & Low-Latency Communication)

New

Ubiquitous Connectivity

AI and Communication

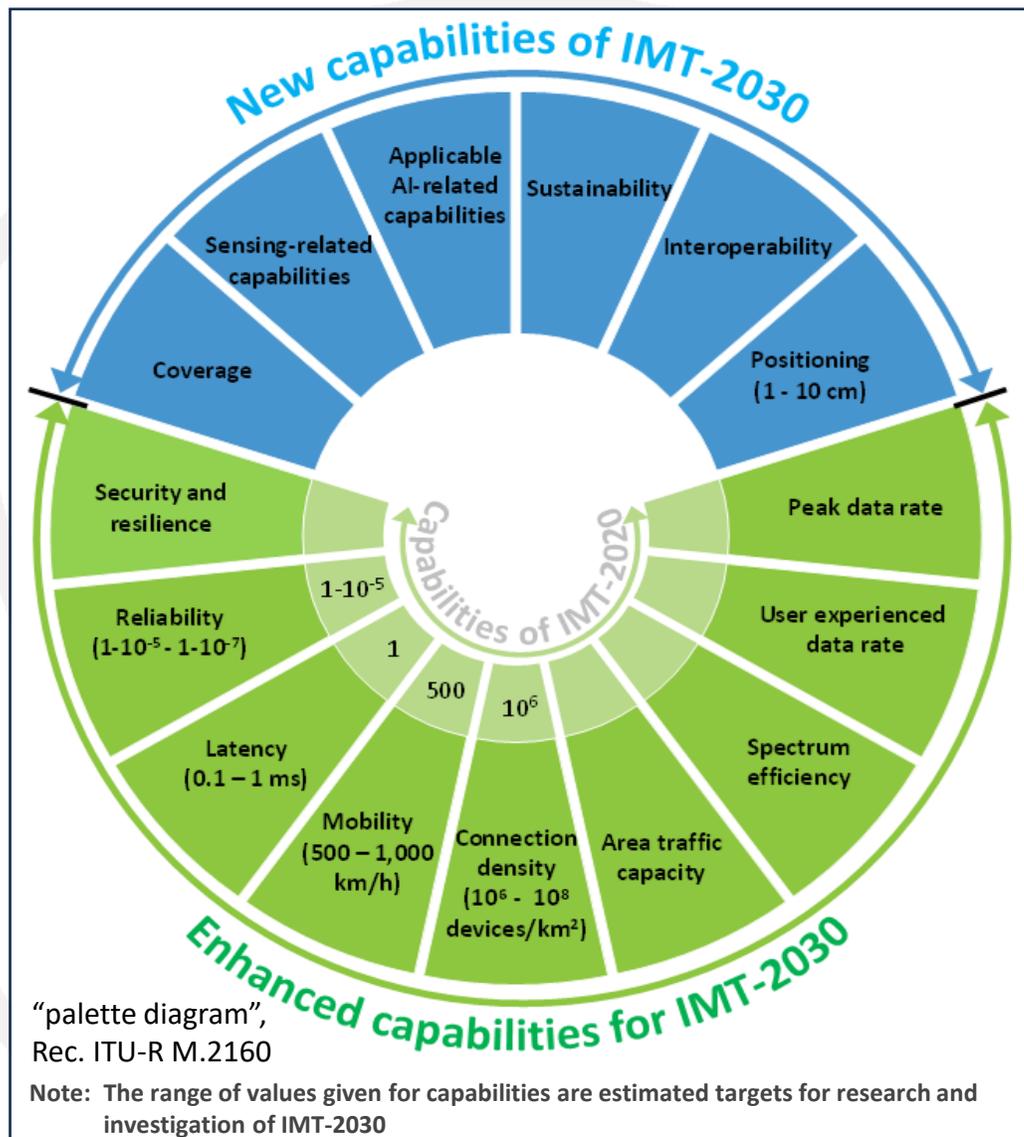
Integrated Sensing and Communication

4 Overarching aspects

act as design principles commonly applicable to all usage scenarios

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

Rec. ITU-R M.2160 (§4) - Capabilities of IMT-2030



IMT-2030 Framework Recommendation identifies **15 capabilities** for 6G technology

- Nine of those capabilities are derived from existing 5G systems

The range of values given for capabilities are 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 values 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



Rec. ITU-R M.2160 (§5) - Relationship and Timelines

§ 5.1 Relationships

- § 5.1.1 Relationship between IMT-2030 and existing IMT

Enhancements to existing IMT

Interworking with existing IMT

- § 5.1.2 Relationship between IMT-2030 and other access systems

Interworking between different access networks

such as non-terrestrial network of IMT (including satellite, HBS and UASs)

