

# Spectrum Roadmap 5G towards 6G

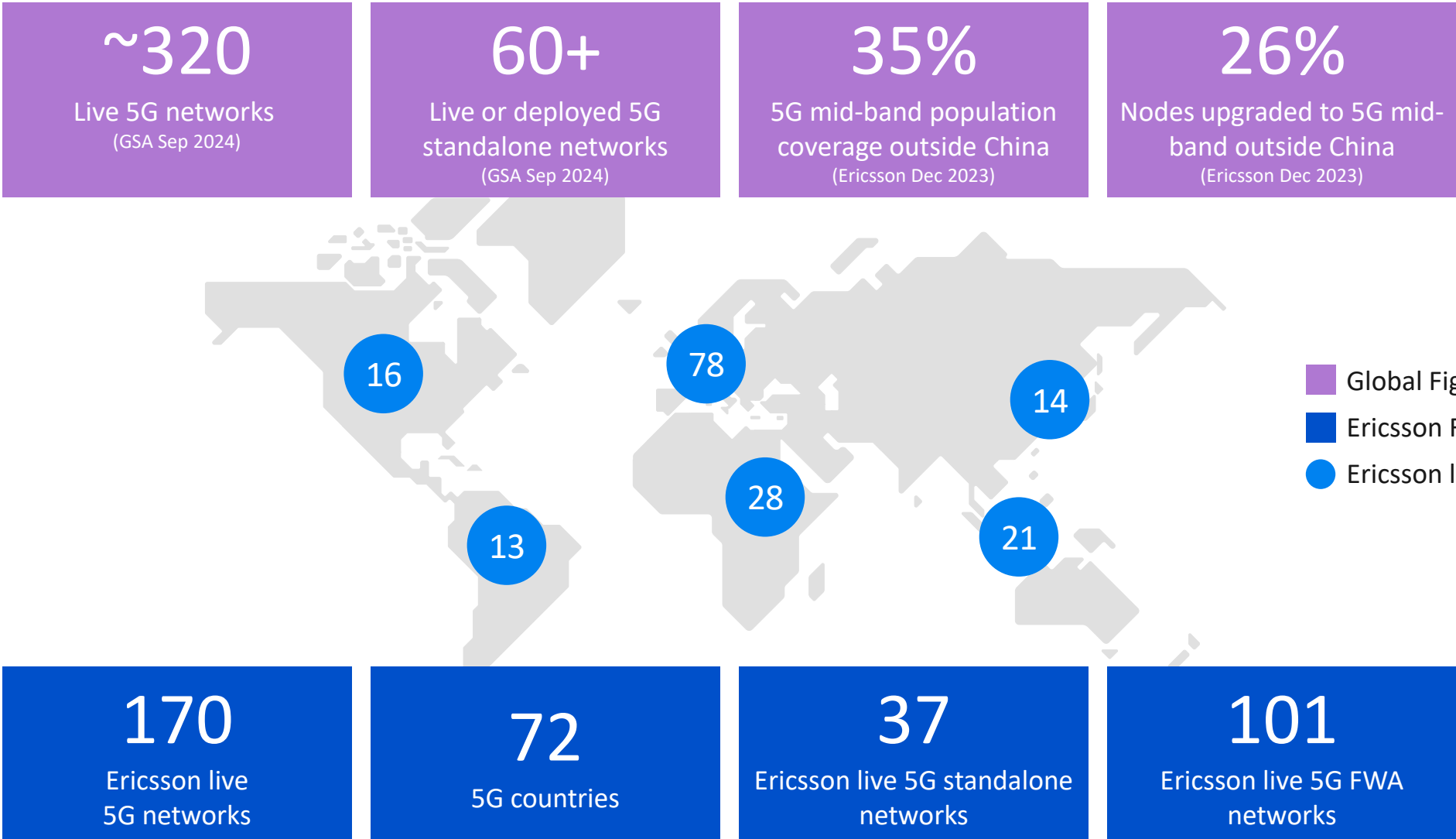
3GPP and ITU-R Perspective

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Ericsson



Sendil Kumar, PhD

# 5G in numbers



# Driving mobile networks for new waves of innovation



1,000,000×

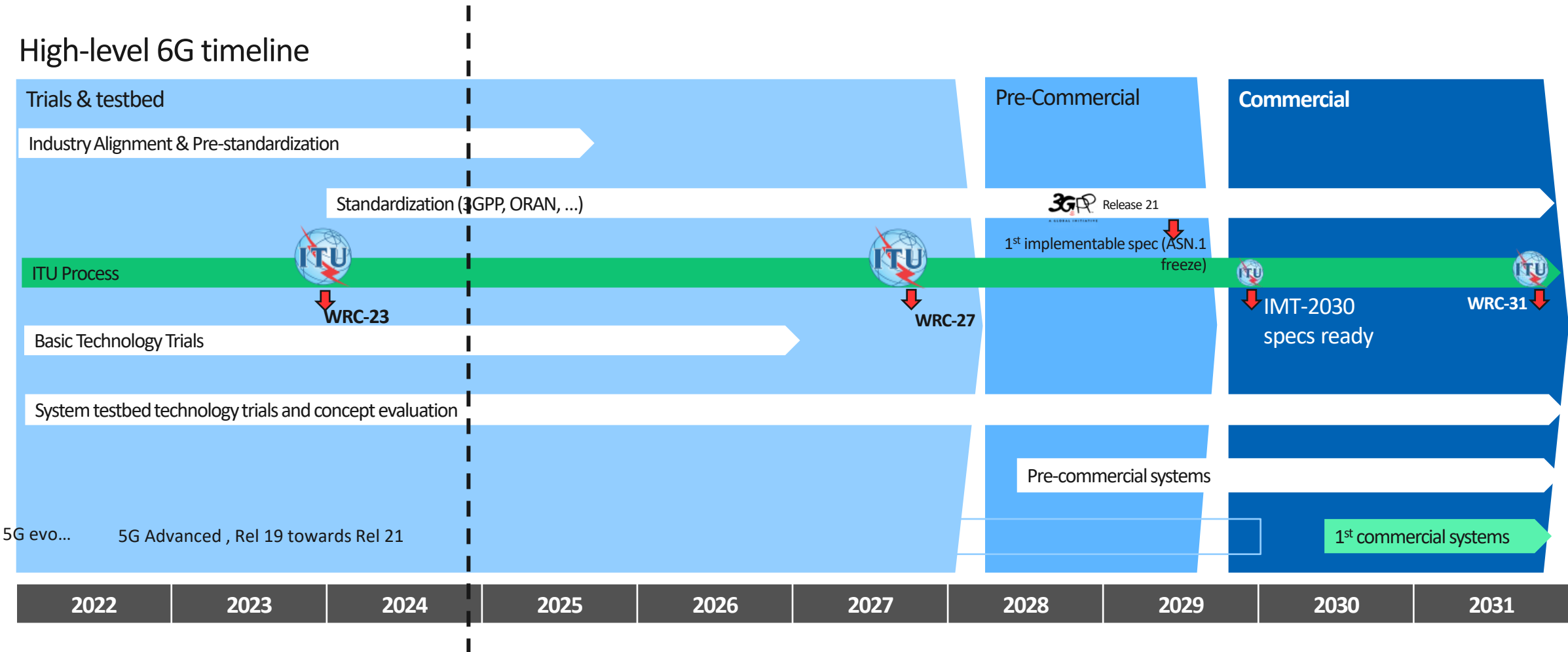
Data speed increase in 30 years



# 6G Timeline

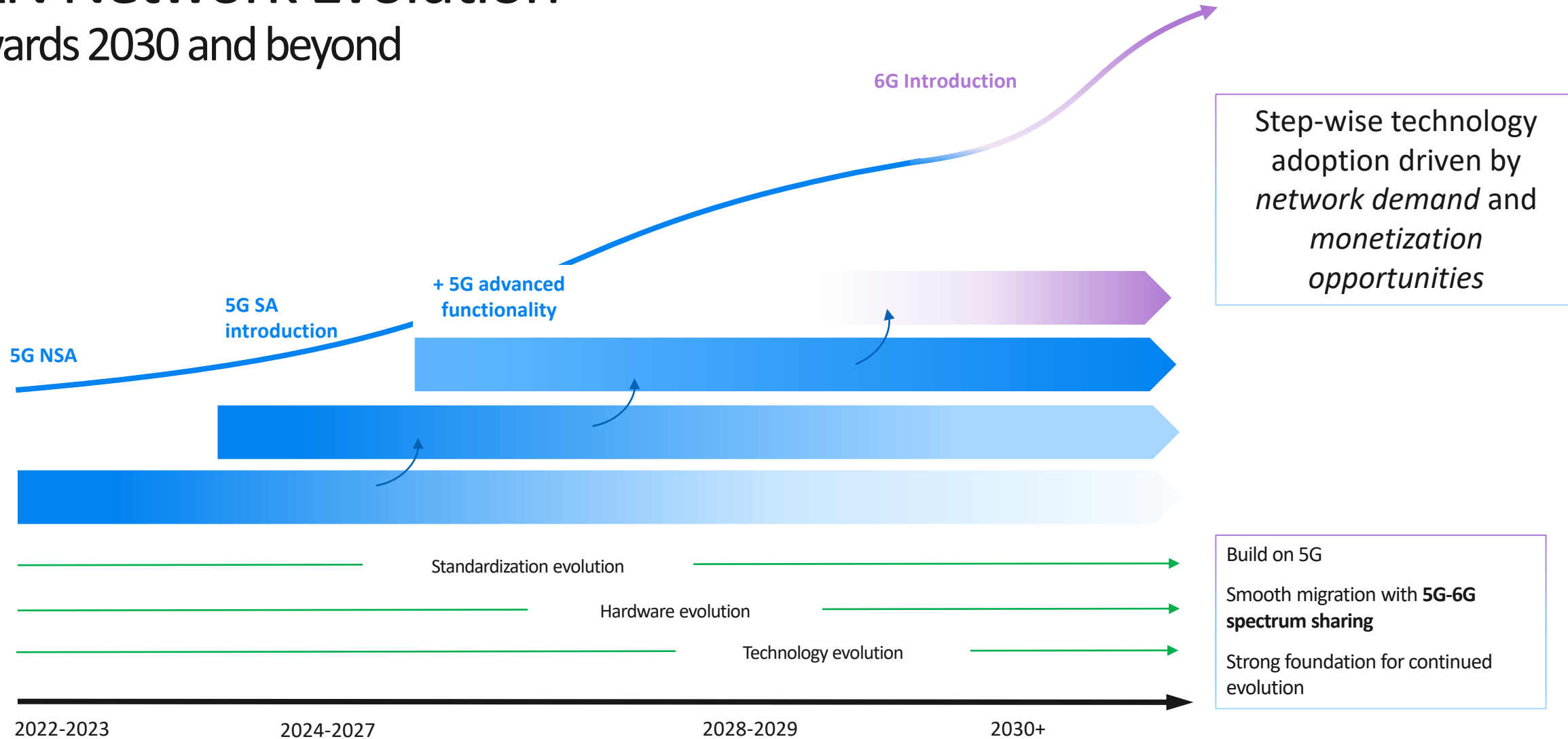


## High-level 6G timeline



# RAN Network Evolution

## Towards 2030 and beyond



# Future Use Cases in 2030+



## Massive Merged Reality

- Immersive XR for Mass Market -



