



6G Spectrum Roadmap

- Jitendra Singh

- Head Govt. Affairs (India) & Spectrum Strategy (APAC) Qualcomm
- Head GSA India
- Chairman SWG SA, ITU-R WP5D
- Chairman Spectrum Committee, BIF
- Vice Chairman IAFI
- Vice President ITS India Forum



Shaping the digital future



Powering the
mobile revolution

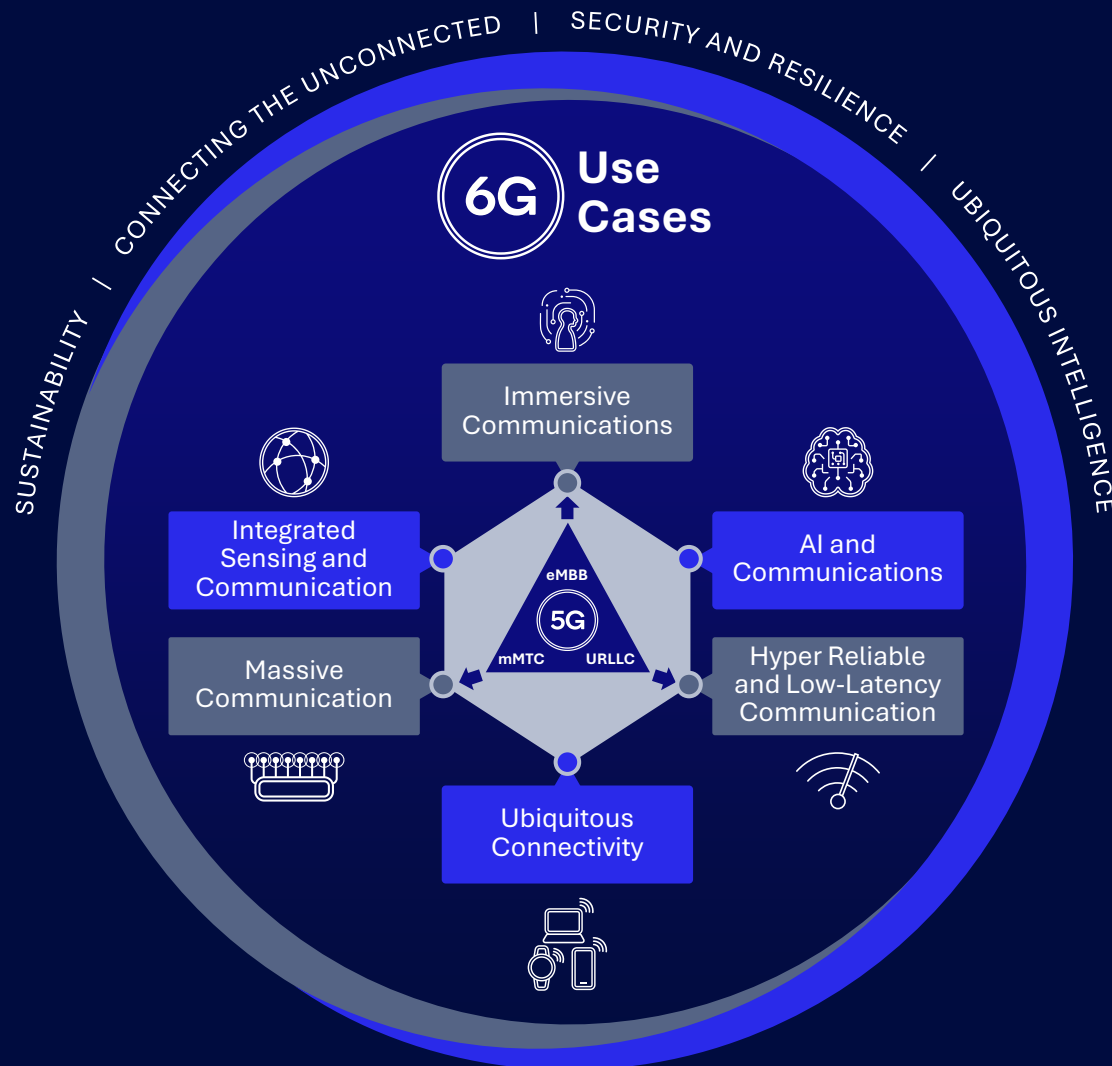


Redefining
connected processing



Enabling intelligent
computing everywhere

6G Framework - Usage scenarios and capabilities



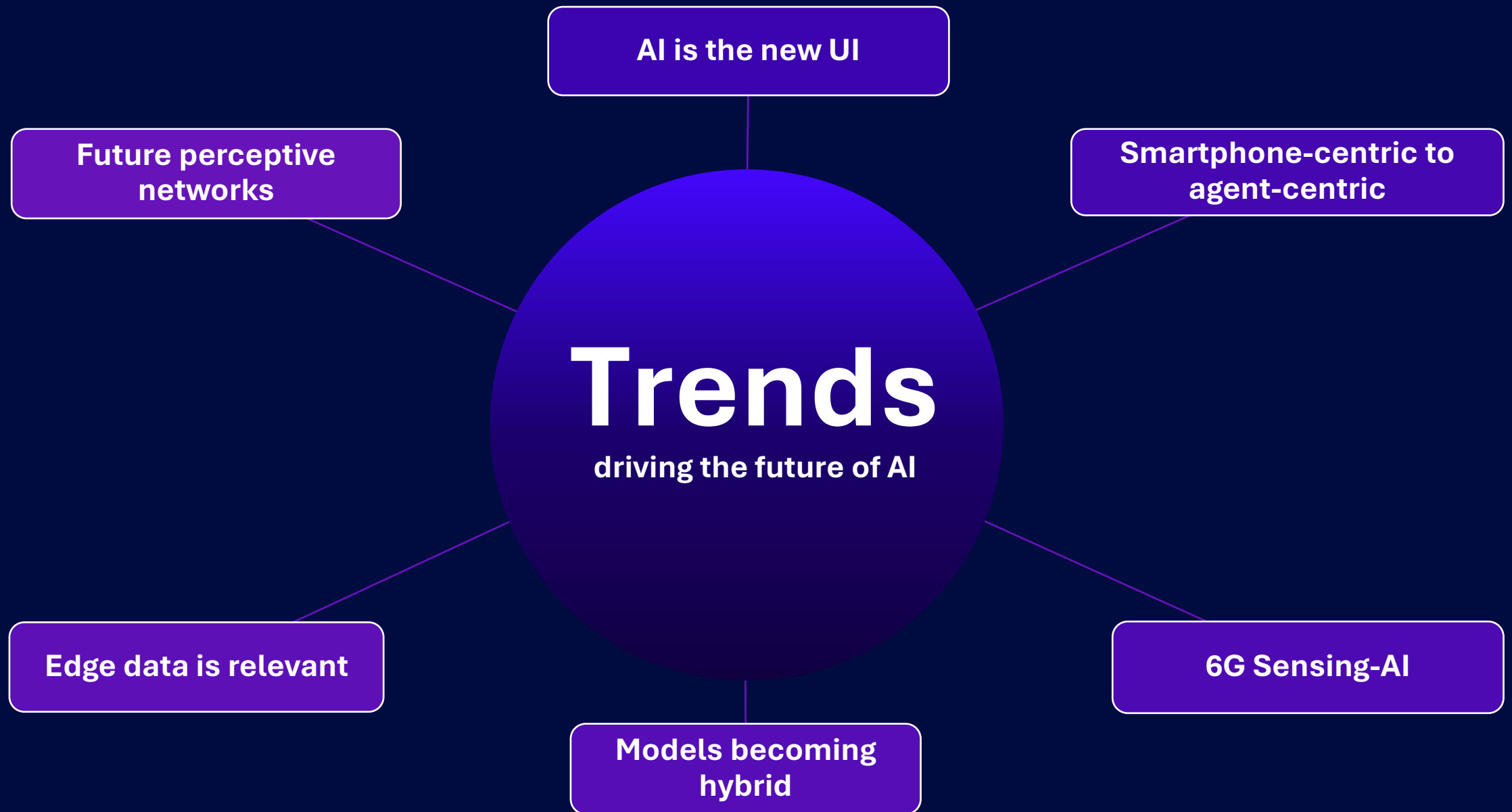
Enhanced Capabilities

Security resilience	
Reliability	5G $1-10^{-5}$ 6G $\uparrow 1-10^{-5} - 1-10^{-7}$
Latency	5G 1 6G $\downarrow 0.1 - 1$ ms
Mobility	5G 500 6G $\uparrow 500 - 1,000$ km/h
Connection density	5G 10^6 6G $\uparrow 10^6 - 10^8$ devices/km ²
Area traffic capacity	
Spectrum efficiency	
User experience data rate	
Peak data rate	

New Capabilities

- Coverage
- Sensing-related capabilities
- AI-related capabilities
- Sustainability
- Interoperability
- Positioning (1-10 cm)

6G Capabilities



We stand at Edge of Intelligent Future

Key Edge-AI Trends Driving Initial Adoption

Reimagined Workflows	Real-time sensing + on-device decisions
	Clinical automation, industrial robotics, adaptive learning
Real-Time Intelligence	Ultra-low-latency inference and decisions
	Audio agents, IoT workflows, portable diagnostics
Bits $\leftrightarrow$ Atoms	Intelligence that is aware of the physical world
	Humanoid cognition, SLAM robots, indoor positioning
Agentic AI Systems	Autonomous prediction-action loops
	5G agent workflows, integration tools
Enabling Tech for AI	Custom silicon + edge stacks
	RISC-V ASICs, edge SoCs, agentic dev tools
Democratizing AI	No-code, low barrier adoption at scale
	SME automation, rapid prototyping
Data Privacy	Secure workflows to keep sensitive data local
	On-prem IP protection, federated learning
Sovereign AI models	Country specific, regulation aligned
	Local contextual language, compliance, translations
Environment resilience	Real-time ecosystem + resource monitoring
	Agriculture, climate and environment tech, remote education
AI Safety and Trust	Explainability + safety checks
	Legal and compliance, customer operations, human care

