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India's Telecom SDO celebrating Years of developing ICT Standards

TECH DEEP DIVE

TTDD 2024 CONFERENCE (7th EDITION)

REALIZING THE 6G VISION :
SOCIETAL NEEDS, USAGE SCENARIOS & TECHNOLOGIES

 **Date:** 16-19 July 2024

Session #5: Spectrum Aspects For 5G Advanced and 6G

18 July 2024

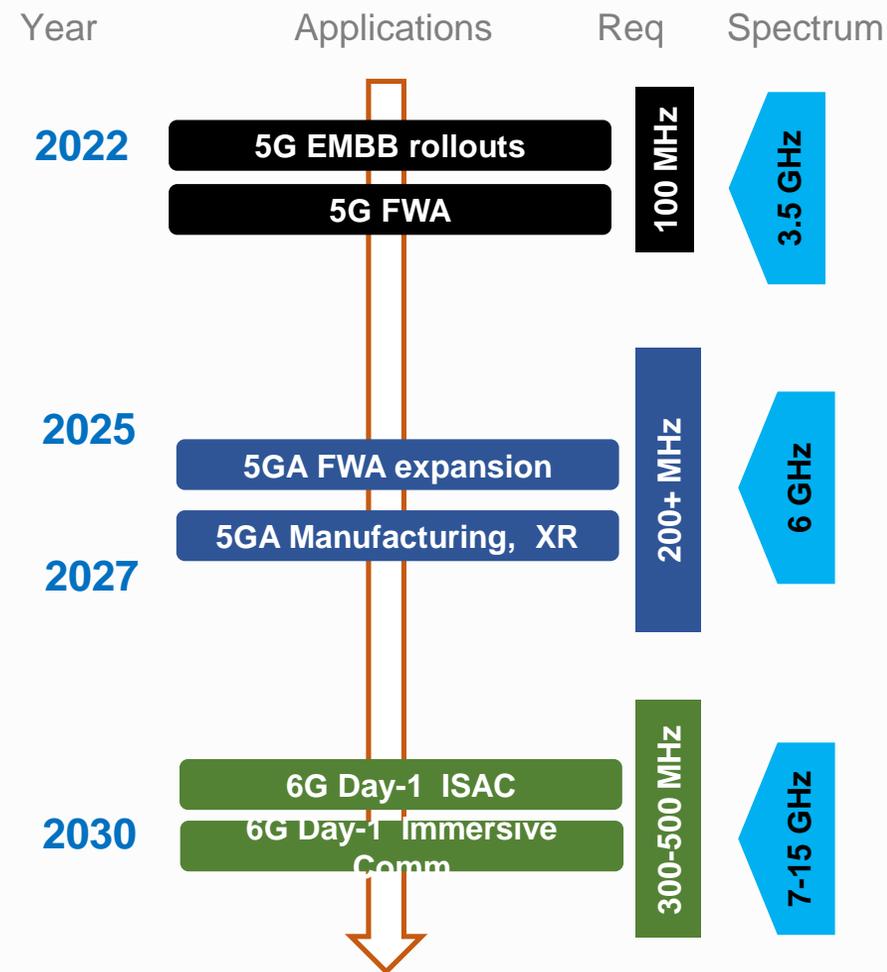
6G Spectrum: Challenges & Opportunities

by

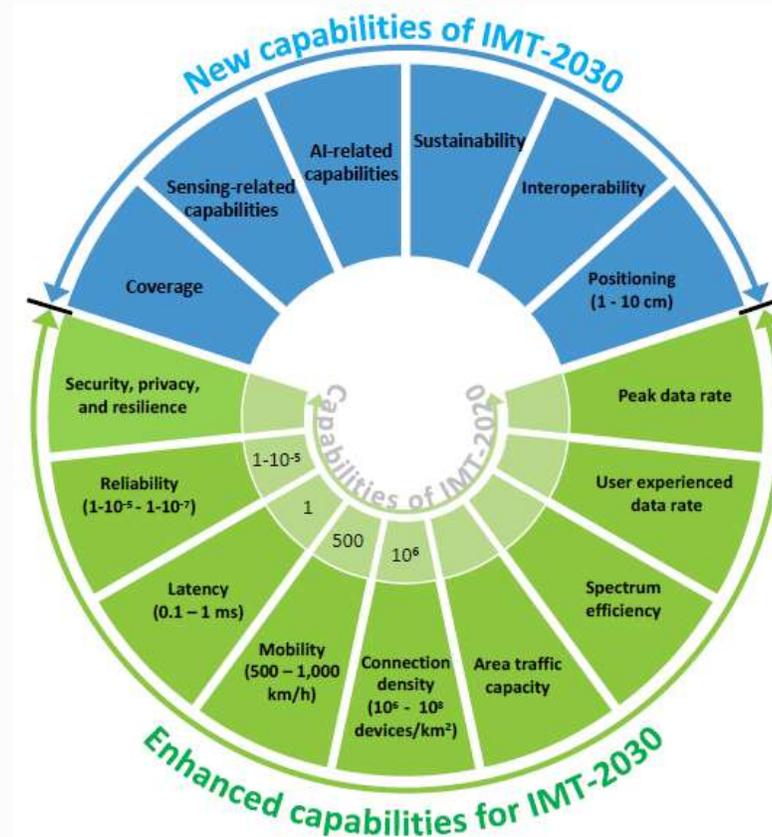
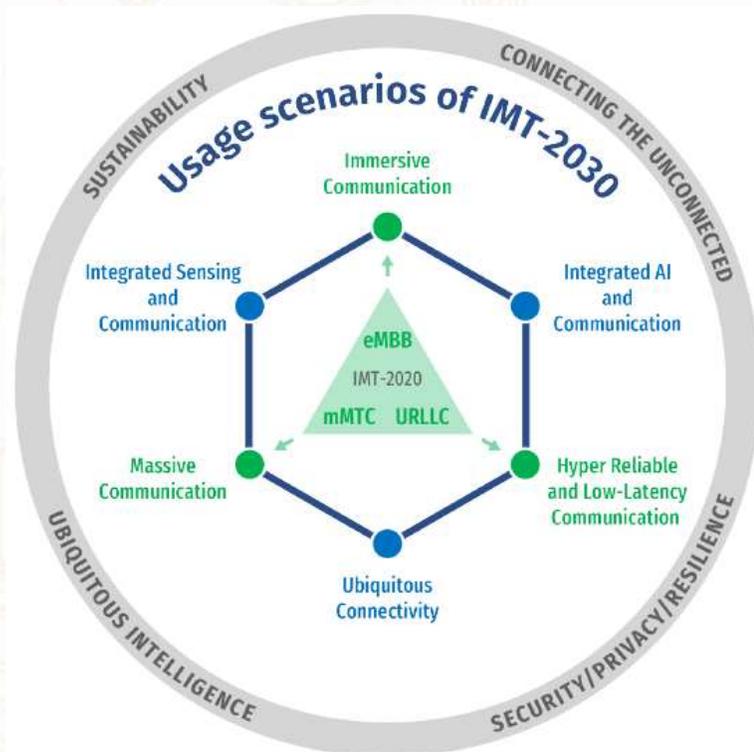
Shri A.K. Tiwari, Reliance Jio Infocomm Ltd

Indian IMT landscape & Spectrum

- Indian TSPs have deployed 5G services at unparalleled speed. The first phase of 5G roll outs are nearing completion.
- For next phase of 5G expansion with 5G Advanced would put up demands for additional mid-band spectrum in 2025 onwards.
- 5G adoption and investment continue to grow in India over this decade. An additional amount of minimum 400-600MHz mid-band spectrum per network would be needed in 2027-2030 timeframe
- 6 GHz spectrum range is an opportunity made available by WRC23 with a potential to offer large contiguous range of spectrum to fulfil these requirements
- For 6G spectrum choice needs to be evaluated for each use case. Additional spectrum needs to be explored in 7-15GHz to be reviewed in WRC27



