A View on 6G: Security & Privacy Considerations

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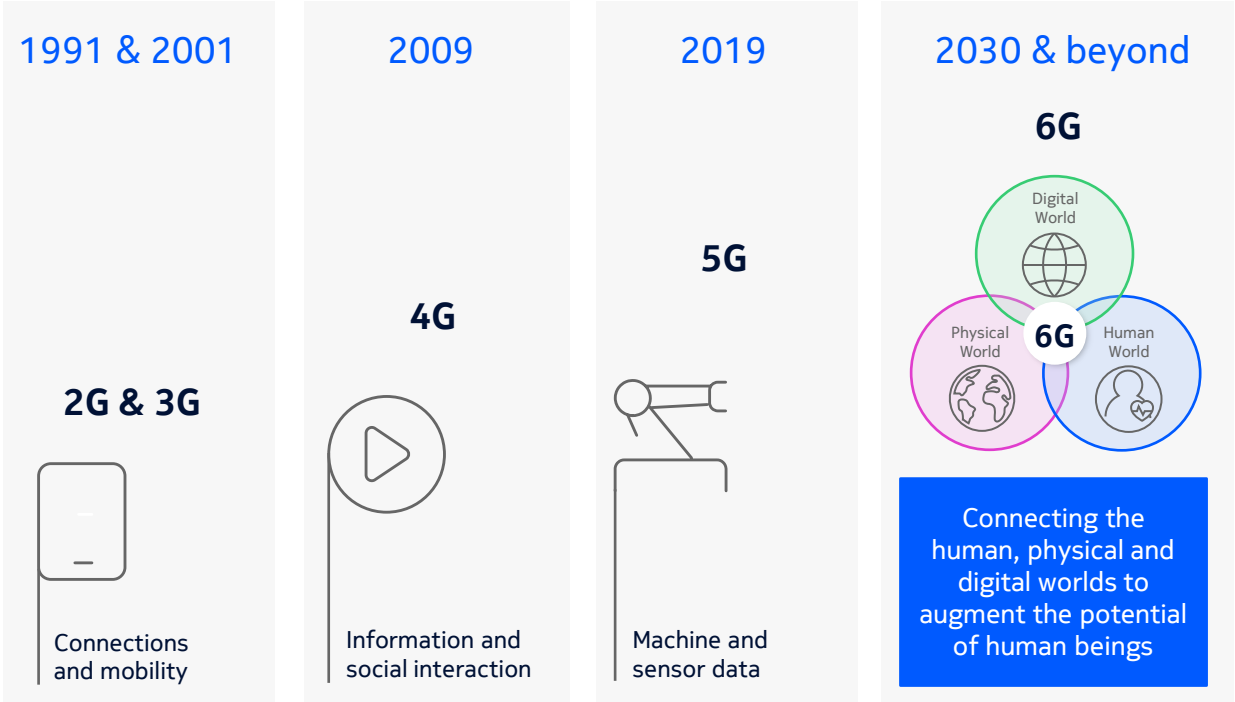
May 15, 2024

28. ITG Fachtagung
Mobilkommunikation
Technologien und Anwendungen
15. + 16. Mai 2024
Hochschule Osnabrück

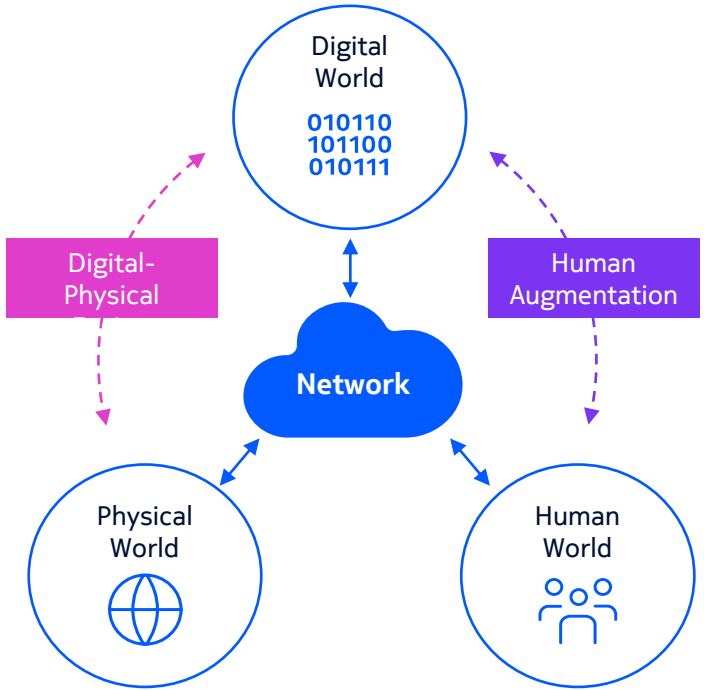
Agenda

1. **6G vision**
2. Key Value Drivers
3. 6G Architecture
4. Security & Privacy
5. Leading the early 6G ecosystem

The human, physical and digital worlds will become seamlessly integrated in the 6G era



The 6G era will be defined by digital-physical fusion and human augmentation



Digital-Physical Fusion

Dynamic, network-connected representations of real-world things in the digital world

Allows the physical world to be replicated, simulated and automated within the digital world - opening doors to a wealth of new possibilities for human benefit.