6G will connect an expanded set of AI-powered devices and enable new services



Enabling tiered AI inferencing
on device, at network edge, and cloud



The smartphone remains the primary mobile hub for connectivity and compute



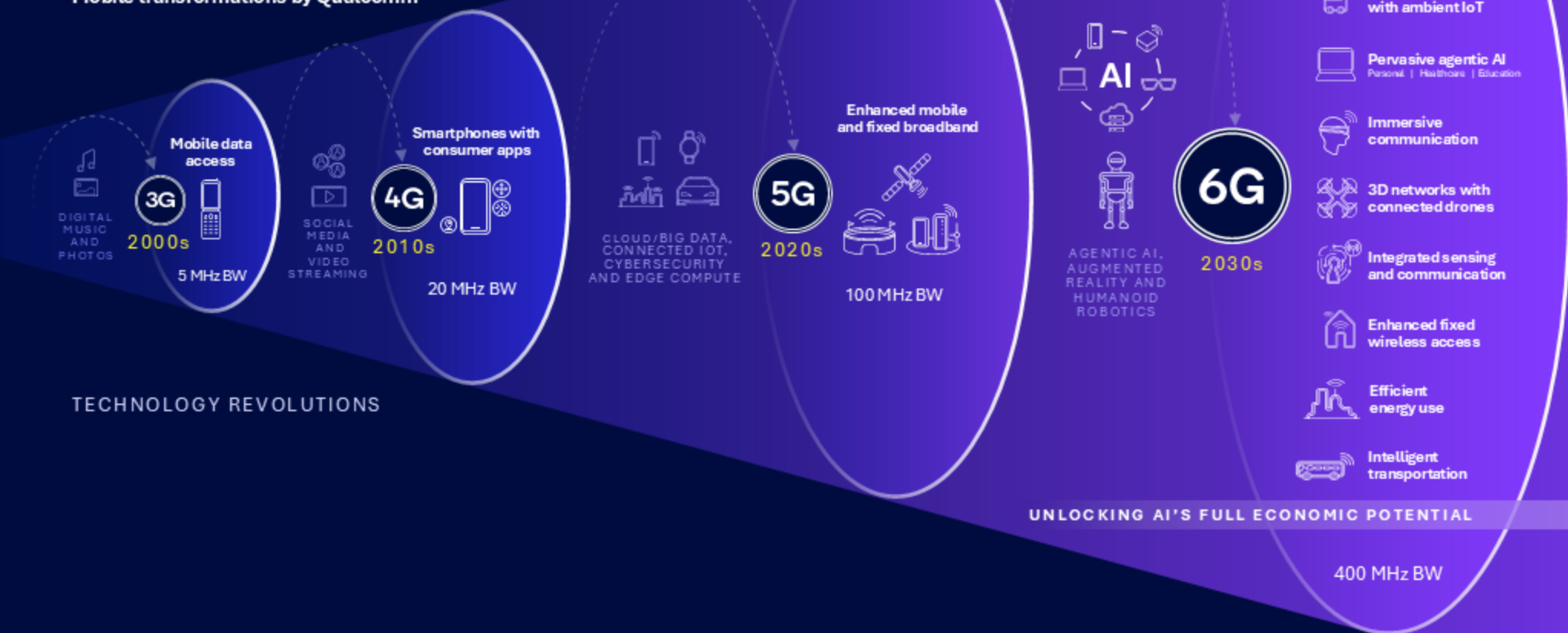
AI-powered consumer devices (glasses, watches, PCs) with cellular connectivity



AI-powered IoT devices, robots, and cars with cellular connectivity

Mobile connectivity is enabling intelligence everywhere

Mobile transformations by Qualcomm



6G

NEXT-GEN WIRELESS

Innovation platform for the next decade and beyond

New user experiences and services at scale

AI-native for efficient and resilient operations

6G Will Remove Multiple Connectivity Bottlenecks and Offer Significantly Enhanced Capabilities

Breaking through connectivity bottlenecks



Uplink at Scale. AI in the real world must continuously send large amounts of sensor and video data



Native Intelligence. AI-scale complexity requires real-time, intelligent control of traffic, computing, and performance



Ubiquitous Coverage. AR/XR and autonomous systems need reliable performance while moving



Lower Latency and Predictable Jitter. Reliable timing is essential for safe autonomy and natural human-AI interaction



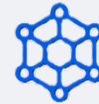
Increase Security and Resilience. Zero-trust continuous authentication and resilience as AI moves into real-world systems

6G is being built to address each of these bottlenecks

New and improved capabilities



Integrated Sensing. Native sensing and precise positioning enable context-aware AI and safer autonomy



Distributed Intelligence. 6G orchestrates end-to-end computing, making AI to be faster, more reliable, and scalable in real time



Context-Aware Multidevice Collaboration. 6G enables devices and machines to coordinate actions instantly, unlocking systems of AI, not just apps



Differentiated Services at Scale. 6G moves beyond best-effort connectivity, delivering the right latency, reliability, and security for each use case



Layered and Resilient Network Architecture. 6G unifies terrestrial and non-terrestrial layers so AI services remain available across geographies and conditions

6G will bring new monetizable capabilities to the market

Three Key Enablers of 6G

- Spectrum

- 6G will demand a huge increase in capacity
- New wide-channel (up to 400 MHz) mid-band allocations for capacity
- Will enable capabilities such as high-resolution sensing
- AI-optimized scheduling will reduce cost per bit and improve spectrum utilization
- Early clarity on spectrum allocations is essential for long term planning
- Early identification will impact radio engineering and semiconductor design

- Software

- AI-native architectures, including intelligent routing and granular slicing
- Where data processing occurs, how workloads move across devices, edge, and cloud
- How multiple devices collaborate with the network to produce seamless experiences
- Self-healing capabilities to reduce downtime and improve energy efficiency

- Hardware

- Advances in antennas, radios, and components
- Advanced semiconductors for modems
- Massive MIMO evolution
- Enabling multilayer, multiband operation and intelligence at the network edge, with improved reliability and coverage

6G Spectrum Requirements

- Drivers
 - XR – Holographic communications, telepresence and immersive reality
 - AI-powered sensing enabling real-time perception with predictive intelligence
 - Hyper Reliable Low Latency Communications (HRLLC) for Autonomous decision-making with Edge AI
 - Integrated sensing and communication (ISAC)
 - Ubiquity in connectivity by enabling terrestrial / non-terrestrial communications
- Spectrum requirements
 - GSA – 400 MHz contiguous block per operator
 - GSMA – 2 blocks of 200 MHz of contiguous blocks per operator
- New Spectrum bands for 6G
 - Greenfield spectrum must for 6G
 - Existing bands to continue with 4G/5G deployment till 6G gets stabilized
 - 600 MHz band (n105 : 663-703/612-652 MHz) is an essential complimentary 6G band
- Management of Incumbents by 2027
 - For India's 6G leadership, spectrum bands 7/8 GHz should be made available by 2027 for initial trials/pilots by 2028
 - Essential to plan migration path and refarming for incumbents using 7/8 GHz bands
 - **One India – One 6G Goal – Single alignment across all stakeholders including incumbents**