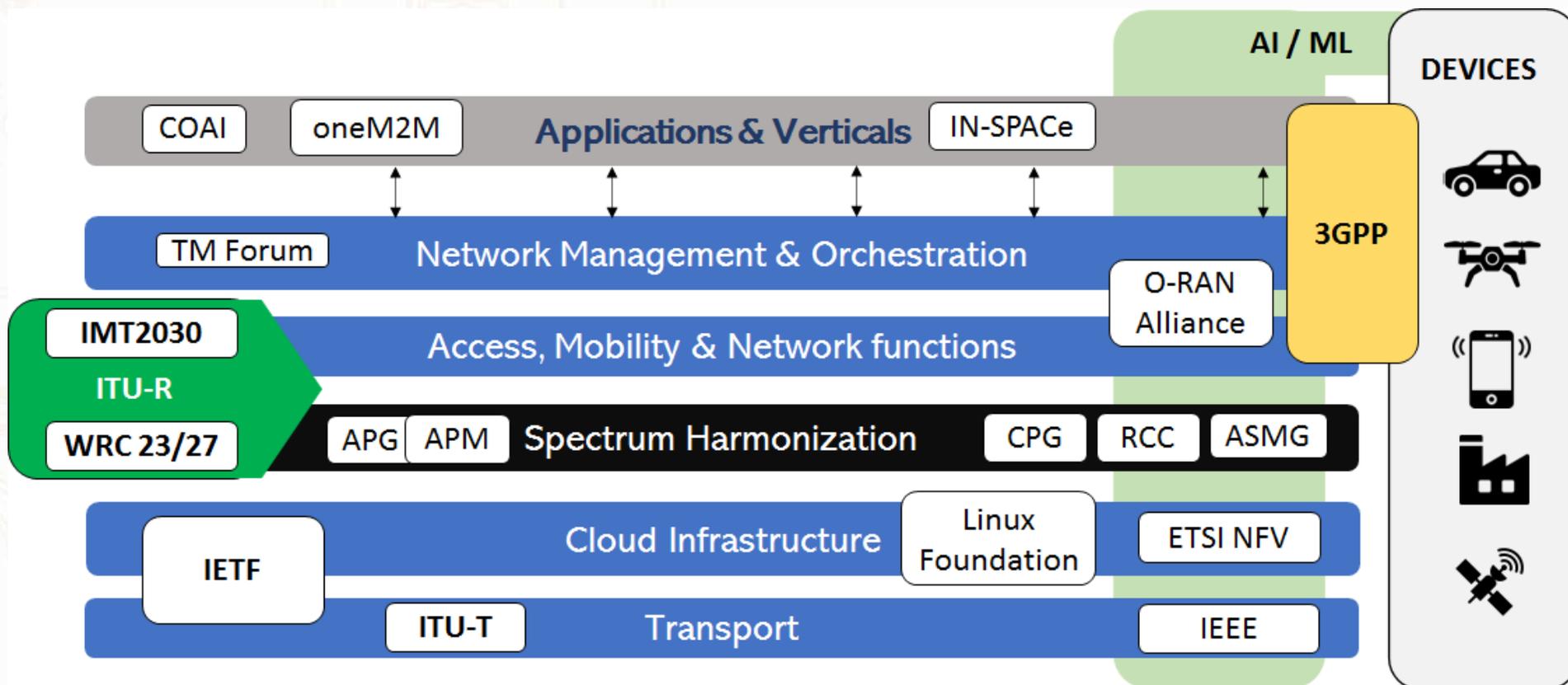
6G usage scenarios & Capabilities



- Three usage scenarios of IMT-2030 (6G) are envisaged to be the extensions of three usage scenarios of IMT-2020 (5G)- eMBB, URLLC, and mMTC
- IMT-2030 is also envisaged to enable three new usage scenarios viz- Ubiquitous Connectivity, Integrated Artificial Intelligence and Communication, and Integrated Sensing and Communication.

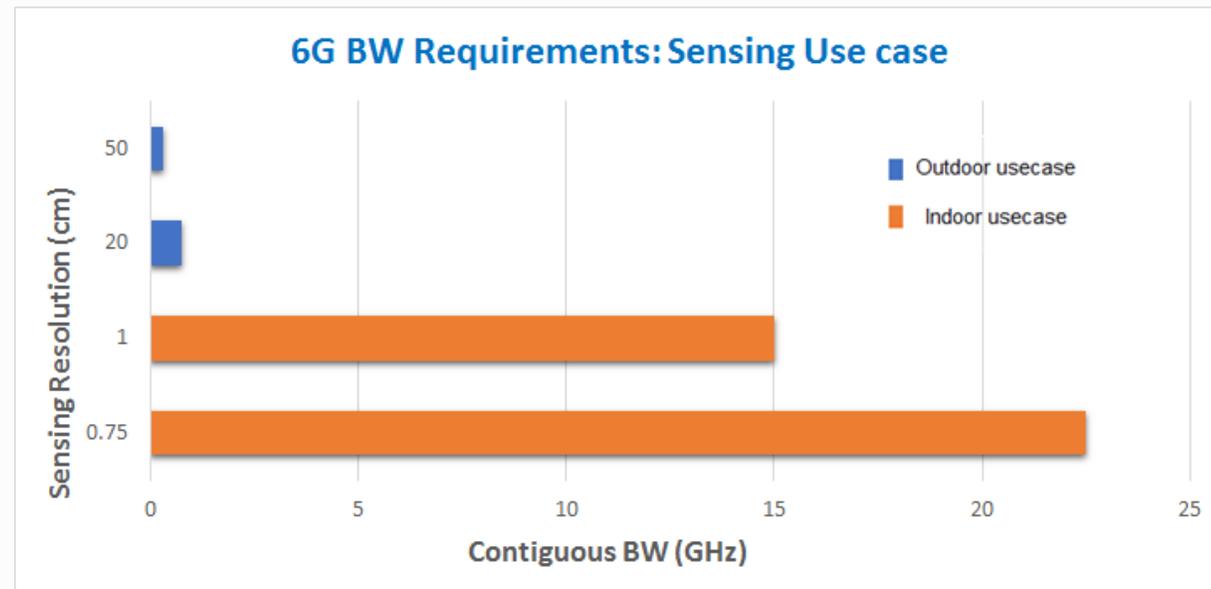
- In addition to the nine enhanced capabilities, 6G also introduces six new capabilities to support the new usage scenarios of IMT-2030

