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# 6G Vision
## Unleashing human potential

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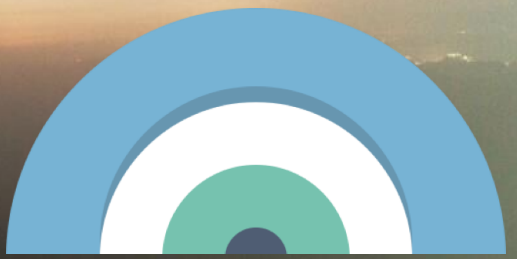


# What future communications will look like in 2030s?

Smartphones &
accessory type devices

Textile integrated
Flexible/stretchable fabrics

Skin patchable
devices

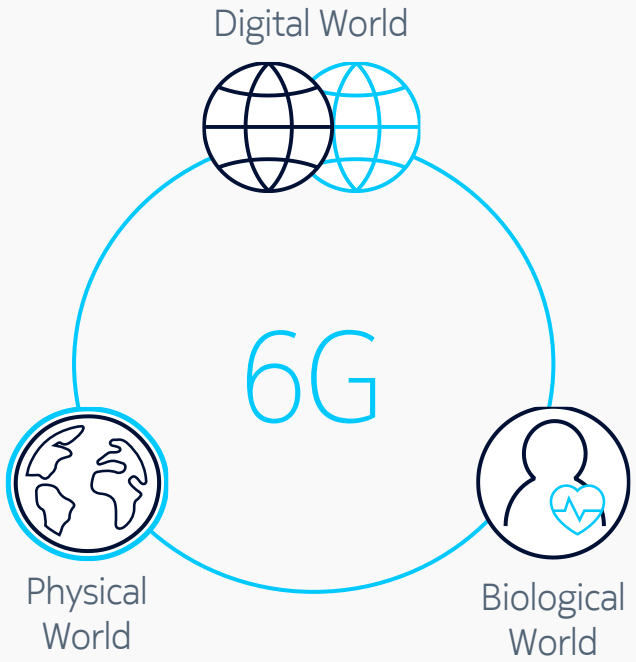
Body implantable
Cyborg

Effortless to use/control, invisible but everywhere

# The enabling foundation for that future…

Ubiquitous compute

Precision sensing & actuation



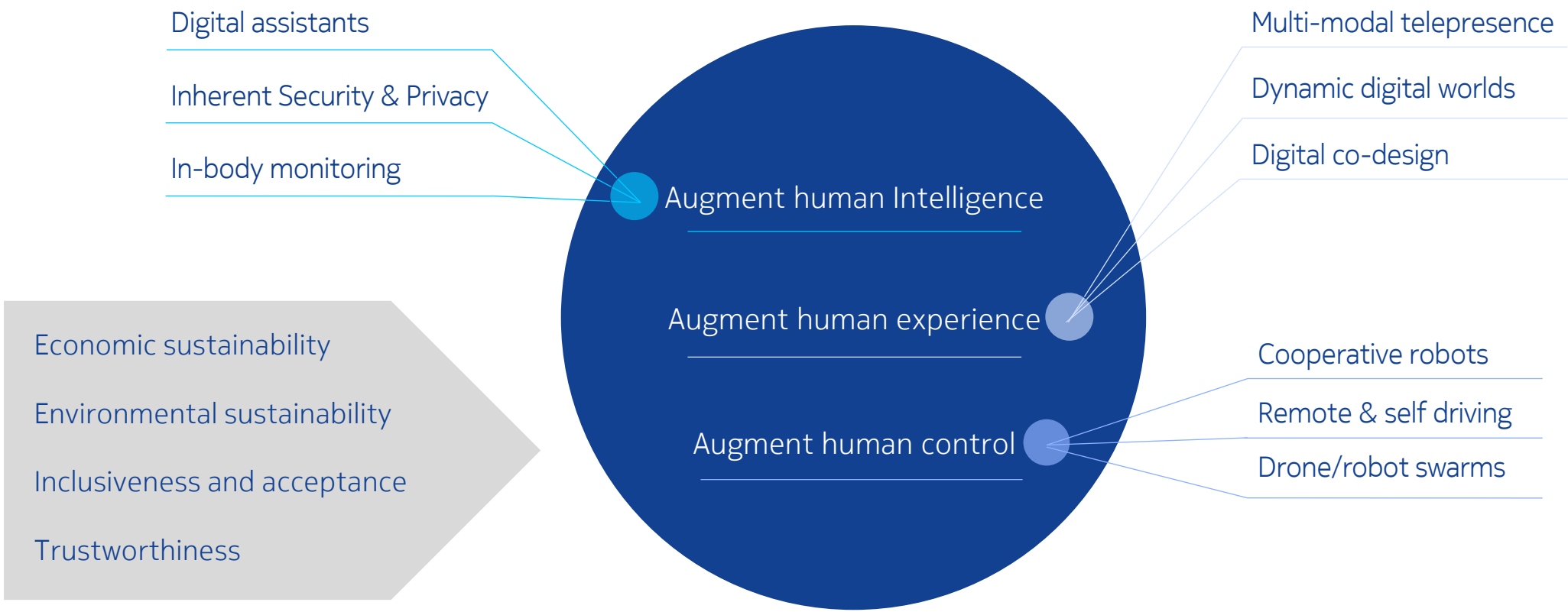

Knowledge systems

Human machine interface