## Global Broadband

- 100% coverage -



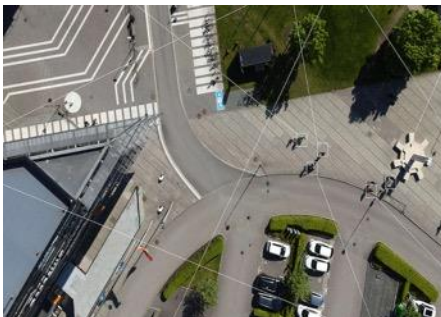
## Massive Digital Twinning

- Data Collection & Modelling -



## Autonomous Mobility

- Smart Transport -



## Resilient Connectivity

- Priority Emergency Communication -



## Spatial Data Engine

- Coordinate-based Data Exposure -



# Key 6G Principles

## - Minimize complexity, Maximize performance

- 6G RAN shall have a **standalone** architecture only
- 6G RAN shall interface a 6G core based on an **Evolved 5G Core**
- 6G architecture shall be **intent-based and programmable**
- 6G architecture shall include selected **open interfaces**
- 6G shall **operate in all existing 3GPP bands** and in **new cmWave** bands
- **Spectrum Sharing** shall be supported between 5G and 6G
- **Sharing by design** shall be supported in cmWave
- 6G shall support **new and evolved use cases**, efficiently & sustainably



# A multi-layer spectrum cake in 2030+



**Sub-Terahertz** (90..300 GHz) : Spectrum for extreme performance in very local areas

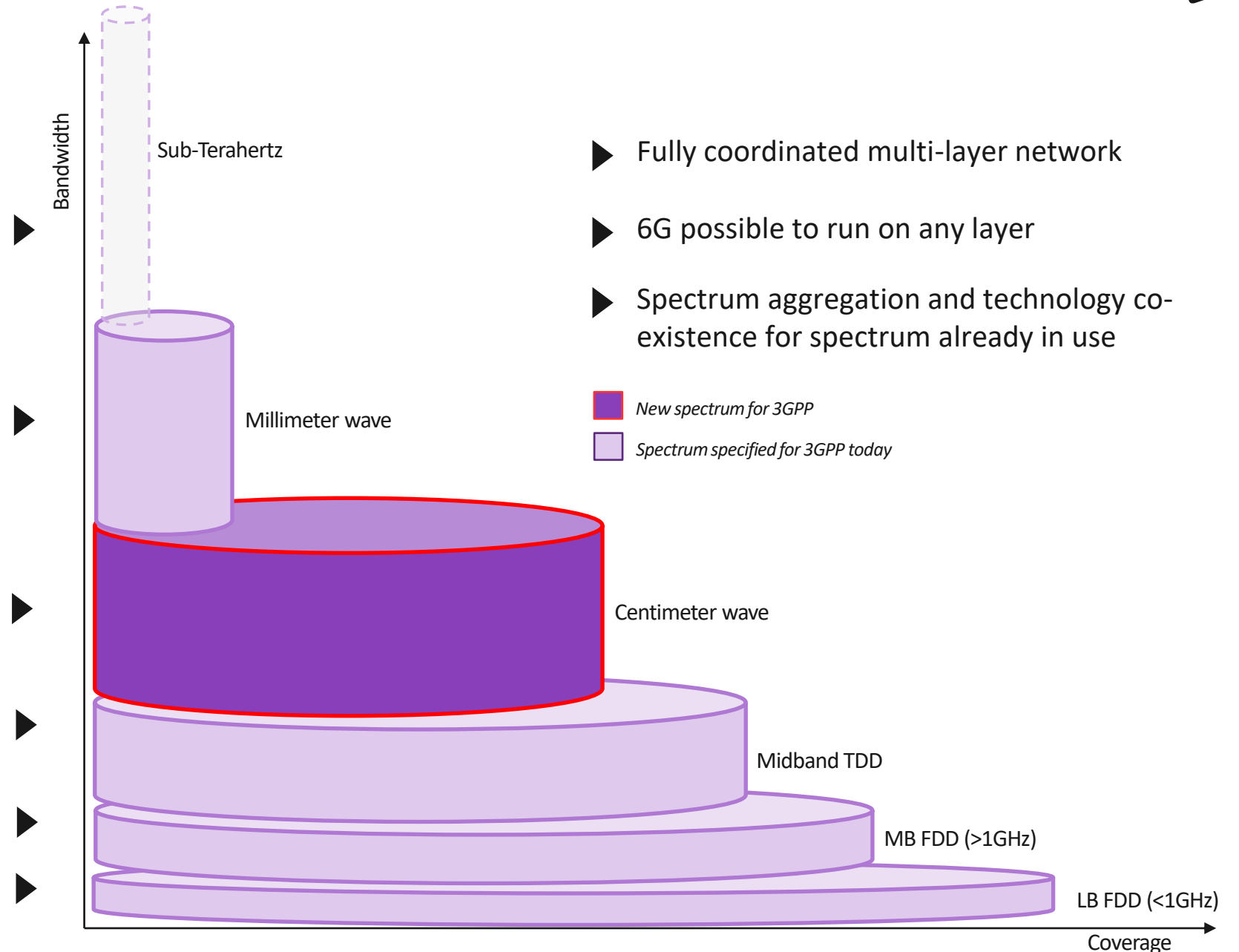
**mmWave** (24...47 GHz) : High-speed, very low latency in hotspots, FWA

