6G-ANNA

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A perspective from the German 6G Lighthouse Project

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6G series workshop by Hexa-X-II

February 13th, 2024

6G-Access, **N**etwork of **N**etworks, **A**utomation & Simplification (6G-ANNA)

6G ANNA - Ambitions

- **Strengthen and push** German and European industry
- **Enable** dissemination by industry
- **Drive** global pre-standardization activities from a German and European perspective
  - Set up a “System Engineering Gremium” (SEG)
  - Support other German 6G projects (aligned with 6G Platform)
- **Strengthen and push** German and European technology sovereignty

Support interaction with other national and international activities:

- German 6G Platform, 6G Hubs and industry projects
- European projects: Hexa-X-II, EC SNS JU, …
- National 6G programs: Finland, Spain, Sweden, France, …
- International 6G programs: Next G Alliance, IOWN, …

Begin: 01.07.2022 / **Duration:** 3 years

Project Partners

Industry
- Nokia
- Airbus
- Bosch
- Ericsson
- Rohde & Schwarz
- Siemens
- Vodafone

SMEs
- AIN
- Blackned
- Cadami
- Meshmerize
- Mimetik
- PHYSEC
- Smart Mobile Labs
- Wandelbots

Research Institutes
- Fraunhofer AISEC
- **Fraunhofer HHI**
- Fraunhofer IPT

Universities
- FAU Nürnberg Erlangen
- KIT
- Ruhr-Universität Bochum
- **RWTH Aachen – ICE**
- RWTH Aachen – INDA
- TU Braunschweig
- TU Dortmund
- TU Dresden – MNS
- **TU Dresden – ComNets**
- TU Hamburg Harburg
- **TU Kaiserslautern**
- **TU München – LKN**
- TU München – LMT
- TU München – NET
- U Bremen
- U Magdeburg

Associated partners
- Airbus
- Einhell
- Mercedes-Benz

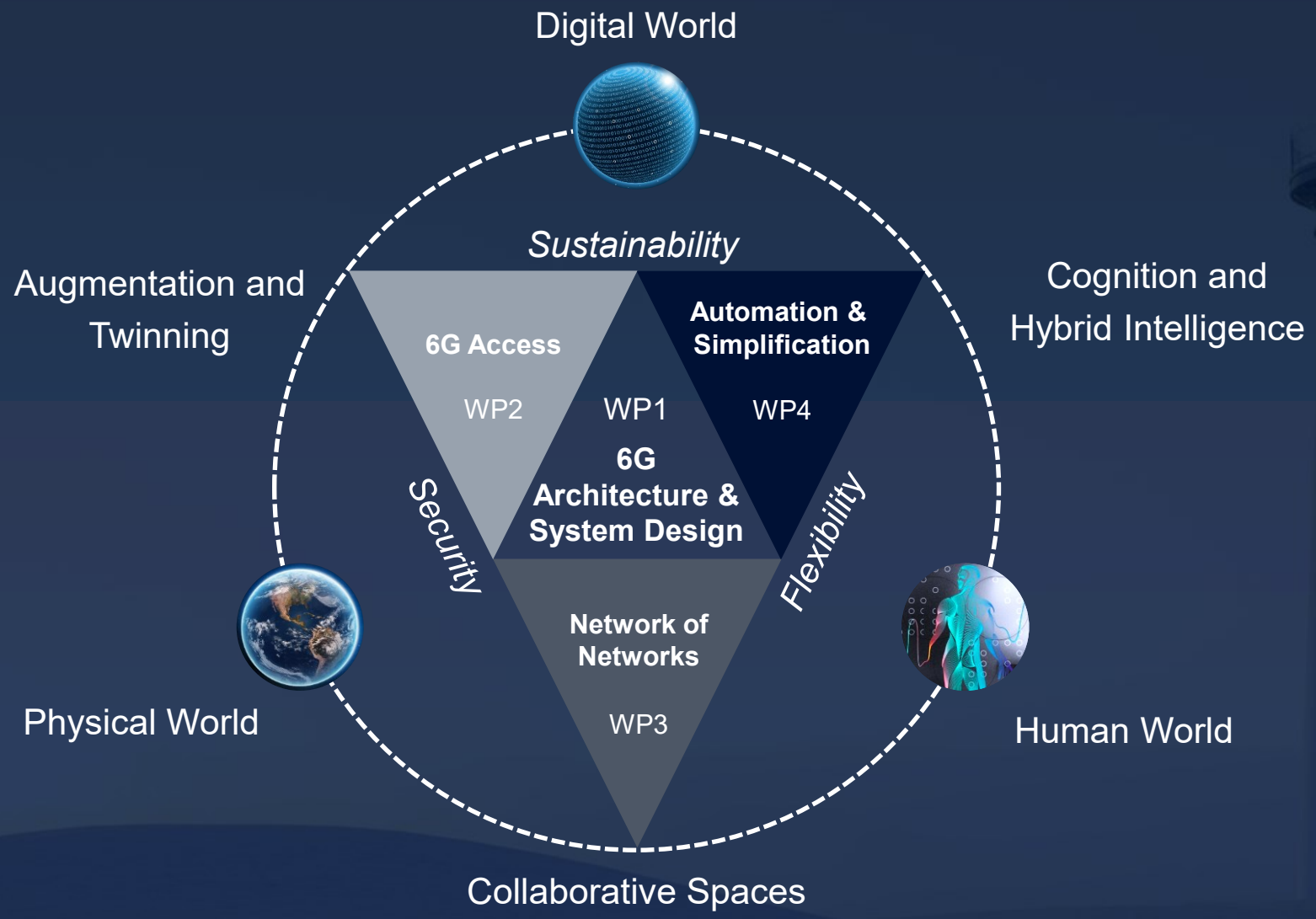
Project Context and Vision – Connecting the Worlds

