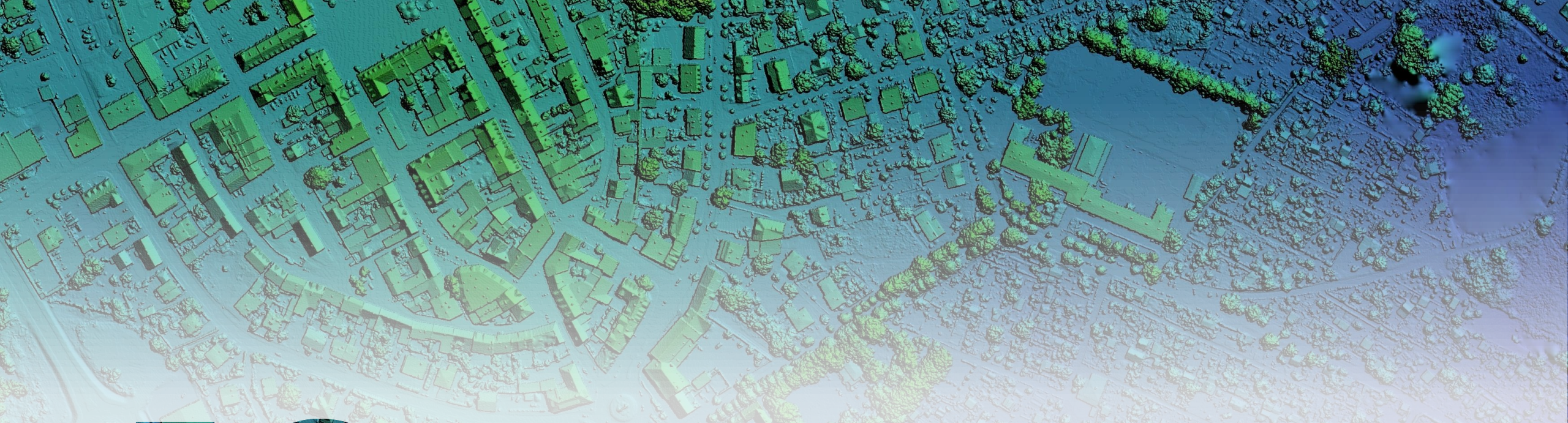


5G as part of GIT

| Armands Meirāns

Innovation Lead – LMT | Master of Business Administration – RBS | Telecommunications engineering PhD Candidate - RTU

Agenda

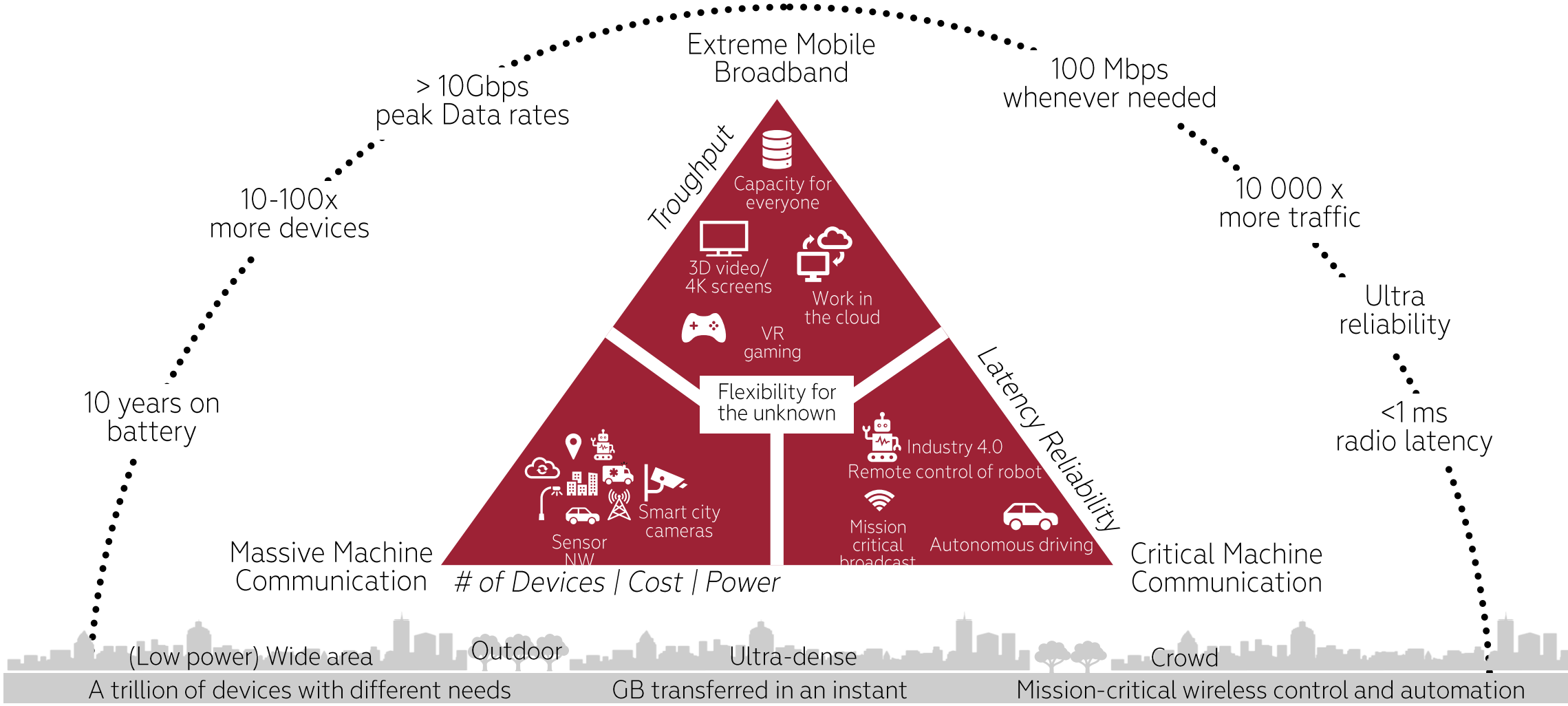
- About 5G
- 5G rollouts
- 5G enabled use-cases
- 5G promises more than only improved connectivity
- 5G and GIT
- 5G from satellites

About 5G

5G or the fifth-generation technology standard for broadband cellular networks

Main added value:

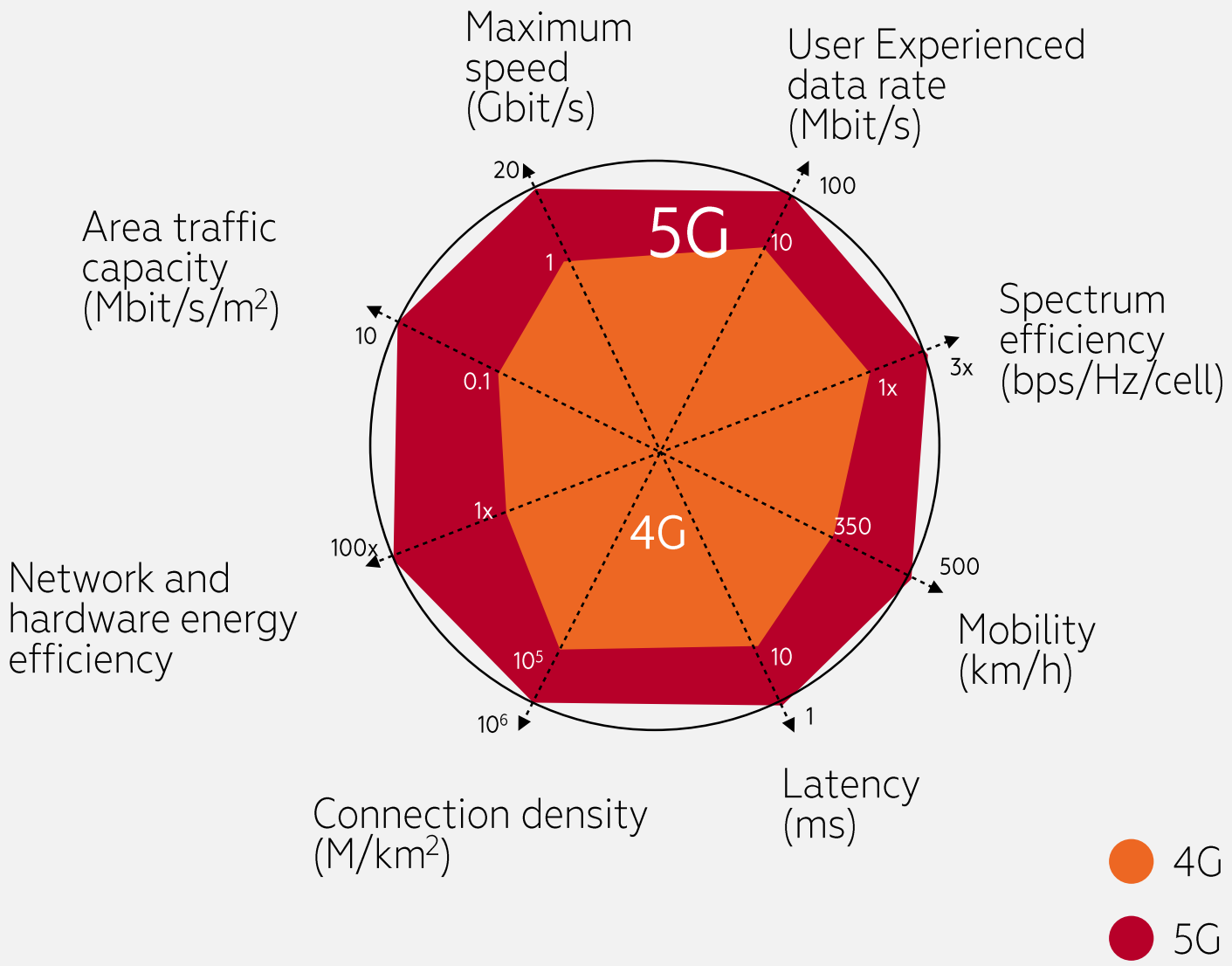
- Extensive mobile broadband (eMBB)
- Critical machine communications (mMTC)
- Massive machine communications (mMTC)



5G

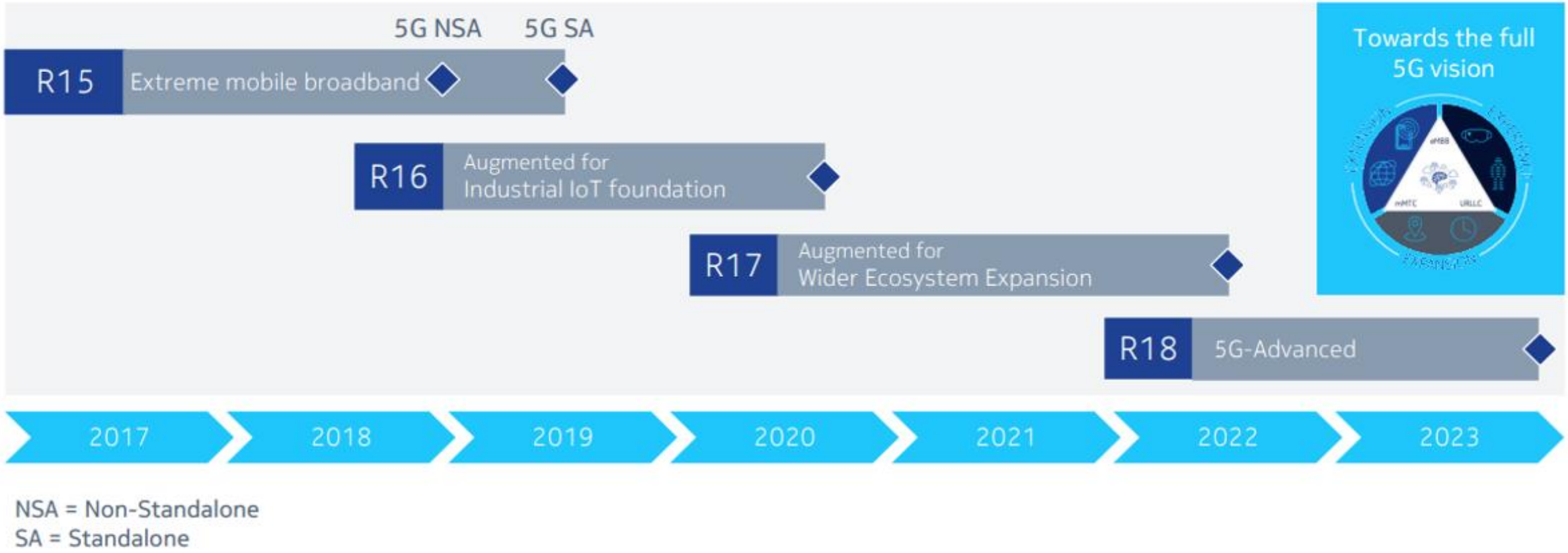
vs

4G


Maximum speed (Gbit/s)
User Experienced data rate (Mbit/s)
Spectrum efficiency (bps/Hz/cell)
Mobility (km/h)
Latency (ms)
Connection density (M/km²)
Network and hardware energy efficiency
Area traffic capacity (Mbit/s/m²)
20
100
10
3x
500
1
10
1x
350
10
10⁶
10⁵
100x
1x
0.1
10
1
5G
4G
4G
5G