6G will unify the experience across physical, digital and biological worlds

# Creating the ‘augmented human’

## What future communications will look like in 2030s?




Augment human potential and well being at scale

# The new requirements

### Throughput & Capacity

> 100 Gbps peak data rates
1 Gbps whenever needed

### Device

Zero Energy
Sub-network (~10)
Intuitive interfaces

### Latency, Reliability & Security

Sub ms
Nine 9s
~100 ns synchronization level
Trustworthiness

### Adaptability Response

Availability and Resilience
Zero touch

### Scale, Flexibility & Sustainability

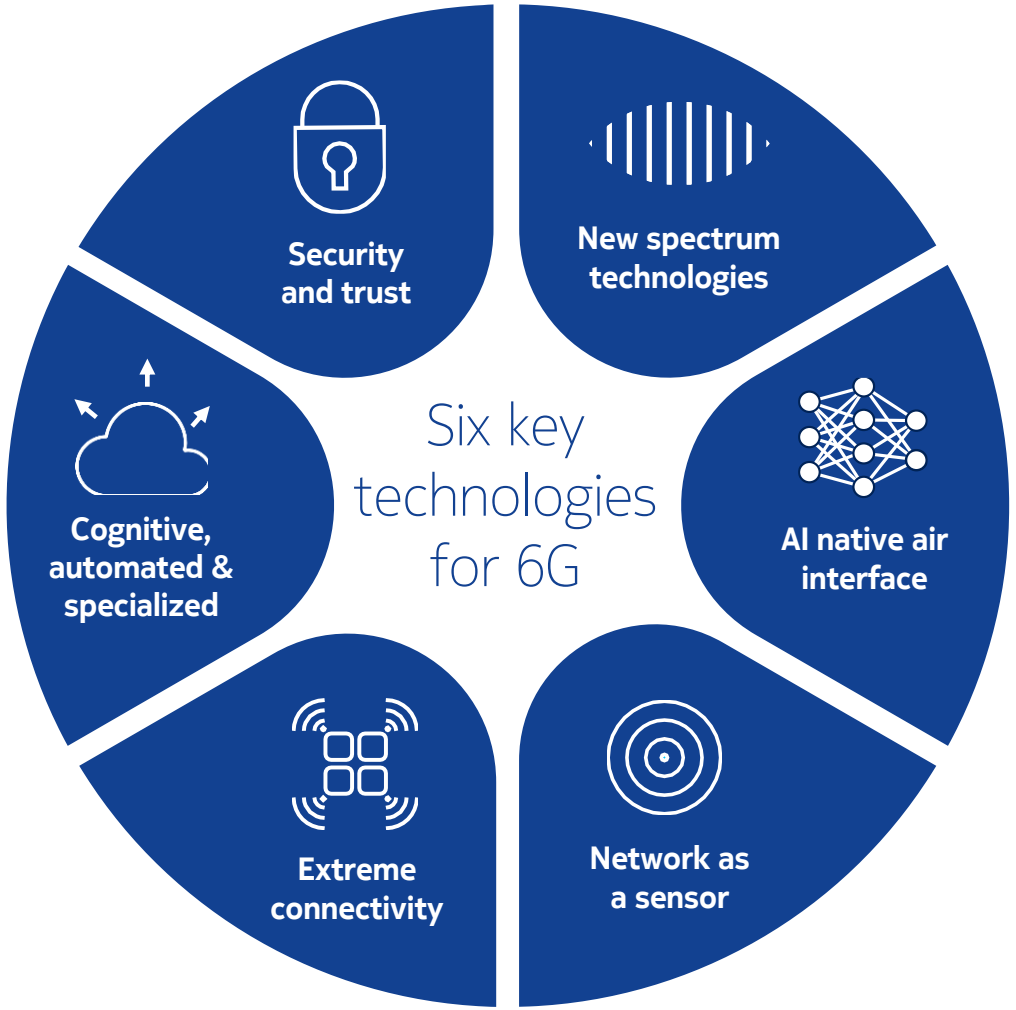
Global coverage
10 Million devices/Sq Km
Platform & services approach
Sustainability & cost efficiency

