6G – Connecting a cyber-physical world

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Agenda

6G Vision

6G Technologies

6G Research initiatives

6G Timeline

Evolution and long-term horizon
5G Advanced and 6G

2030 - Internet of senses

- Enhanced mobile broadband (MBB) [5G]

- Mobile extended reality (XR) [5G Advanced]
  - Augmented/Virtual/Merged reality
  - Time critical communication
  - Processing offload to edge cloud

- Immersive communication [6G]
  - Rich experience, interactive, high definition
  - Holographic communication
  - Intense requirements: rate, latency, compute

2030 - Connected intelligent machines

- Next level of advancements in digitalization of industries

- Industry 5.0 concepts
  - Complementary to Industry 4.0
  - Human-centric manufacturing
    - Collaborative robots (“cobots”)
    - Augmented operator
  - Digital twinning

2030 - Connected sustainable world

- Resource and energy-efficient networks
- Sustainability by connectivity
  - Smarter solutions, faster control loops for process optimization
    - E.g. based on ubiquitous sensor deployments
  - Evolution of education & covering unconnected communities
    - Remote learning, immersive communication
  - …

2030 – A digitalized and programmable world based on 6G

Human and society needs

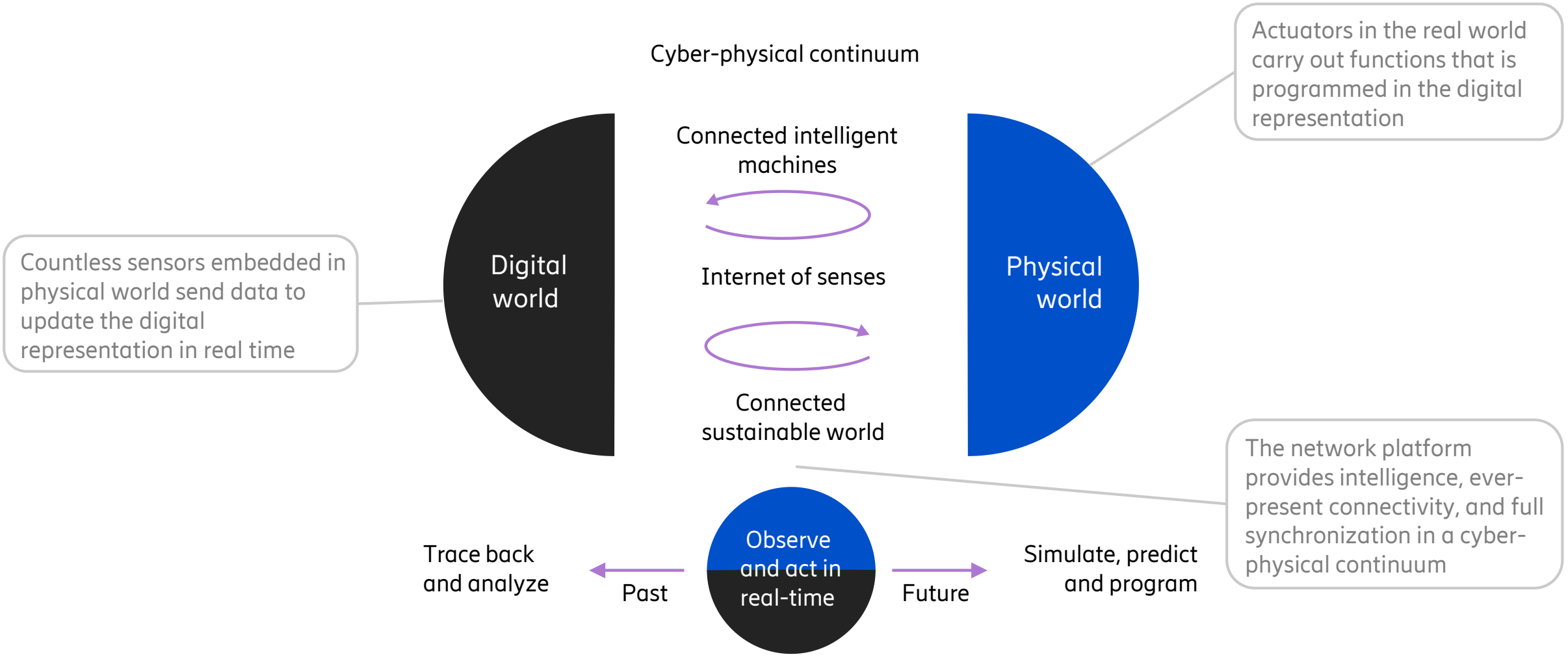
- The Internet of Senses
- Connected intelligent machines
- Connected sustainable world

Digitalized and programmable world

6G network platform

- Limitless connectivity
- Trustworthy systems
- Cognitive network
- Network compute fabric