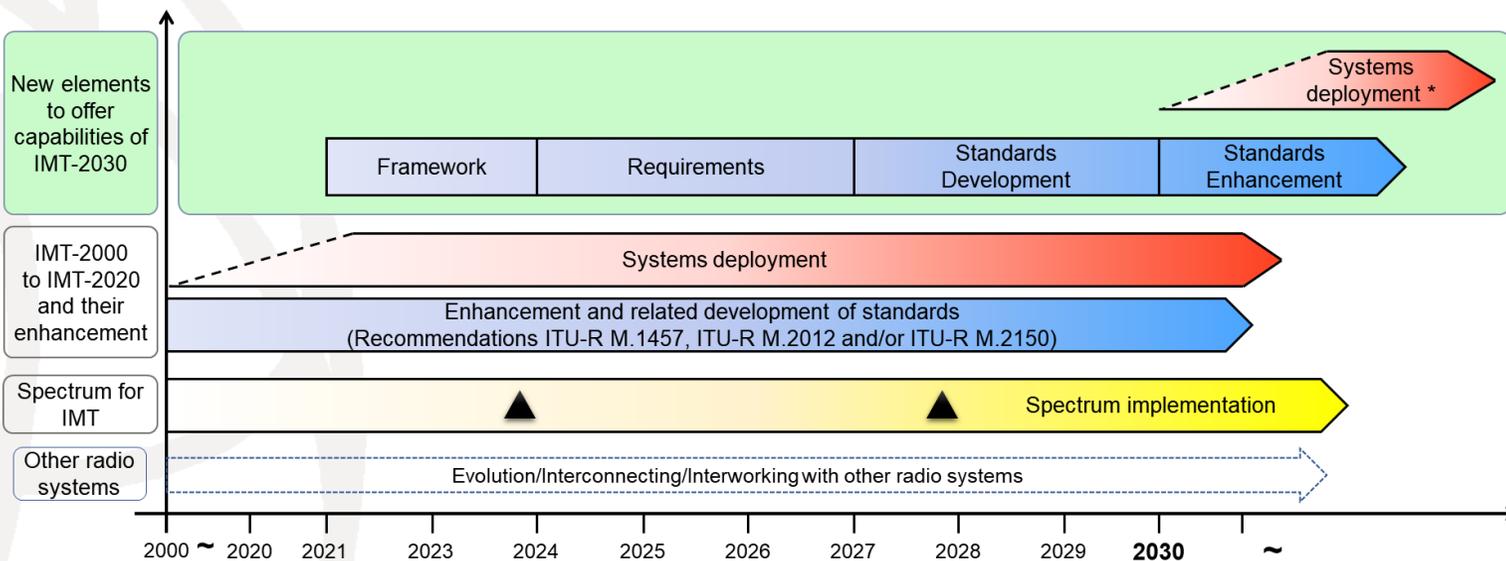
as well as with other non-IMT terrestrial networks (including RLAN and broadcast)

§ 5.3 Focus areas for further study

- Radio interface(s) standards development
- Access network related issues
- Traffic characteristics
- Spectrum related issues

§ 5.2 Timelines

- Roadmap for technology/standard development, deployment and spectrum
- In addition, enhancement of existing IMTs and relationship with other radio systems



The sloped dotted lines in systems deployment indicate that the exact starting point cannot yet be fixed.

▲ : Possible spectrum identification at WRC-23, WRC-27 and future WRCs

* : Systems to satisfy the technical performance requirements of IMT-2030 could be developed before year 2030 in some countries.
 : Possible deployment around the year 2030 in some countries (including trial systems)

Newer applications have demanding performance requirements

Immersive Communications



Mobile hologram



Integrated Communication & Sensing



e.g.

Spectrum requirements need to be met from existing and new allocations

SPECTRUM

- All frequency bands currently identified for IMT in the Radio Regulations are relevant for IMT-2030 (6G) as well
- In addition, **WRC-27 (agenda item 1.7)** will consider identification of frequency bands 4400-4800 MHz, 7125-8400 MHz and 14.8-15.35 GHz (or parts thereof) for the terrestrial component of IMT, based on sharing and compatibility studies with other services in these bands and adjacent bands
- **WRC-27 (agenda item 1.13)** will also consider appropriate regulatory actions for direct connectivity between space stations and IMT user equipment to complement terrestrial IMT network coverage in the frequency range between 694/698 MHz and 2.7 GHz, based on sharing and compatibility studies with other services in these bands and adjacent bands (incl. protection of the terrestrial component of IMT)

