



Vigyan Bhawan, New Delhi, India

International workshop on 6G Standardization

Traffic Projections, 6G Spectrum Demand and
Migration Strategy

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Architecting
tomorrow



6G Context

AI on Networks

A glimpse

Predominantly GenAI

1.3T

AI sessions per year

~100T

Tokens per day

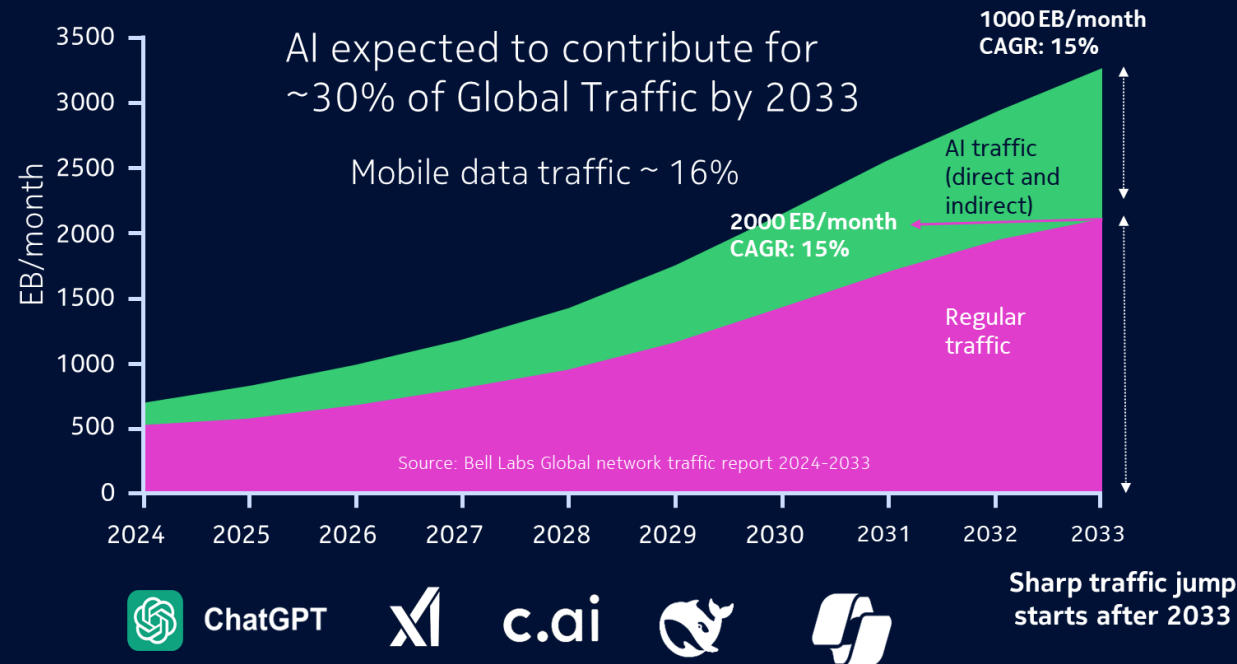
Top platforms

77 EB/month

AI traffic

53.5%

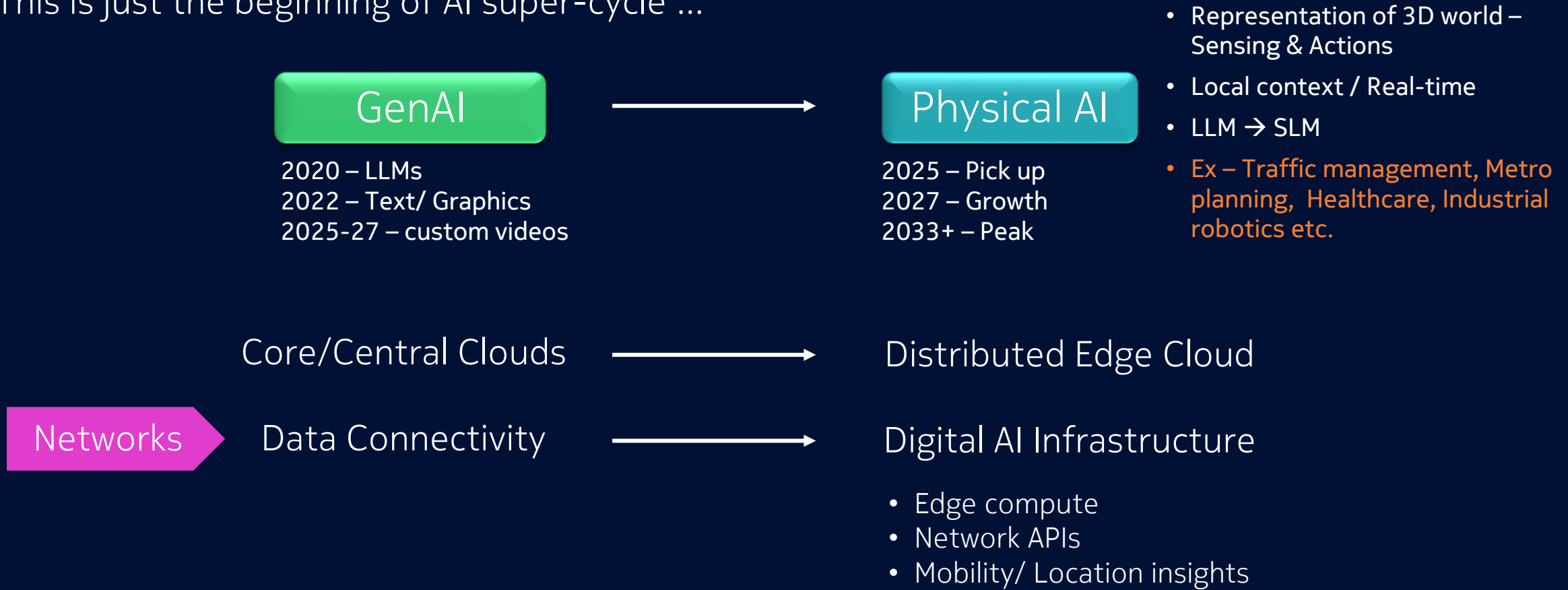
Mobile GenAI



Genesis of AI-RAN

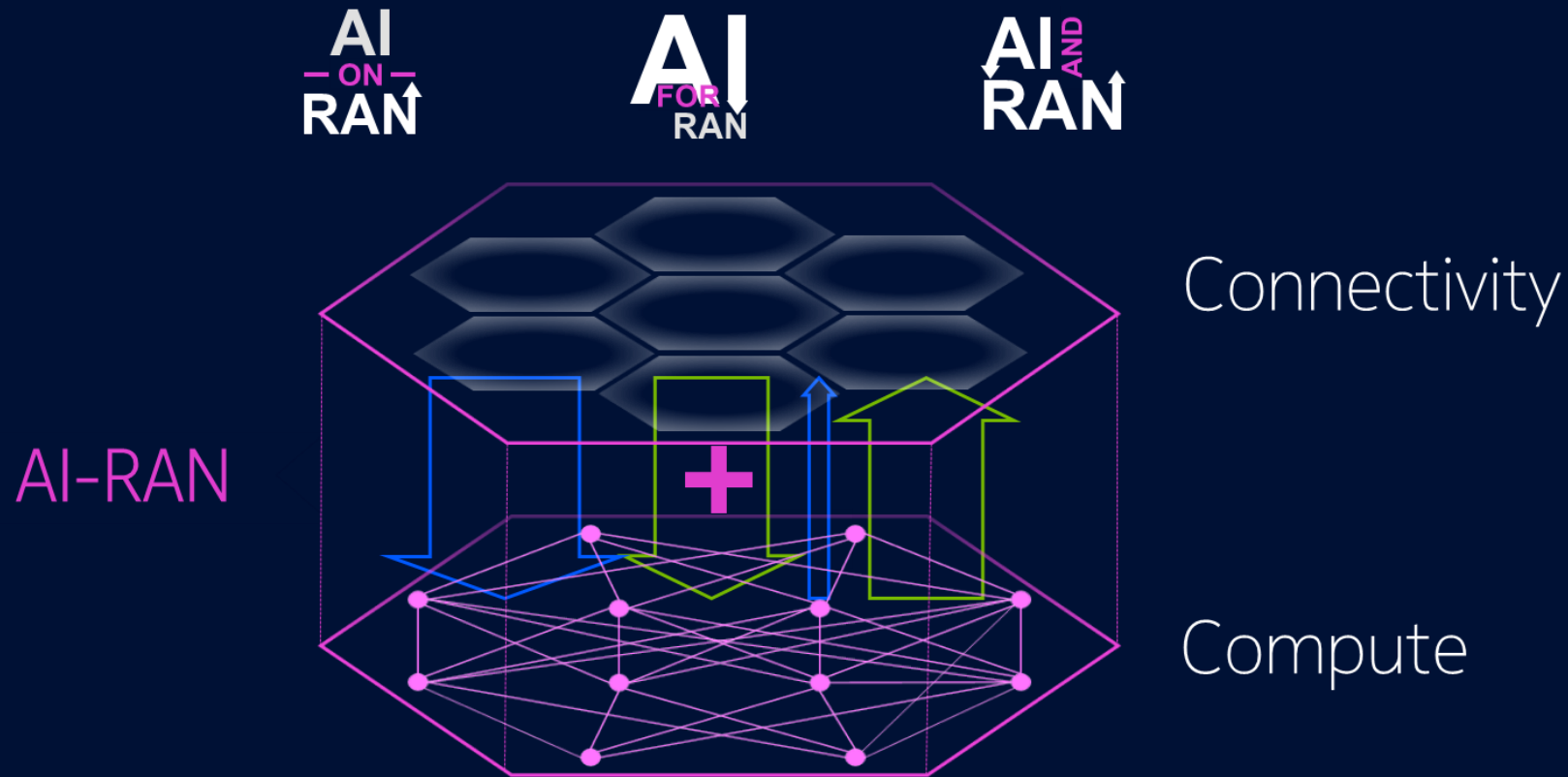
6G – Fusion of Connectivity, Compute and Intelligence (AI)

This is just the beginning of AI super-cycle ...



Genesis of AI-RAN

6G – Fusion of Connectivity, Compute and Intelligence (AI)



India mobile data outlook (2024-30)