Human Augmentation

Extensions that enable people to interact with and within the digital world

Evolves the digital world from a source of two-dimensional experiences and information, to a focal point of immersive and productive interaction

Realization of this 6G vision comes in stages

Technology enablers and services examples

6G day-one focus

- Extreme MIMO on existing grid
- Smooth migration and core evolution
- Programmable networks and API native
- Framework for native AI
- Framework for energy efficiency

NextG mobile broadband

Fixed Wireless Access (FWA)

Immersive /Cloud gaming

Extended Reality

IoT/LPWA native support

6G to build on 5G success and do so in a more efficient, economical, scalable and sustainable way

6G evolution and beyond

Potential services that take us:

- From connectedness to **togetherness:** immersive holographic experience, connect the unconnected

- From information to **knowledge:** cognitive and complete context awareness, leveraging ambient IoT, digital twins, sensing

- From efficiency to **purpose:** mission & life-critical services supported by subnetworks

Augmenting humanity and the full realization of digital-physical fusion

6G Day One focus

The sustainable answer to the unceasing demand for connectivity

Extreme MIMO on existing grid

Smooth migration and core evolution

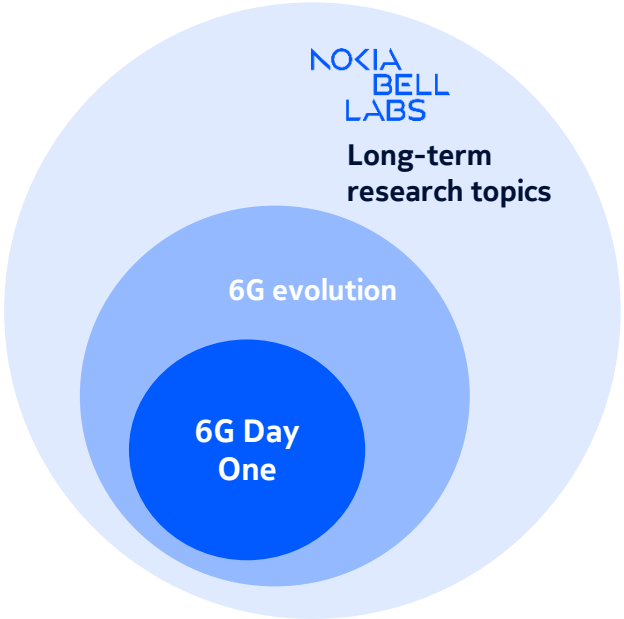
Programmable networks and API native

Framework for native AI

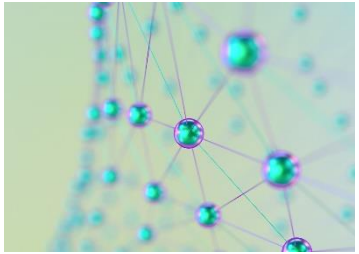
Framework for energy efficiency

Long term research topics

Through the innovation powerhouse Nokia Bell Labs



Integrated communications and sensing

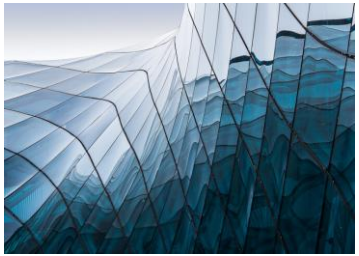


Sub-networks

Learning networks

Unified networking experience

Energy efficient ASIC technology



Radio on glass for wireless backhaul

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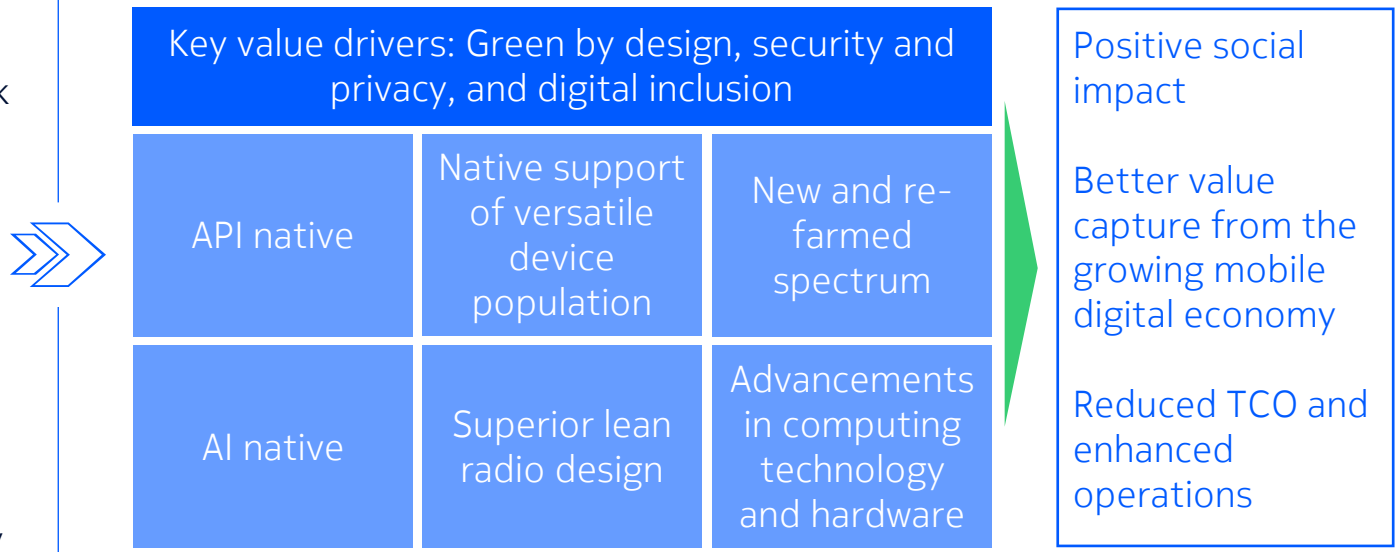
The push and pull trends point to the need for 6G

6G will bring a major leap in “baseline” performance

- The increasing need for network capacity
- The vastly growing device ecosystem
- The surging power of AI and emergence of the API economy