**cmWave** (7...15GHz) : Good coverage and capacity (the lower , the better)

**Midband TDD** (2.3...<7 GHz) : Wide area coverage and good capacity

**Midband FDD** (1.. 2.7 GHz) : Nationwide coverage and indoor penetration

**Lowband FDD** (<1 GHz) : Nationwide coverage and deep indoor penetration



# Key takeaways



Standardization starts 24.Q3, commercial solutions in **2030**



6G will **evolve** from 5G and **expand** into new areas



Global efforts needed to secure additional 3GPP **spectrum**



12 month focus: Alignment on **key principles**, **1<sup>st</sup> 6G** release scope, clarifying **quantifiable benefits** of 6G

# Is there enough spectrum for 5G-A and 6G?



## Spectrum in 2024

### 5G

- Legacy 2G/4G spectrum
- Low bands (< 1 GHz)
- Mid bands (e.g., 3.5 GHz)
- High bands (e.g., 26 GHz)



## Spectrum in 2025-2030

### 5G-Advanced

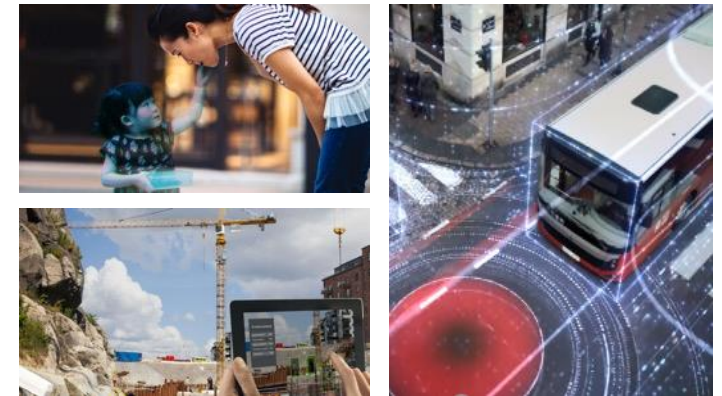
- 4G/5G spectrum
- Additional bands (3GPP, WRC-23)



## Spectrum beyond 2030

### 6G

- 4G/5G/5G-A spectrum
- Additional bands (e.g., 7.125-8.4 GHz)



6G will need additional spectrum, beyond what will be made available in 2025-2030

# Ericsson Mobility Report :



## Global

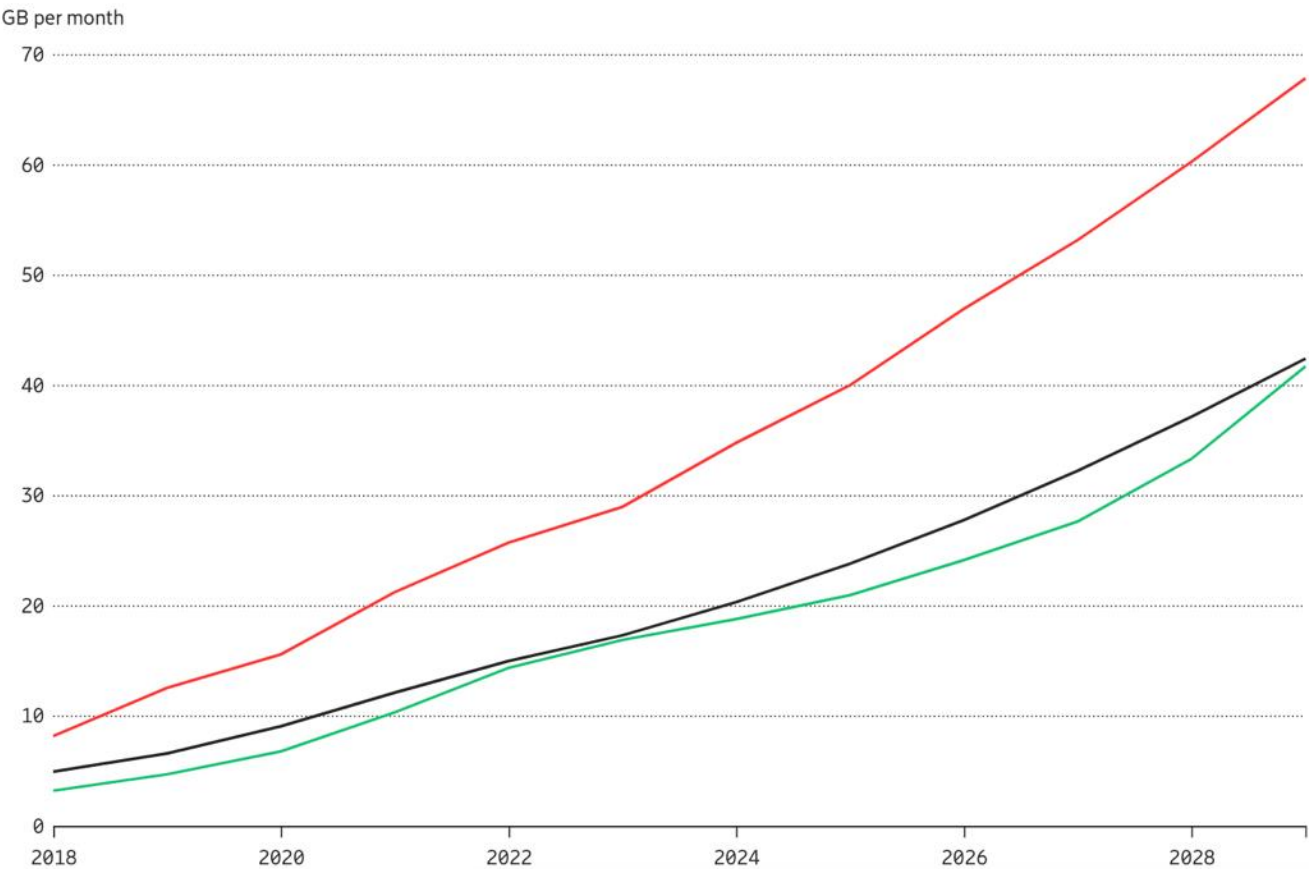
~75%

Mobile traffic by 5G  
(2029)