Physical World

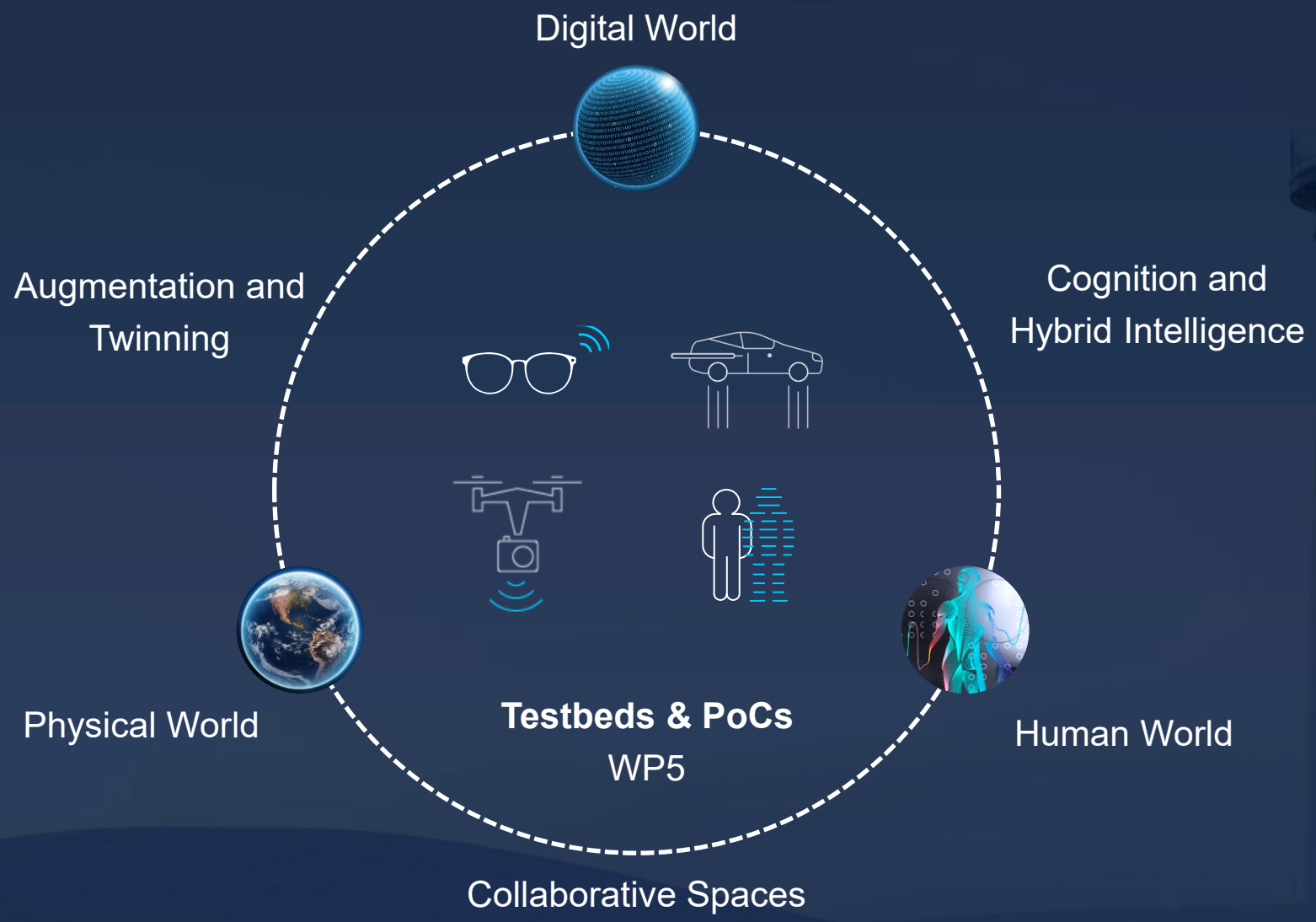
Human World

Digital World

Project Context and Vision – Connecting the Worlds



Project Context and Vision – Connecting the Worlds



WP1 – 6G Architecture and System Design – Objectives

Use cases and requirements

- *Evaluation of existing use cases & requirements*
- *Extension with project-specific areas and details*
- *One focus is on enabling sustainability for other industries (6G handprint)*

Secure e2e architecture & system design

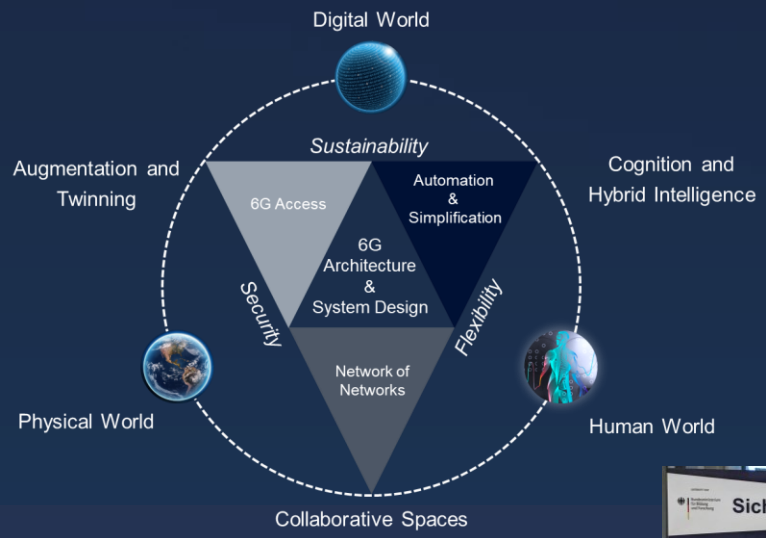
- *Functional 6G architecture definition based on WP2-4 results*
- *Security architecture based on WP1 threat and risk analysis*