What 6G will bring



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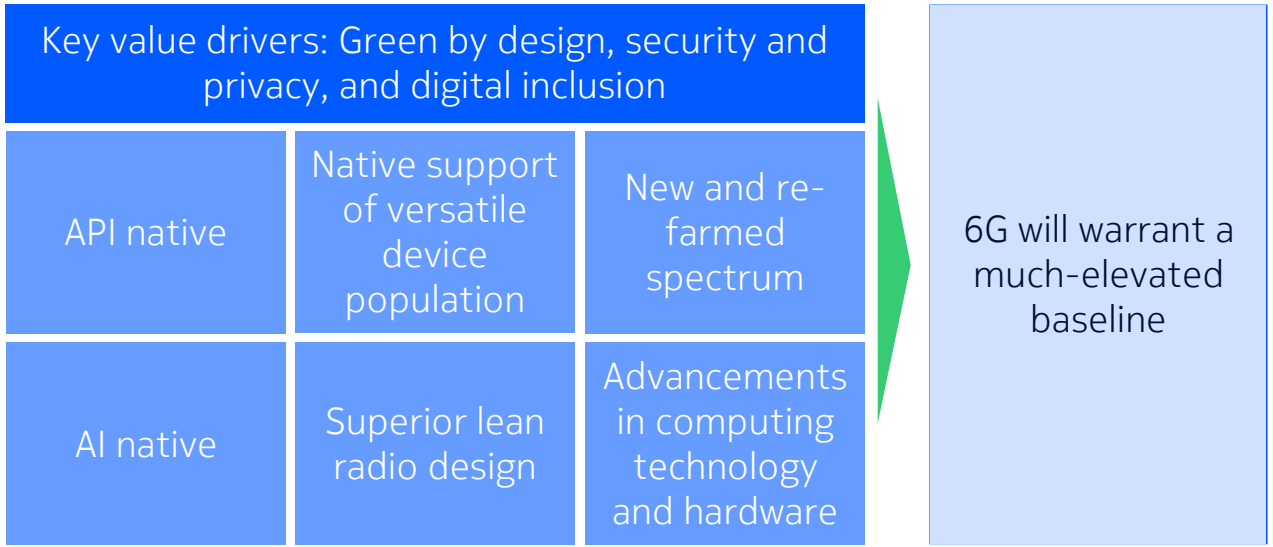


Key value drivers for 6G

Green by design

- 10X capacity increase with 50% power reduction, compared to 5G

Security and privacy

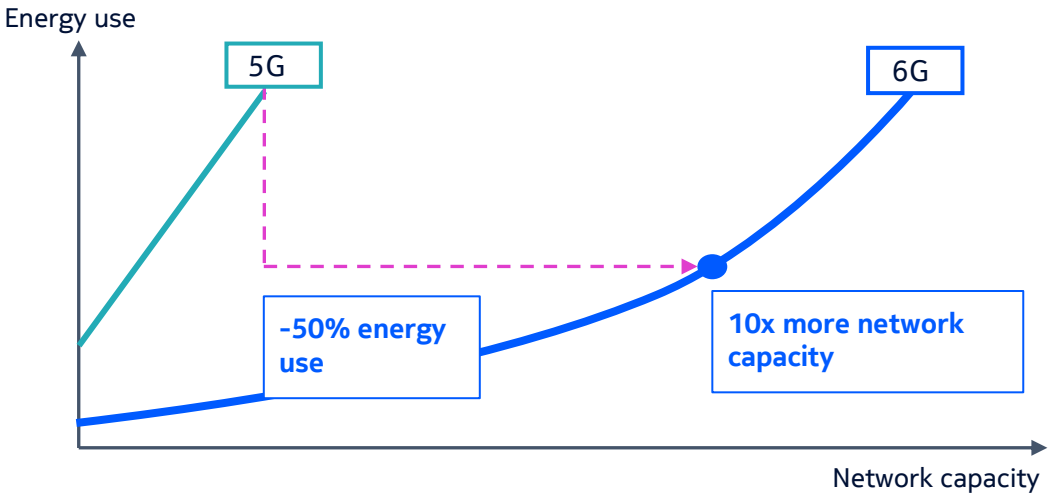
- Increasing security and privacy risks require higher levels of control

Digital inclusion

- Aims to address three key factors: accessibility, affordability and consumability

Green by design

Lower the baseline power requirements of the network at all times



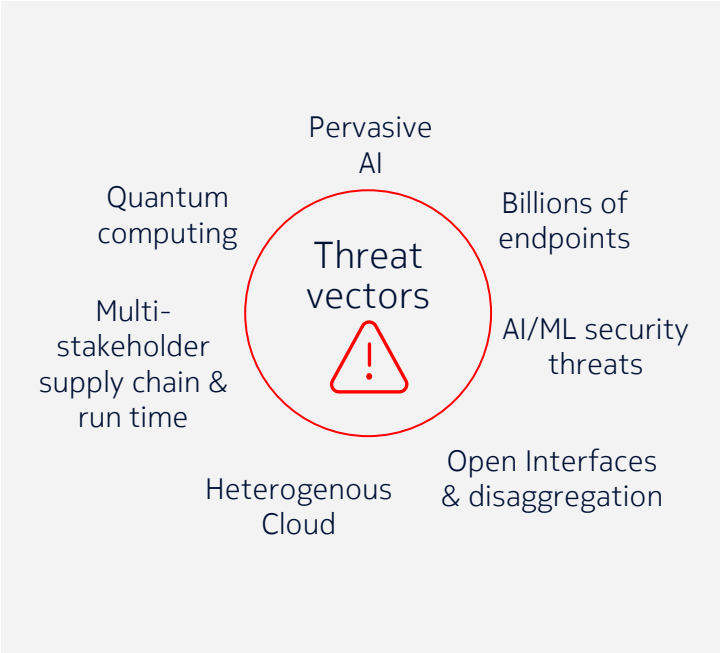
Minimize relative power consumption in low-to-mid-load conditions: **zero users – zero power consumption**