Draft Report – “Feasibility of IMT above 100 GHz” *

- IMT-2030 is expected to enable new use cases and applications with **extremely high data rate and low latency**, which will benefit from **large contiguous bandwidth spectrum with around tens of GHz**, which suggests the need to consider **spectrum in higher frequency ranges above 92 GHz**.
- This report
 - investigates **technical feasibility** of IMT >92 GHz
 - provides a series of **propagation measurements** carried out by academia and industry
 - describes **enabling antenna and semiconductor technologies**, material technologies including reconfigurable intelligent surfaces and MIMO and **beamforming technologies** as potential solutions
 - envisages some **typical use cases**
 - includes summary of **measurement activities** collected

The report indicates that utilizing the bands above 92 GHz is feasible for studied IMT deployment scenarios and could be considered for IMT-2030

§ 4 - **Radio wave propagation in bands above 100 GHz**

§ 4.1 Radio channel characteristics

§ 4.2 Activities on radiocommunication channel characteristics and modelling

§ 4.3 Summary of the results of the studies

§ 5 - **Characteristics of IMT in bands above 100 GHz**

§ 5.1 Outdoor-to-outdoor coverage

§ 5.2 Outdoor-to-indoor coverage

§ 5.3 Indoor-to-indoor coverage

§ 5.4 Mobility

§ 5.5 Impact of bandwidth

§ 6 - **Enabling technologies toward IMT in bands above 100 GHz**

§ 6.1 Antenna technology

§ 6.2 Semiconductor technology

§ 6.3 Material technology

§ 6.4 MIMO and Beamforming

§ 6.5 Radio over Fiber (RoF) technology

§ 7 - **Deployment scenarios and architectures**

§ 7.1 Use cases for IMT in bands above 100 GHz

§ 7.2 Deployment scenarios

§ 7.3 Deployment architecture

§ 8 - **Conclusions**

plus **22 Annexes with specific measurements and studies**

ITU work related to ITS (Intelligent Transportation Systems)

ITU-R WP 5A (Land Mobile except IMT)

- Revised **Rec. M.2121-1 (12/23)** - Harmonization of frequency bands for ITS in the mobile service
- Revised **Report M.2444-1 (09/23)** - Examples of arrangements for ITS deployments under the mobile service
- **New Report M.2534 (09/23)** - Connected automated vehicles (CAV)

ITU-R WP 5D (IMT)

* application not limited to ITS

- Rev. **Rec. M.1036-7 (12/23)*** - IMT Frequency arrangements
 - Now include the bands identified at WRC-19 (mmWaves)
- **New Report M.2520 (09/23)** - Use of the terrestrial component of IMT for the Cellular-Vehicle-to-Everything

RA-23: ITU-R Question (assigned to WP 5A)

- **New Question ITU-R 264/5** - “Studies related to Intelligent Transport Systems, including Connected Automated Vehicles and future applications”

Detailed description, see annex

Note: Questions ITU-R 205-6/5 and ITU-R 261/5 have been suppressed

CITS Collaboration on ITS Communication Standards

- Globally-recognized forum for the coordination of an internationally accepted, globally harmonized set of ITS communication standards.
- In CITS, representatives of car manufacturers, regulators, and international organisations (incl. ITU) are participating



