# 6G Standards and Spectrum

HTE General Assembly 25th May 2023

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NOKIA

# Outline

**1**

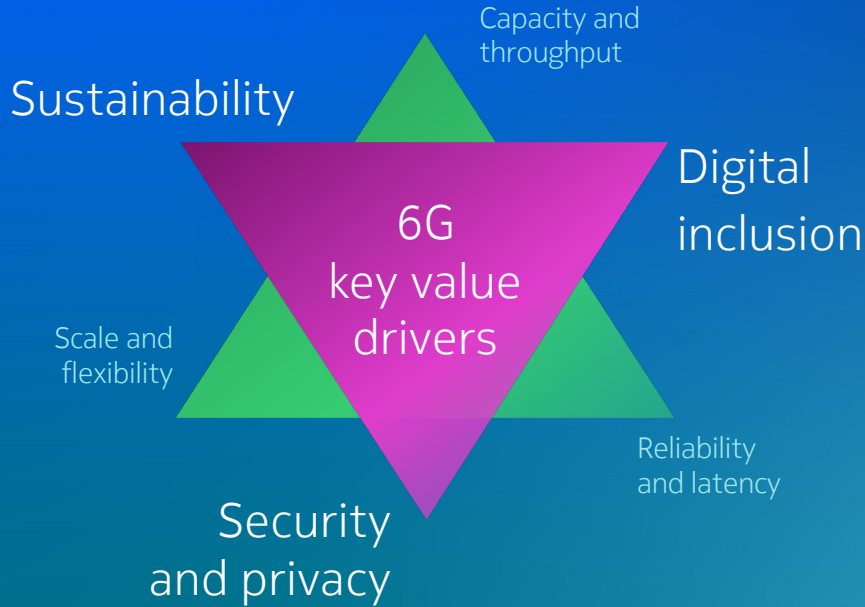6G Technology Trends

**2**

6G Timeline and Spectrum

**3**

6G Architecture and Migration

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# 6G technology trends

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# Wireless system design principles
## Extended with new emphases for 6G

Capacity and throughput

Sustainability

Digital inclusion

Scale and flexibility

6G
key value
drivers

Reliability and latency

Security
and privacy

**Sustainability**

▲ X10 capacity increase with 50% power reduction, compared to 5G

**Digital inclusion**

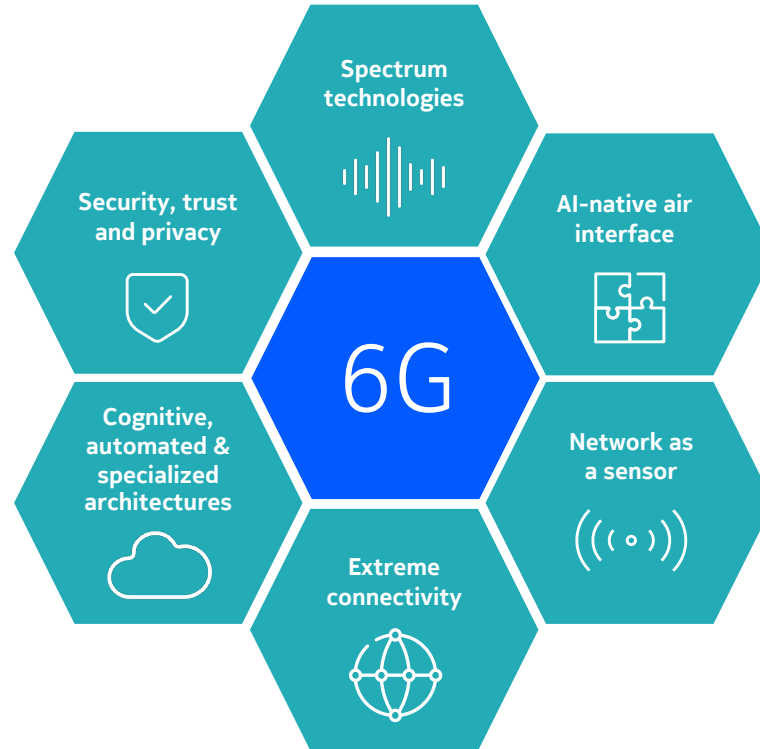▲ Aim to address three key factors: accessibility, affordability and consumability