Telecom Standardization landscape



6G Spectrum requirements: Sensing

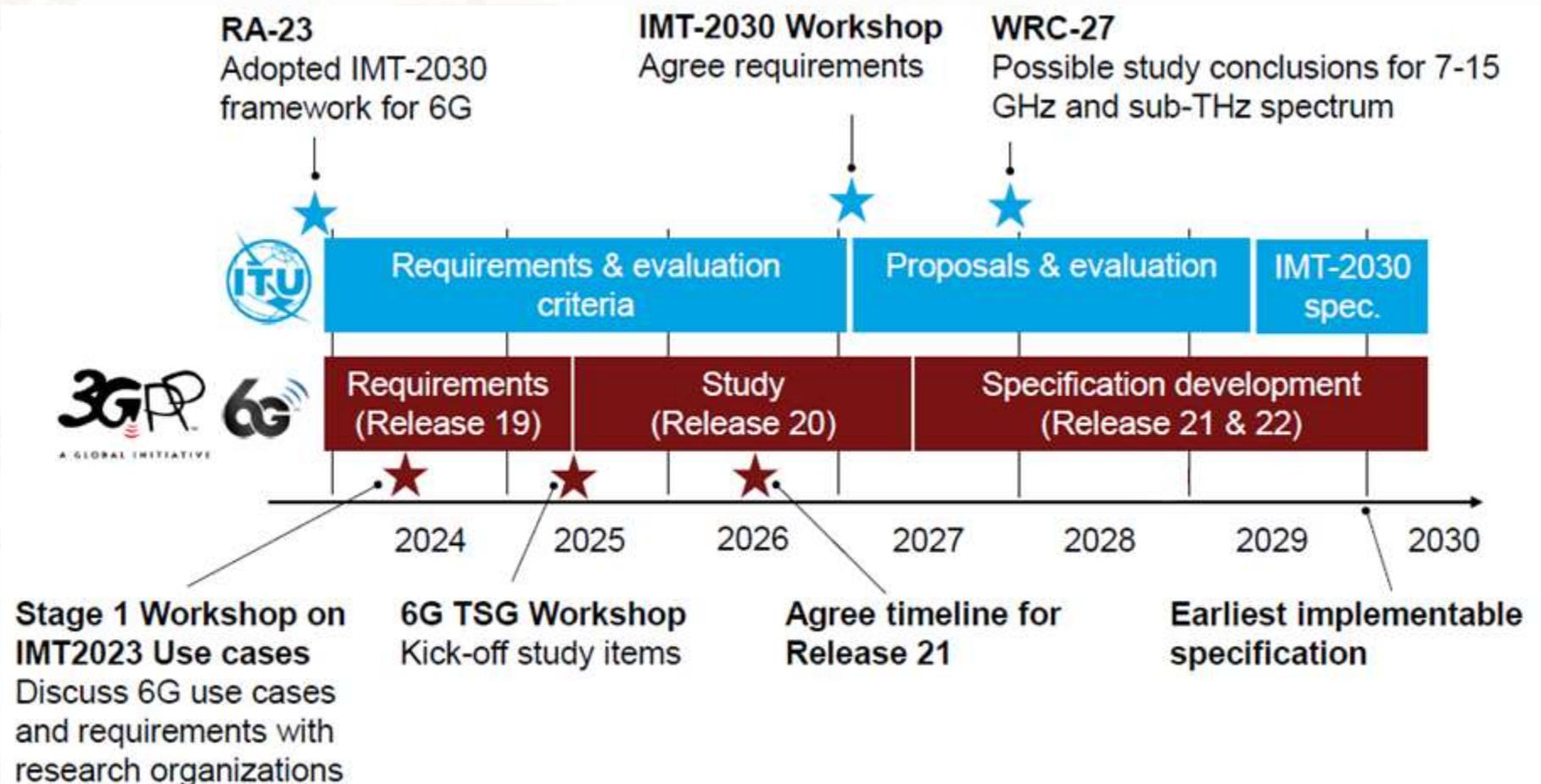
Usage scenarios	Representative capability
Immersive Communication	Peak data rate, user experienced data rate, area traffic capacity, spectrum efficiency, latency, mobility
Extreme Communication	Latency, reliability
Massive Communication	Connection density, area traffic capacity, energy efficiency
Integrated AI and Communication	AI-related capabilities, security, privacy and resilience
ISAC (Integrated Sensing and Communication)	Positioning accuracy, sensing- related capabilities
Ubiquitous Connectivity	Coverage



Spectrum Need: (in GHz)	XR	Holographic communications	ISAC/JCS
Wide area use cases	1	1.1	0.3-0.75
Local area use cases		>10s of GHz	>15