Mobile communication outlook in India

Subscription trends 2024-2030

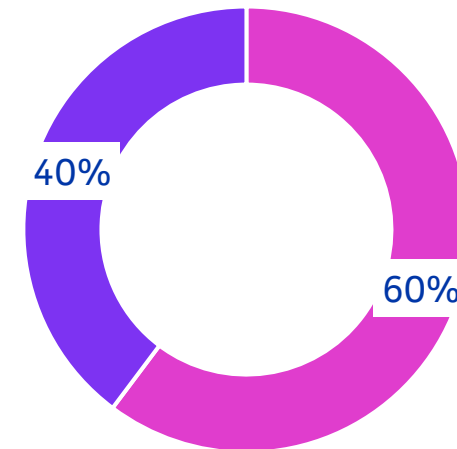


500K sites

~400m users

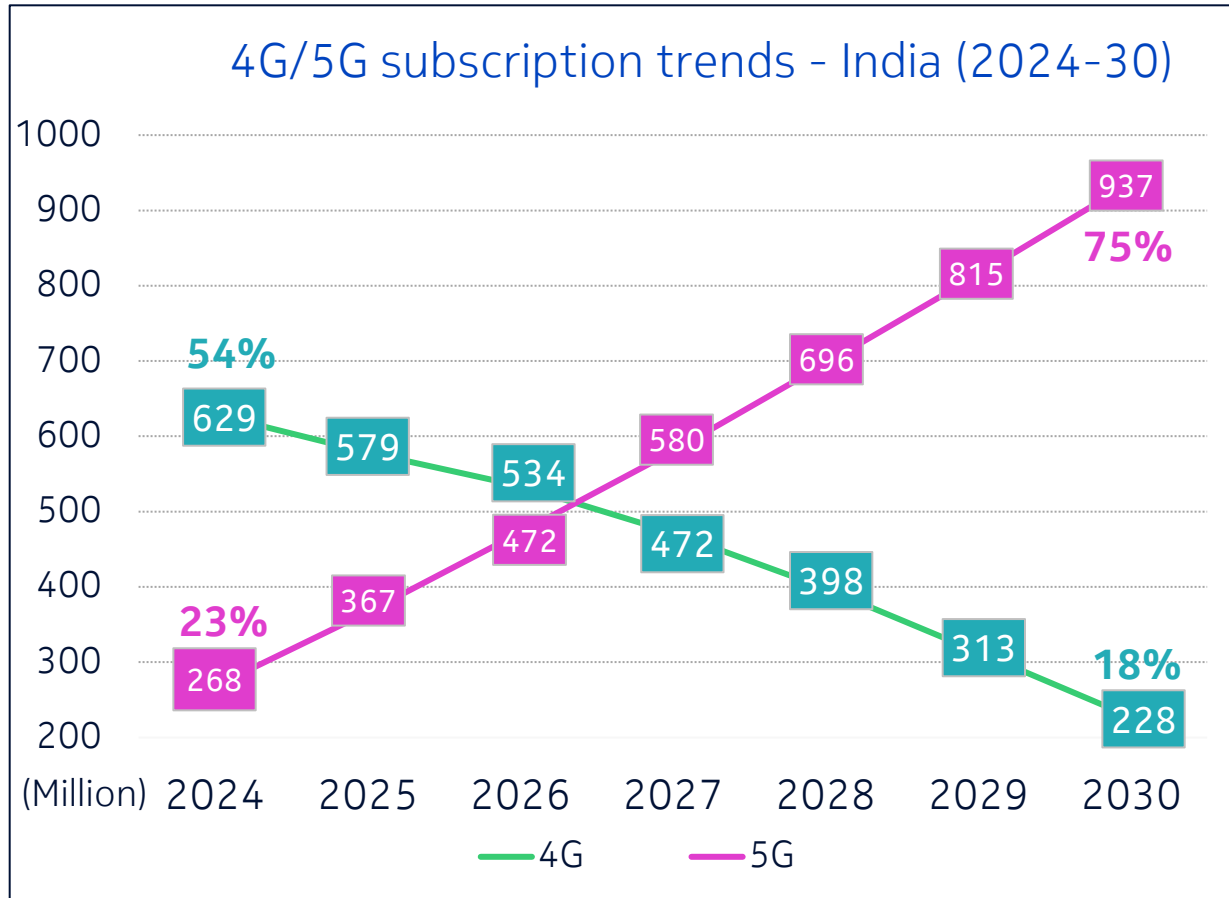