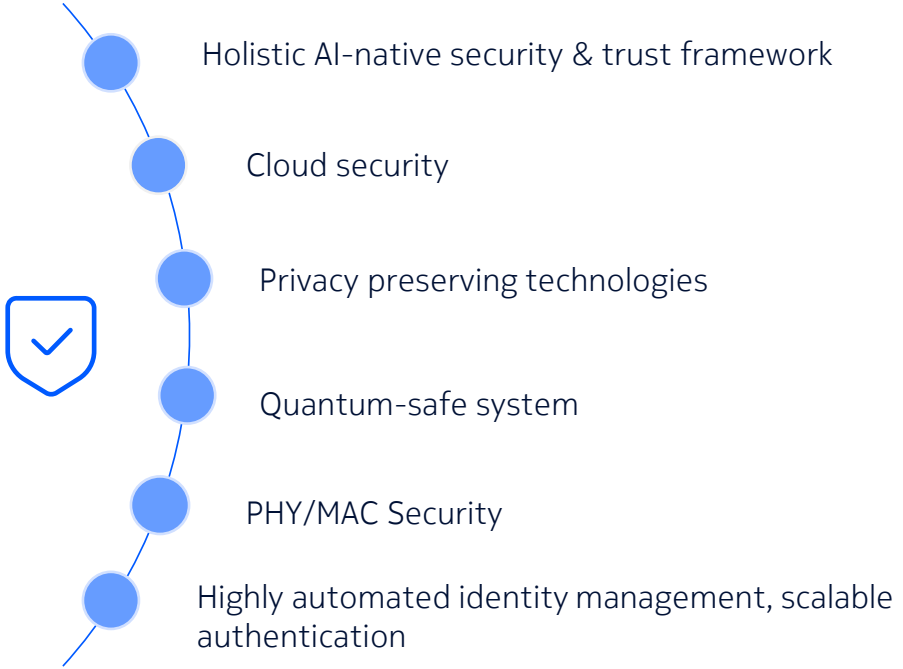
Maximize the efficiency of the network in mid-to-high-volume conditions: **substantial reduction in energy per bit**

6G target: 10x more capacity with 50% less power usage
➔ 20x lower kW/Gbps

Security and privacy

Design new solutions to address future threat vectors





Digital inclusion

Accessibility

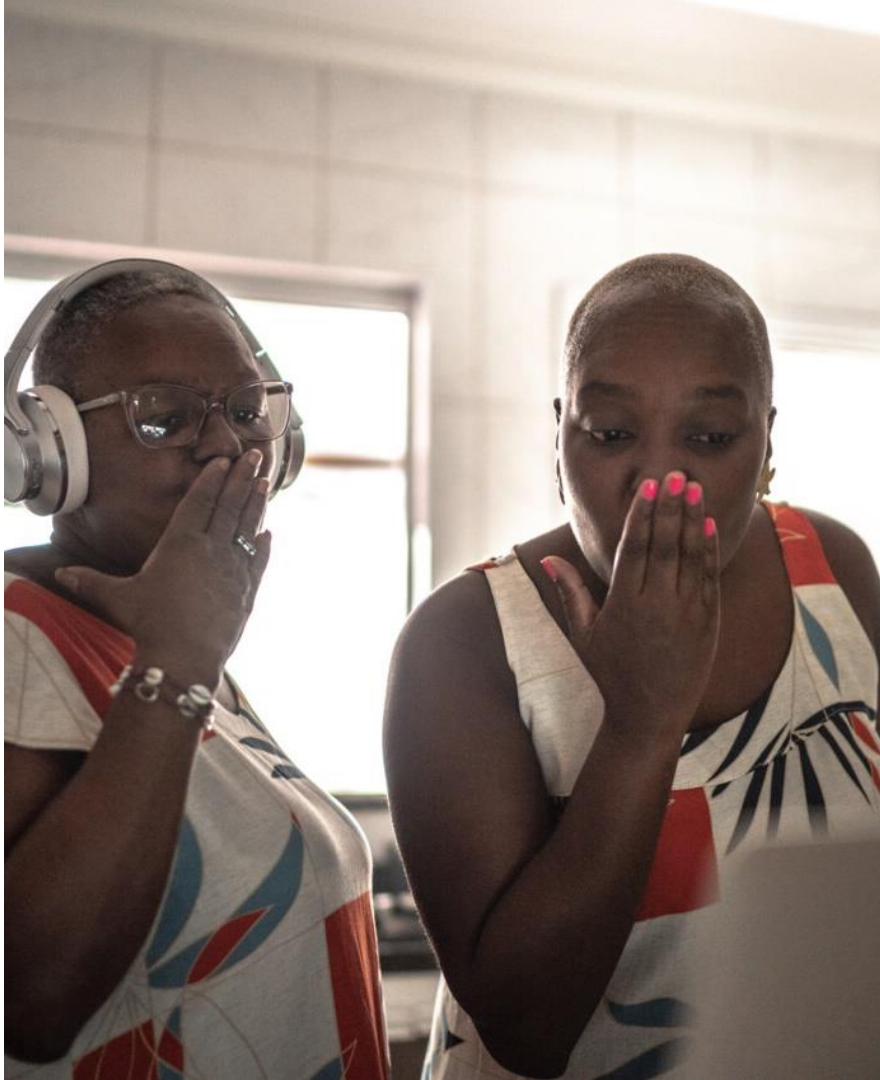
- New solutions such as integrated non-terrestrial networks and terrestrial networks will help make global connectivity a reality

Affordability

- Interoperability from global standards and delivery of cost-effective 6G solutions

Consumability

- User-centric design with enhanced usability, serviceability and operability, ensuring intuitive interactions and seamless integration with existing systems



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Creating the pre-standardized platform that will form the basis for future 6G standardization

European flagship project Hexa-X II

Funded through **Horizon Europe SNS-JU**, with **44 partners** covering the entire value stack, including hardware, system, platform, applications, service providers and academia.

NOKIA Overall project lead

NEXT G ALLIANCE
An ATIS Initiative

Driving North American leadership for Next G technologies

A comprehensive model built on North American 6G technology developments, R&D needs, standards goals and market readiness. The Alliance has **over 70 members** and is growing.