### Precision & Accuracy

cm range resolution
Max velocity and velocity resolution

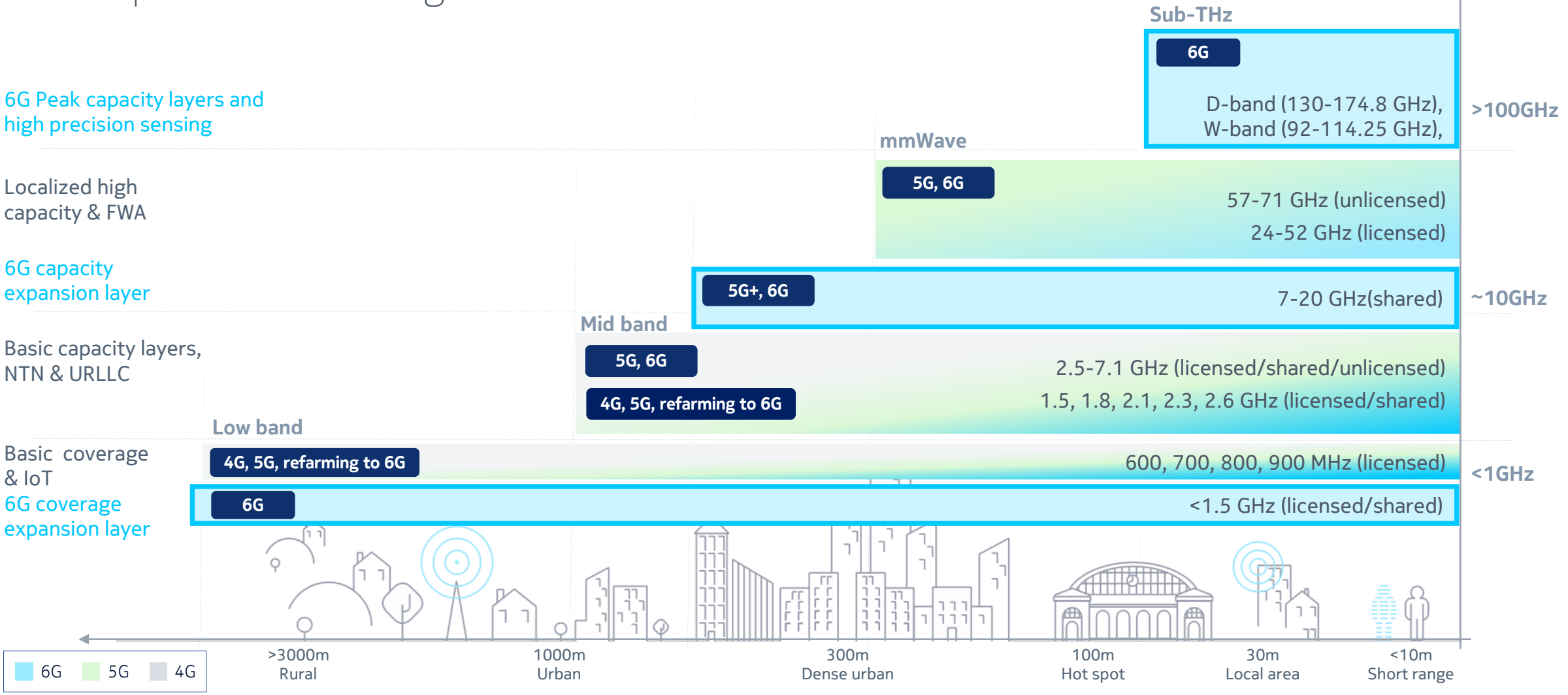
All the requirements may not be achieved simultaneously