Connecting a cyber-physical world



Connecting a cyber-physical world

Real incident

Cyber-physical continuum

Connected intelligent machines

Internet of senses

Connected sustainable world

Cyber-physical analysis

Digital world

Physical world

Preventive action

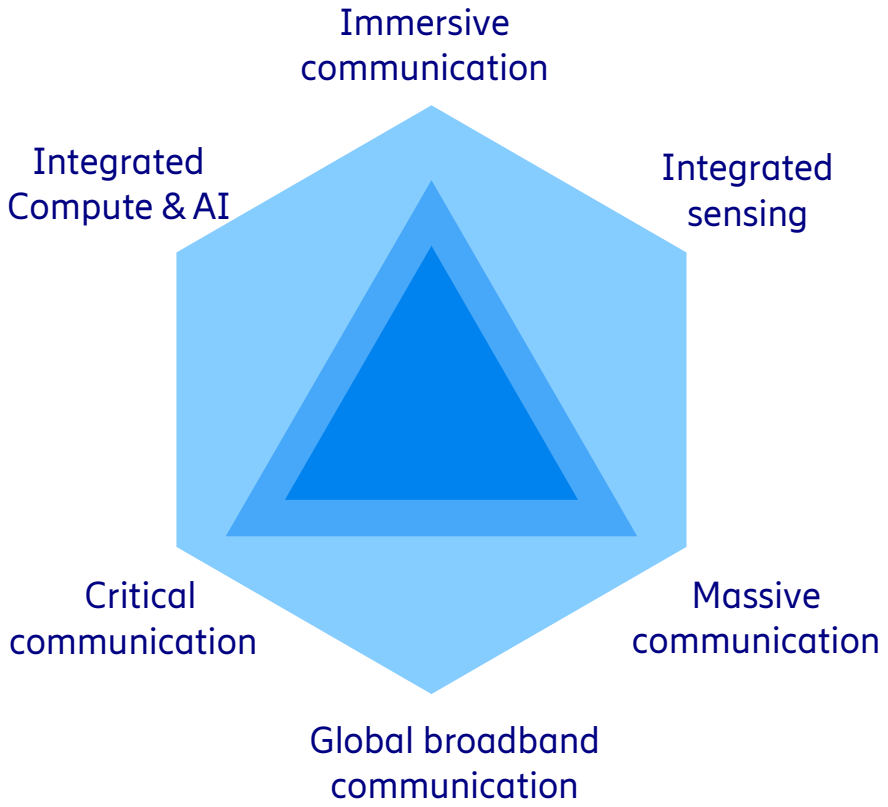
6G focus areas

Communication beyond 5G & Further enhanced MBB

Immersive communication – expanding eMBB

Critical communication – expanding URLLC

Massive communication – expanding mMTC



Beyond-communication networks

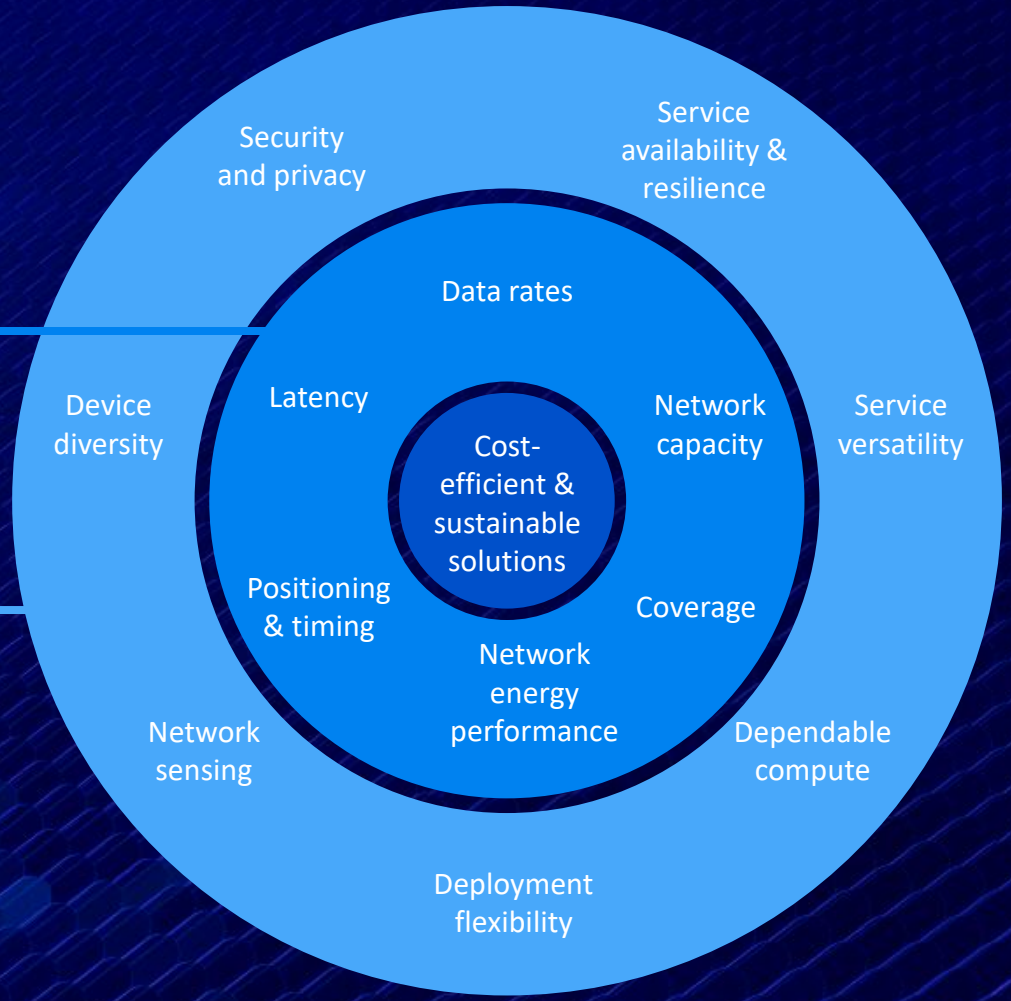
New services on 6G platform

Efficient network operations

Sustainability and trust imperatives

Needed capabilities

- Inner ring of classical capabilities to be enhanced in networks
  - Stretching 5G
- Outer ring of new dimensions to be addressed by networks
- Total cost of ownership at the core



Some technology trends

Hardware
Generic HW acceleration
New materials
Quantum technology

Open source
Higher reliance on
open-source components

Integrated AI
Widespread use of AI for
automation and cost-efficiency in
cognitive and data-driven networks

Cloud
Continued cloudification for cost/efficiency,
also in RAN, adapted
implementation/standard, programmability

Continuous evolution
Fast evolution of underlying tools
and development (DevOps)
at a higher pace

Internet evolution
Distributed resilient services,
evolving multi-path tailorable
transport and security

6G Radio Technology Components

(not exhaustive and not in priority order)