5G rollouts

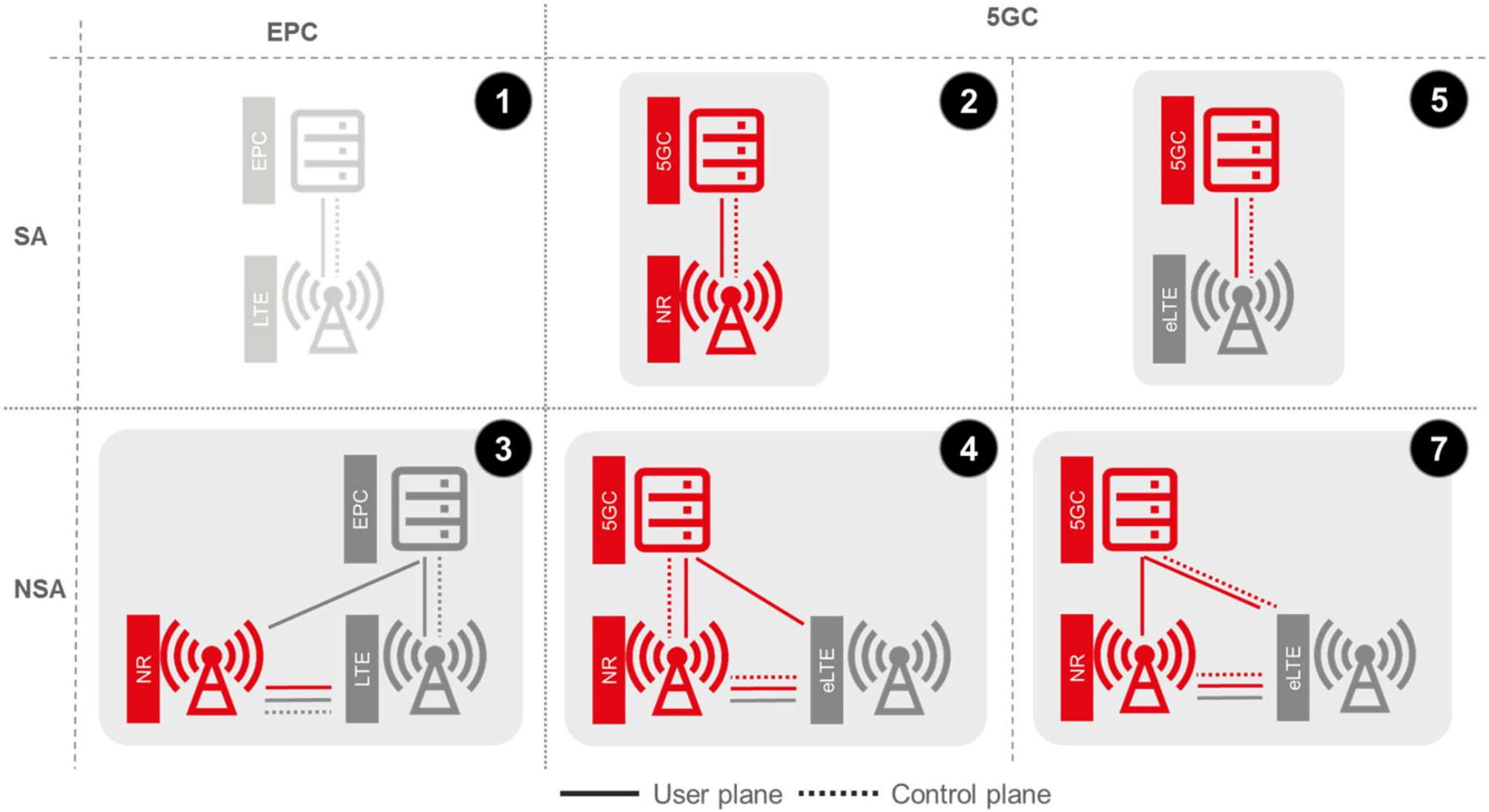
Standards roadmap



NSA = Non-Standalone
SA = Standalone

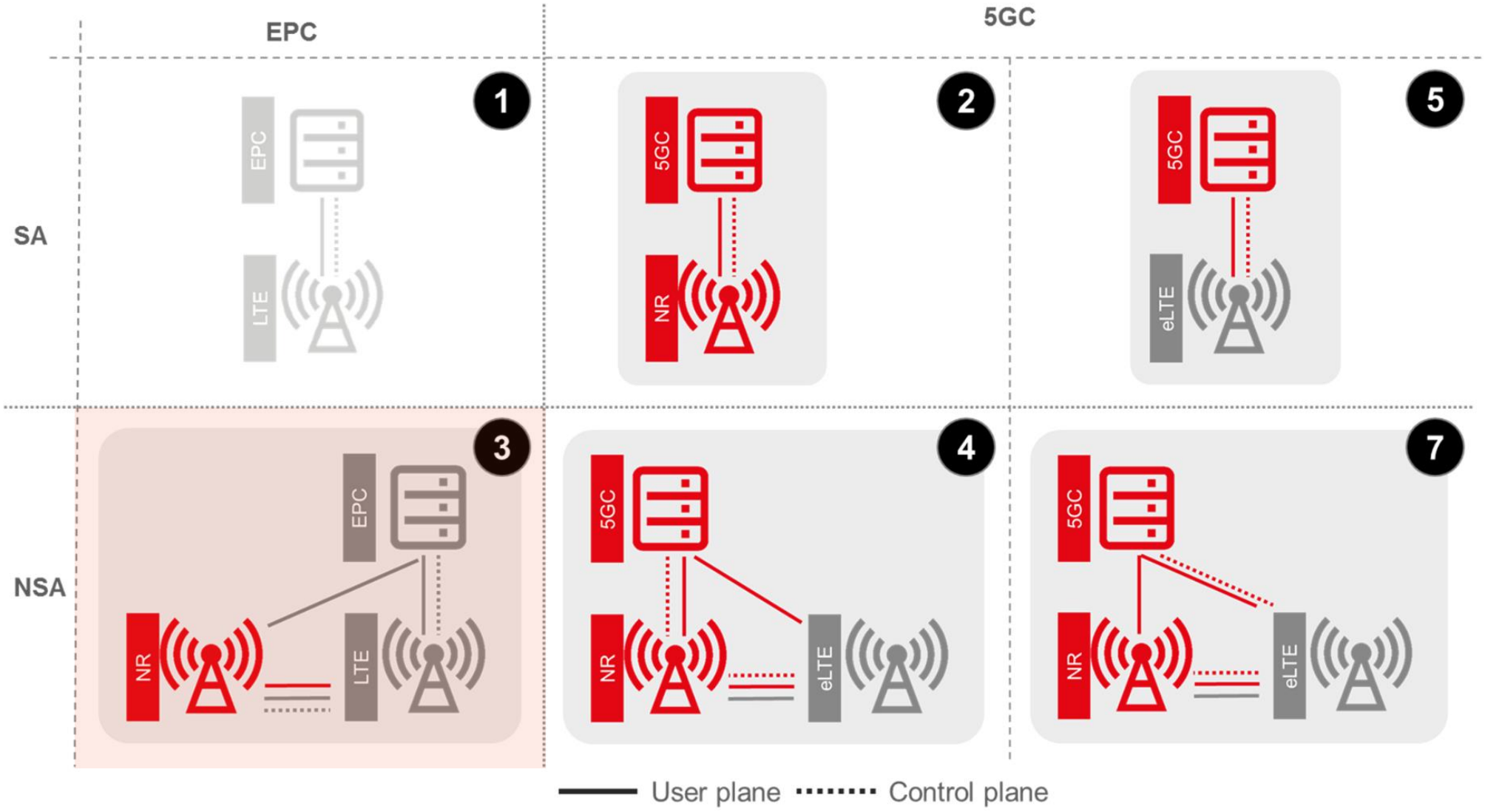
Source: Nokia, 2022

5G core connectivity options



Source: gsma.com/futurenetworks

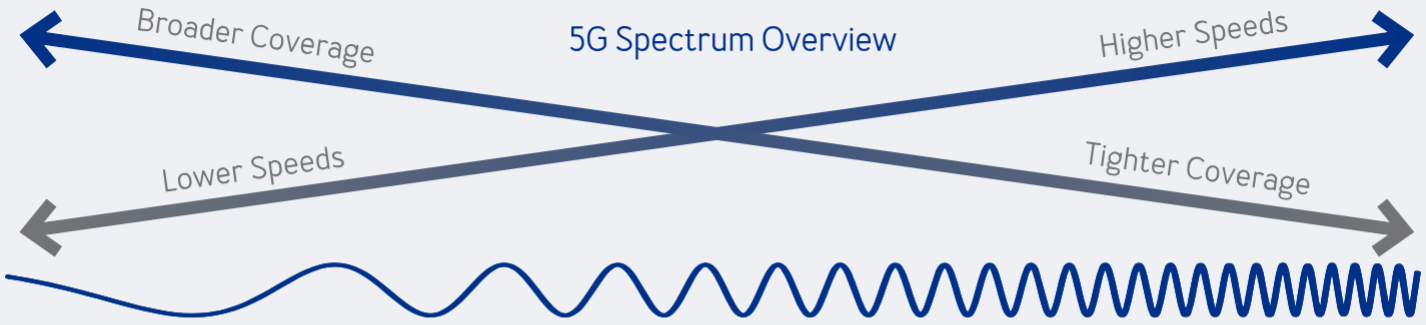
5G core connectivity options



Source: gsma.com/futurenetworks

5G provide flexibility in customization

e.g. Radio Frequencies



Low band
Low Frequency (<1 GHz)

- Supports widespread coverage of urban, suburban, and rural areas
- Helps enable IoT services
- Extends coverage deep into buildings
- Europe has prioritized the 700 MHz band for wide area 5G deployments; the United States and Canada have already licensed the 600 MHz band

Mid-band
Medium Frequency (1-6 GHz)

- Offers a mix of coverage and capacity —often called the "sweet spot"
- Includes the 3.3 to 3.8 GHz range expected to be the basis of many initial 5G services—the "global backbone"