5.6b

5G Mobile subscriptions  
2029

## Avg Mobile Data Consumption



## India

840m

5G Subscriptions in  
INDIA by 2029

29GB

Avg Monthly usage  
INDIA

68GB

Avg Monthly usage  
INDIA (2029)

India, Nepal, Bhutan

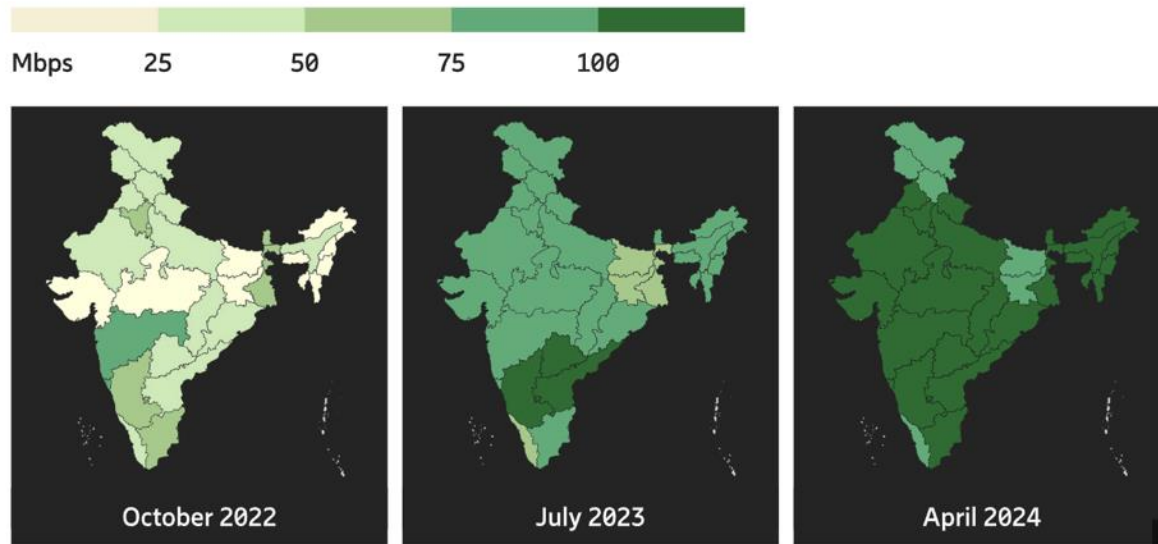
Global average

South East Asia and Oceania

# Ericsson Mobility Report : 5G Mid-band Experience



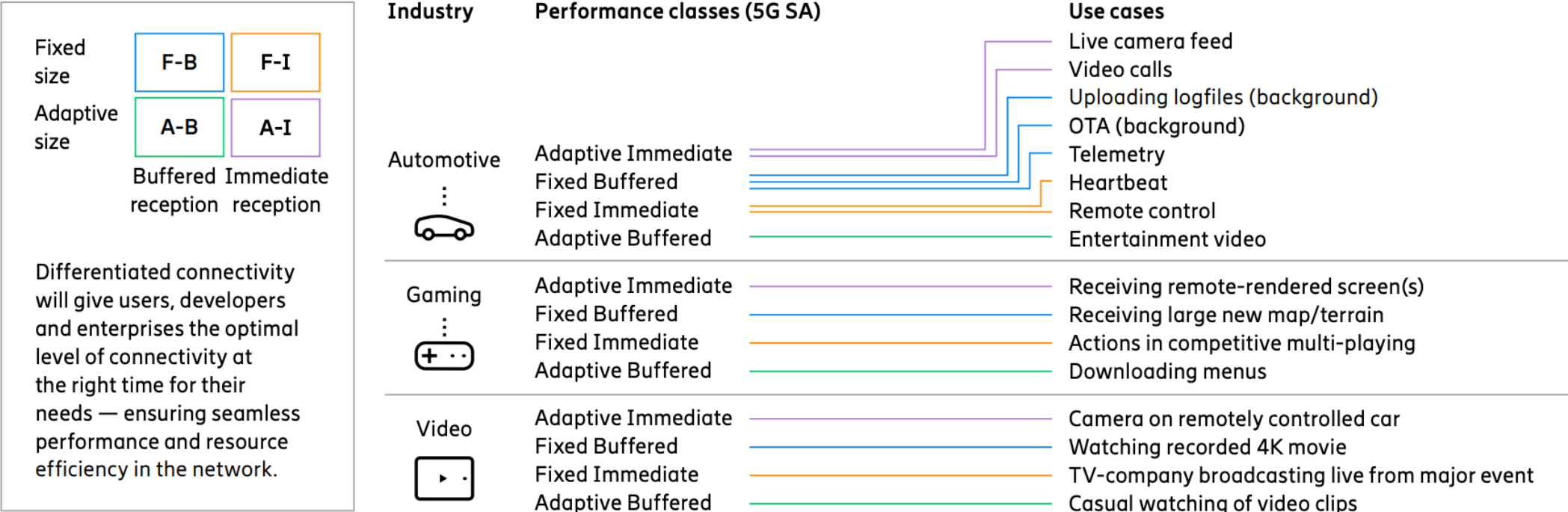
5G mid-band is being deployed by leading service providers to provide a great smartphone user experience.