New Spectrum Bands

Waveform and Channel Coding

Duplex Flexibility

Distributed MIMO

Joint communication and sensing

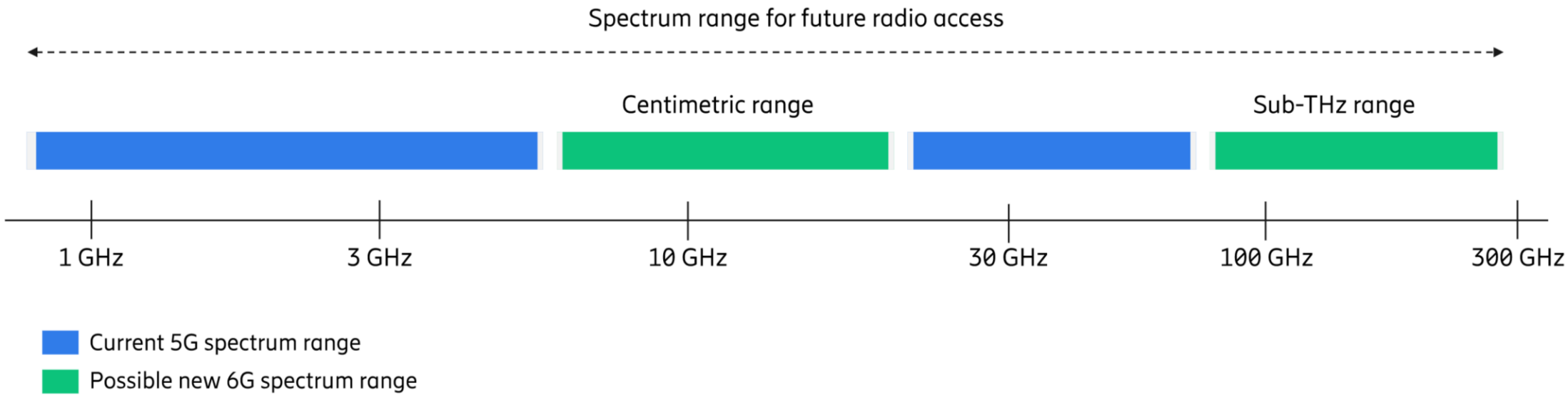
Reconfigurable intelligent surfaces

Satellites/non-terrestrial networks

AI and machine learning

"Zero-energy" devices

6G Spectrum



"Existing" spectrum

- sub-6 GHz important for coverage
- Dynamic spectrum sharing with 5G essential

"New" spectrum

- 7 – 20 GHz – highly relevant range
- "sub-THz" – for specific scenarios

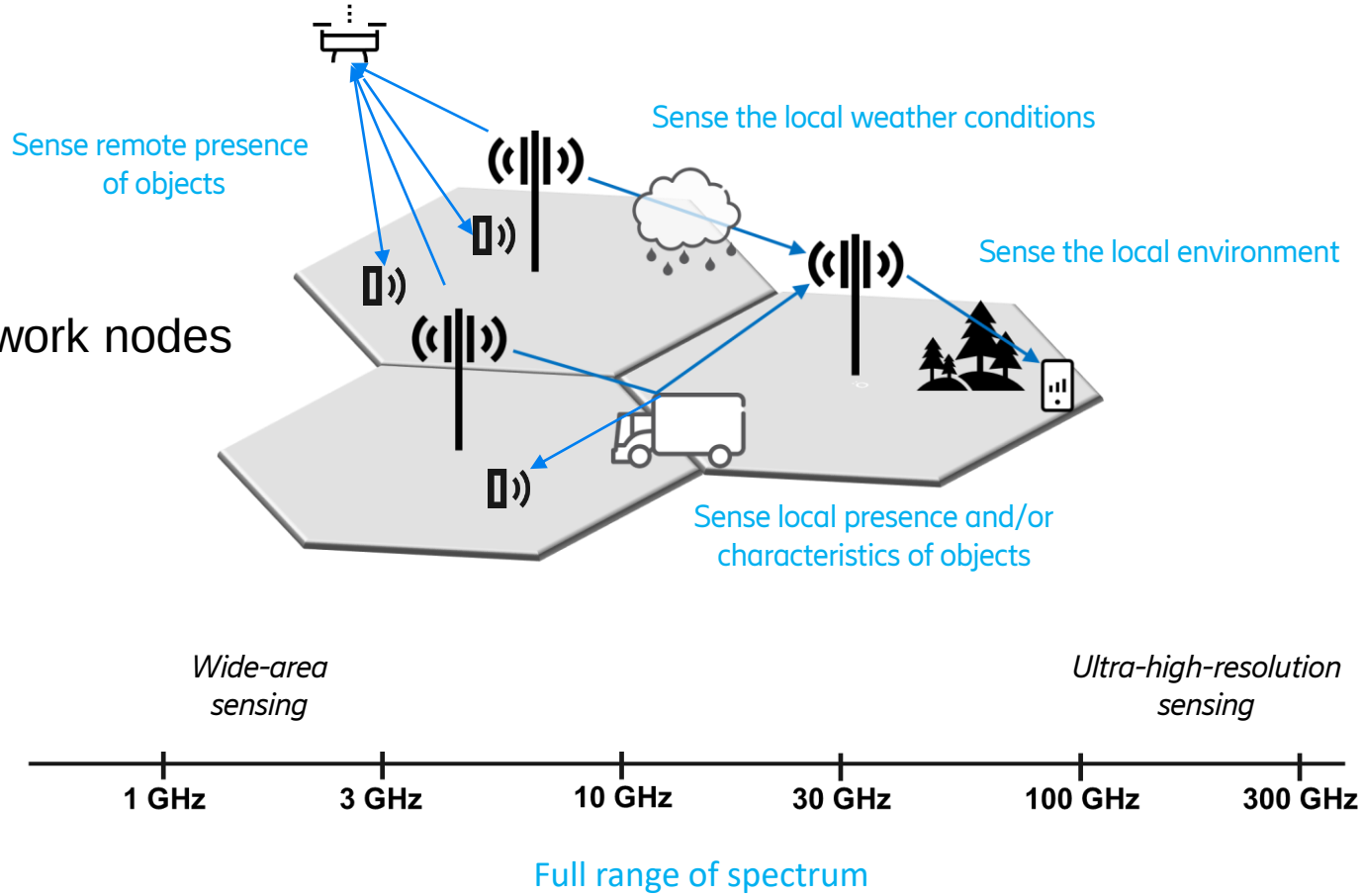
Joint communication and sensing (JCAS)