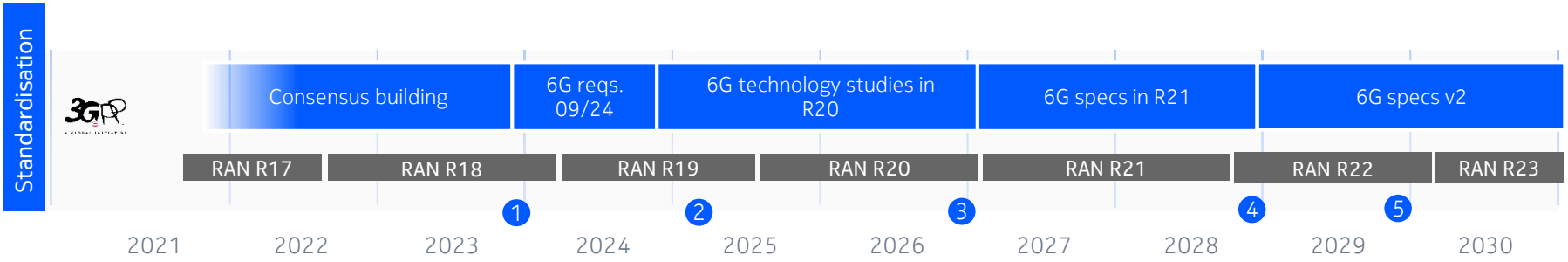
NOKIA Founding member

NOKIA

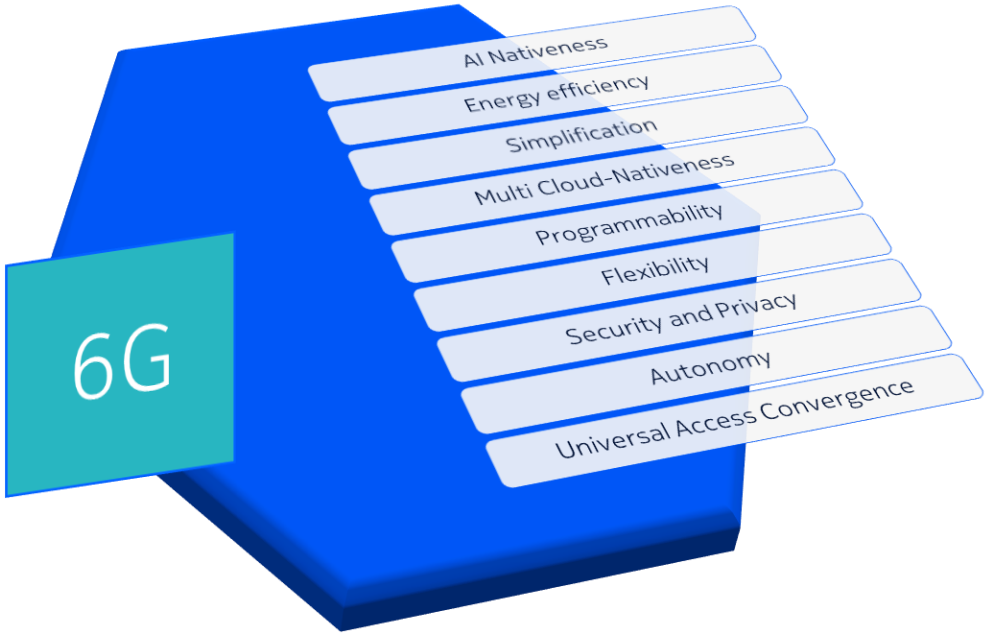
3GPP confirms 6G will come with Rel-21

Commercialization will start Q4 2029

1	2	3	4	5
3GPP TSG joint plan December 2023	3GPP 6G workshop March 2025	Rel-21 work item starts December 2026	First 3GPP 6G specifications December 2028	6G commercial launch Q4 2029
Reached agreement on 6G timeline	6G requirements and targets	**Key architecture and physical layer decisions**	Specs content frozen	**6G Day One**



6G architectural principles



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Re-architecting the System for Security, Trust & Privacy

to deal with AI/ML, Post Quantum & Cloud Native

THREATS

- Cloud-native design principles adopted across full e2e architecture
- AI applied to management, control and user plane
- Exposure of network data and capabilities in multi-party ecosystem
- Prepare for Post-Quantum Cryptography (PQC)

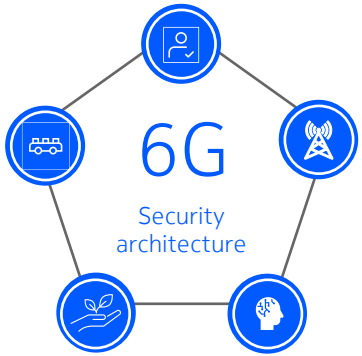
ADD-VALUE

- Secure and automated SW supply chain
- Resilient against AI based attack
- Privacy preserving technology
- Fresh look into the overall security framework

6G Security Architecture Fundamentals

Evolved Core Security
- Updated Trust Models
- Improved Authorization Mechanisms

Infrastructure Security
- Trusted Computing
- Confidential Computing
- Secure Supply Chain



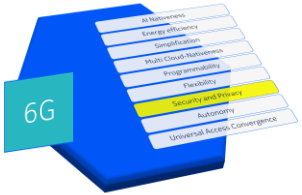
Access Network Security
- Lower Radio Layer Security
- RAN privacy

Secure Service Exposure
- Secure exposure at different levels
- Privacy Preservation

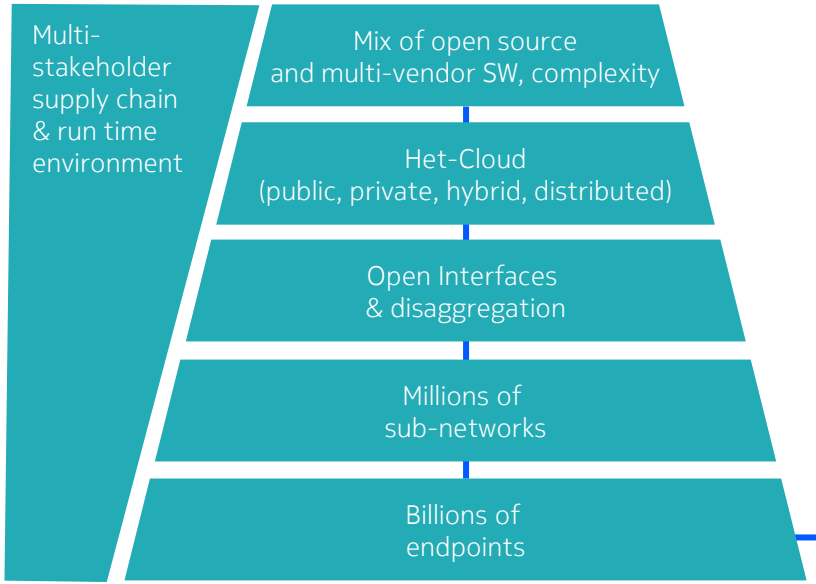
Authentication Enhancements
- Post Quantum Safe Authentication
- Optimized Re-authentication