SENSING Bandwidth Requirements	Outdoor use case		Industrial use case	
	Sensing range resolution Δr (in cm)	50	20	1
Required contiguous bandwidth B (GHz)	0.3	0.75	15	>15

IMT2030 Timeline



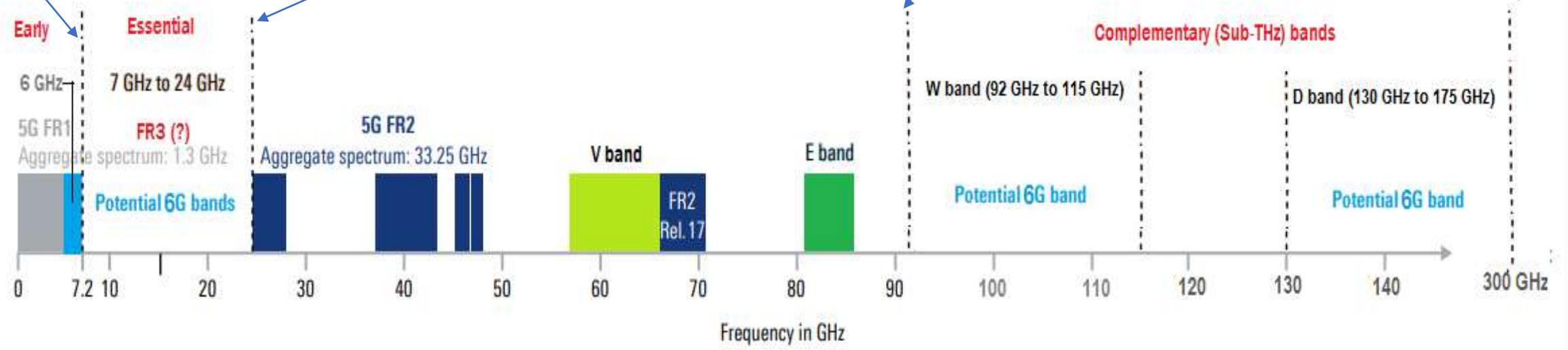
Potential 6G bands & Use cases

Extended mid-band/ cm-Wave / FR3

Immersive Communication
Massive Digital twinning
Internet of senses
Holographic communication
Sensing

Sub-THz bands

High-capacity backhaul
Enhanced short-range hotspot
Device-to-device communications
Inter-chip communication
Body networks

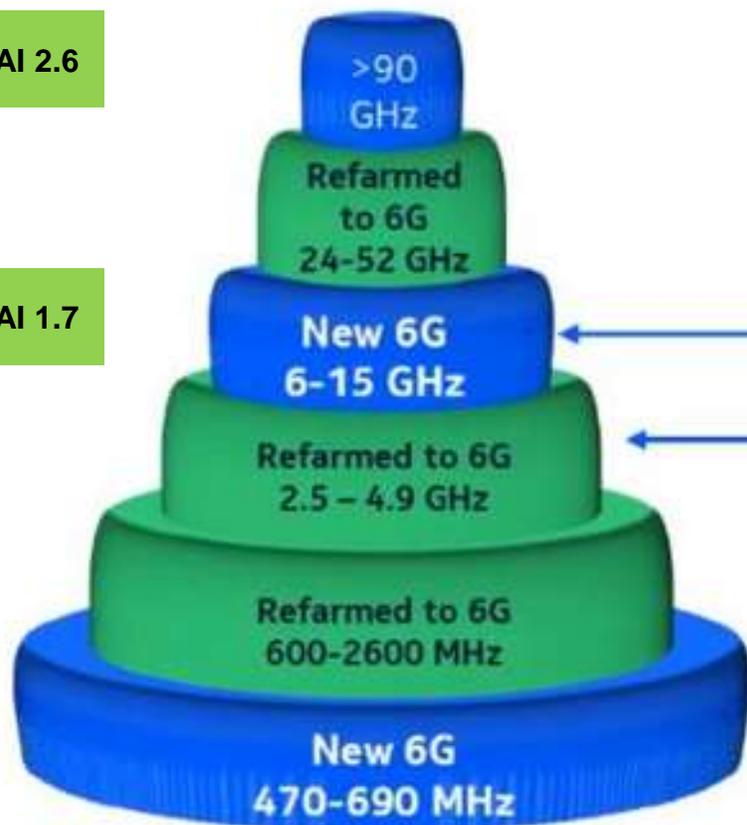


The 6G use cases applicable for each band are unique and depend upon the propagation characteristics of the band. Hence the role of each band- Low, Mid & High- is critical, indispensable, and irreplaceable in 6G journey.