Measurements from one leading CSP show that;  
*97% of all user activities on 5G mid-band achieved a time-to-content (TTC) of less than 1.5 seconds*

*The regions are colored based on downlink throughput (0→100 Mbps). Source: EMR ' June : Airtel's analysis of crowdsourced data.*

# Differentiated connectivity to drive growth and service innovation



# Differentiating traffic in high-performance networks



## QoS/speed/latency

Dynamic control  
Resource intense



## TCO/simple operations

Wireless  
as-a-service

## Reliability

Flexible manufacturing  
Broadcasting



## Positioning & advanced capabilities

3D mapping  
Location check

## Coverage (in/outdoor, 3D)

Automated  
guided vehicles



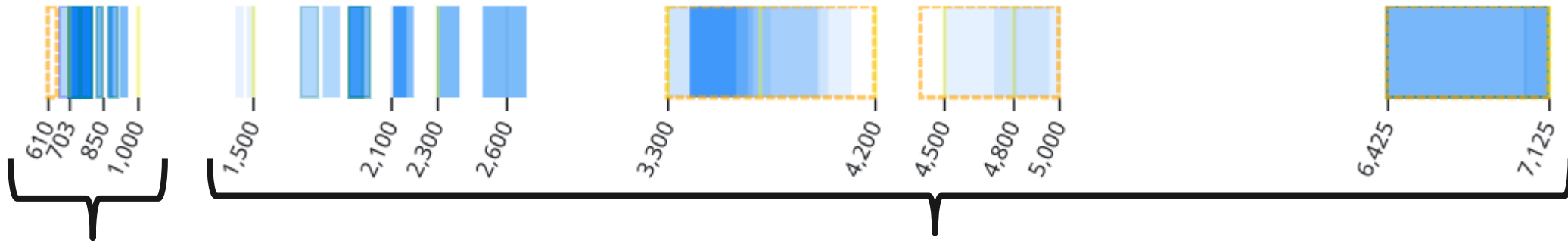
## Security, ID & authentication

Identification  
2-factor authentication  
Secure access service edge

Use 5G to its full potential

# 3GPP Bands : Low- and mid-band

Incl. identified from WRC23



## Low-band

- Finalize digital dividend allocations
- 700 MHz: 3GPP band 28 (APT)
- 600 MHz: 3GPP band n105, n71

## Mid-band

- Additional availability in:
  - 3300 – 4200 GHz 3GPP band 77
  - 4400 – 5000 GHz 3GPP band 79
  - 6425 – 7125 MHz 3GPP band 104

Enable carrier aggregation with Low-band and 2 GHz BW capacity in Mid-band spectrum

# WRC-27: AIs



## Fixed, Mobile and Radiolocation issues

- 1.7 IMT identification (RES 256)
- 1.8 Radiolocation >230 GHz
- 1.9 Appendix 26
- 1.10 FS and mobile protection @71- 76 GHz and 81-86 GHz from FSS, MSS, BSS

## Mobile Satellite issues

- 1.11 Space-to-space
- 1.12 MSS low data rate NGSO
- 1.13 MSS D2D (RES253)
- 1.14 MSS 2 GHz (RES254)

## Science issues

- 1.15 SRS allocations
- 1.16 RAS protection
- 1.17 Space weather sensors
- 1.18 EESS protection > 81 GHz
- 1.19 EESS 4 200-4 400 MHz and 8 400-8 500 MHz, (RES 674)

## Fixed Satellite and broadcasting satellite

- 1.1 ESIM 50 GHz
- 1.2 FSS UL 14 GHz
- 1.3 Gateway earth stations 51 GHz
- 1.4 FSS 17 GHz
- 1.5 unauthorized FSS, MSS
- 1.6 FSS 37, 42, 47, 50 GHz
- 7 Resolution 86

## General issues

- 2 incorporation by ref in RR
- 4 editorial review
- 8 deletion footnotes
- 10 AI for WRC-31