6G security and privacy

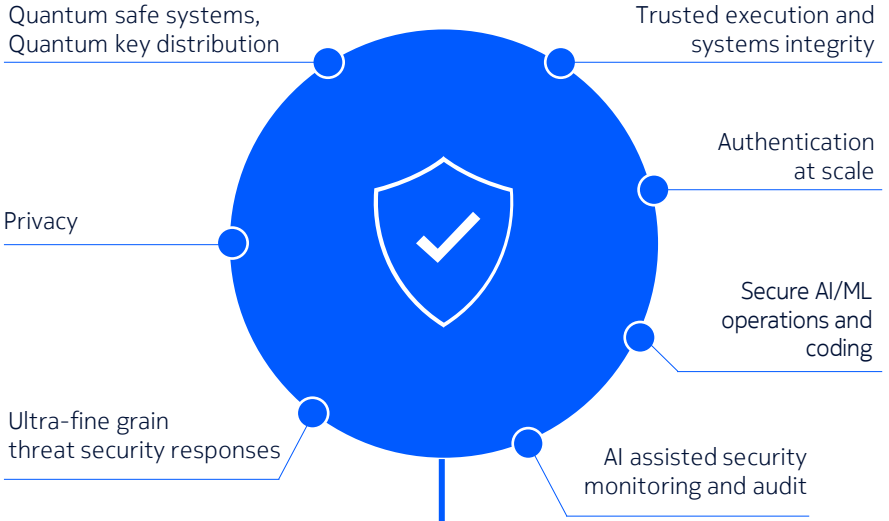
Addressing the ever-expanding threat landscape



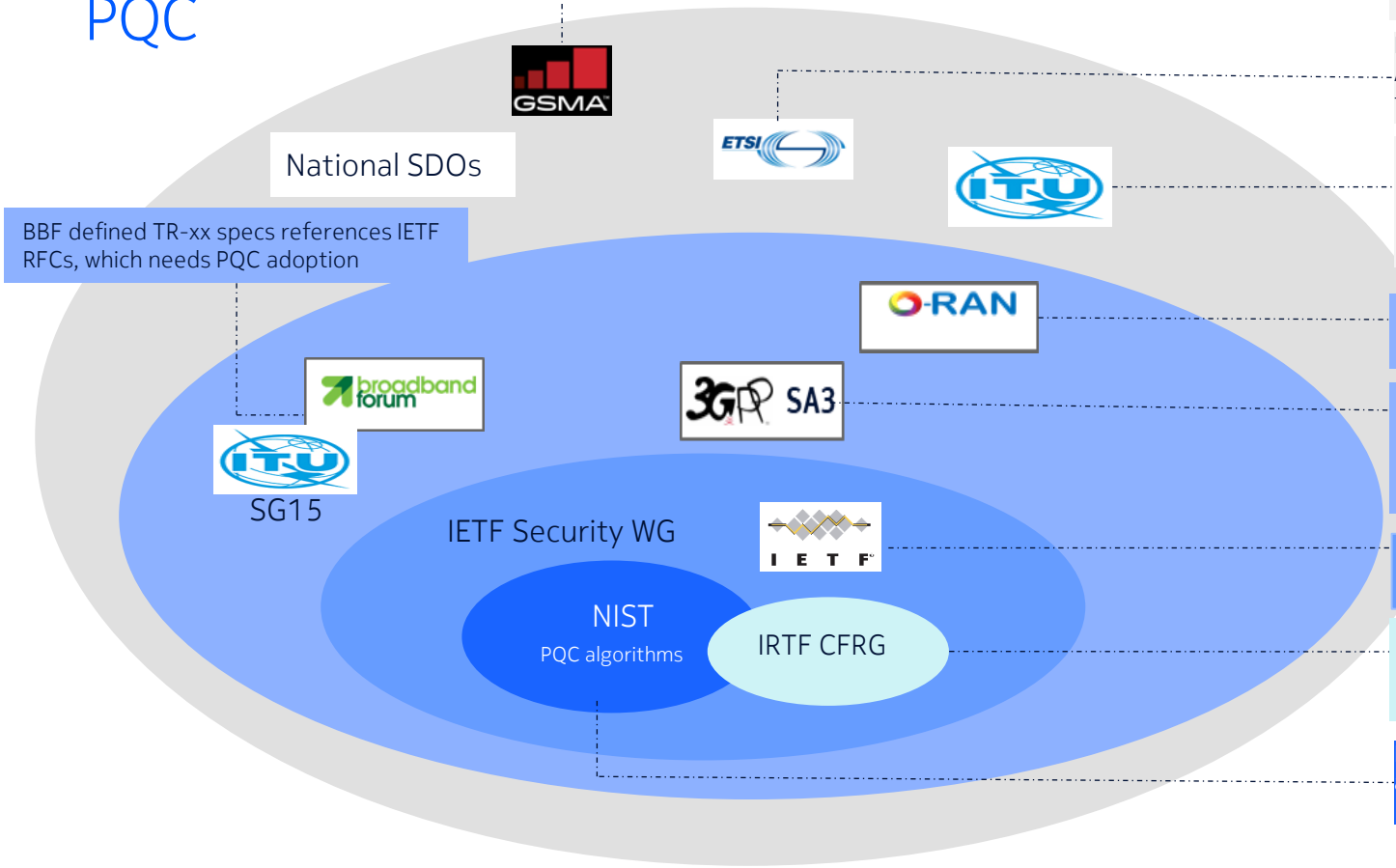
Threat vectors



Technology enablers



PQC



GSMA PQTN- prepare Telcos for PQC adoption. Publish WP/ Periodic reports

ETSI Quantum Safe Cryptography- Address threat to cryptographic techniques, make standards PQC ready