5G devices penetration ~ 42%

4G/5G Data Ratio QE 12-2025



■ Data (4G) ■ Data (5G)

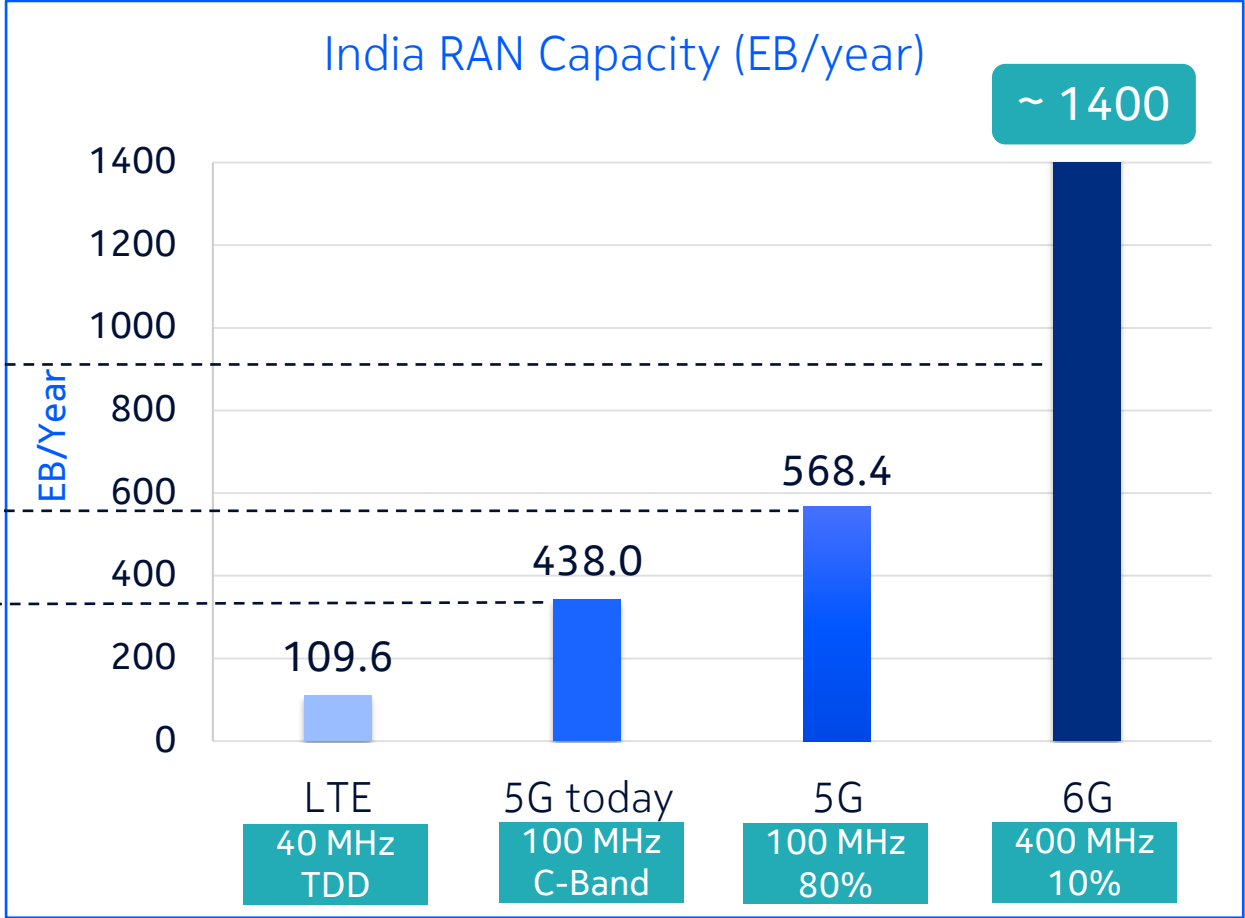
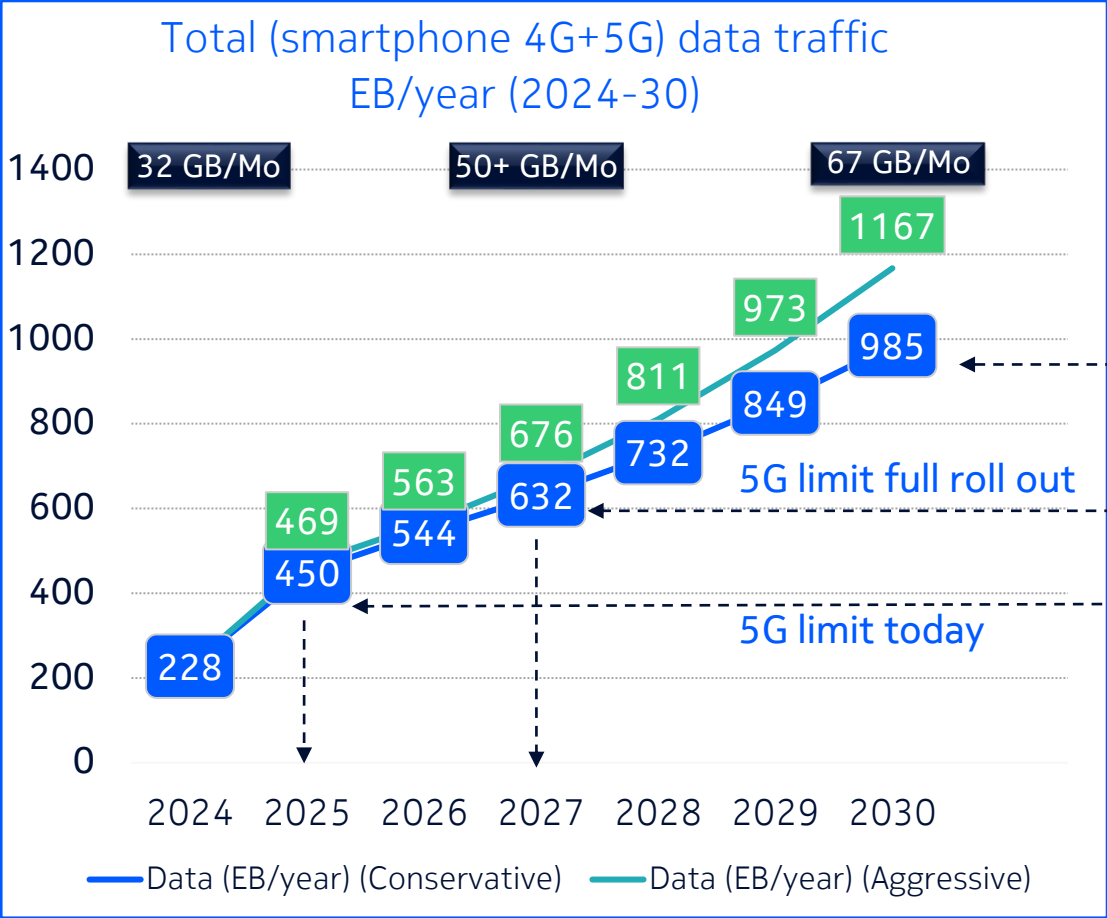
NOKIA