# Six key areas for the 6G essential infrastructure



# 6G new spectrum technologies

## Band options for a new generation







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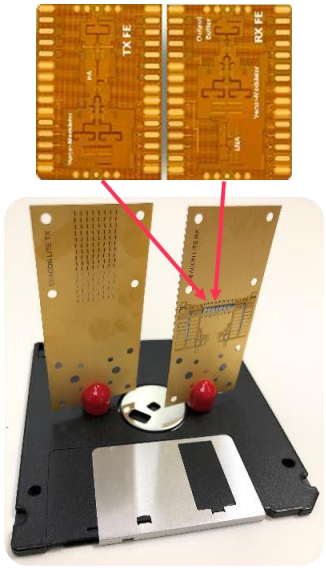
# Sub-THz air interface

## Efficiently providing ultra high bandwidth under challenging conditions

### Ultra-high data rates

Future applications requiring
up to and beyond **100 Gbit/s**

### Advanced HW components

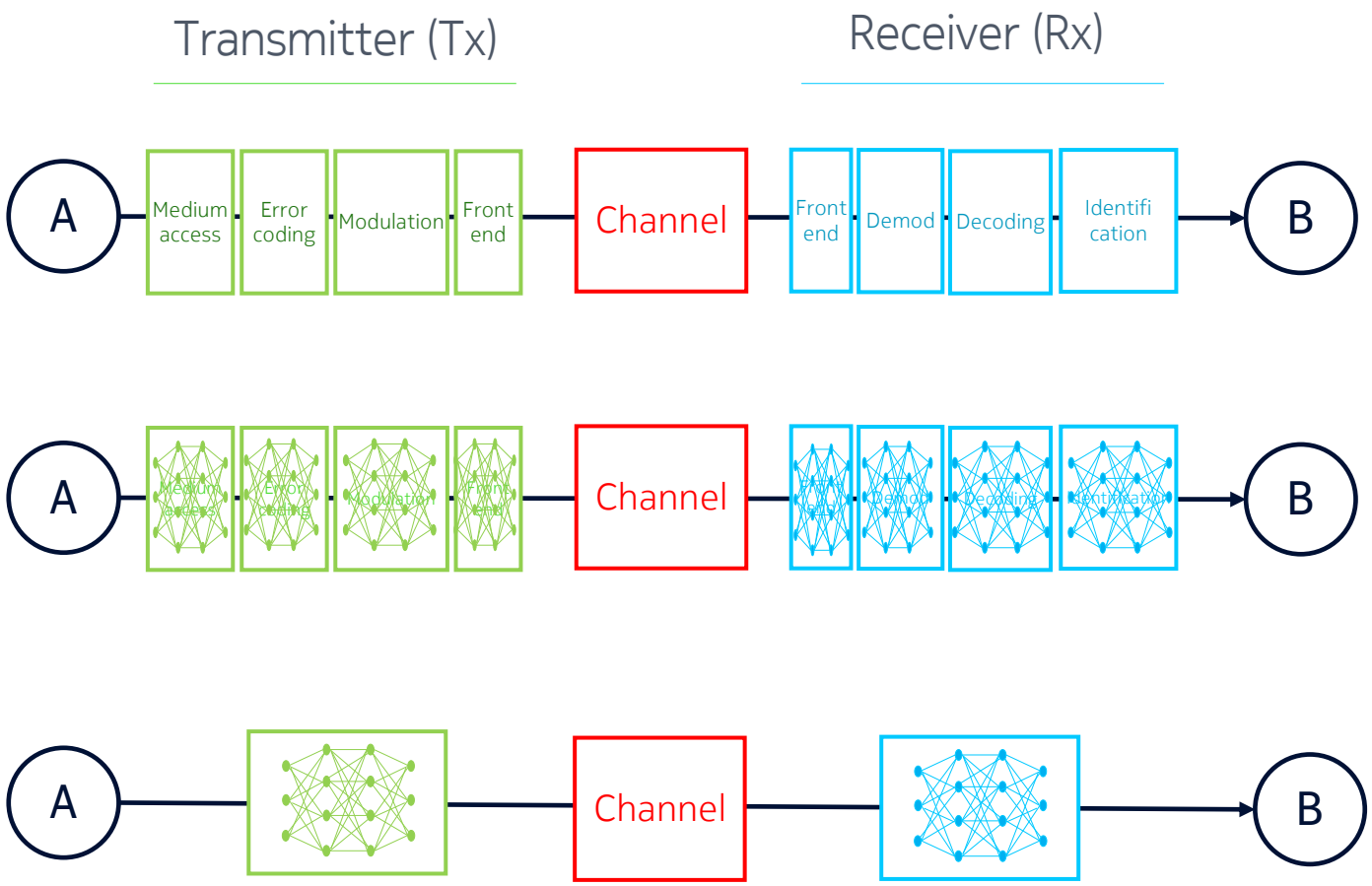



World's first D-Band
Phased-Array-on-Glass

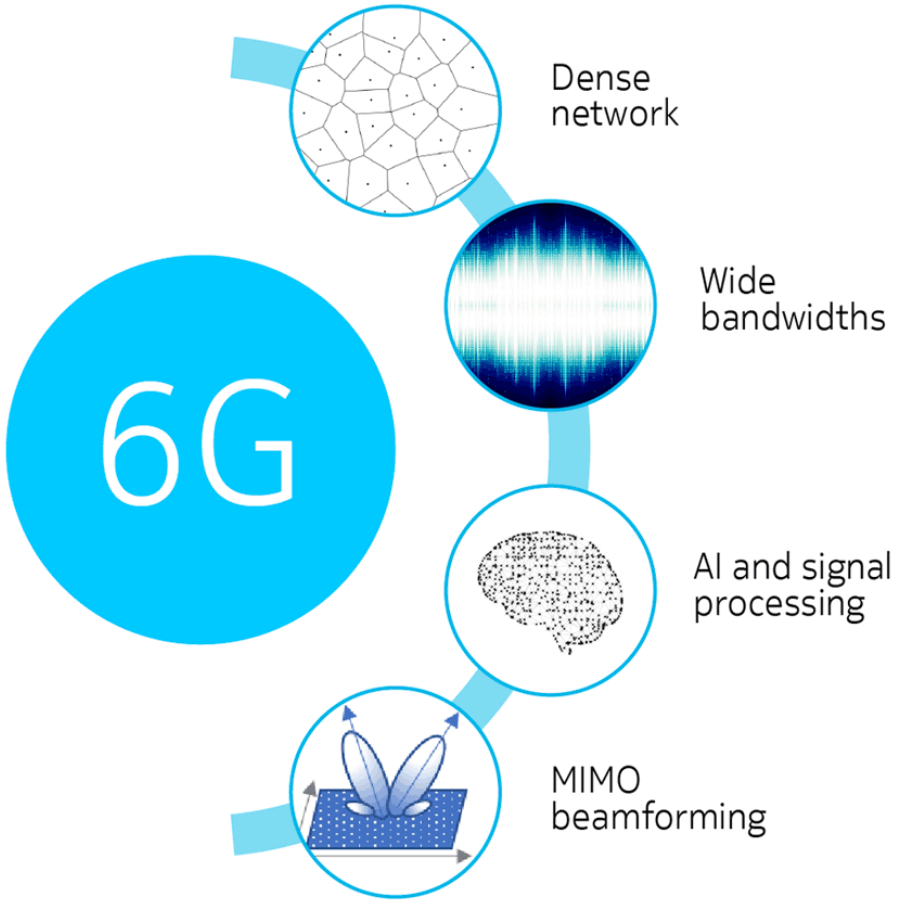
### New PHY layer for sub-THz

- Low PAPR waveforms
- High gain antenna arrays
- Advanced beam forming for hybrid architectures