**Security and privacy**

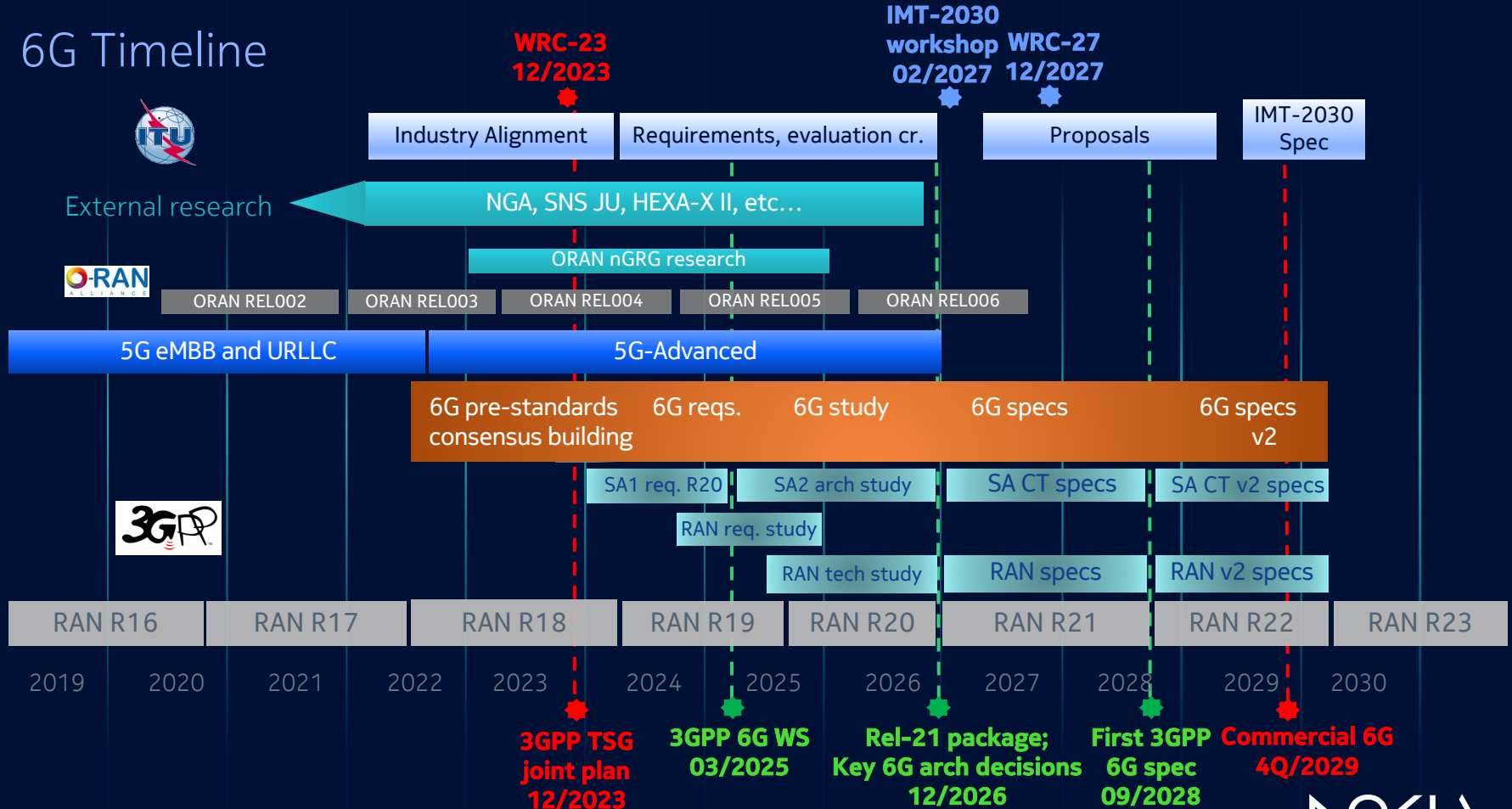▲ Increasing security and privacy risks require higher levels of control