6G Spectrum Background

- APG23-5

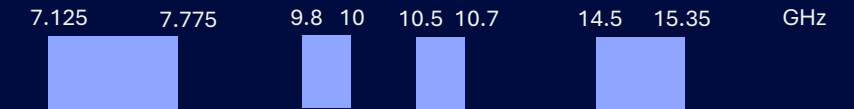
- India pushed for WRC agenda item on 6G spectrum
- India proposed spectrum in range 7.125-24 GHz (APG23-5/INP-31)
- Supported by Korea, Vietnam and Laos

- WRC-23

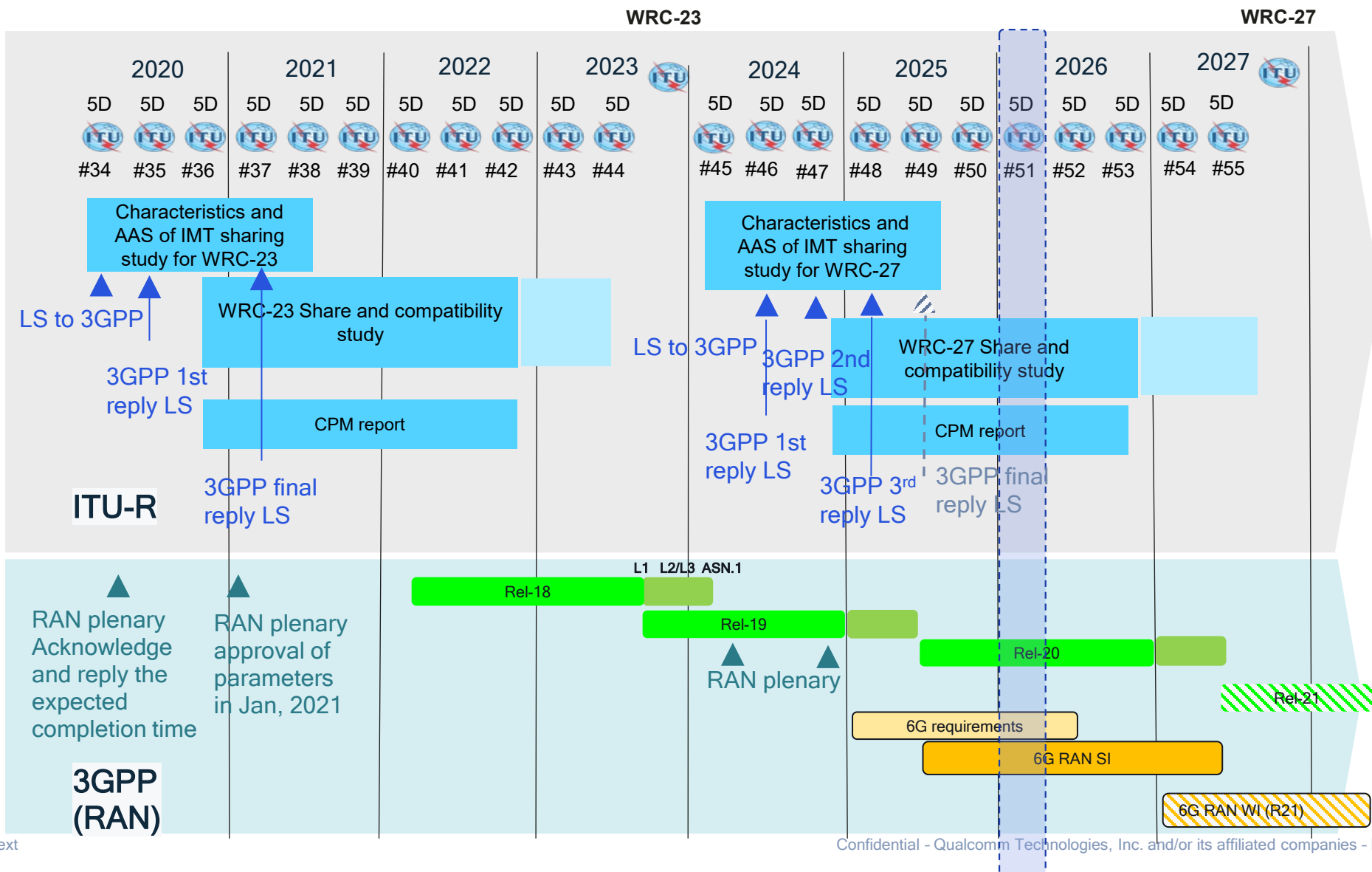
- India pushed for WRC agenda item on 6G spectrum
- Supported by multiple countries across the globe
- WRC-23 decided following ranges for studies in WRC-27 cycle under AI 1.7
 - 4.4-48 GHz, 7.125-8.4 GHz and 14.8-15.35 GHz

- Spectrum Studies

- WP5D : India chairing studies of 7.125-8.4 GHz group (Dr. Punit Rathod)
- Studies to close by October 2026 for preparation of CPM text



ITU-R WP 5D WRC-27 AI1.7 Sharing Study Timeline



Spectrum Bands Identified for IMT studies

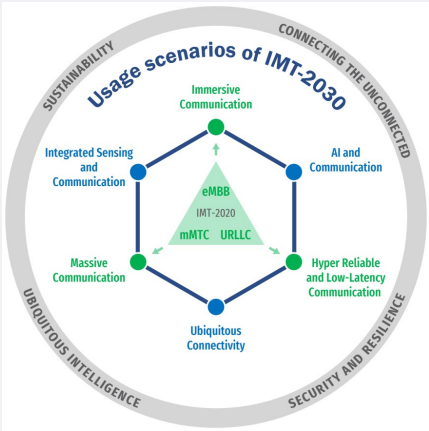
WRC-27 Agenda item 1.7

Administrations or Regions will study new candidate bands for use by 6G/IMT-2030, for decisions WRC-27.