# WRC-27 : AI 1.7 (RES 256 ) : IMT Identification



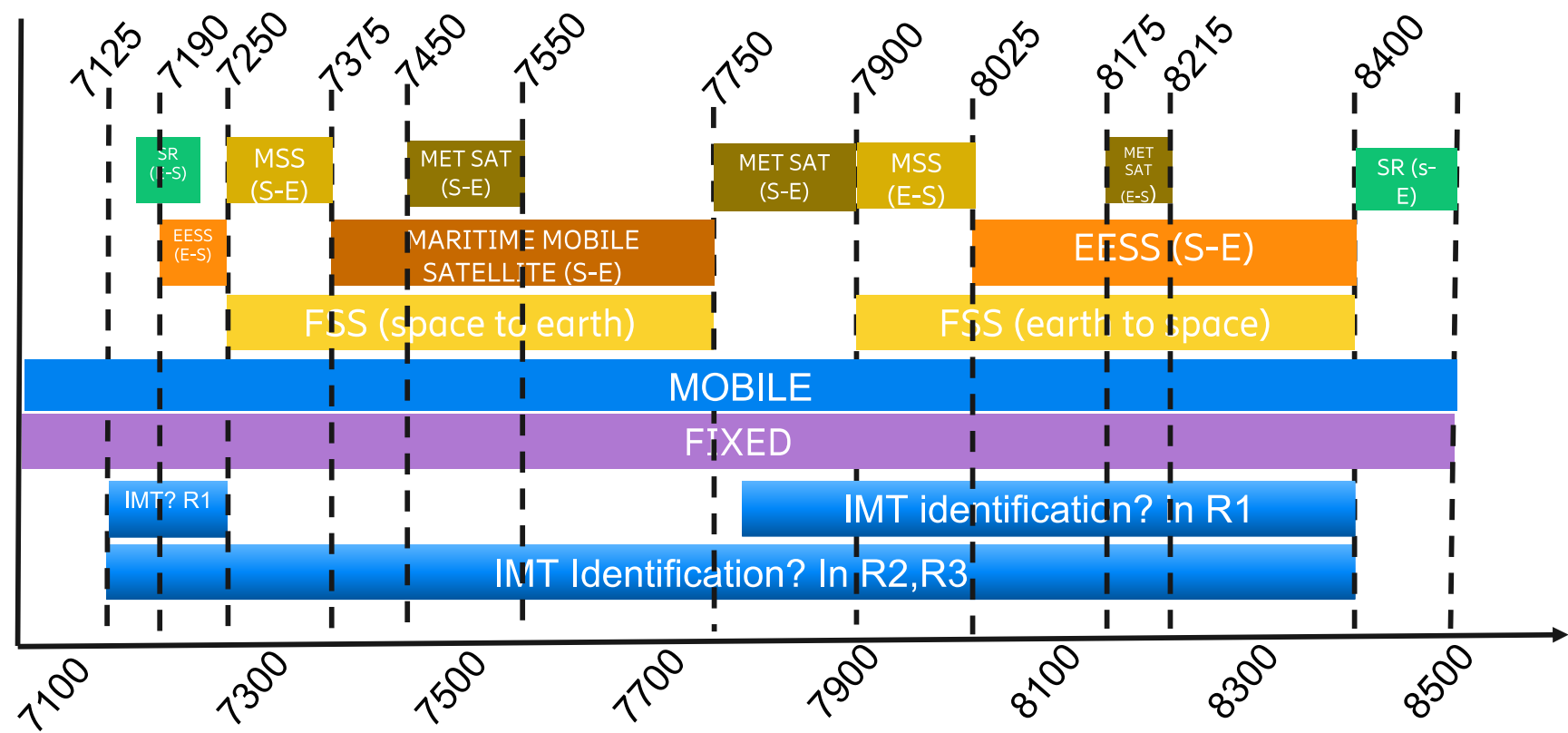
*...to consider studies on sharing and compatibility and develop technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz taking into account existing primary services operating in these, and adjacent, frequency bands, in accordance with Resolution COM6/26 (WRC-23)*



7.125 – 8.4 GHz , lowest part of centimetric wave spectrum large contiguous range

# Agenda Item 1.7

## Sharing Studies - Combinations



# WRC-27 AI 1.13 : MSS in IMT bands



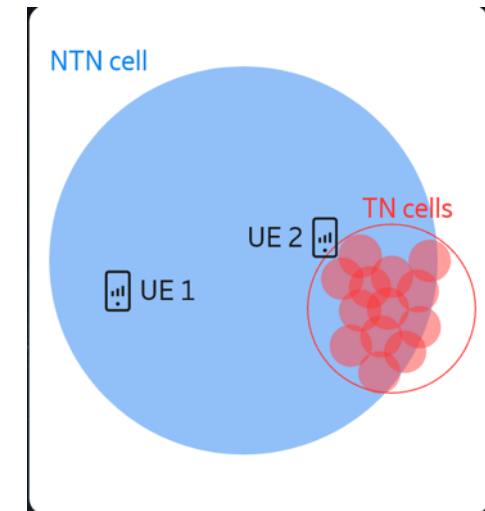
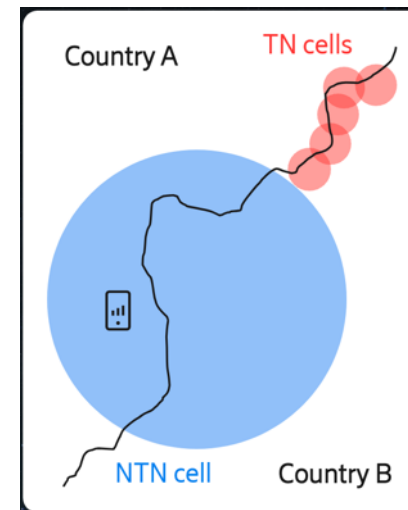
**AI 1.13 MSS in IMT bands between 694/698 MHz and 2 700 MHz; new allocation for “direct connectivity between space stations and IMT user equipment to complement terrestrial IMT network coverage”, i.e. D2D using 3GPP technology.**

*“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 [COM6/9] (WRC-23);”*

## RESOLUTION COM6/9 (WRC-23)<sup>u</sup>

**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**<sup>u</sup>

- resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference<sup>u</sup>
  - 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;<sup>u</sup>
  - 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.<sup>u</sup>