Sensing functionality as an *integrated* part of the communication network

- Reuse the communication spectrum & infra-structure for sensing

→ Low-cost introduction of sensing functionality

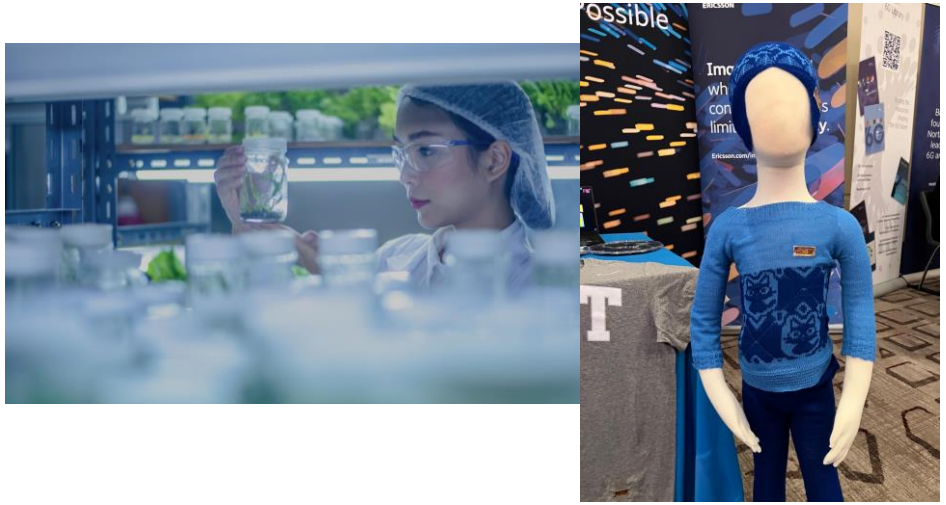
→ Benefit from huge number of co-operative network nodes



Multiple uses

- Enable new/enhanced end-user services
- Enhance the network performance

Zero-energy devices



Devices harvesting ambient energy

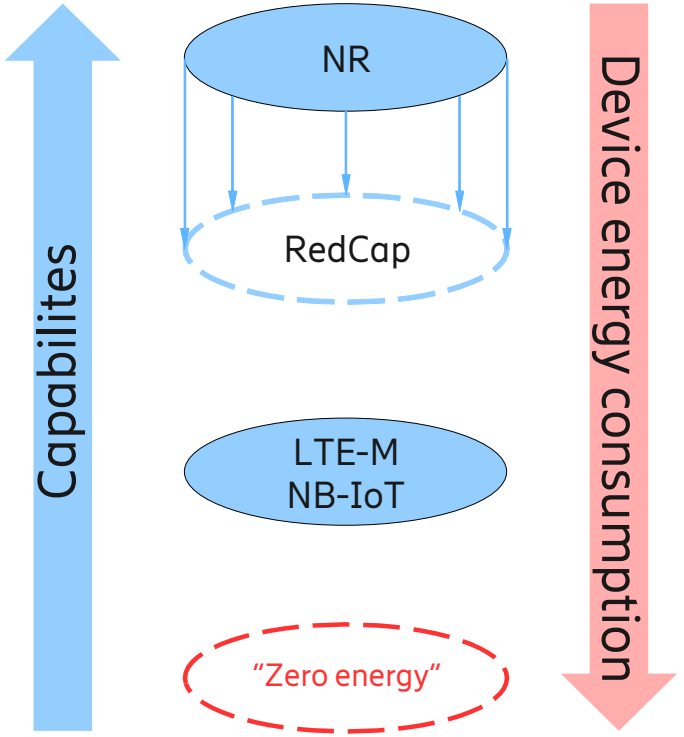
- "No need to change battery"
- Much smaller and cheaper than previous IoT generations
  - Sustainable asset trackers, sensors for mass deployment, on-body sensors, …