# 6G native AI/ML air interface

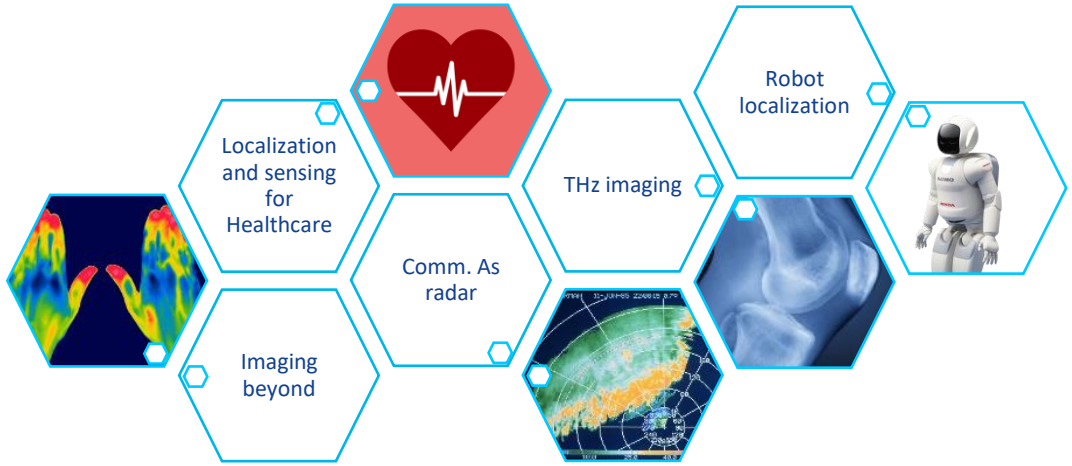


# 6G network with a 6th sense




## Simultaneous communication and sensing

- Waveform multiplexing
- Resource allocation
- Beam sweeping
- CSI based sensing
- High precision localization in NLOS



# 6G security and trust

## Mitigate the exploding threat surface

Multi-stakeholder supply chain & run time environment

Mix of open source and multi-vendor SW, complexity

Het-Cloud (public, private, hybrid, distributed)