- Also includes other ranges which may be assigned to (or re-farmed by) 5G operators including 1800 MHz, 2.3 GHz and 2.6 GHz, C band, etc.

High band
High Frequency (>6 GHz)

- Needed to meet the ultra-high speeds envisioned for 5G
- Travels shorter distances and is easily blocked (by leaves, buildings, rain, etc.)
- May be limited to high-density urban cores where small cells are cost-effective
- 26 GHz and/or 28 GHz bands (mmWave) have the most international support

More bases stations compering with 4G is needed when 5G use high band frequencies.

With low frequency bands like 700MHz number of needed base station could be even smaller.

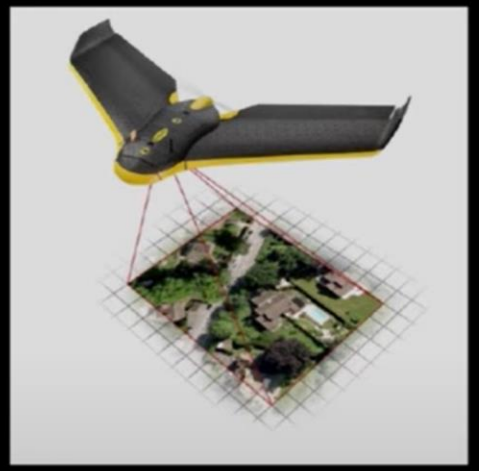
Source: dejero.com/technology/field-connectivity-in-a-5g-world

5G enabled use-cases

Future 5G connectivity has potential to be as one of the enabling technologies for different use-cases up to autonomous vehicles