Mobile data traffic (India)

Demand vs Supply 2024 - 2030

- More deployments by 2027
- More spectrum post 2027
- New Radio in new 6G spectrum 2030



Spectrum demand analysis

Demand study for Delhi to deliver 100 Mbps everywhere

Bharat 6G Alliance



Bands	Deployed (MHz)	Macro SE DL	Macro SE UL	Act factor	High-band offload	# Sectors	Cell rad (m)	Small cell SE DL	Small cell SE (UL)	Macro cap per site Mb/s DL	Macro cap per site Mb/s UL	Small cell per Macro	Small cells cap per site Mb/s DL	Small cells cap per site Mb/s UL	Total cap per site (DL) Mb/s	Total cap per site (UL) Mb/s
700	10	1.8	1.8	25%	20%	3	130	3.7	3.2	54.00	54.00				54.00	54.00
800	20	1.8	1.8	25%	20%	3	130	3.7	3.2	105.30	105.30				105.30	105.30
900	25	1.8	1.8	25%	20%	3	130	3.7	3.2	133.92	133.92				133.92	133.92
1800	55	2.5	2.2	25%	20%	3	130	3.7	3.2	411.00	361.68				411.00	361.68
2100	40	2.5	2.2	25%	20%	3	130	3.7	3.2	300.00	264.00				300.00	264.00
2300	80	2.5	2.2	25%	20%	3	130	3.7	3.2	450.00	132.00	2	444.00	128.00	894.00	260.00
2500	40	2.5	2.2	25%	20%	3	130	3.7	3.2	225.00	66.00	2	222.00	64.00	447.00	130.00
1800NR	0	2.5	2.2	25%	20%	3	130	3.7	3.2	0.00	0.00		0.00	0.00	0.00	0.00
3500	370	6.0	4.1	25%	20%	3	130	3.7	3.2	4995.00	1137.75	2	2053.50	592.00	7048.50	1729.75
															9393.72	3038.65

Area (sqkm)	1484
Pop. density	10000
#macro sites	27965

Capacity delivered Mb/s per sqkm	43728.4231
Capacity demand Mb/s per sqkm	2,50,000.00
Offload to high-bands @25%	62,500.00
Capacity gap Mb/s per sqkm	1,43,771.58
Capacity gap Mb/s per cell site	30,517.53
Spectrum gap GHz per cell site	1.60 GHz

Additional 1600 MHz mid-band spectrum needed to deliver 100 Mbps everywhere.



Spectrum requirements

IMT-2030 (6G)

Immersive Communication (Cloud XR)

B = Data rate / 5% Spectral efficiency

- B is the amount of spectrum (Hz) required
- **Data rate = 450 Mb/s** for 16x16 XR
- 5% SE = 0.45 Outdoor, 0.6 bps/Hz indoors

16Kx16K resolution

Frame rate 60 Hz (for single eye)

12 bits/ pixel

Required throughput ~ 0.45 Gbit/s , given 800:1 compression ratio. 16384 (pixels width) $\times$ 16384 (pixels height) $\times$ 12 (bits/pixel) $\times$ 60 (frames/s) = 180 Gbit/s (H.266): Raw data / 800 = 0.225 Gbit/s

For stereo (two eyes): 0.225 Gbit/s $\times$ 2 = 0.45 Gbit/s (compressed by VVC)

High accuracy sensing / positioning

$B = c / 2\Delta r$

- B is the required bandwidth (Hz)
- c is the speed of light (m/s)
- Δr is the range resolution (m)