Open Interfaces & disaggregation

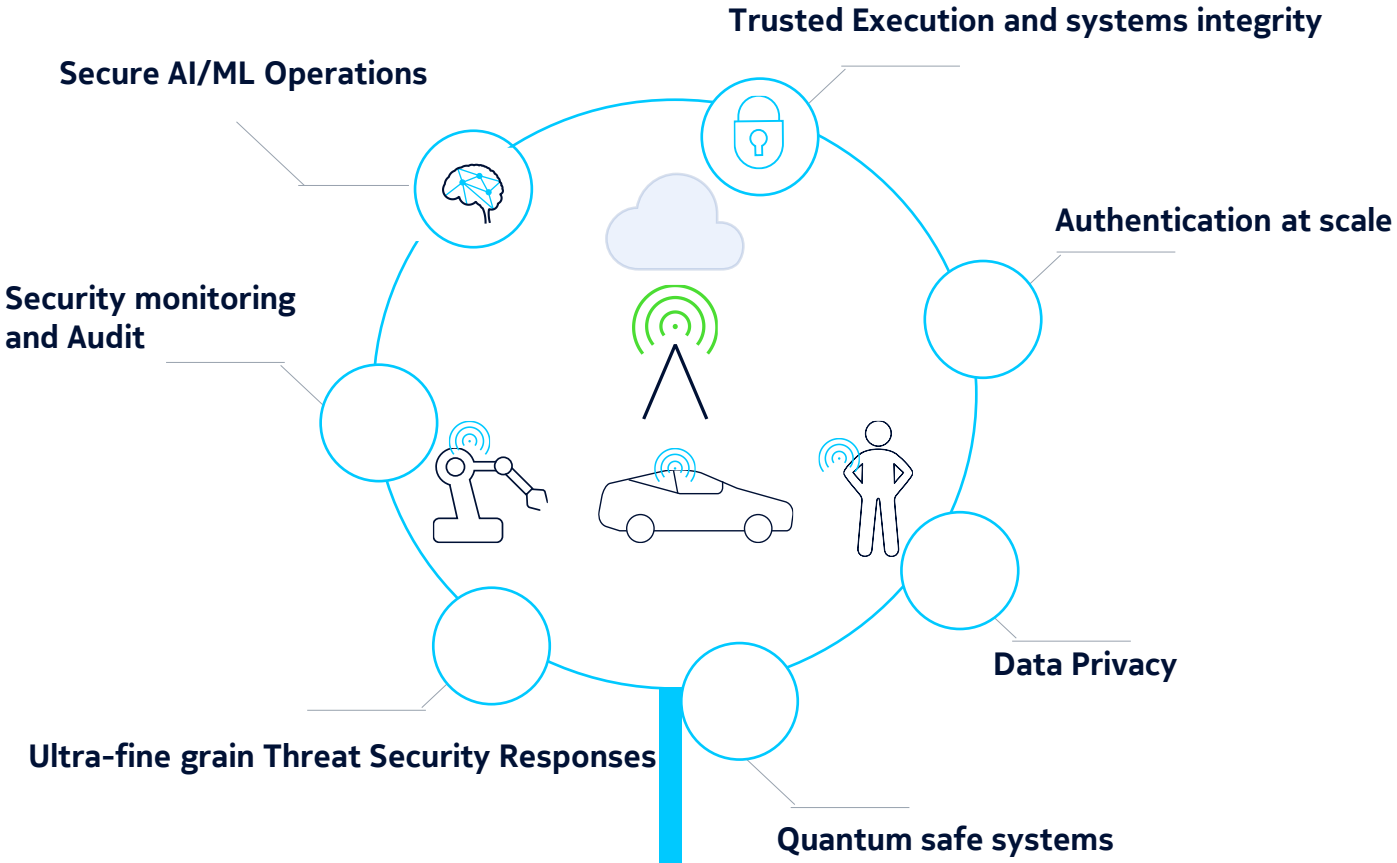
Millions of sub-networks

Billions of endpoints

New HMI

Zero trust

### Technology enablers



# 6G architecture themes

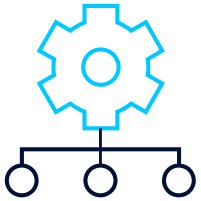
Het-Cloud

RAN-core unification

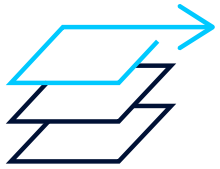
Cognitive Networking

Automated Management and Orchestration

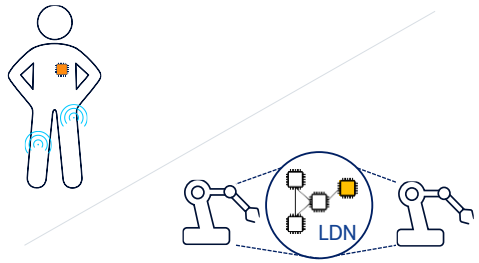
Data and Information Architecture



Deep Slicing



6G Subnetworks



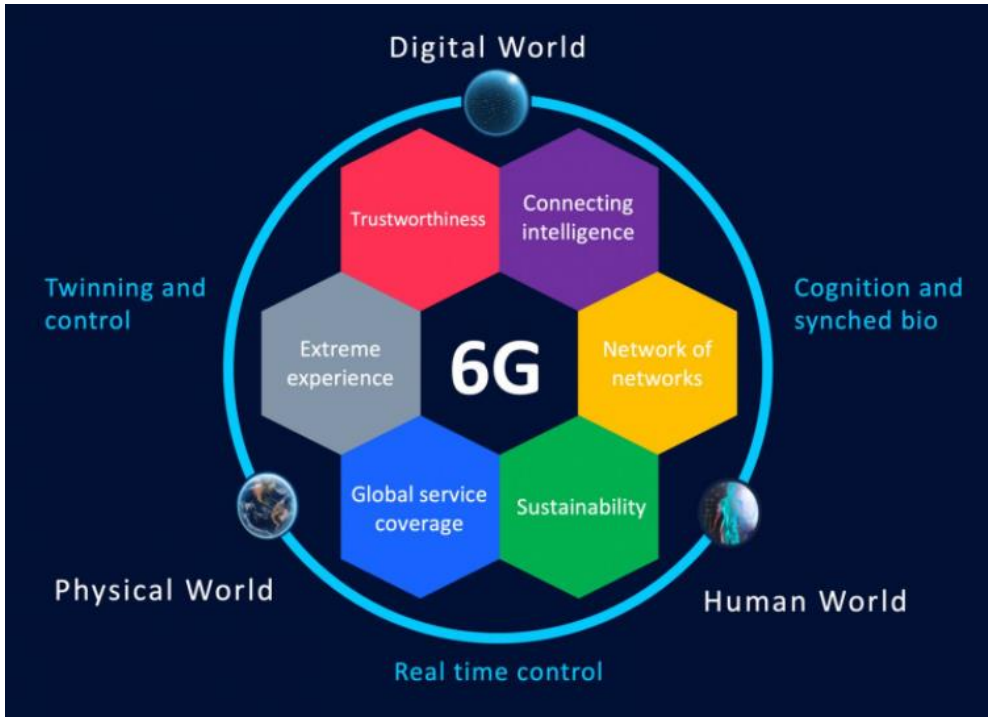

- Simplification
- Flexibility
- Specialization
- Programmability
- Trustworthiness
- Sustainability