Virtual Reality

Augmented Reality

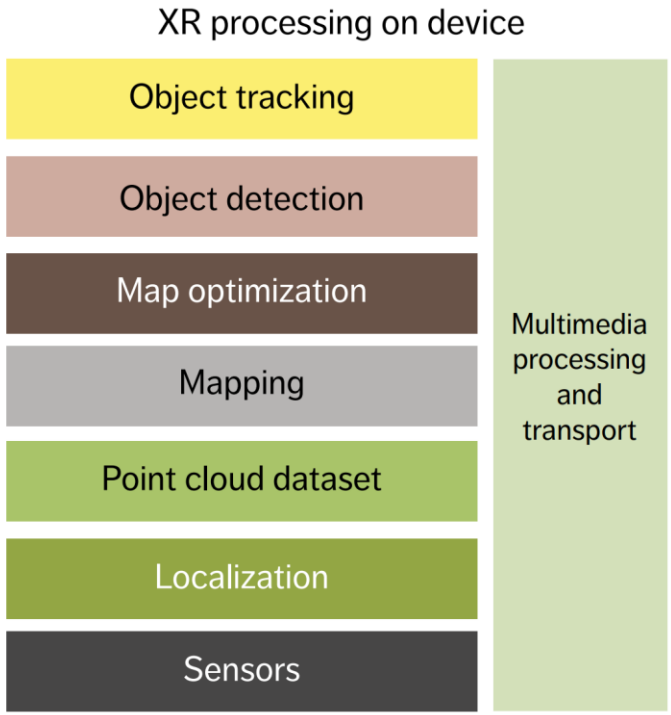


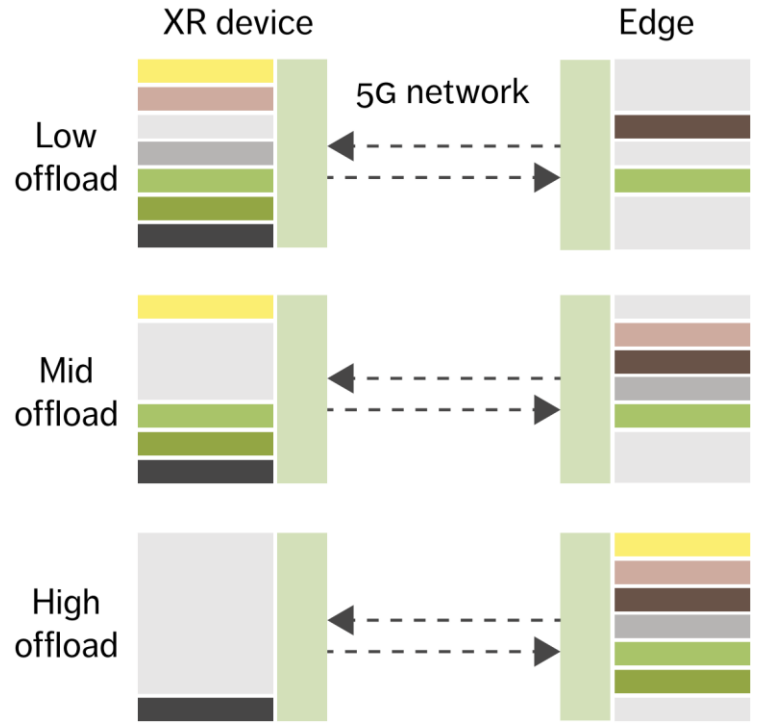
Large-scale Mapping

Autonomous Driving

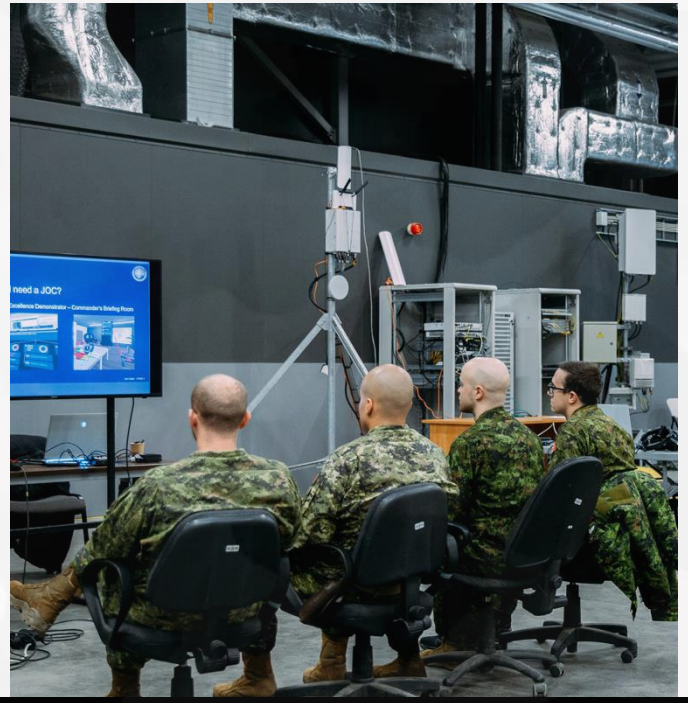
Source: https://www.youtube.com/watch?v=_7x_Rpe_bzw

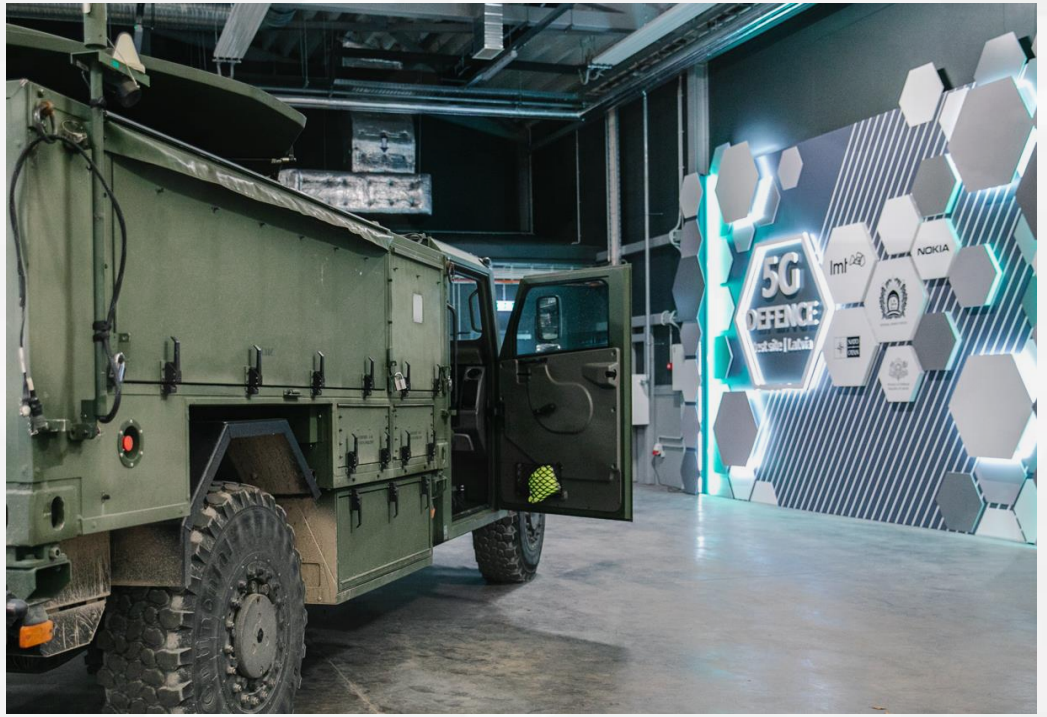
5G and eXtended Reality (XR)