Much more extreme than today's NB-IoT/LTE-M devices

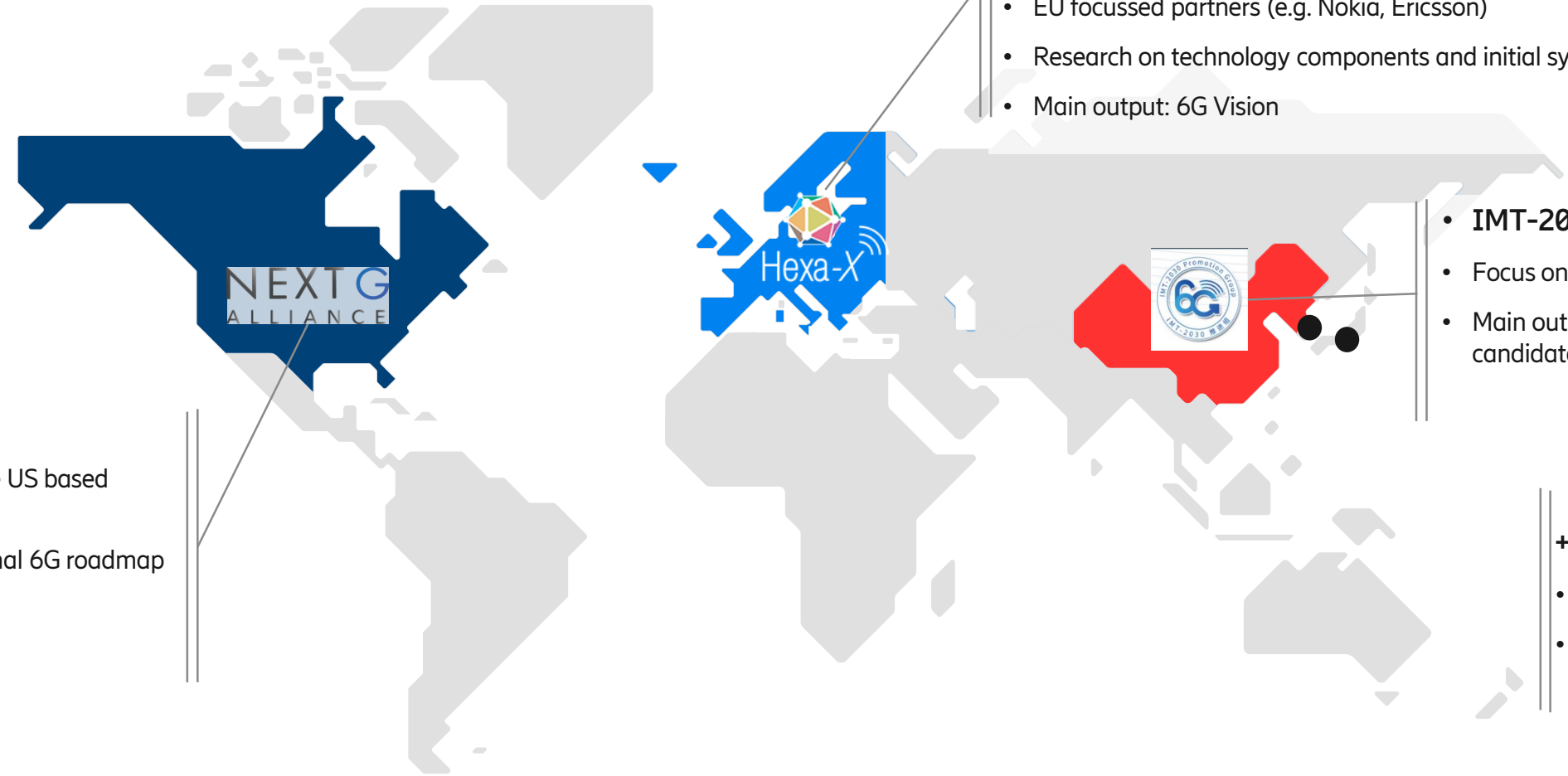
- not an incremental enhancement

Very small amounts of energy available

- Redesign of PHY, L2, security etc. required even when considering much lowered capabitlies



Main regional 6G initiatives



- **Next G Alliance**
- More than 60 active US based members
- Main output: National 6G roadmap

- **Hexa-X / Hexa-X II + national initiatives**
- Limited time projects
- EU focussed partners (e.g. Nokia, Ericsson)
- Research on technology components and initial systemization
- Main output: 6G Vision

- **IMT-2030 promotion group**
- Focus on Chinese community
- Main output: 6G Vision and candidate technologies

+ more initiatives

- E.g. Korea, Japan
- …

Ericsson & BMBF 6G program

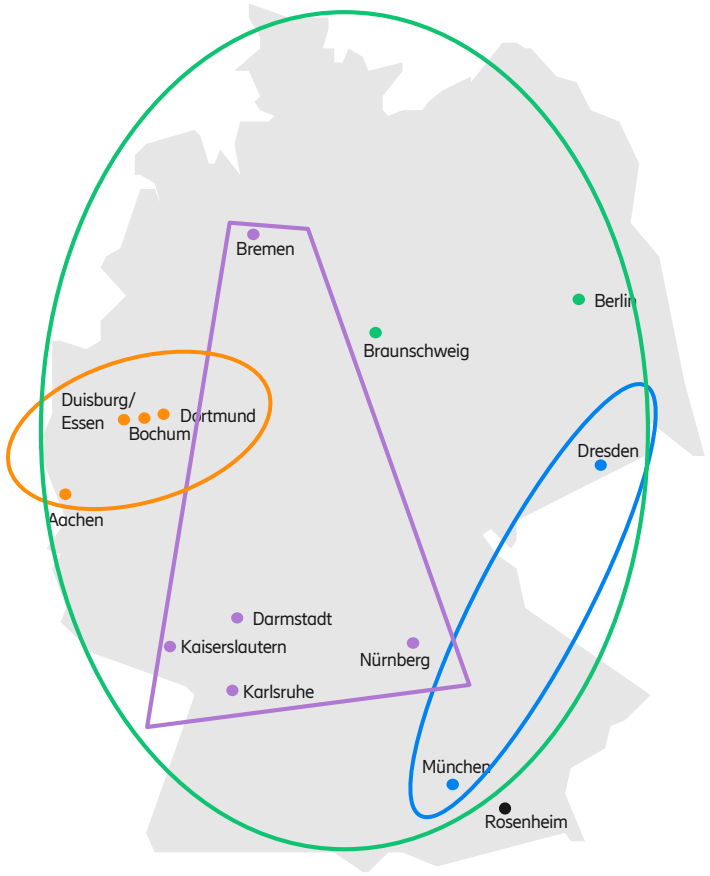
(BMBF: Federal ministry of education and research)