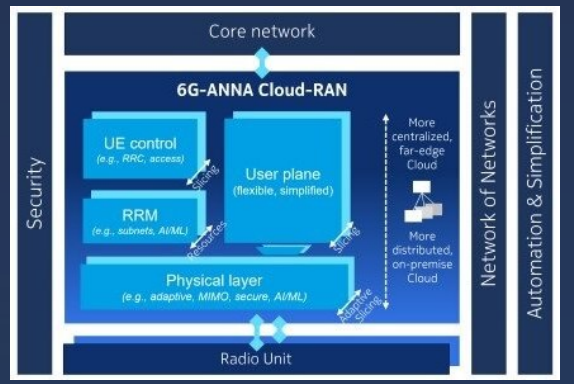
Sustainable 6G

- *Increased sustainability / energy efficiency (6G footprint) compared to 5G*

6G System Engineering Gremium

- *6G-ANNA results and findings are prepared for and contributed to 6G (pre-) standardization*



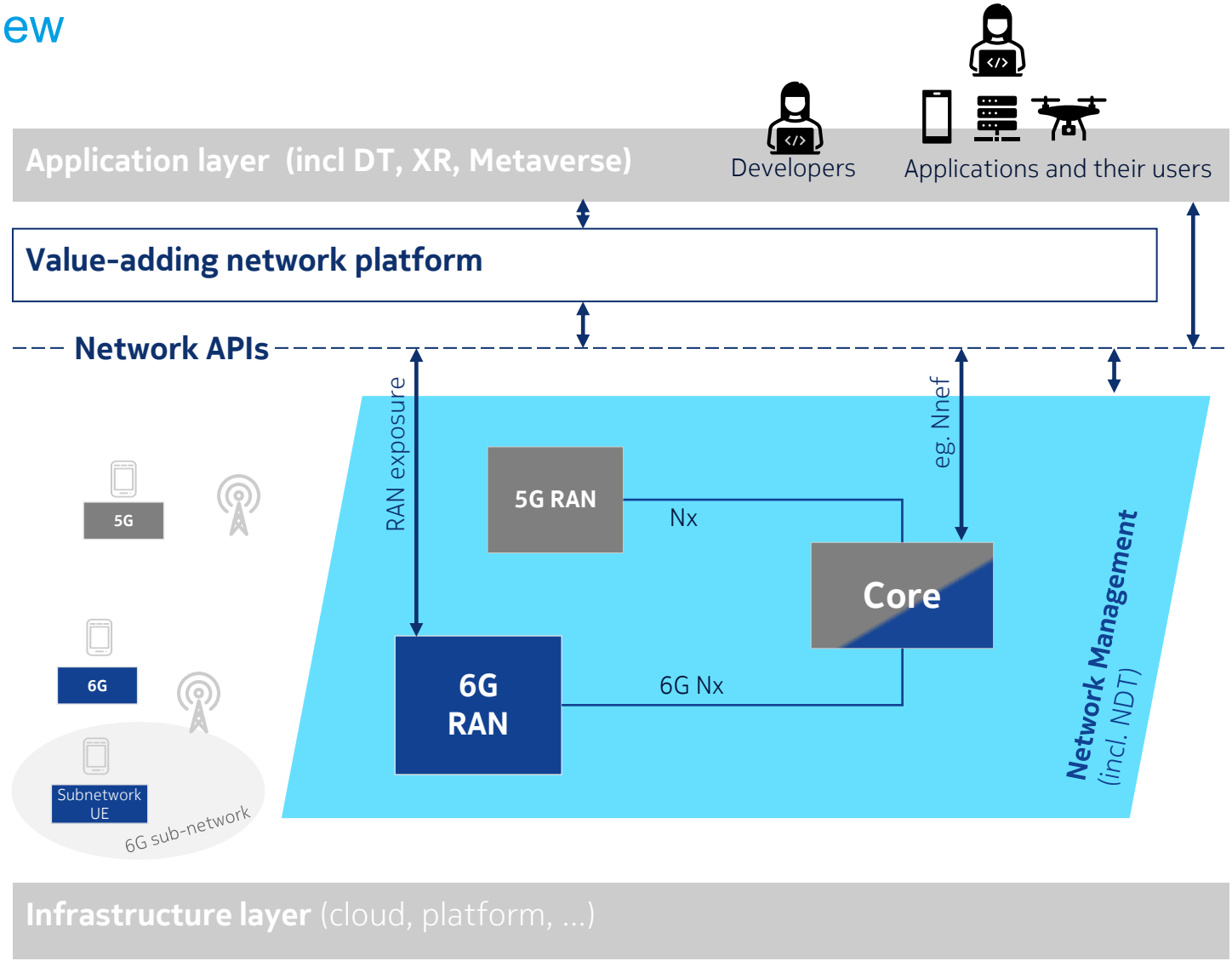


Source: M. Hoffmann *et al.*, "A Secure and Resilient 6G Architecture Vision of the German Flagship Project 6G-ANNA," in *IEEE Access*, vol. 11, pp. 102643-102660, 2023, doi: 10.1109/ACCESS.2023.3313505 : link

Source: 6G-ANNA 6G security poster @ Sicherheit für 6G (German national conference on IT security), Berlin, Germany : link