Study Stage :

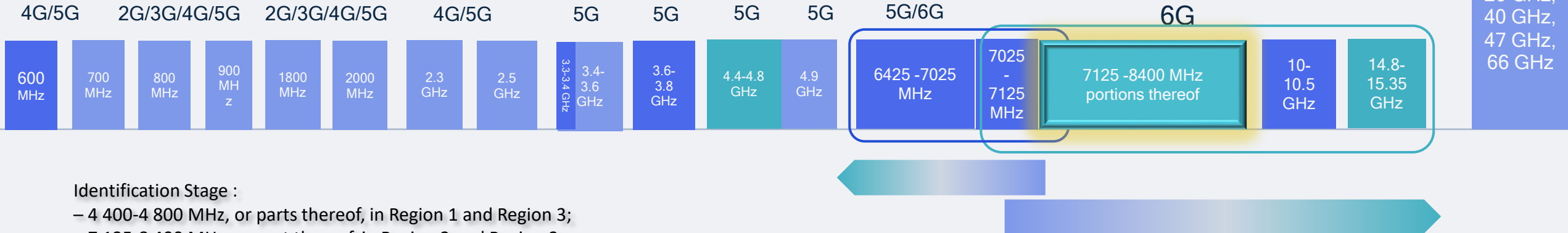
- 4 400-4 800 MHz
- 7 125-8 400 MHz
- 14.8-15.35 GHz.

Additional contiguous broadband spectrum in FR3 range is required to support the immersive communication and high-resolution sensing in wide area coverage deployment.



5G/6G

mmW
26 GHz,
40 GHz,
47 GHz,
66 GHz

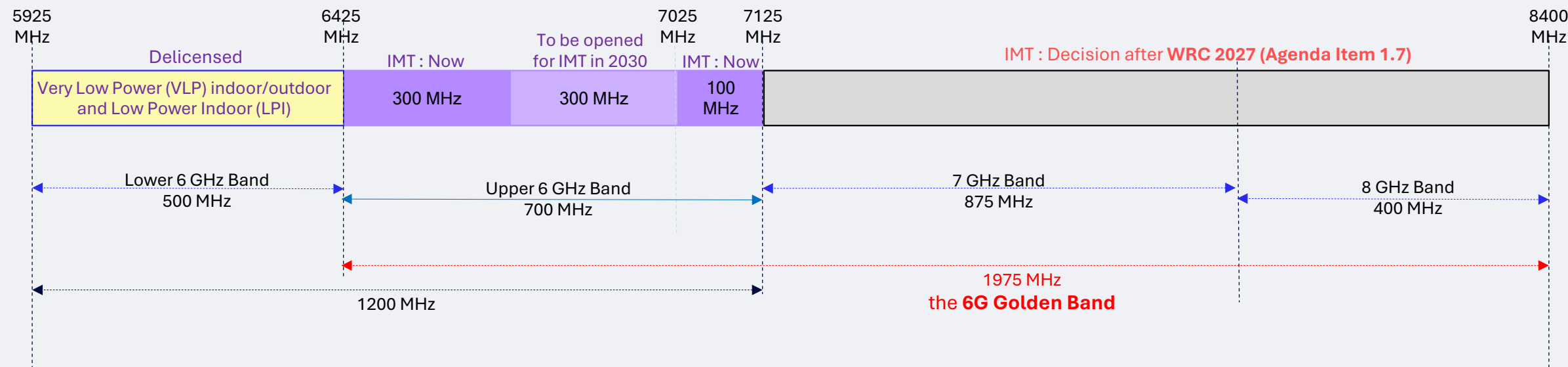


Identification Stage :

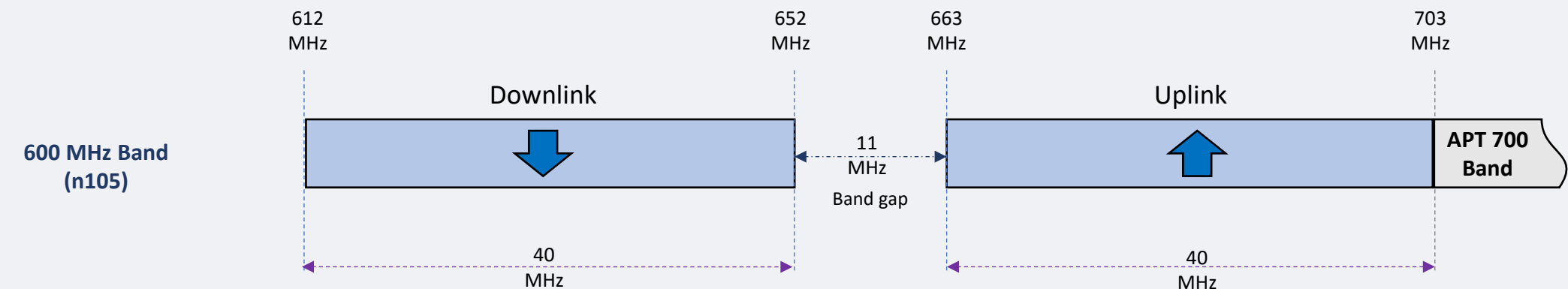
- 4 400-4 800 MHz, or parts thereof, in Region 1 and Region 3;
- 7 125-8 400 MHz, or part thereof, in Region 2 and Region 3;
- 7 125-7 250 MHz and 7 750-8 400, or part thereof, in Region 1;
- 14.8-15.35 GHz, Global