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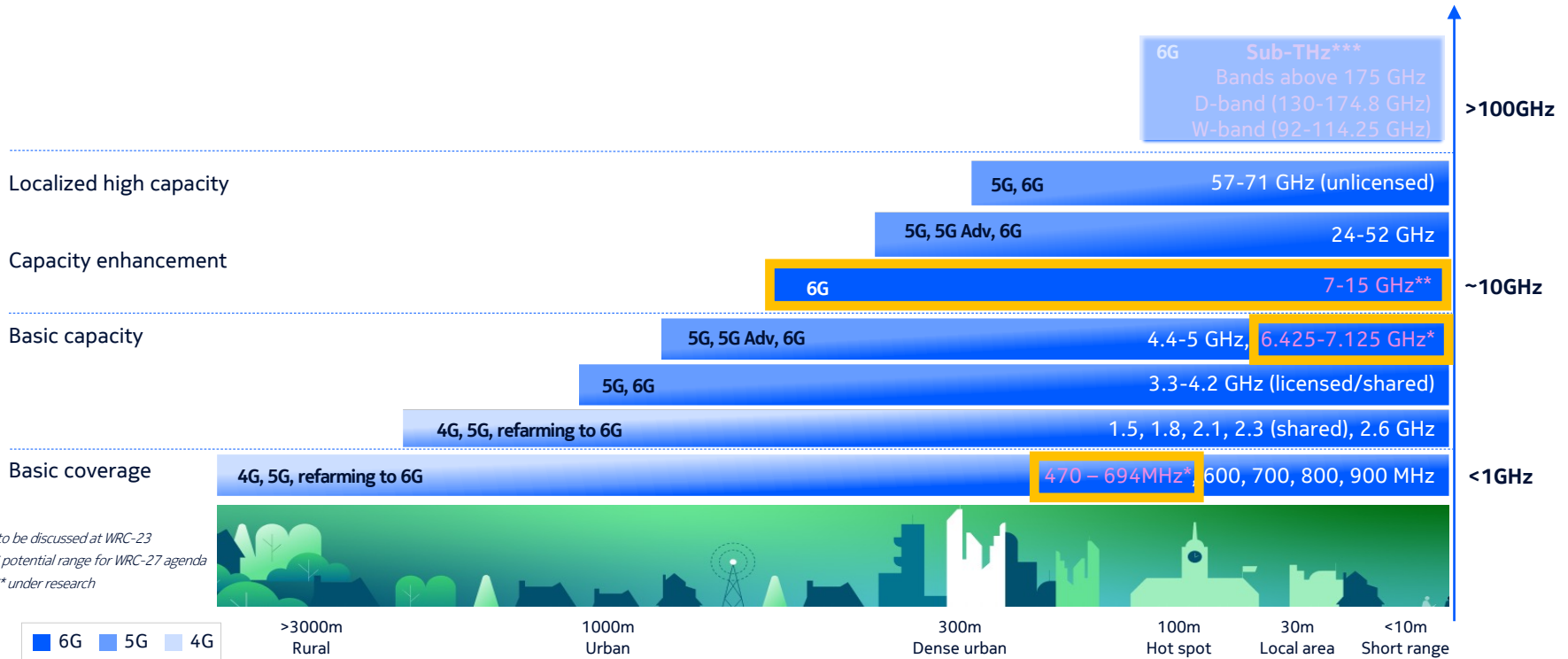# Bringing the future to life

Six key technology areas for 6G

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# 6G Timeline and Spectrum

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# 6G Timeline



**WRC-23** 12/2023

**IMT-2030 workshop** 02/2027

**WRC-27** 12/2027

| Industry Alignment | Requirements, evaluation cr. | Proposals | IMT-2030 Spec |

**ITU**

External research → NGA, SNS JU, HEXA-X II, etc…

**O-RAN ALLIANCE**

ORAN nGRG research

| ORAN REL002 | ORAN REL003 | ORAN REL004 | ORAN REL005 | ORAN REL006 |

| 5G eMBB and URLLC | 5G-Advanced |

6G pre-standards consensus building | 6G reqs. | 6G study | 6G specs | 6G specs v2

**3GPP**

| SA1 req. R20 | SA2 arch study | SA CT specs | SA CT v2 specs |

| RAN req. study | | | |

| RAN tech study | RAN specs | RAN v2 specs |

| RAN R16 | RAN R17 | RAN R18 | RAN R19 | RAN R20 | RAN R21 | RAN R22 | RAN R23 |

| 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |

**3GPP TSG joint plan** 12/2023

**3GPP 6G WS** 03/2025

**Rel-21 package; Key 6G arch decisions** 12/2026

**First 3GPP 6G spec** 09/2028

**Commercial 6G** 4Q/2029

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# Spectrum for 6G – new and re-farmed bands

## Band options for a new generation of wireless technology

**6G**

**>100GHz**

6G **Sub-THz\*\*\***
Bands above 175 GHz
D-band (130-174.8 GHz)
W-band (92-114.25 GHz)

**Localized high capacity**
5G, 6G — 57-71 GHz (unlicensed)

**Capacity enhancement**
5G, 5G Adv, 6G — 24-52 GHz
6G — 7-15 GHz\*\*

**~10GHz**

**Basic capacity**
5G, 5G Adv, 6G — 4.4-5 GHz, 6.425-7.125 GHz\*
5G, 6G — 3.3-4.2 GHz (licensed/shared)
4G, 5G, refarming to 6G — 1.5, 1.8, 2.1, 2.3 (shared), 2.6 GHz

**Basic coverage**
4G, 5G, refarming to 6G — 470 – 694MHz\*, 600, 700, 800, 900 MHz

**<1GHz**

\* to be discussed at WRC-23
\*\* potential range for WRC-27 agenda
\*\*\* under research

| >3000m Rural | 1000m Urban | 300m Dense urban | 100m Hot spot | 30m Local area | <10m Short range |

■ 6G  ■ 5G  ■ 4G

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# Key points on spectrum

**1**

### 7-15 GHz in US/JP/KR

Secure sufficient amount of **new spectrum** in the 6G spectrum range of 7-15GHz. Lower part of the band preferred.