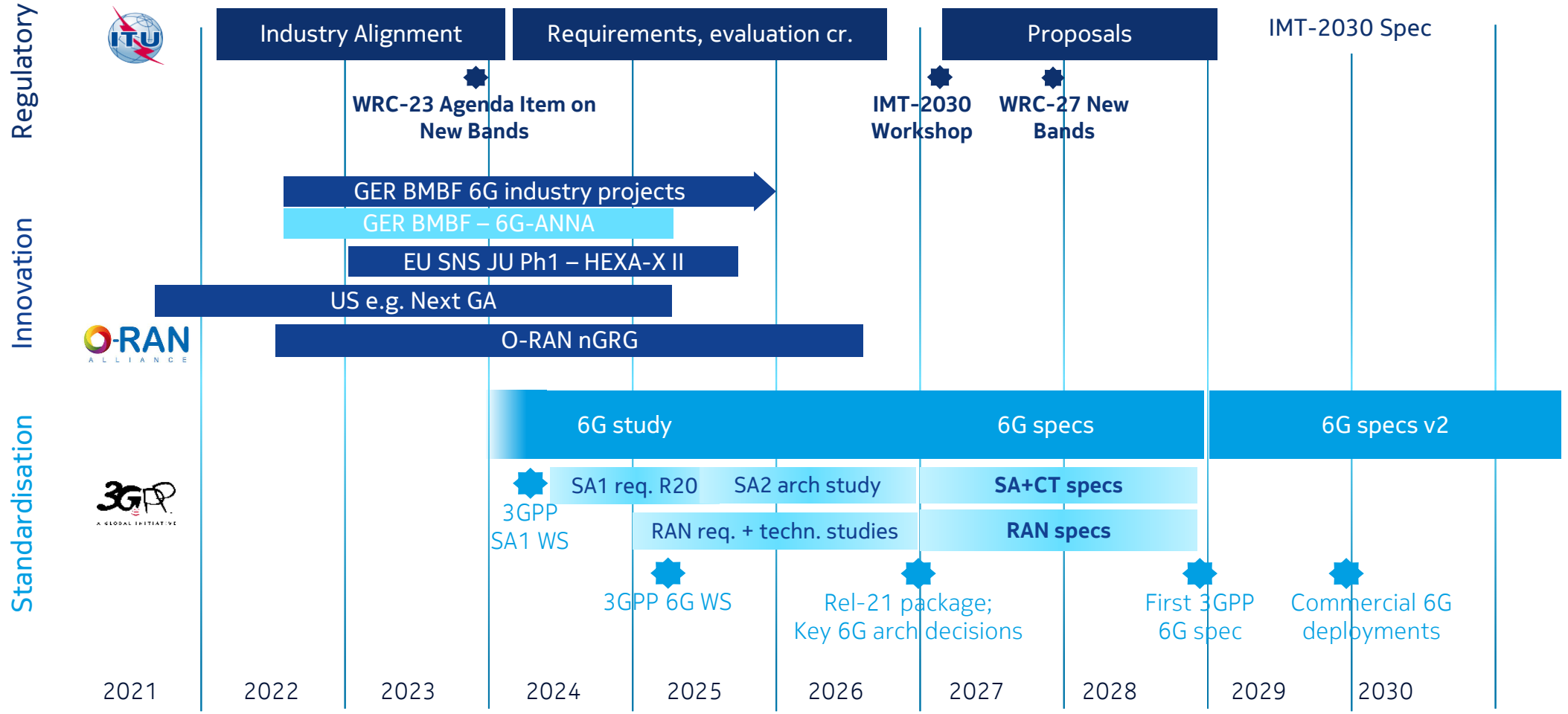
6G functional architecture

Initial 6G-ANNA view



6G timeline

Milestones of 6G standardization



Note : 3GPP timeline / milestones of 6G standardization is 6G-ANNA's view.
Note: Future O-RAN release planning still under discussion

WP2 – 6G-Access – Objectives

Dedicated Session on Wednesday morning

Task 2.1: Access Overview, Interworking & Spectrum Usage

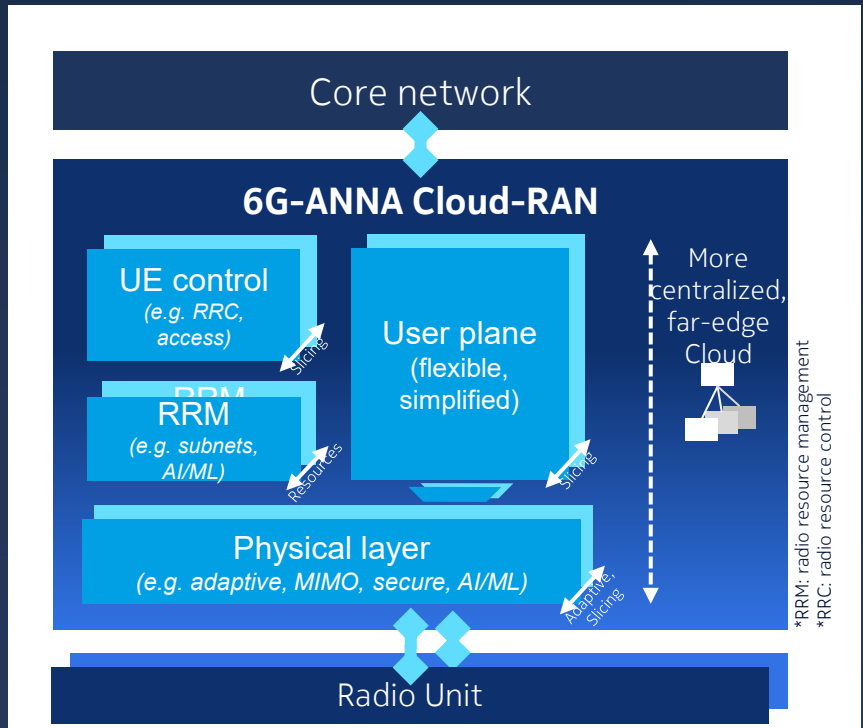
- *Breakdown of use-case requirements for the 6G access with input from relevant projects, e.g., 6G-Hubs, Hexa-X*
- *Evaluation of 6G spectrum options and migration solutions towards 6G*

Task 2.2: Flexible, Secure & Harmonized PHY

- *Concepts for physical layer design, including programmability and inclusion of AI*
- *Development of next-generation distributed MIMO solutions*
- *Integration of concepts for physical layer security*

Task 2.3: RAN Protocols & Cloud-Based Architecture

- *Concepts for RAN protocol design, user-/control plane and mobility*
- *Development and evaluation of concepts for AI into radio resource management aspects*
- *Development of solutions for RAN virtualization and Cloud RAN.*



High-level 6G Cloud-RAN architecture

WP3 – Network of Networks – Objectives

Secure and reliable flexible topologies

Task 3.1: 6G sub-networks

- *Integration aspects of mobile & dynamic 6G sub-networks and D2D communication in various scenarios*
- *Integration aspects of access technologies, identity, authentication with AI control*
- *Optimization of energy consumption, cost, availability, reliability, security*
- *Combination of licensed and unlicensed spectrum*
- *Design and optimization of access networks, data center interfaces and edge clouds*