Typical outdoor applications

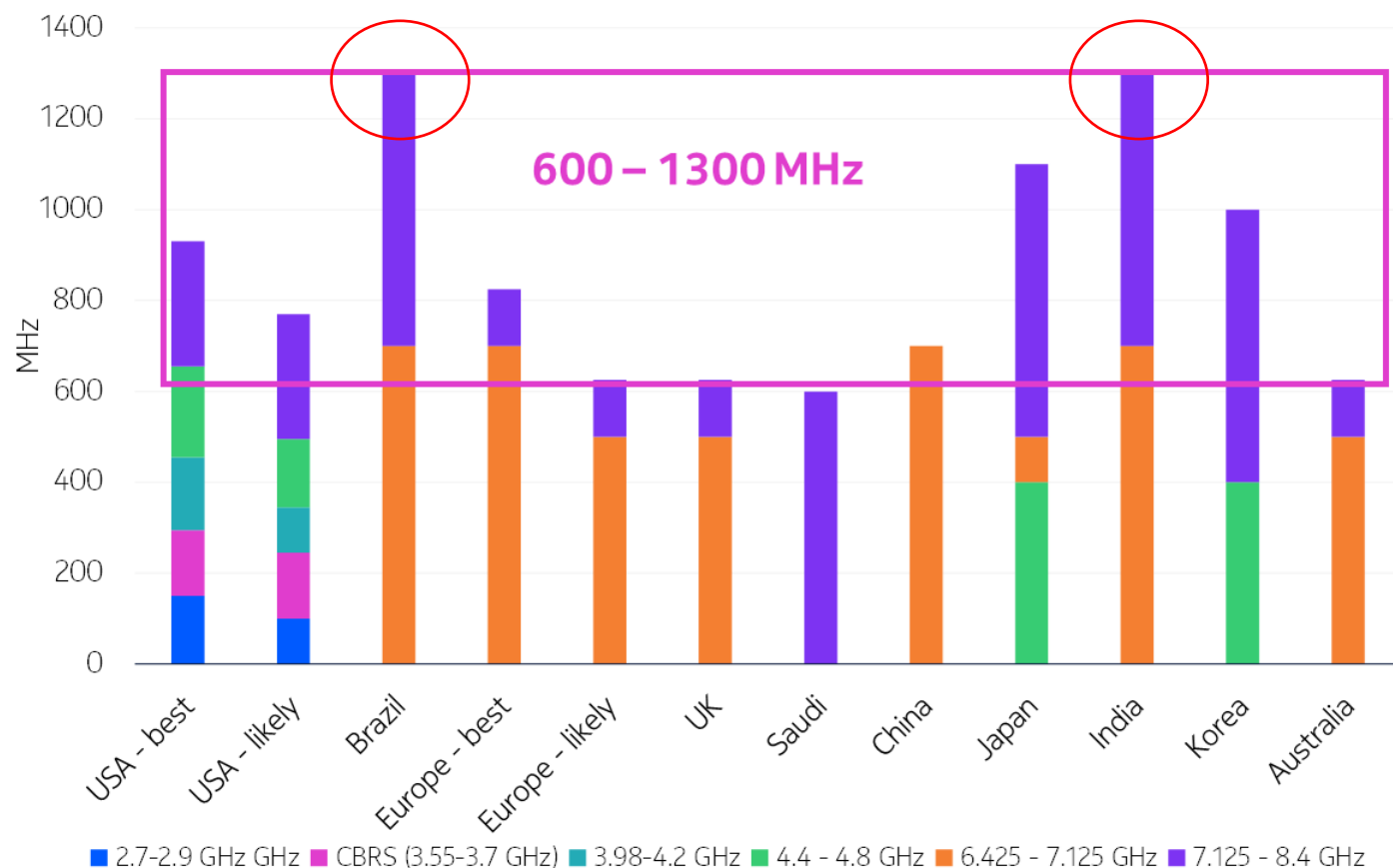
Sensing range resolution Δr (in cm)	50	20
Required contiguous bandwidth B (MHz)	300	750

Additional 750 MHz (Indoor), 1 GHz (outdoor) DL spectrum per network needed

Expected new mid-band spectrum globally for 6G

India uniquely placed for success with u6GHz and 7/8GHz for 6G

Rapid 5G deployments in 3.5 GHz is the evidence – Starting Oct 2022, India became #2 market globally

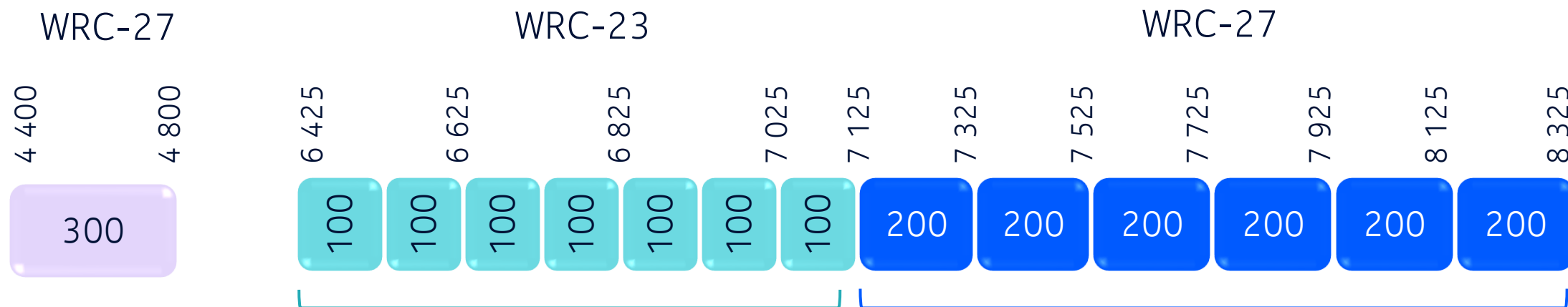


- Most global markets expected to get new spectrum around 7 GHz band
- **6G target is 400 MHz per operator**
- **Channel size 200 MHz**
- Early spectrum roadmaps and timelines for release of frequency bands are key to a successful 6G roll out
- **Harmonization of 6-8 MHz is key to economies of scale !**

Spectrum inventory and migration strategy

Potential inventory for 6G

Marco IMT Deployments

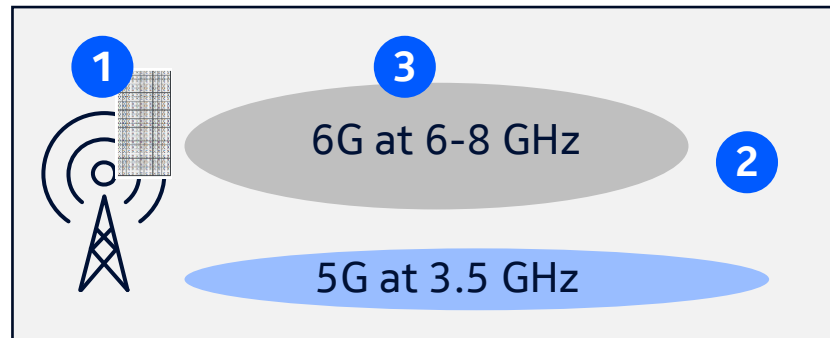


- RALT issues
- Conclusions on LRTC is important to leverage the range for macro deployments

Ideal target is 400 MHz per MNO for 6G

- **This continuous range is precious spectrum for 6G**
- **6 to 8.4 GHz has the potential to offer 400 MHz contiguous per network**
- **Important to consider 6-8 GHz as a continuous range, to optimise radio design for wider IBW and minimum TCO**
- Spectrum identification, regulatory preparation and final assignment is a long cycle.