# Nokia's view on 6G timeline

# Nokia leads the EU 6G flagship project Hexa-X

- Hexa-X is a flagship research initiative from the European Commission, with strong participation of major industry and academia stakeholders in Europe, to develop the foundation and contribute to industry consensus leading beyond 5G to 6G.
- The focus is on structuring, framing, and developing technology for connectivity needs in the 2030 timeframe, as a first step towards realizing 6G.
- It aims to develop key technology enablers in the areas of
  - fundamentally new radio access technologies at high frequencies and high-resolution localization and sensing;
  - connected intelligence though AI-driven air interface and governance for future networks, and
  - 6G architectural enablers for network disaggregation and dynamic dependability.

Hexa-X vision on 6G and research challenges



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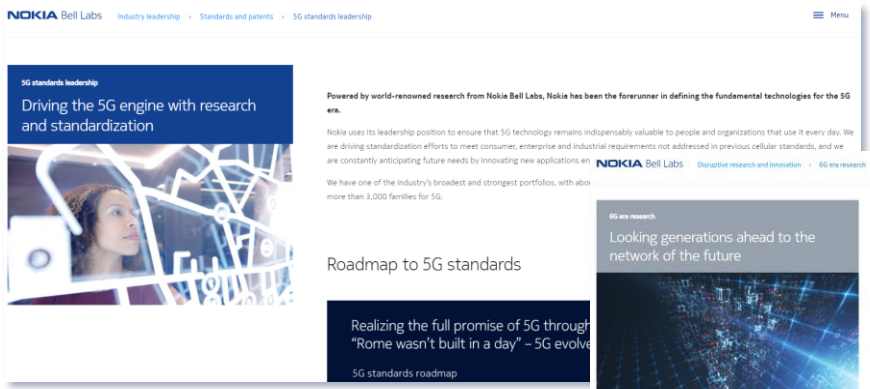
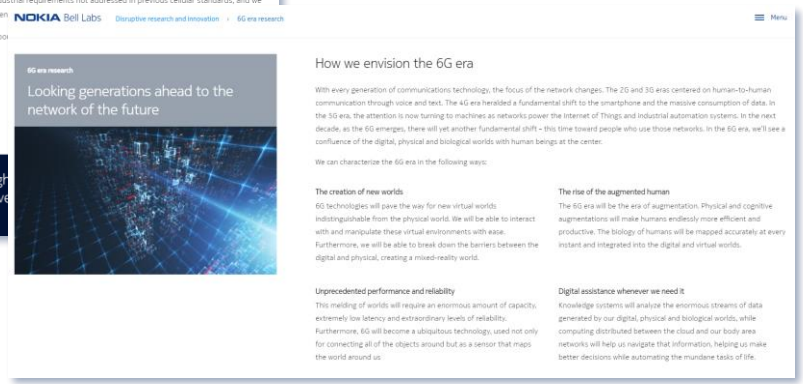
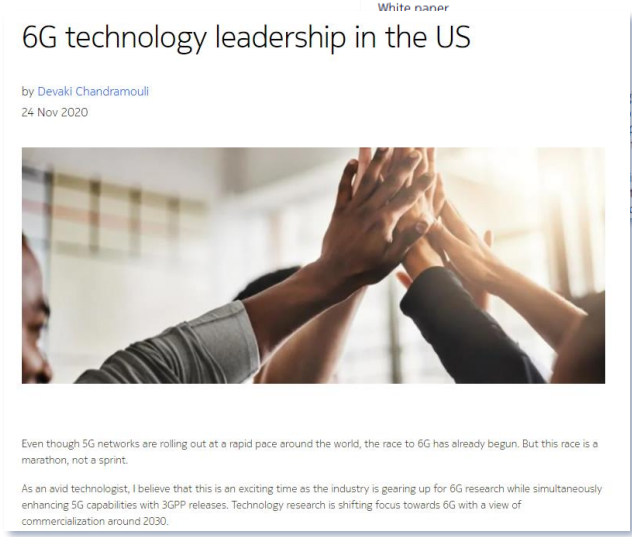
# 6G related resources

- Webpage: Nokia Bell Labs 6G era research page
- White Paper: Communications in the 6G Era
- Webpage: Hexa-X official website
- Blog: 6G technology leadership in the US
- Webpage: Nokia Bell Labs 5G standards and research leadership





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