Key 6G bands for India

- Mid Range

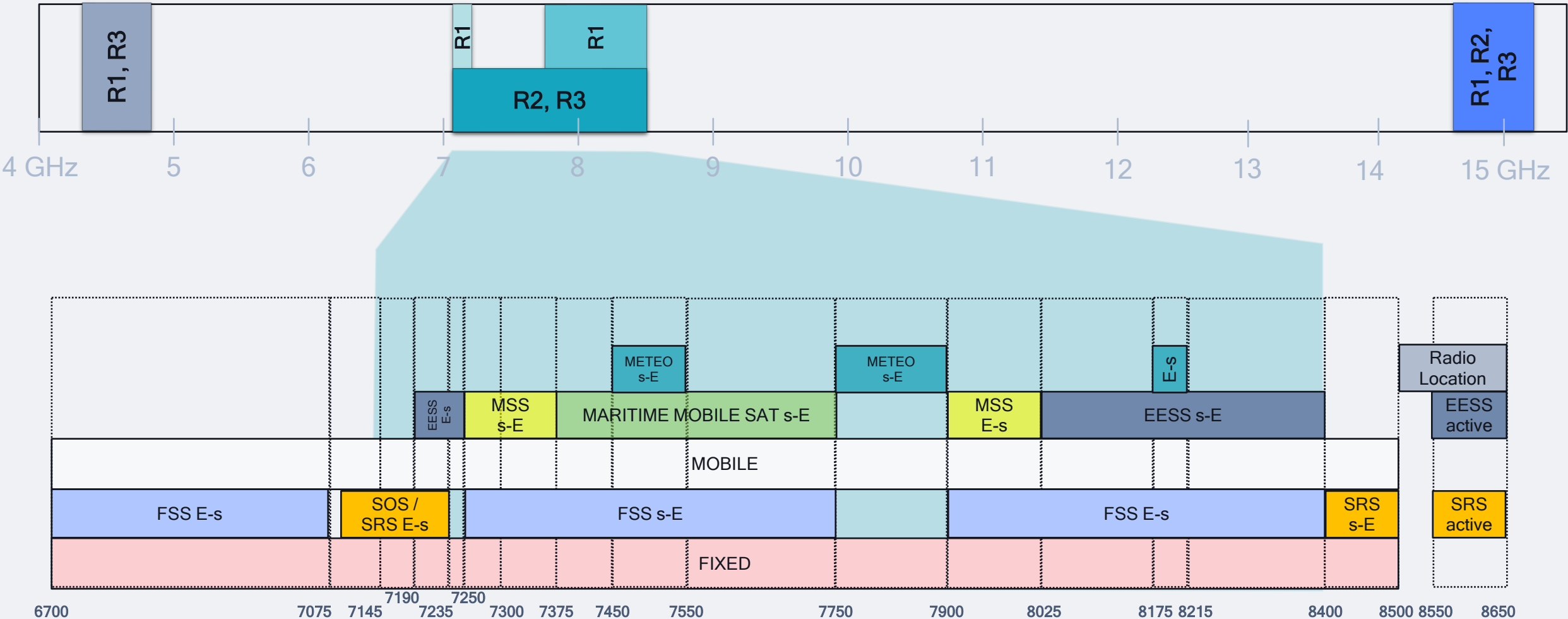


- Sub-GHz Range



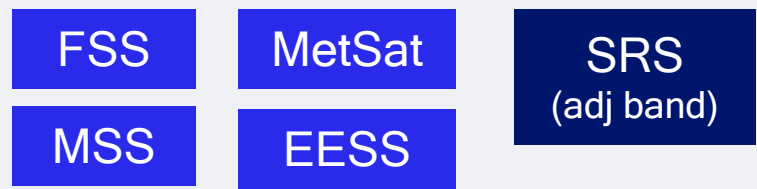
Overview of WRC 27 AI 1.7 – focus on 7.125-8.4 GHz

WRC-27 agenda item 1.7 considers International Mobile Telecommunications (IMT)