Targets for 6-8 GHz deployments

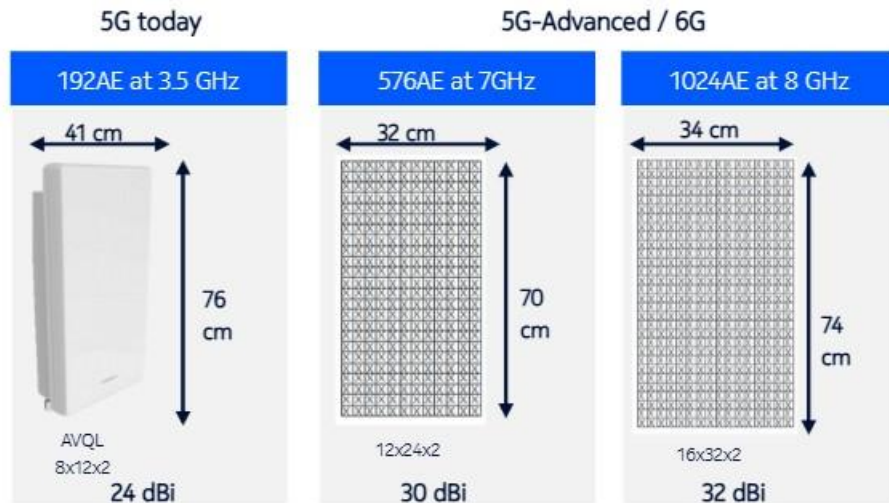


Coverage solution: 6 dB higher antenna with 4X antenna elements/ 4 dB link budget gain = 10dB coverage

Capacity solution: 4x more spectrum and 5x more spectral efficiency with more TRXs & beamforming

20x
Cell
capacity

4T4R (20MHz) 40 Mbps → 64TRX
(100MHz) 800 Mbps → >2x TRX (400MHz)
16000 Mbps cell capacity



6G at 7-15 GHz may bring up to 20x capacity
with 4x bandwidth and 5x efficiency

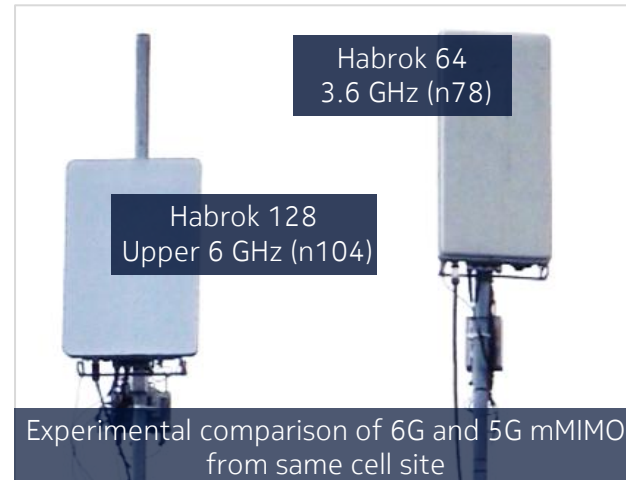
Realizing the vision of 6G in upper mid-bands

20+ trials and PoC completed during 2025



Key learnings:

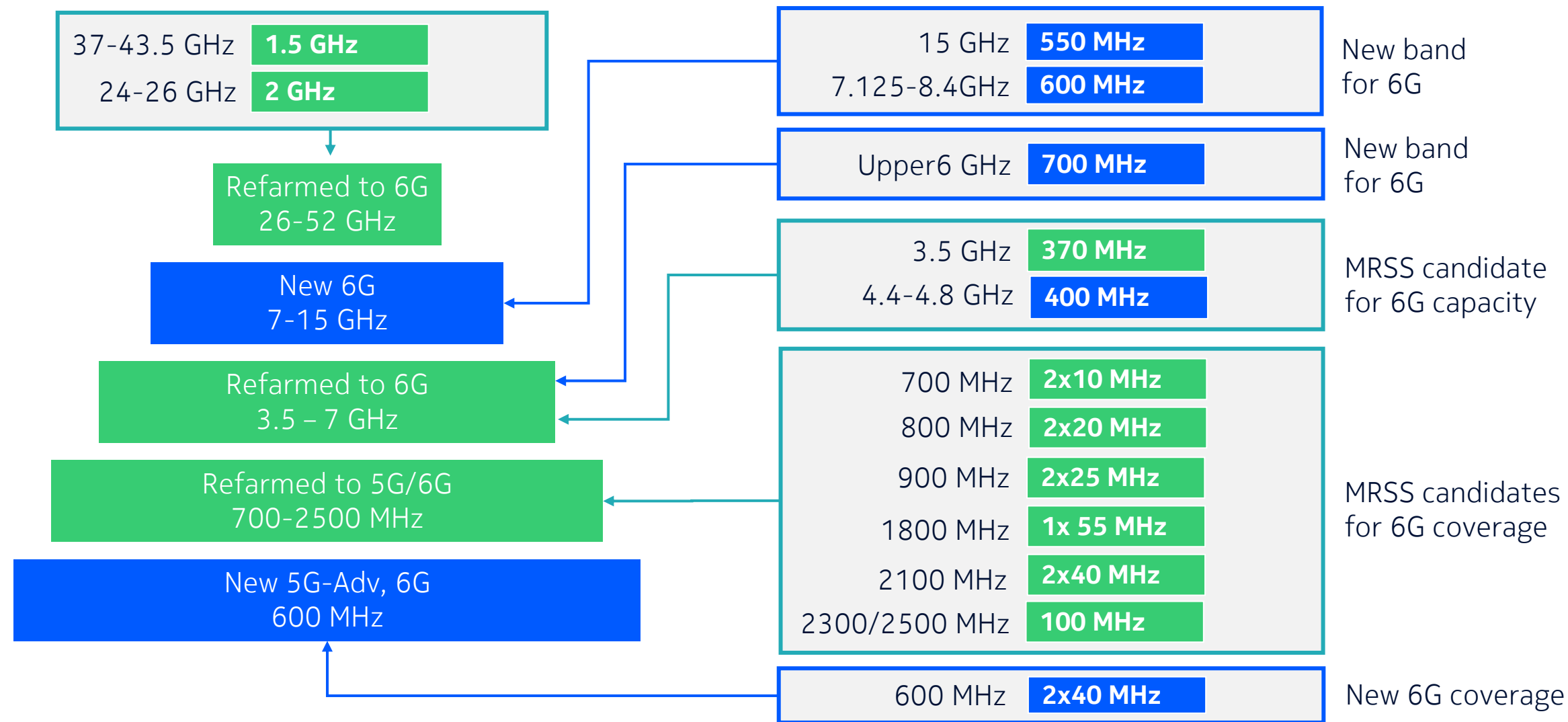
- 6G can be deployed at upper 6 GHz and 7 GHz radios with 5G site grid in urban and dense urban areas
- 200MHz bandwidth provides 3x better performance in both O2O and O2I scenarios, for both uplink and downlink