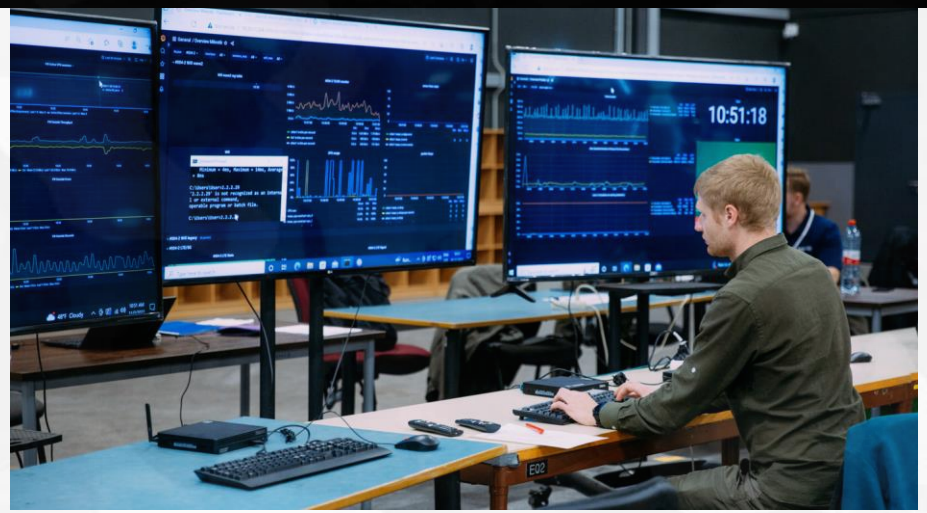


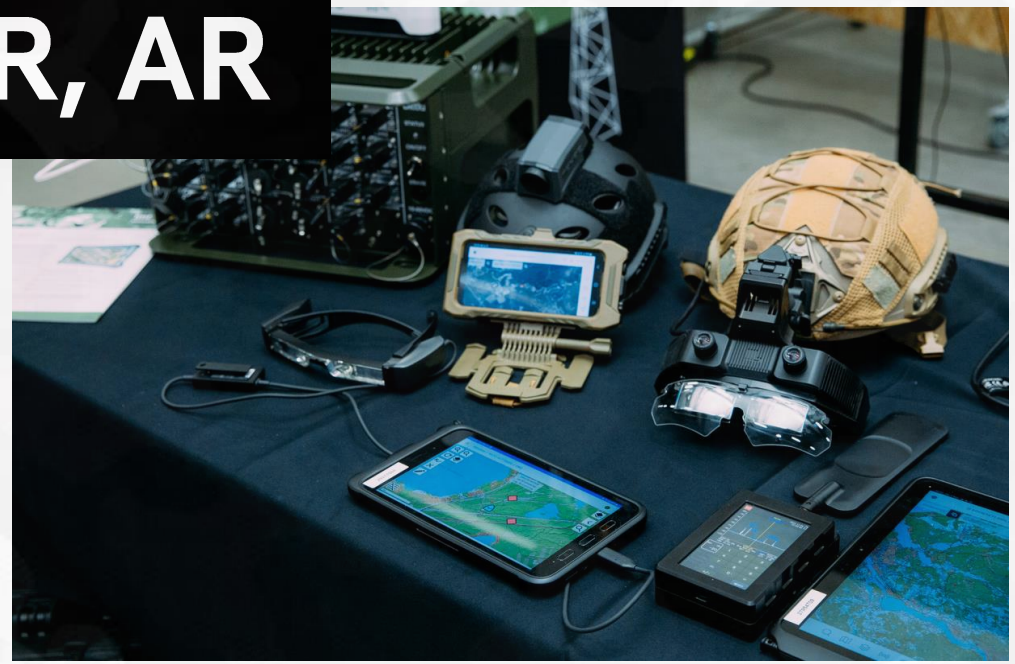
Source: ericsson.com/4a492d/assets/local/reports-papers/ericsson-technology-review

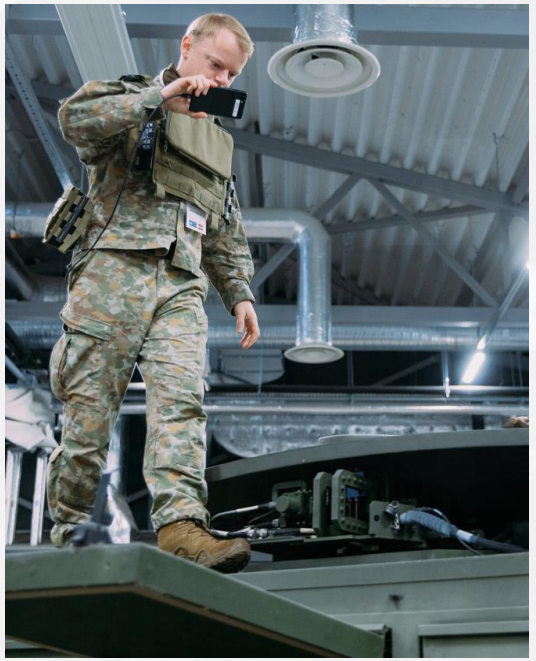




5G and VR, AR



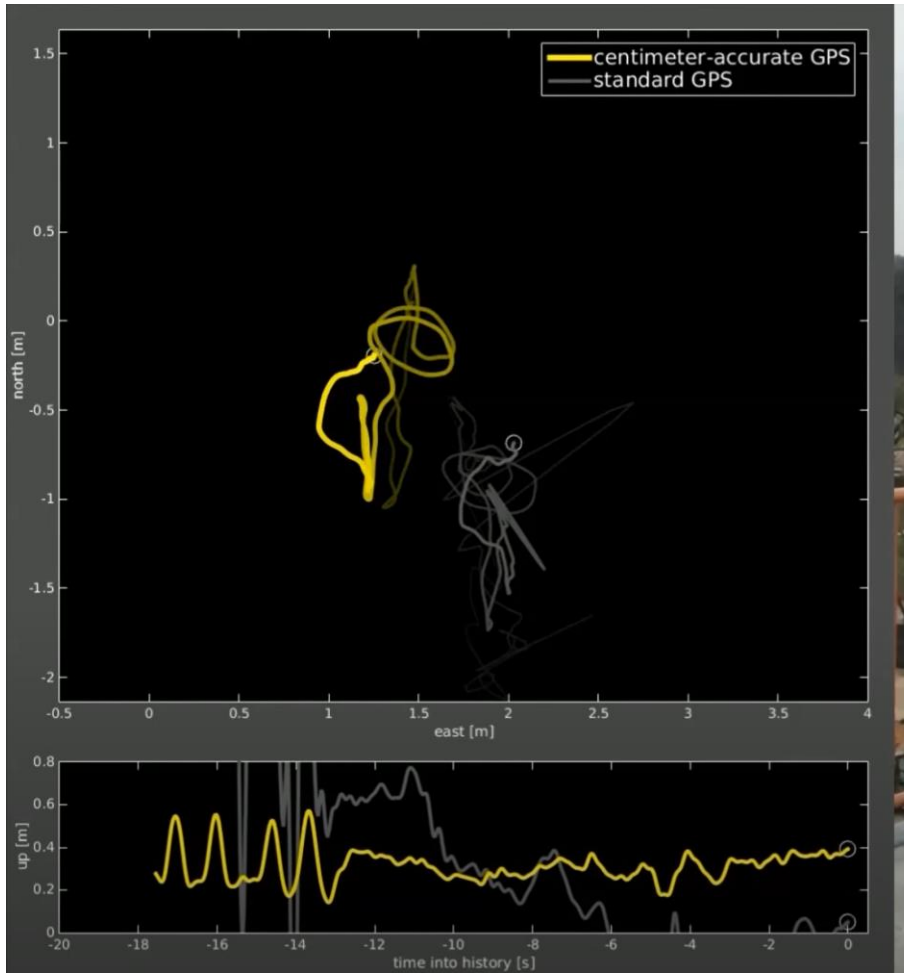




5G promises more than only improved connectivity

5G positioning:

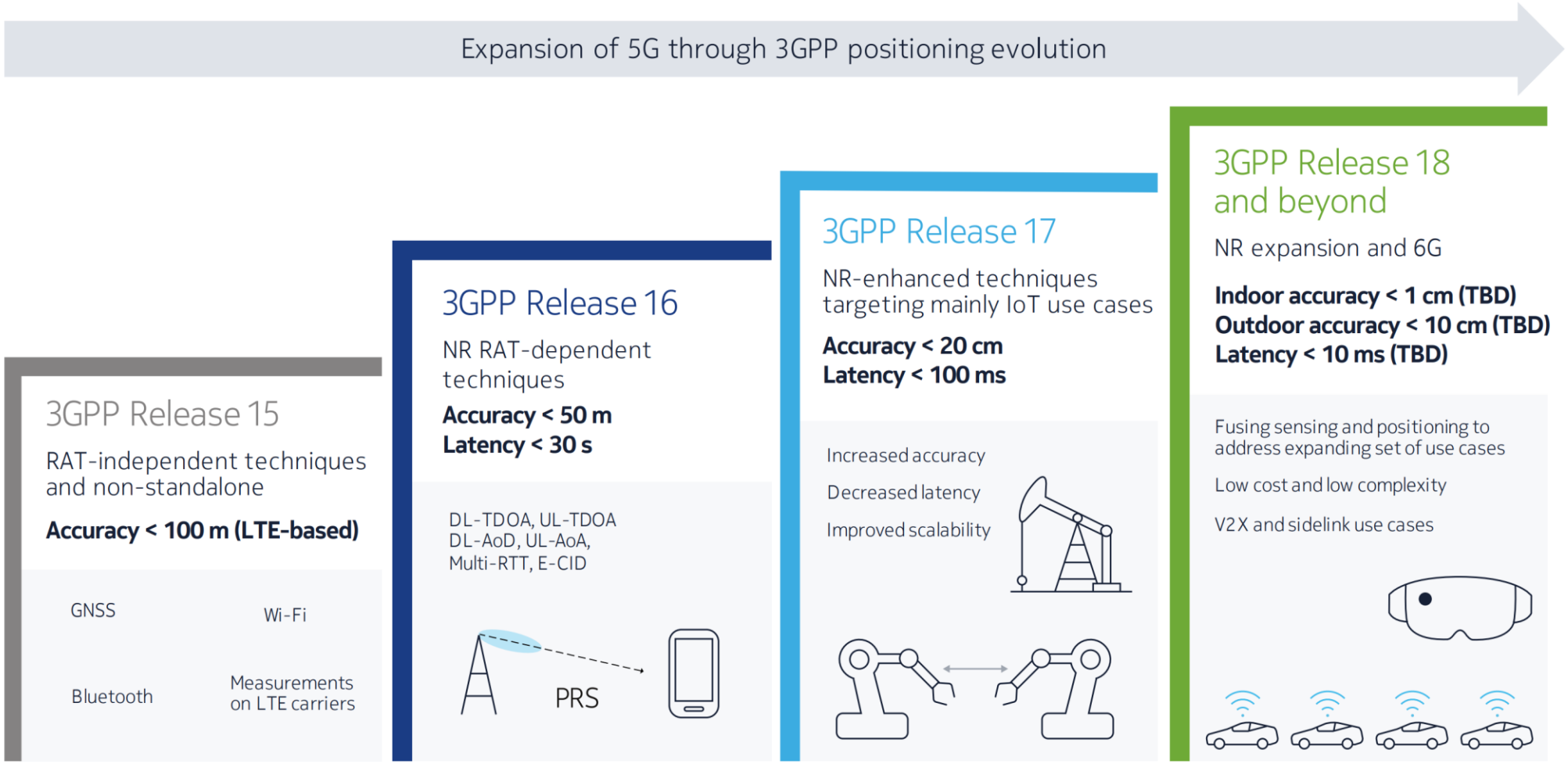
1. Higher precision
2. Outdoor also indoor positioning
3. Horizontal also vertical positioning.



Source: https://www.youtube.com/watch?v=_7x_Rpe_bzw

GPS alternative and supplementary positioning

5G positioning



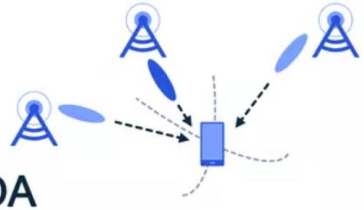
Source: Positioning features for 3GPP Rel-15 to Rel-18 - https://www.bell-labs.com/institute/white-papers/evolution-5g-new-radio-positioning-technologies/#gref

5G brings multiple positioning techniques

For different deployment scenarios and use-cases

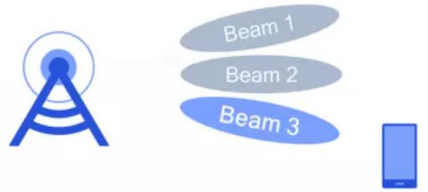
Cell-ID

The network reports the location of the cell-site serving the device or the centroid of its coverage



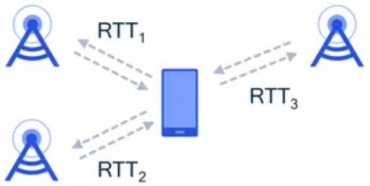
DL-TDOA

The device measures the time difference of arrival (TDOA) of downlink positioning reference signals (PRS) from different cells and cell-sites



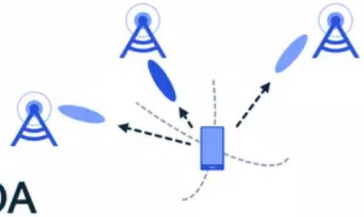
DL-AoD

The device measures and reports the strength with which it receives PRS for each beam, where the angle of the beam is known



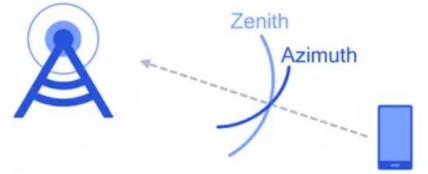
MC-RTT

Time differences between downlink PRS from multiple cells and uplink SRS are reported either by the cell-site or the device



UL-RTOA

The network measures the relative time of arrival (RTOA) of the device's sounding (SRS) from different cells and cell-sites



UL-AoA

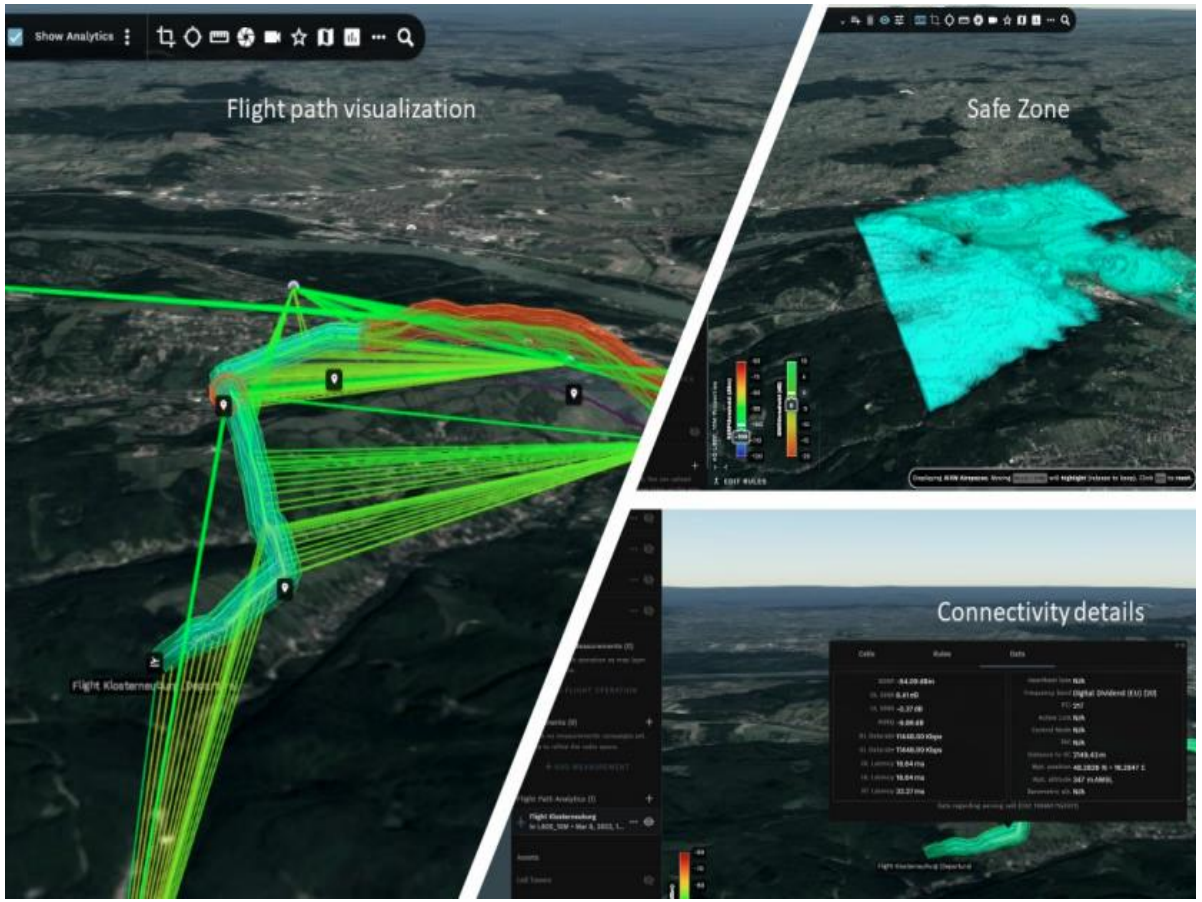
The network measures the azimuth and zenith of arrival of SRS from the device relative to a reference direction