General grouping of interference scenarios

Satellite Downlink

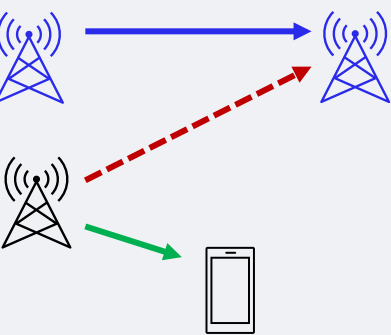


* Some of the Earth Stations could be both FSS / MSS

Satellite Uplink

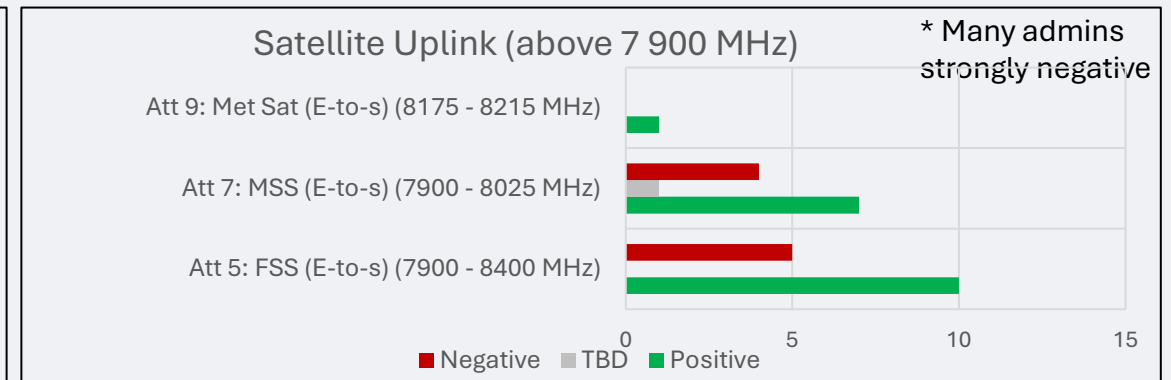
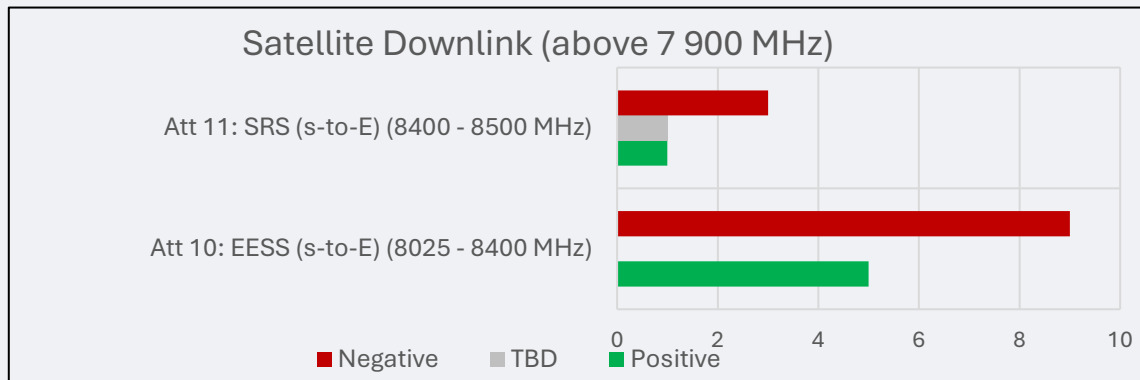
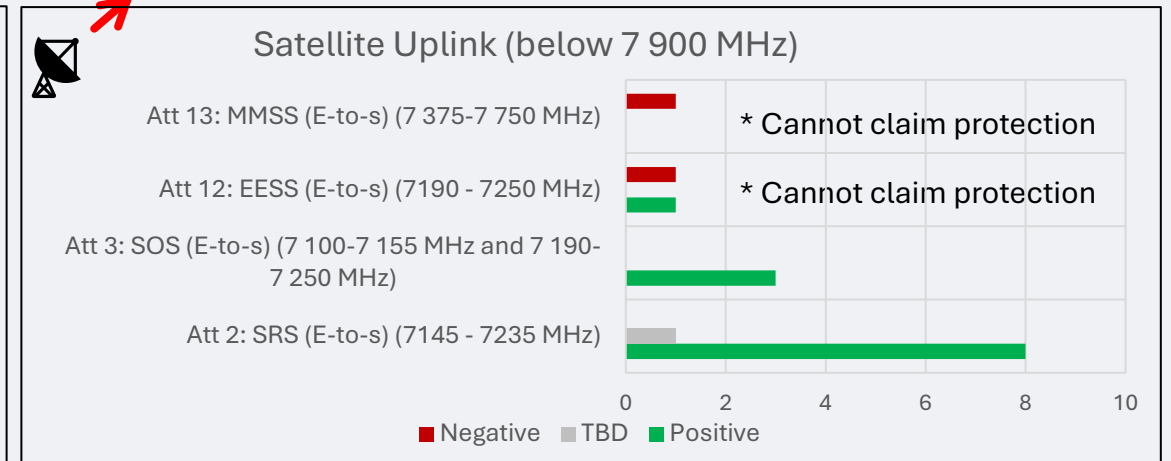
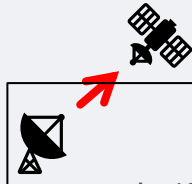
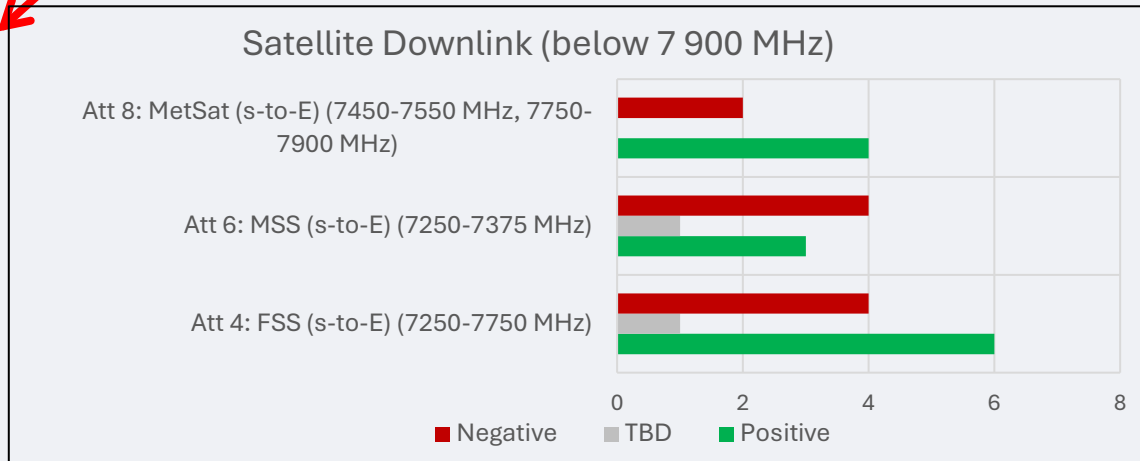
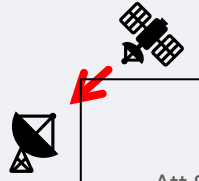