Spectrum stack

NEW

EXISTING



A single architecture for smooth deployment

5G today

7 architectures defined in 3GPP and 2 implemented (NSA, SA)

5G core is a major upgrade on top of 4G core

4G + 5G dual connectivity (DC) and 4G RAN – 5G RAN interface

Two radios (LTE + 5G) active in devices simultaneously

Refarming mostly with static spectrum split

6G evolution

Only **single architecture** option for simple evolution

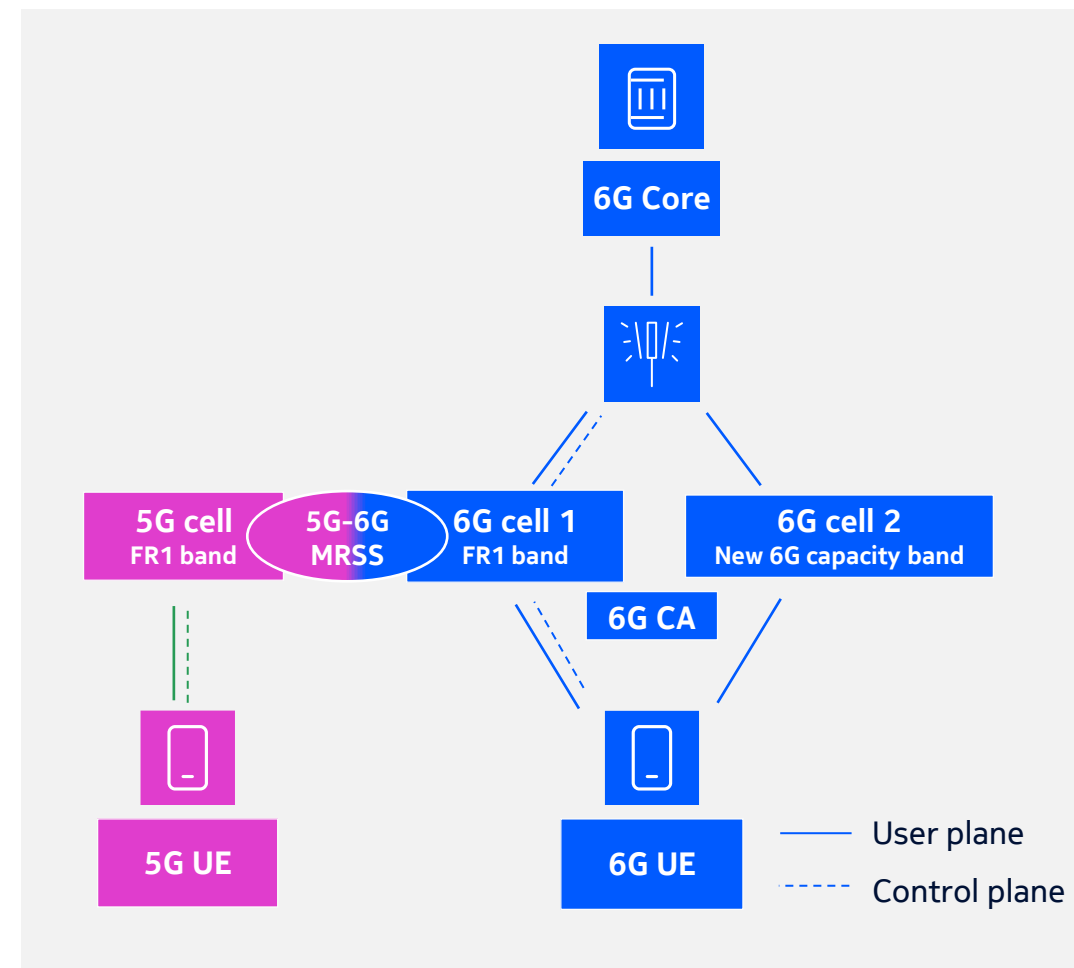
6G **core is a smooth migration** from 5G core

No 5G – 6G dual connectivity (just MRSS* control)