BMBF 6G Platform Germany

Interworking between 6G-Research Hubs and Industry Projects

Academic call:
6G-Research Hubs

- 6G-life
- 6G-RIC
- Open6GHub
- 6GEM



Industry call (incl. Ericsson):

- 6G-ANNA: Lighthouse 6G research project
- KOMSENS-6G: Joint Communication and Sensing
- 6G MassIMO: Distributed MIMO
- 6G LICRIS: Reconfigurable Intelligent Surface
- 6G TERAKOM: THz Antenna for D-Band (> 100 GHz)

+ many more (total 18 projects, 70 industry partners)

6G-ANNA

Federal Ministry of Education and Research

German 6G Lighthouse Project

01.07.22-30.06.2025

27M total funding by BMBF, ~80 FTEs

Work Packages:

- 6G Architecture
- 6G Access
- Network of Networks
- Automation & Simplification
- PoCs

6G-ANNA: Partners (34)

Lead: NOKIA (wp1 lead)

Industry (7)

ERICSSON (wp2 lead), AIRBUS SecureLandCom., SIEMENS, ROHDE&SCHWARZ, BOSCH, vodafone (wp3 lead)

SMEs & start-ups (8)

Mimetik, MESHMERIZE, blackned, PHYSEC SECURITY FOR THINGS, CADAMI, SMART MOBILE LABS (wp5 lead), wandelbots, aim

Research Institutes (3)

Fraunhofer HHI, Fraunhofer IPT, Fraunhofer AISEC

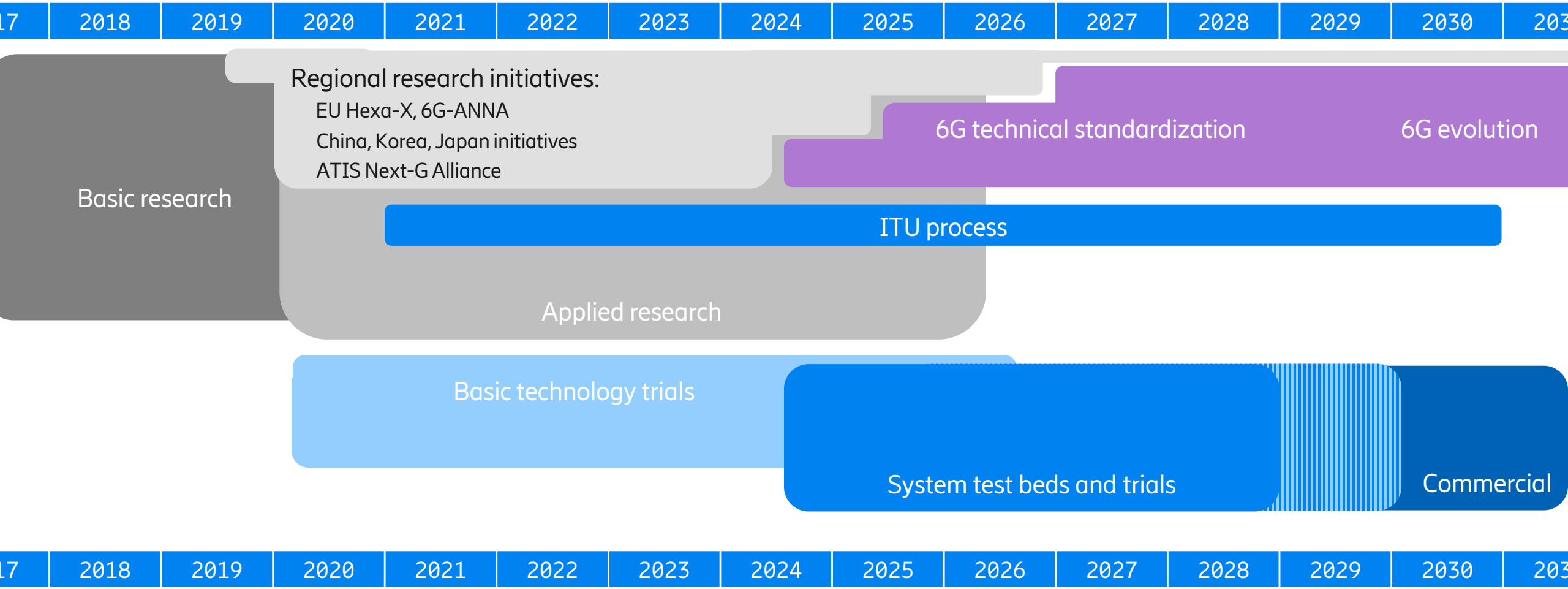
Universities (12)