Source: 5G positioning for the connected intelligent edge (slideshare.net)

5G & GIT

GIT as technology and/or database

GIT for 5G coverage planning



5G for GIT

5G connected sensors to monitor environmental changes:

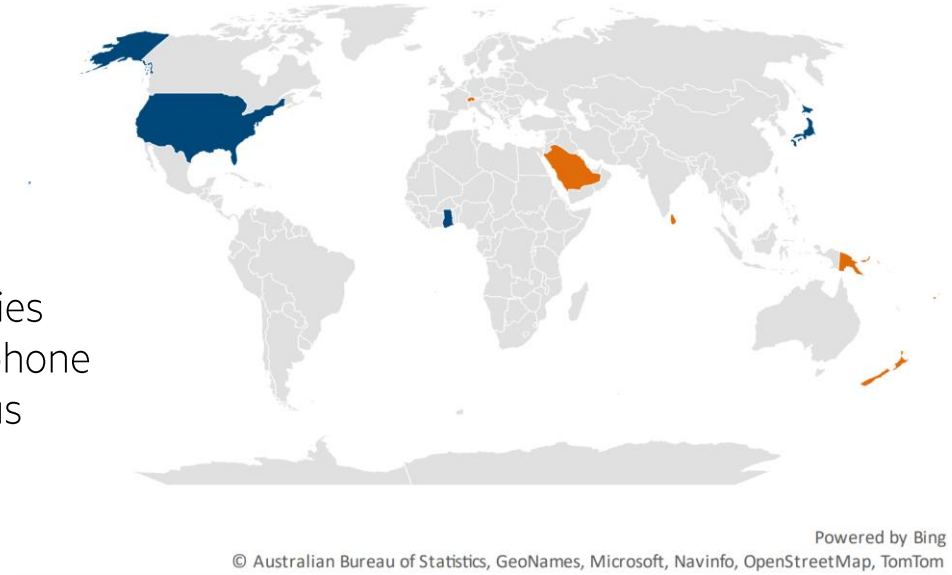
- Video cameras – stationary and on the move (e.g. drones)
- Environmental sensors for GIT 3D mapping and digital twin creation and updating. Sensors like - Seismic sensors, air quality sensors, soil moisture sensors and others

May 2023

5G Non-Terrestrial Networks and Satellite Connectivity

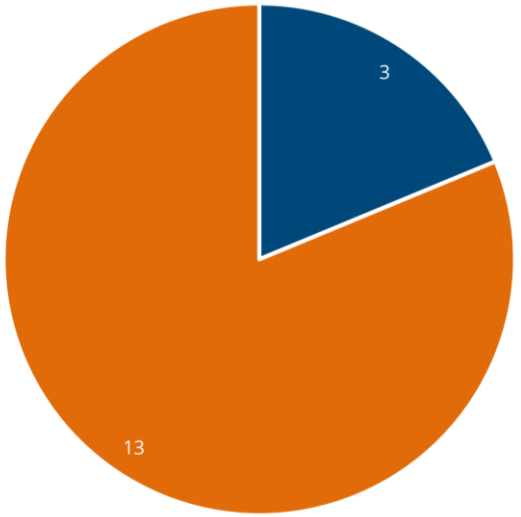
GSA

Countries and territories with satellite-to-cellphone partnerships, by status



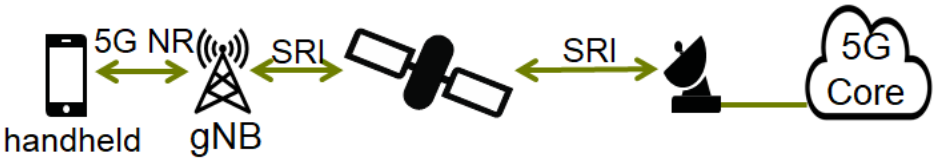
- Evaluating/testing/trialling
- Planned

Announced satellite-to-cellphone partnerships, by number

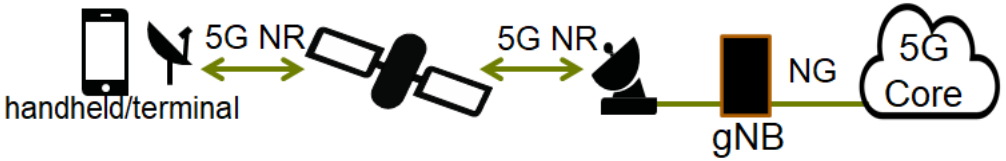


5G from satellites

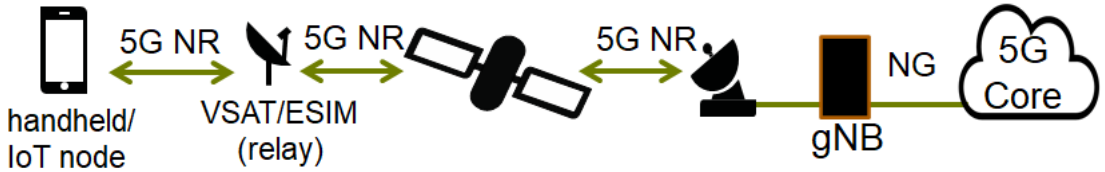
a) Satellite backhaul to support 5G



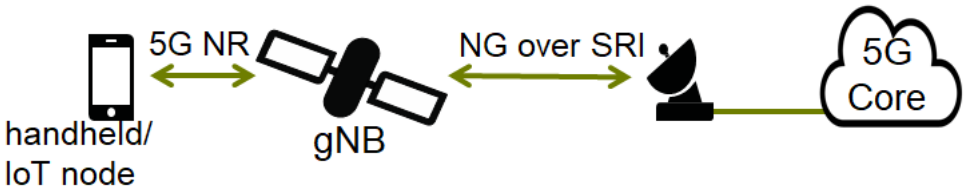
b) Direct 5G access over transparent or regenerative satellites



c) Indirect 5G access via VSAT/ESIM over transparent or regenerative satellites



d) Direct access where (part of) gNB is deployed in space



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Thank you!