WRC23 direction towards 6G spectrum

WRC-31, AI 2.6

WRC-27, AI 1.7



Wide area capacity and data rate boost

14.800 GHz	550 MHz	15.350 GHz *
7.125 GHz	1275 MHz	8.400 GHz *

Expansion of existing mid-bands

6.425 GHz	700 MHz	7.125 GHz
4.400 GHz	400 MHz	4.800 GHz *

Coverage at low bands **

470 MHz	220 MHz	690 MHz
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Note: only part of these spectrum blocks will be possible in each geographical regions

* To be studied towards WRC-27

** Initial proposal to be considered for WRC-31

WRC27 Agenda Item 1.7

- Sharing and compatibility studies and development of technical conditions for the use of IMT in the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz
- Studies of technical, operational and regulatory issues pertaining to the possible use of the terrestrial component of IMT sharing and compatibility studies to ensure the protection of incumbent services.
- *WRC-27 is invited to consider, based on results of studies, the identification of frequency band(s):*
 1. *4 400-4 800 MHz, or parts thereof, in Region 1 and Region 3;*
 2. *7 125-8 400 MHz, or part thereof, in Region 2 and Region 3;*
 3. *7 125-7 250 MHz and 7 750-8 400, or part thereof, in Region 1;*
 4. *14.8-15.35 GHz, for the terrestrial component of IMT*

AI 1.7 – 4 400-4 800 MHz

India
4 200-4 400 AERONAUTICAL MOBILE (R) 5.436 AERONAUTICAL RADIONAVIGATION 5.438 5.437 5.440
4 400-4 500 FIXED MOBILE 5.440A
4 500-4 800 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE 5.440A
4 800-4 900

- Favourable propagation conditions
- Low incumbent FSS allotment/usage in some regions

- Adjacent to radio altimeters in 4.2- 4.4 GHz
- FSS is a planned band (Appendix 30B)
- AI 1.19 studying EESS (passive) in 4.2-4.4 GHz
- Extensive military usage in the band

AI 1.7 – 7.125-8.4 GHz

India
7 450-7 550 FIXED FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth) 5.461AA 5.461AB 5.461A
7 550-7 750 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth) 5.461AA 5.461AB
7 750-7 900 FIXED METEOROLOGICAL-SATELLITE (space-to-Earth) 5.461B MOBILE except aeronautical mobile
7 900-8 025 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE MOBILE-SATELLITE (Earth-to-space) 5.461

India
8 025-8 175 EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A
8 175-8 215 EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) METEOROLOGICAL-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A
8 215-8 400 EARTH EXPLORATION-SATELLITE (space-to-Earth) FIXED FIXED-SATELLITE (Earth-to-space) MOBILE 5.463 5.462A

- Golden band due to continuity with 6425 - 7125 MHz band
- Propagation conditions favorable for Urban & Sub-urban deployments

- Extensive military usage in the band
- Heavy Fixed Service (MWB) usage
- Allocation to science services
- AI 1.19 studying EESS (passive) in 8.4-8.5 GHz