# 3GPP : 5G NTN Spectrum & Devices

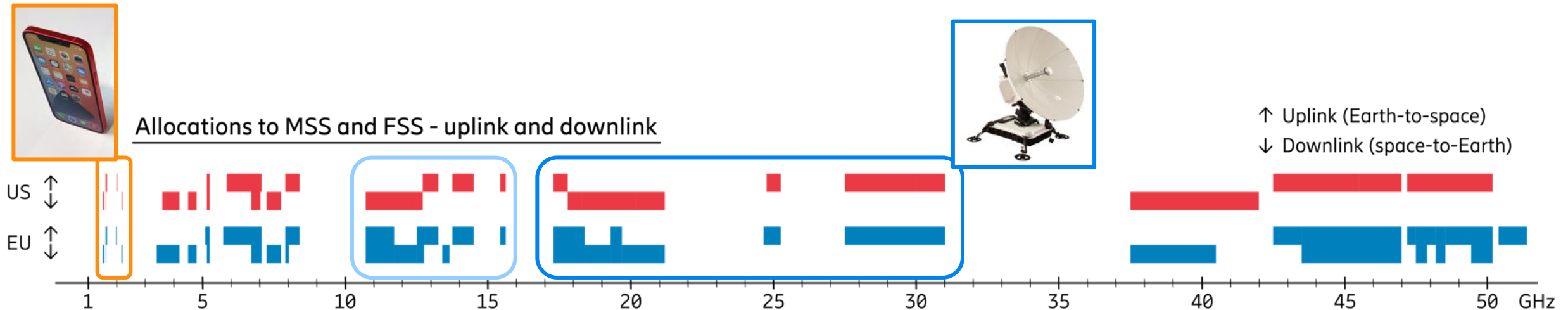


- Rel-17: **S-band** & **L-band** (2 GHz & 1.6 GHz) → **handheld devices**
  - With Rel-19, 3GPP operating bands are defined in practically all satellite spectrum below 3 GHz (close to 100 MHz in total)!
- Rel-18: **Ka-band** (20/30 GHz) → **high-gain devices with directive antenna**
- Rel-19: **Ku-band** (12/14 GHz)

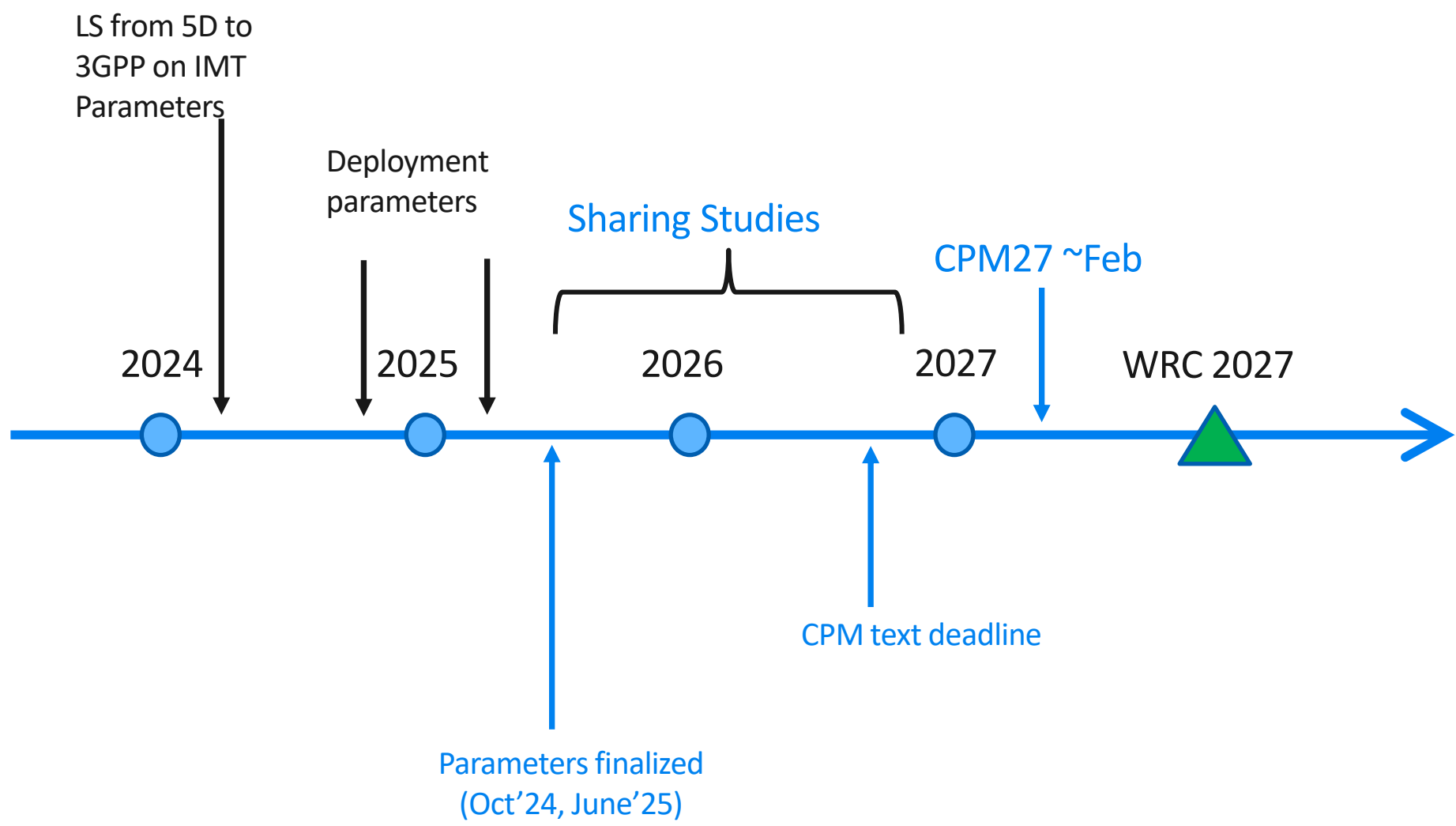
## Key characteristics:

- Operating bands in spectrum which is allocated to satellites
- → **“3GPP follows regulation”**

3GPP NTN bands separate from terrestrial bands



# Timeline in ITU towards WRC-27 (WP5D)



# Action Plans



## Spectrum Sharing Studies

- NSG5 – Working group on sharing studies engagement
- Stakeholder discussions with incumbents
- Regional leadership and coordination - **APG, WP5D, CPM**

## National Spectrum Roadmap

- Short Term (5G Expansion) by 2025
- Mid Term (5G, 5GA Expansion) by 2027
- Long term (Post WRC-27, Access to new spectrum for 6G)

*(Ref : B6GA – Whitepaper released in Oct'24)*