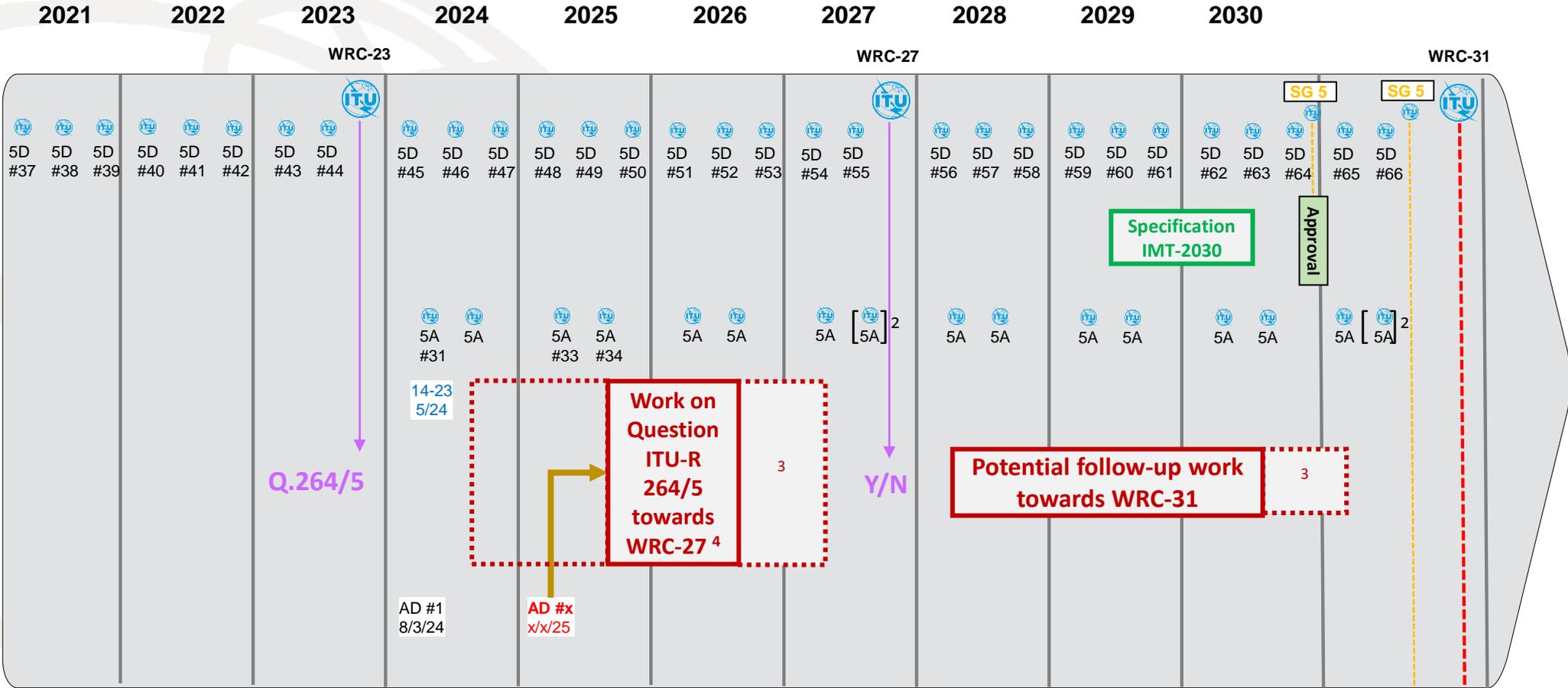
EG ComAD ITU Expert Group on Communications Technology for Automated Driving

- Shaping the future of vehicular communications technology for automated driving systems (ADS)

1. The vehicle manufacturers are ready for a mandate of V2X starting in 2032 if their requirements are met
 - “**UNECE WP.29**” created the “TF on Vehicular” as a first step.
2. ITU has created **EG ComAD** to bring the requirements from the vehicle manufacturers formally to the communications world.
3. WRC-23 approved **Question ITU-R 264/5** for ITU-R to explore the future requirements, including spectrum, for V2X (see annex)



Liaison between CITS and ITU-R WP 5A



ITU-R WP 5A (ITS)

CITS & EG ComAD

- Notes**
- (2) In the year of a WRC, the second meeting of WP 5A may not happen (depending on the needs / detailed timing).
 - (3) The Conference Preparatory Meeting (CPM) has special contribution deadlines towards WRC: ~1Y before (draft CPM-Text) / ~6M before (final CPM-Text)
 - (4) The assumed time of 3 meetings (= 1Y) for WP 5A to work on Question ITU-R 264/5 needs to be confirmed by WP 5A (e.g. via early liaison from CITS/EG)

Summary

- The **Future Technology Trends Report ITU-R M.2516** summarizes anticipated developments
- The new **“Framework Recommendation” ITU-R M.2160 for IMT-2030** describes the overall objectives including use cases
- This marks the achievement of the initial phase, **setting the basis for the development of IMT-2030. The next phase (2024-2027)** will be the definition of relevant requirements and evaluation criteria for potential radio interface technologies (RIT) for IMT-2030.
- With the evolution of information and communications technologies, **IMT-2030 is expected to support enriched and potential immersive experience, enhanced ubiquitous coverage, and enable new forms of collaboration.** Furthermore, IMT-2030 is envisaged to support expanded and new usage scenarios compared to those of IMT-2020, while providing enhanced and new capabilities.
- Essential part of the IMT-process is **liaison with External Organizations** to receive contributions covering and elaborating future trends and new services ...
... but also, **internal liaison within ITU** (other ITU-R Study Groups and ITU-sectors)



ITU – Radiocommunication Bureau

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ITU-R M.2516 “Future Technology Trends” (FTT) *

Contents “*Future Technology Trends of Terrestrial IMT Systems towards 2030 and beyond*”