AI 1.7 – 14.8-15.35 GHz

India
14.8-15.35
FIXED
MOBILE
Space research
5.339

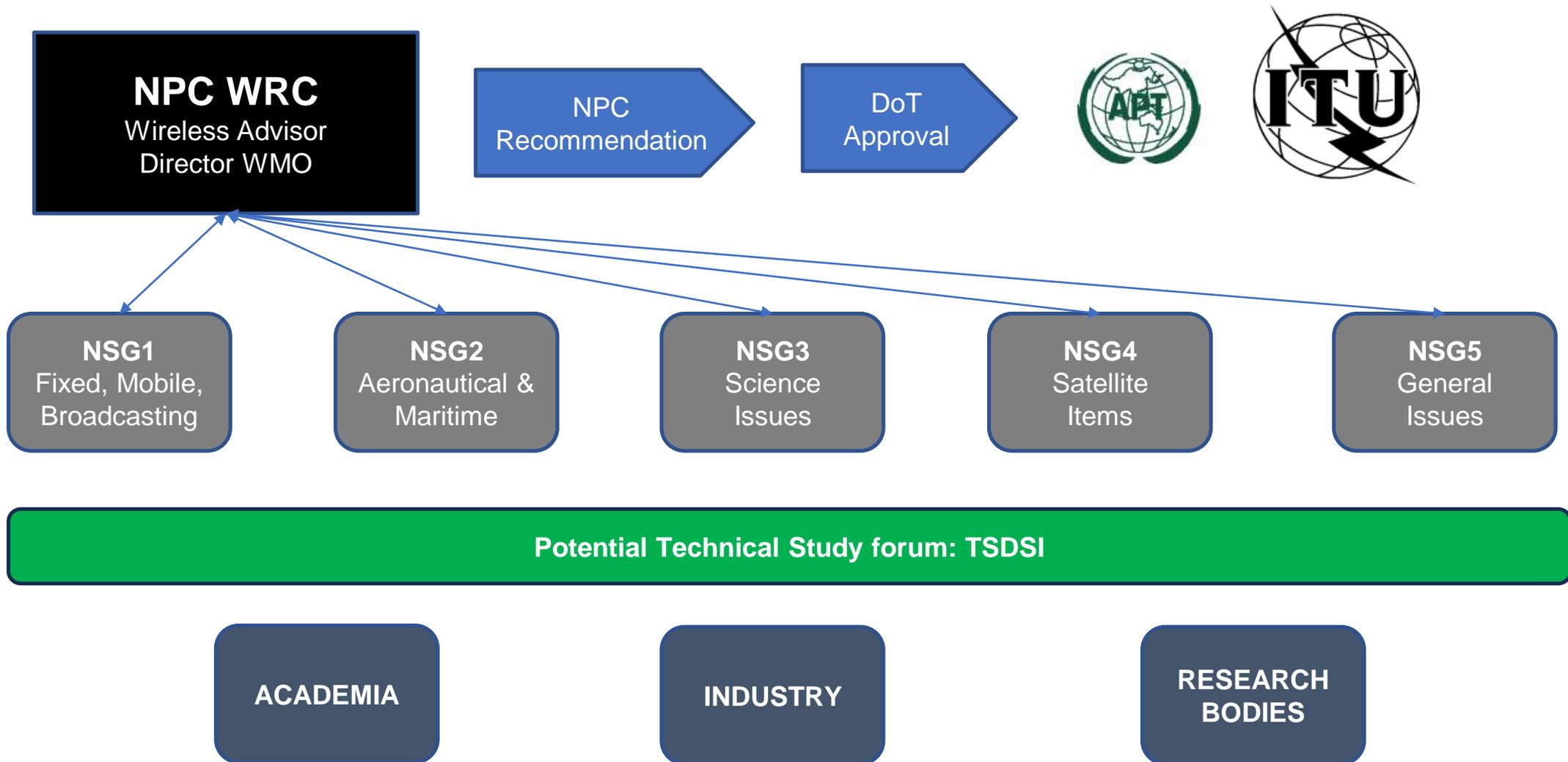
- Contiguous 550MHz upper mid-band
- Higher propagation losses
- Fixed Service and Space research allocations
- Protection to passive services in adjacent band 15.35-15.4 GHz
- Military usage in some regions

AI 1.7 – Aspects to address

- Audit current incumbent spectrum allocations in 7.125 GHz -8.4 GHz
- Formulate clear road-map for migration of services if sparsely used
- Identify the sharing and compatibility studies to be undertaken
- Formulate a common body for Sharing studies where all stakeholders can interact and provide relevant inputs
- Work towards formulating the system characteristics for use in studies specific to Indian incumbent services
- Study Indian urban/sub-urban clutter models for identified deployment scenarios with help from academia



National Preparatory Committee





National framework: Spectrum studies

Potential Contributors

- Indian Industry – Identification of correct Usage parameters for study
- Indian Academia – channel propagation modeling
- TSDSI – Regional SDO. Good platform to contribute on technical aspects