**2**

### Upper 6GHz in EU/CH

Build an **initial 6G spectrum story** for Europe and China around upper-6GHz

**3**

### Low-band

No significant amount of new low band spectrum expected to become available, **existing low-band spectrum will be occupied by 5G** (and/or 4G).

**4**

### Dynamic re-farming

Ensure that **dynamic re-farming** (MRSS) of existing spectrum to 6G is an intrinsic part of 6G design from day 1.

**5**

### Sharing

**Spectrum sharing** schemes with incumbents in the 7-15 GHz range shall be considered from day1

**6**

### mmWave

Fully **exploit mmWave** spectrum with 6G to ensure capacity by 2030 for first movers, and 2035+ for mainstream.

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# Spectrum roadmap for early movers

1a) 6G macro is expected to be first deployed in the new 6G spectrum band:

 - 7-15GHz in US, Japan, Korea

 - Upper-6GHz in Europe, China

1b) In conjunction with the 6G mid-band deployments some low-band FDD component carriers will be dynamically re-farmed to 6G with MRSS and aggregated with CA (or DC) with the new 6G bands to ensure day-1 coverage for 6G.

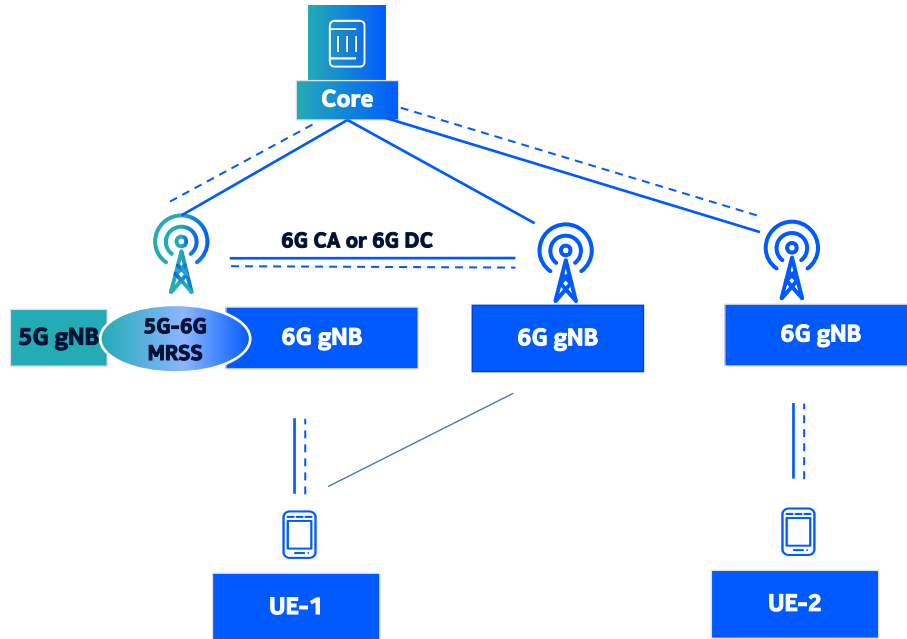2a) Existing 5G mid-band is dynamically re-farmed to 6G using MRSS.

3a) Existing 4G and 5G bands are gradually statically re-farmed to 6G.

4) mmWave is taken into use for 6G; Migration of 5G mmWave?

6GHz in the US?? Unlicensed operation?

**Timeline**

# 6G Architecture and Migration

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# 6G Standalone System Architecture

Core

6G CA or 6G DC

5G gNB

5G-6G MRSS

6G gNB

6G gNB

6G gNB

UE-1

UE-2

CA: Carrier Aggregation
DC: Dual connectivity
MRSS: Multi-RAT Spectrum Sharing

—— User plane
- - - Control plane

- ✓ Single standalone architecture for 6G
- ✓ 5G-6G MRSS transparent to the UE, targeting significantly higher efficiency than 4G-5G DSS.
- ✓ 6G CA including UL CA supported from Day 1. No inter-RAT aggregation!
- ✓ UL CA with dual PUCCH to manage better latencies and difference in numerologies between primary and secondary cells
- ✓ 6G DC  may follow after initial phase
- ✓ 6G radio features can be fully utilized with 6G SA

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