Terrestrial



- Incumbent link
- IMT link
- Interfering link

Summary of 7-8 GHz studies in different ranges and satellite transmit direction



FSS/MSS/MetSat Downlink:

- Debate on applicability of Clutter Loss
 - key difference in +ve and -ve
- Debate on M.2101 v/s TVG
 - Key difference in conservative envelope v/s monte-carlo

FSS/MSS Uplink:

- Debate on Contour
 - 3dB / 20 dB / 30 dB / full-view
- Debate on high-gain satellite antenna (4A System K)
- Debate on apportionment and polarization losses

- China, France (supported by Apple/Airbus), Germany (Airbus), ESA, Iran, UK, Australia, Canada are negative, and Brazil, Korea (UL/DL is negative Korea military), Saudi Arabia, Russia, India, Japan are positive (some of USA studies are positive)

WRC-27 agenda item 1.7 – Technical studies summary for CPM

- 4.4 – 4.8 GHz: Radio Altimeter may need additional coordination, and Aeronautical Mobile Service (AMS) may consider PFD limits (implying BS power reduction) at lower edge
- 7.125 – 7.25 GHz: **Positive**; SRS/SOS UL may follow similar conditions as WRC-23
- 7.25 – 7.9 GHz: **Positive**; with some keep-off distance
- 7.9 - 8.4 GHz: NATO usage for sat Uplinks
- 14.8-15.35: Feasible, TSPs using for Backhaul

	Coordination with Keep-off Distance			RF measures (in-band and/or out-of-band)							Both coordination and RF measures						
	Services																
Frequency band	FS	AMS	MMS	FSS (s-E)	AM(R) S	ARNS	SRS (E-s)	SOS (E-s)	FSS (E-s)	MSS (s-E)	MSS (E-s)	MetSat (s-E)	MetSat (E-s)	EESS (s-E)	SRS (s-E)	EESS (E-s)	RAS
4 400-4 800 MHz	X	X	X	X	X	X											X
7 125-7 250 MHz	X						X	X								X*	
7 250-7 750 MHz	X			X						X		X					
7 750-8 400 MHz	X								X		X	X	X	X	X		
14.8-15.35 GHz	X	X					X								X		X
• Should not claim protection per RR FN 5.460A • FS = Fixed service, AMS = Aeronautical mobile service, ARNS = Radio navigation service, MMS = Maritime mobile service, SRS = Space research services, SOS = Space operation service, MSS = Mobile satellite service, FSS = Fixed satellite service, MetSat = Metrological satellite, EESS = Earth exploratory satellite service, RAS = Radio astronomy																	

Where are we in the cellular innovation cycle?

5G

Ramping volume and expanding to new use case

5G ADVANCED

Completing 1st standard
—2nd phase of 5G innovations

6G

Aligning on vision, foundational research, timeline, requirements



Global Momentum for 6G is growing



ITU
IMT-2030 defines next-gen mobile system requirements for 2030 and beyond



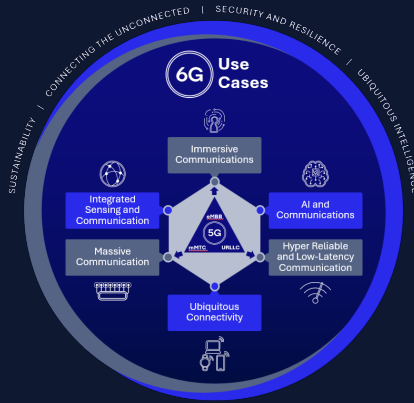
3GPP
A GLOBAL INITIATIVE
The standards body responsible for global 6G technology standardization



- **New global strategic coalition** to accelerate development and commercialization of 6G
- **Targeting commercial** systems starting from **2029 onward**
- **Global operators**: Airtel, BT Group, Deutsche Telekom (via affiliates), KDDI, NTT DOCOMO, Reliance Jio, SK Telecom, Swisscom, T-Mobile, Telstra, TIM Group, Viettel, and others
- **Network & infrastructure vendors**: Ericsson, Nokia, NEC, Fujitsu/1finity, Siemens, Tejas Networks
- **Cloud, compute & platform players**: Amazon, Google, Microsoft, Meta, Dell, HP, HPE, Lenovo
- **Device & automotive ecosystem**: Samsung Electronics, LG Electronics, Motorola, Asus, Stellantis, Sharp

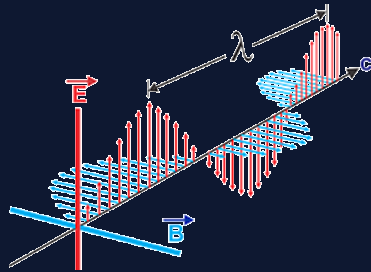
Summary : 6⁶6

- 6_G



- 6-8 GHz

- 600 MHz (n105)



Key Takeaways

- Spectrum is a complex subject
- Regional/global harmonization essential
- Extensive coordination needed
 - To harmonize spectrum requirements between incumbents and commercial usages/plans
 - To continue pushing for opening of harmonized 7125-8400 MHz band for 6G in ITU/WRC
 - To push India as 6G leader with 7125-7900 MHz as 6G golden band
- Focus on 6G leadership : **Initial commercial pilots in 2029**
- Active participation & technical contributions in ITU-R activities

One India – One 6G Goal – Single alignment across all stakeholders including incumbents

Thank you



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