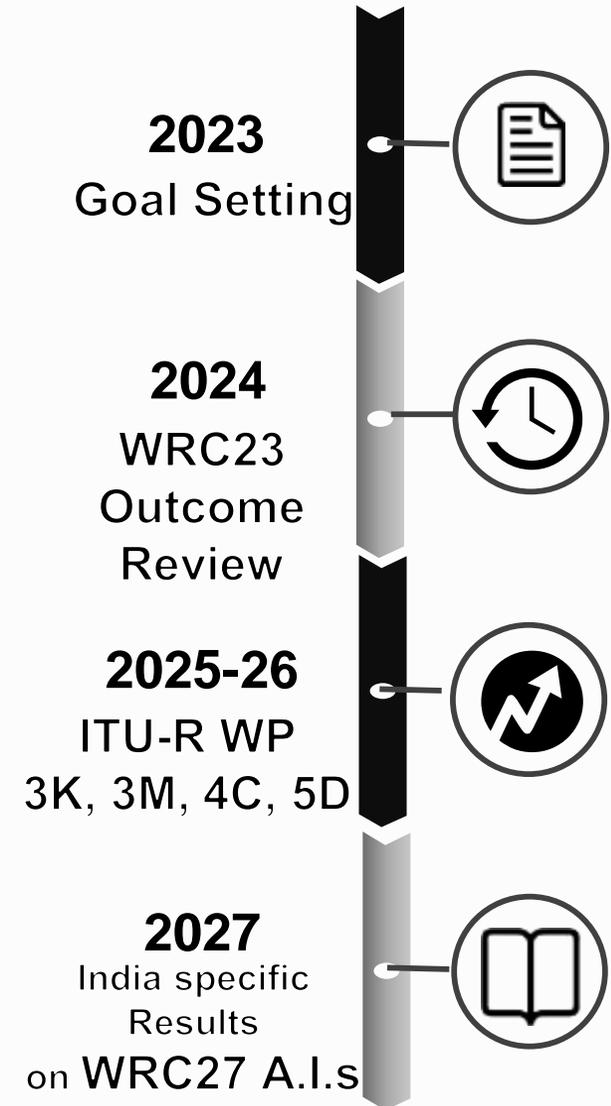
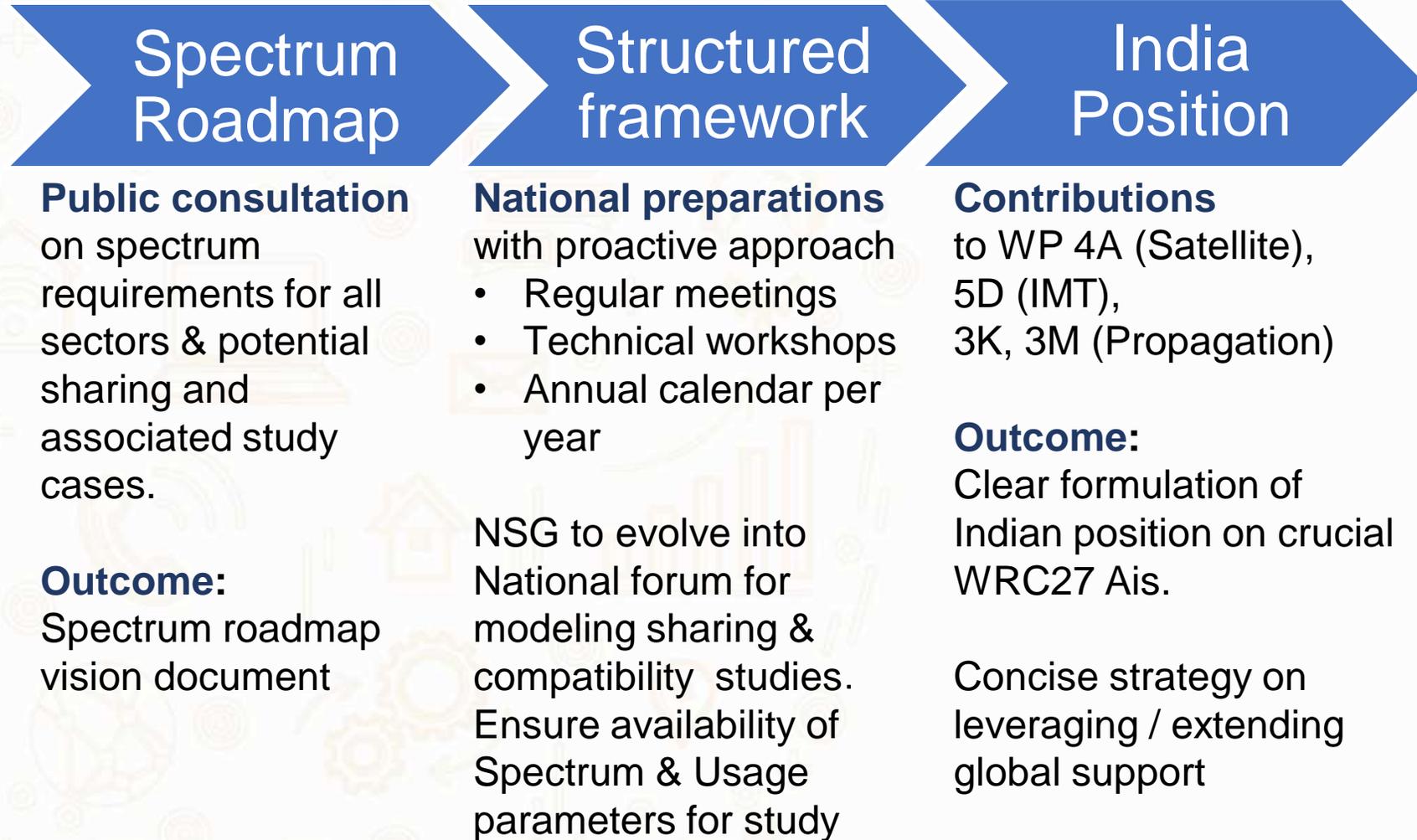
Challenges

- Availability of incumbent Spectrum allotment details
- Availability of usage parameters of incumbent services
- Involvement of appropriate stakeholders in Spectrum studies
- Availability of a common national platform for sharing studies
- Channel & clutter modeling for Indian Metro cities





National 6G spectrum framework



Thank You
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