§ 4 - Overview of **emerging services and applications**

- § 4.1 - New services and application trends
- § 4.2 - Drivers for future technology trends towards 2030 and beyond

§ 5 - Emerging **technology trends and enablers**

- § 5.1 - Technologies for AI-native communications
- § 5.2 - Technologies for integrated sensing and communication
- § 5.3 - Technologies to support convergence of communication & computing architecture
- § 5.4 - Technologies for device-to-device communications
- § 5.5 - Technologies to efficiently utilize spectrum
- § 5.6 - Technologies to enhance energy efficiency and low power consumption
- § 5.7 - Technologies to natively support real-time services/communications
- § 5.8 - Technologies to enhance trustworthiness

§ 6 - Technologies to **enhance the radio interface**

- § 6.1 - Adv. modulation, coding & multiple access schemes
- § 6.2 - Advanced antenna technologies incl. E-MIMO
- § 6.3 - In-band full duplex communications
- § 6.4 - Multiple physical dimension transmission incl. Reconfigurable Intelligent Surface (RIS)
- § 6.5 - Terahertz (THz) communications
- § 6.6 - Technologies to support ultra-high accuracy positioning

§ 7 - Technology enabler to **enhance radio network**

- § 7.1 - RAN slicing
- § 7.2 - Technologies to support resilient and soft network and guaranteed QoS
- § 7.3 - New RAN interface
- § 7.4 - Technologies to support Digital Twin Networking (DTN)
- § 7.5 - Technologies for interconnection with non-terrestrial networks
- § 7.6 - Support for ultra-dense radio network deployments
- § 7.7 - Technologies to enhance RAN infrastructure sharing



IMT-Family history

Report (FTT)

Recommendation (Vision/Framework)

Reports (Requirements, evaluation methodology and submission template)

Recommendation (Radio Interface Tech.)

	IMT-2000 (3G)	IMT-Advanced (4G)	IMT-2020 (5G)	IMT-2030 (6G)
Future Tech Trends (FTT)	-	-	Rep. ITU-R M.2320	Rep. ITU-R M.2516
	-	-	Nov 2014	Nov 2022
Vision/Framework	Rec. ITU-R M.687 & M.816	Rec. ITU-R M.1645	Rec. ITU-R M.2083	Rec. ITU-R M.2160
	Feb/Mar 1992 → 1997	June 2003	September 2015	November 2023
Technical Performance Requirements	Rec. ITU-R M.1034	Rep. ITU-R M.2134	Rep. ITU-R M.2410	↑ Future work ↓
	Feb 1997	2008	2017	
Submission Template	8/LCCE/47 + Add	Rep. ITU-R M.2133	Rep. ITU-R M.2411	
	1998	2008	2017	
Evaluation Methodology	Rec. ITU-R M.1225	Rep. ITU-R M.2135-1	Rep. ITU-R M.2412	
	Feb 1997	2009	2017	
RIT Specifications (1st release)	Rec. ITU-R M.1457	Rec. ITU-R M.2012	Rec. ITU-R M.2150	
	May 2000	Jan 2012	Feb 2021	

Question ITU-R 264/5

<https://www.itu.int/pub/R-QUE-SG05.264>

“Studies related to Intelligent Transport Systems, including Connected Automated Vehicles and future applications”

noting

a) that the Conference developed Recommendation **208 (WRC-19)** for harmonization of frequency bands for evolving ITS applications ...;

....

decides that the following Questions should be studied

1 For ITS in general:

- What are the **radiocommunication and spectrum requirements for ITS services and functional elements** that might benefit from international standardization, and **to what extent can the evolving mobile telecommunications systems be used to deliver ITS services?**

2 In particular, for ITS applications to CAV:

- What are the **radiocommunication and spectrum requirements, including broadband and/or low-latency radiocommunication connectivity, and operational characteristics of the radiocommunication systems that are capable of supporting CAV?**
- What are the **interworking requirements for ad-hoc direct radiocommunication with cellular-network connected radiocommunication to deliver ITS applications to CAV**, both in an efficient and sustainable manner?

3 For the future and other ITS applications beyond *decides* 1 and 2 above:

- What are the **objectives, use cases, radiocommunication and spectrum requirements, technical and operational issues, including safe operation, associated with future and emerging applications** used for ITS, including CAV?

further decides

1 that the **existing** ITU-R Reports and/or Recommendations ... should be revised and updated ...;

2 that **new results** ... should be included in ... new ITU-R Recommendation(s) and/or Report(s);

3 that the above studies should be **completed by 2027**.