TECHNISCHE UNIVERSITÄT DRESDEN 2x, KIT, TECHNISCHE UNIVERSITÄT KAISERSLAUTERN, Universität Bremen, FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG, TECHNISCHE UNIVERSITÄT MÜNCHEN 3x, TUHH Technische Universität Hamburg, RWTH AACHEN UNIVERSITY 2x, Technische Universität Braunschweig (wp4 lead), OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG, RUHR UNIVERSITÄT BOCHUM RUB, technische universität dortmund

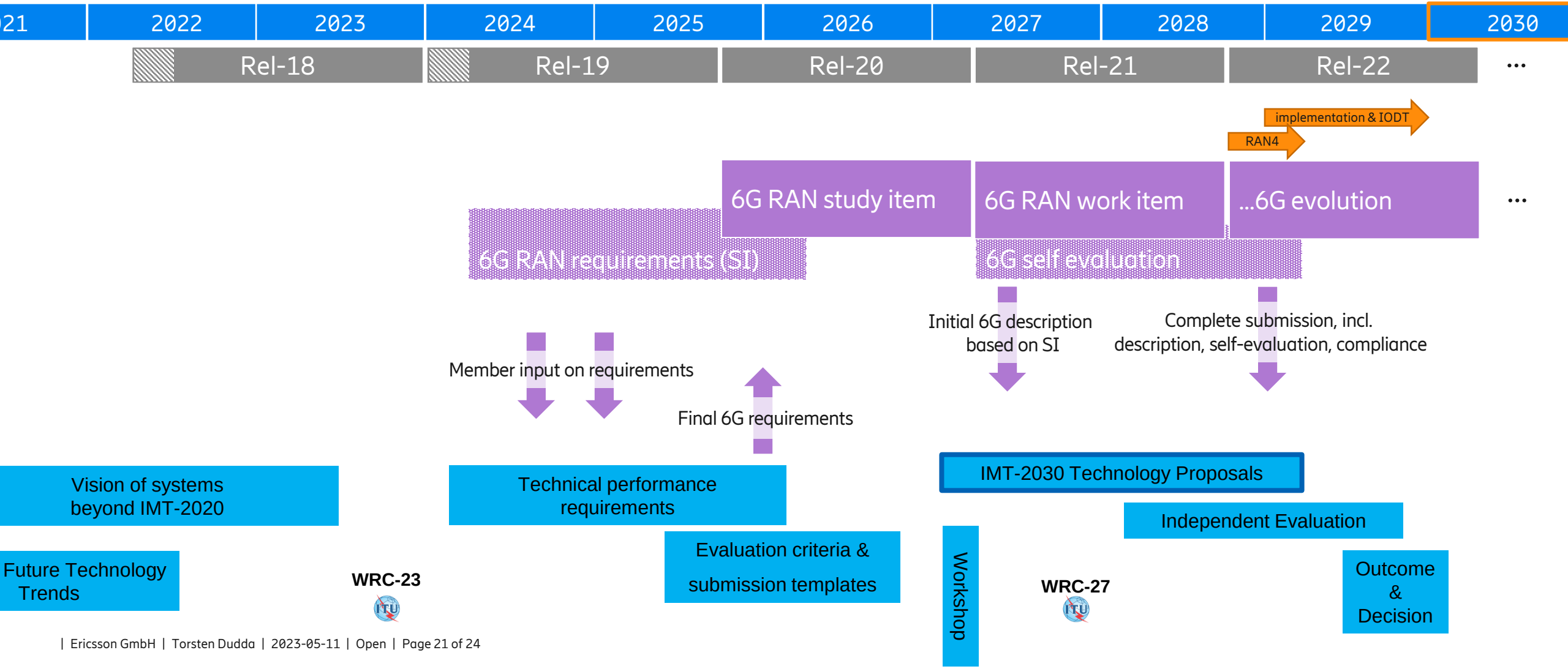
Associated (4)

Einhell, SAP, Mercedes-Benz, AIRBUS Defense&Space

6G industry timeline



6G timeline: 3GPP – ITU - WRC



Conclusions

- Connecting the physical and digital worlds is fundamental for advanced use-cases in 2030
- 5G networks will be the base for exploring and developing new 6G applications
- New technology components are being researched – many new capabilities to be integrated into future 6G networks
- 6G requirement work will start in 3GPP in 2024
- Valuable input from projects like HEXA-X, HEXA-X II, 6G-ANNA, + more


ericsson.com/6g

References

- Ericsson whitepaper, Connecting a cyber-physical world, February 2022, [link]
- Ericsson whitepaper, 6G spectrum - enabling the future mobile life beyond 2030, March 2023, [link]
- Ericsson blog, Near-immortal devices and a sustainable deploy-and-forget future, February 2022, [link]
- Hexa-X, Targets and requirements for 6G – initial E2E architecture, March 2022, [link]