Only a single radio is active (6G) in a device at a time

Multi-Radio Spectrum Sharing (MRSS) for truly dynamic refarming

* MRSS: Multi-RAT spectrum sharing

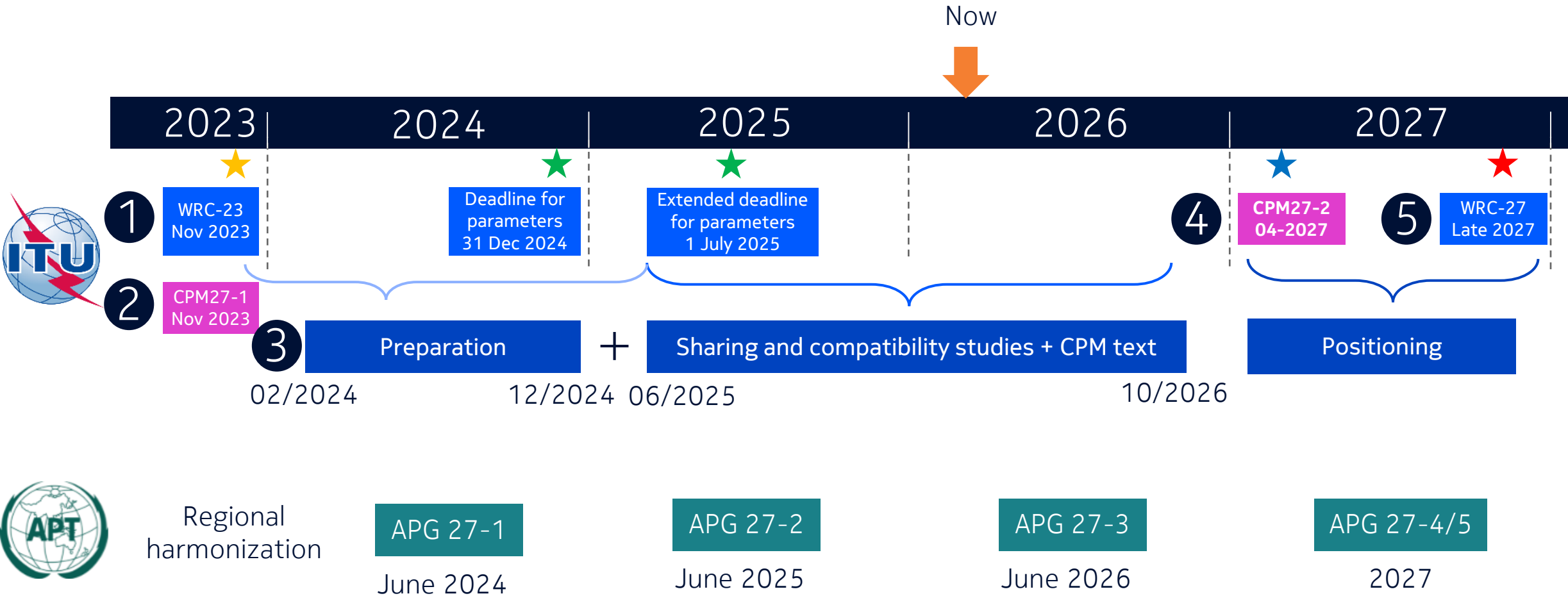


Note: These are preliminary views for discussion – options need to be evolved as 6G concepts become more mature

WRC-27

ITU WRC-27 Timeline

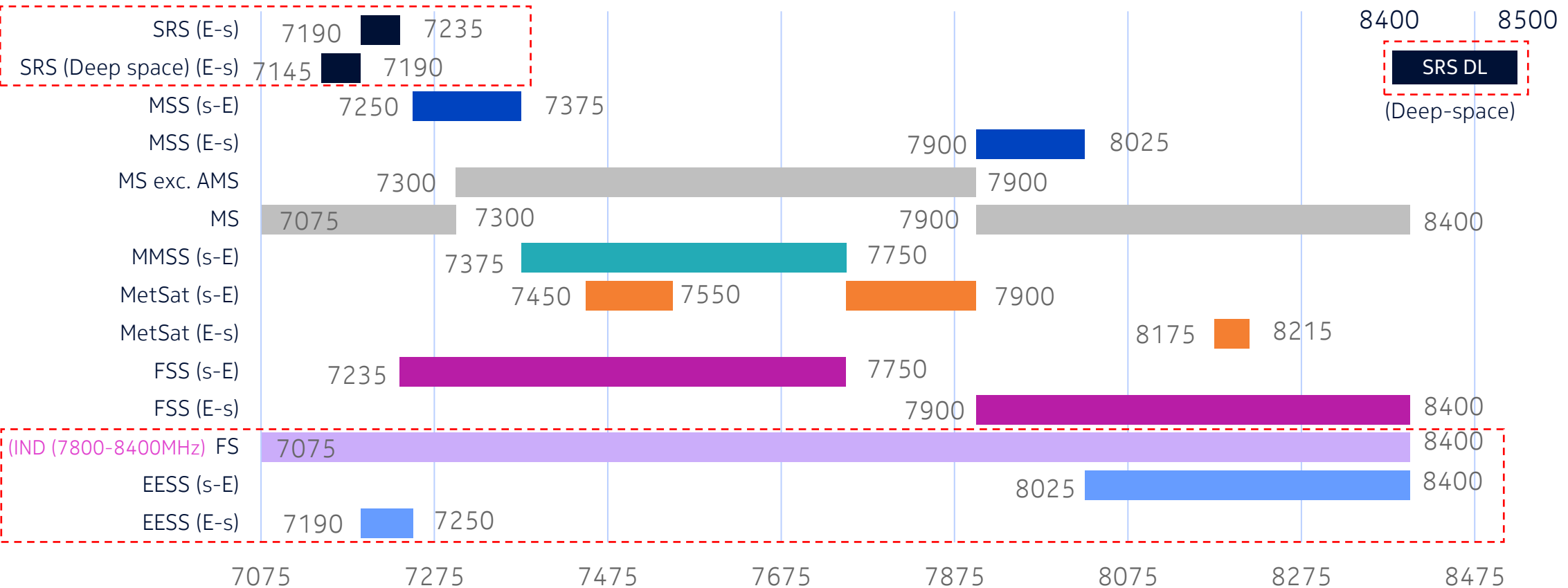
... over the 4 years



AI 1.7 (WRC-27)

Services allocation in Region 3

Region 3 Allocation AI 1.7 (WRC-27)



A quick view to what sharing studies in WP5D indicate

7-8 GHz band

Service (Direction)	# Studies	Notes
Fixed Service (7125–8400 MHz)	11	>50–315 km separation
FSS (s-to-E) 7250–7750 MHz	11	USA: 10 Kms, CAN: 34-155 Km, CHN: 65-180 Km (GSO) 45-110 Km NGSO, many results TBD
FSS (E-to-s) 7900–8400 MHz	13	GSO: Global beams – Meets criteria NGSO: High exceedance report by GER, USA (high-gain beams)
MSS (s-to-E) 7250–7375 MHz	7	CAN: 44–186 km separation (long-term) BRA: 2 km India Study C (No results)
MSS (E-to-s) 7900–8025 MHz	9	USA: Positive 4-12 dB (spot), others show exceedance
EESS (s-to-E) 8025–8400 MHz	8	USA: 55 km NGSO, 45–50 km GSO, CAN: 34 Urban / 202 Km Sub-urban NGSO, CHN: 60-220 km NGSO
MetSat (s-to-E) 7450–7900 MHz	5	GSMA: 1-8.5 Km (GSO), BRA: 10 Km (GSO), CHN: 65-331 km (GSO)
MetSat (E-to-s) 8175–8215 MHz	1	BRA: 15 dB margin – Meets criteria
SRS (near-Earth & deep-space)	8	50–415 km separation
SOS (E-to-s)	3	RUS - C/I from 21–31 dB - Meets criteria

100+

Very divergent results across studies – benchmarking and alignment needed for objective comparison and classification of outcomes

In summary

- Provision 400 MHz per network spectrum – 6GHz and 7/8 GHz continuous range is very important for affordable, accessible and sustainable 6G access
- In ITU-R WP5D, very important to weed out divergence and summarise studies at the next meeting
- Development of appropriate CPM methods to fulfil the agenda
- Drive widest possible harmonization of 7/8 GHz range within APT Region-3.

Summary

6G will move **networks beyond connectivity** to become **AI-native intelligent platforms**

Spectrum is the **raw material** to realize **Bharat 6G Vision** with **affordable, accessible** and **sustainable access**

6G's **foundations are being laid** today through wide **ecosystem collaboration and co-creation**



India has strong plans, readiness and stands to succeed immensely.. if it plays its cards well !!!