Focus Group on Quantum Information Technology for Networks (FG-QIT4N) provide a collaborative platform for pre-standardization aspects of QIT

ORAN referencing IETF RFCs need update

Updates 3GPP specifications with PQC algorithms. SA3 will adopt PQC IETF RFCs, also SA3 defined protocols are getting updated for PQC

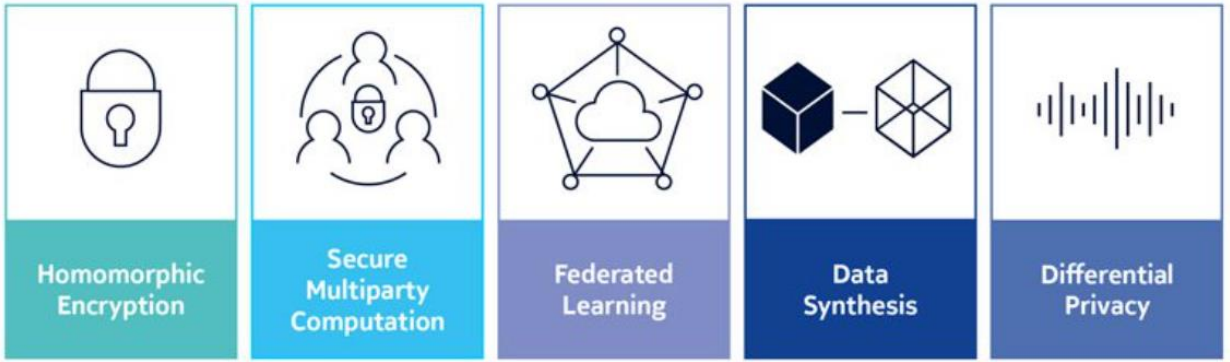
Shape the security landscape of the internet by developing standards

Cryptographic research, addressing challenges, proposing solutions, and providing guidance on (PQC) algorithms.

Defines Quantum safe asymmetric crypto algorithms for general use

Privacy

- **Homomorphic encryption**: directly compute on encrypted data with no need to decrypt
- **SMPC**: split data processing across the het-cloud, sub-networks and devices
- **Federated Learning**: train locally without sharing individual data
- **Data Synthesis**: replace real data points with synthetic ones
- **Differential Privacy**: adding noise to prevent individual inference

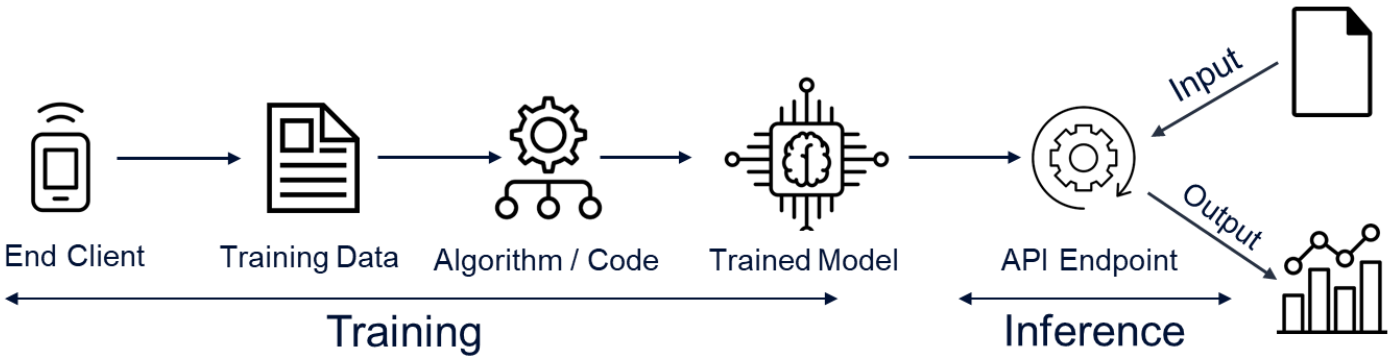


AI/ML Security

Model Poisoning
Attackers can tamper with model parameters sent via distributed end nodes resulting in perturbating the result of the global ML model

Data Poisoning
Malicious tampering of training data resulting in incorrect inferences by ML model

Inference Attack
Attackers query ML models via API endpoints and observe response to replicate model behavior and get insights regarding training data



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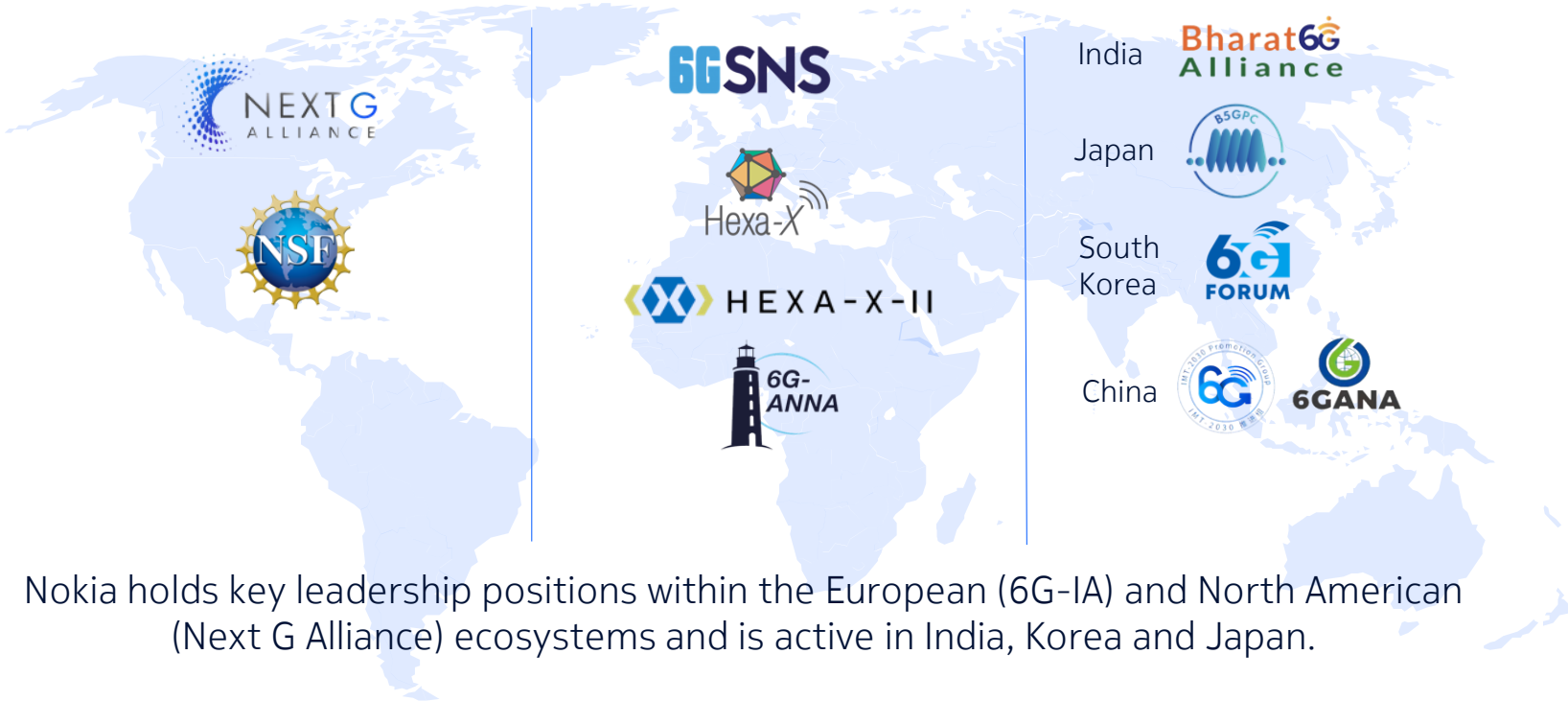
We are leading the way to make 6G a reality

PPP to create the architectural platform that will form the basis for 6G standardization

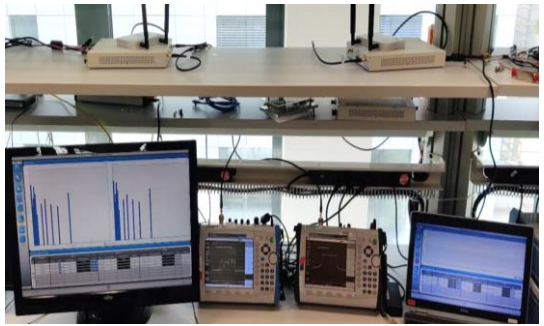


Nokia holds key leadership positions within the European (6G-IA) and North American (Next G Alliance) ecosystems and is active in India, Korea and Japan.

Experimenting with future technologies

Partnering with CSPs and industry peers

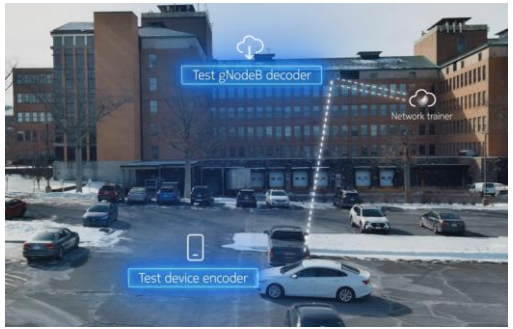
6G AI-native air interface



Joint 6G collaboration agreement signed

docomo NTT SK telecom

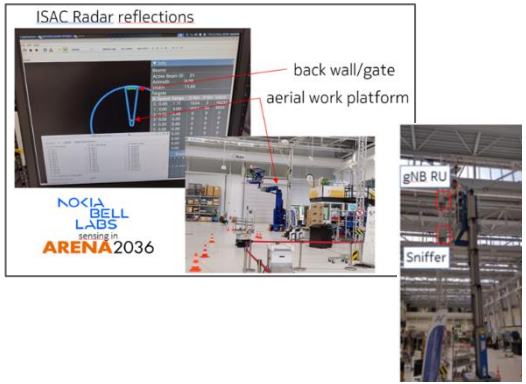
Wireless AI Interoperability



Joint research on AI-interoperability technology to boost wireless capacity and performance

Qualcomm

Integrated communications & sensing



Explore real world use cases in an industrial environment and a traffic scenario

BOSCH

ARENA2036

NOKIA

Creating the future through research collaborations

Working with the leading academia and research institutions

NYU TANDON SCHOOL OF ENGINEERING

Berkeley UNIVERSITY OF CALIFORNIA

PRINCETON UNIVERSITY

UC San Diego

TEXAS

Brooklyn 6G Summit

Communications Beyond 5G and into the 6G Era

A landmark industry event created by Nokia and the NYU WIRELESS research center in 2014, and rebranded in 2021.

Nokia is a member of 6G@UT, a funded collaboration between industry and University of Texas at Austin.

6G (@) UT

Aalto University

UNIVERSITY OF CAMBRIDGE

UNIVERSITY OF OULU

Inria

UNIVERSITY OF HELSINKI

cea

TECHNISCHE UNIVERSITÄT DRESDEN

université PARIS-SACLAY

imec

Technische Universität München

TUM

Institut Mines-Télécom

AALBORG UNIVERSITET

University of Stuttgart Germany

KU LEUVEN

Fraunhofer IESE

In May 2018, Nokia became co-creator member of University of Oulu 6G flagship program.

6G FLAGSHIP UNIVERSITY OF OULU

KOREA UNIVERSITY

東京大学 THE UNIVERSITY OF TOKYO

SOUTHEAST UNIVERSITY

XIDIAN UNIVERSITY

In October 2023, Nokia established a 6G Lab at its Global R&D center in Bangalore, India

NOKIA

6G is necessary to shaping the future of communications

6G is both evolutionary and revolutionary

Nokia is leading the charge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