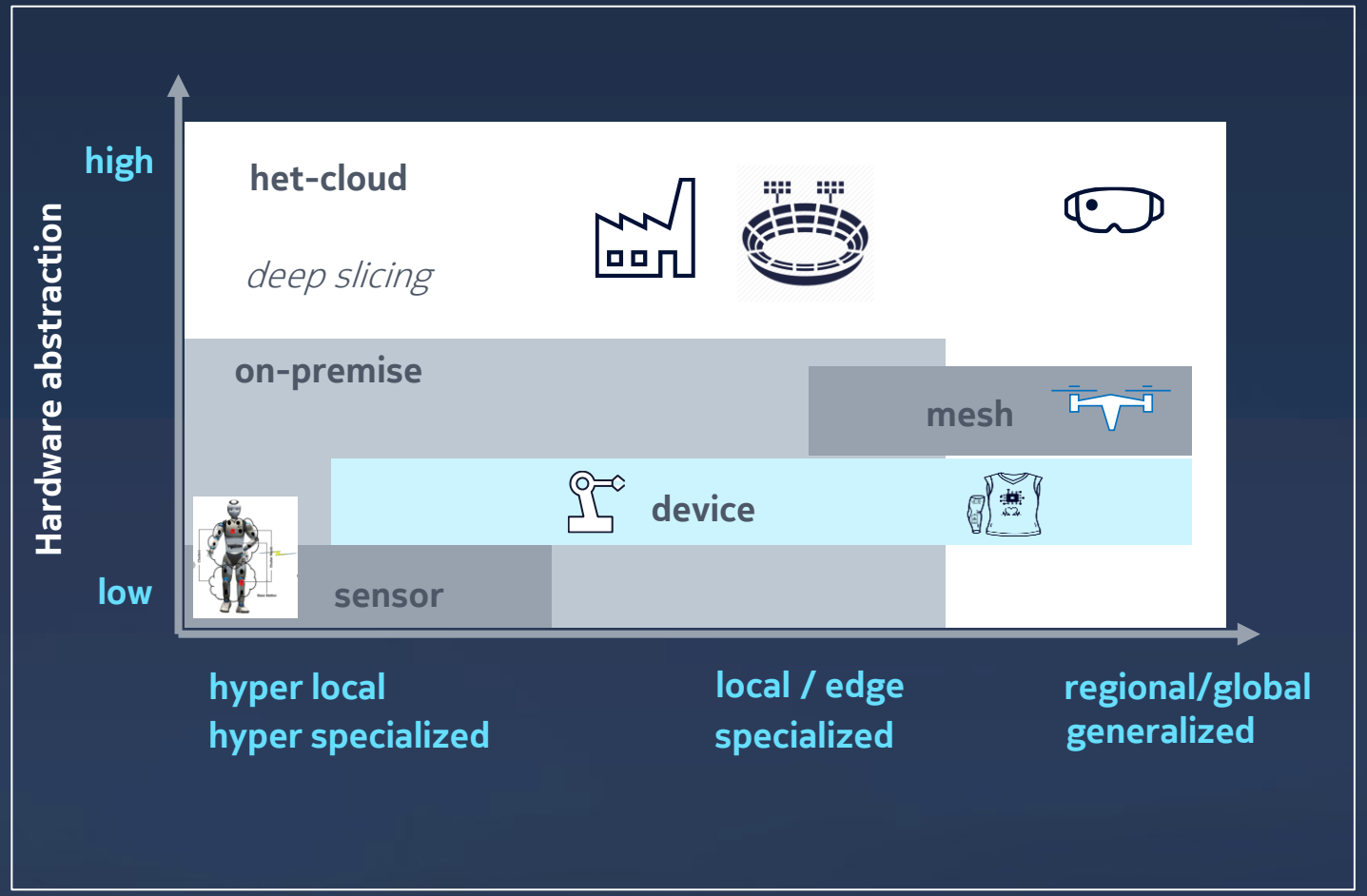
Task 3.2: Security & Resilience

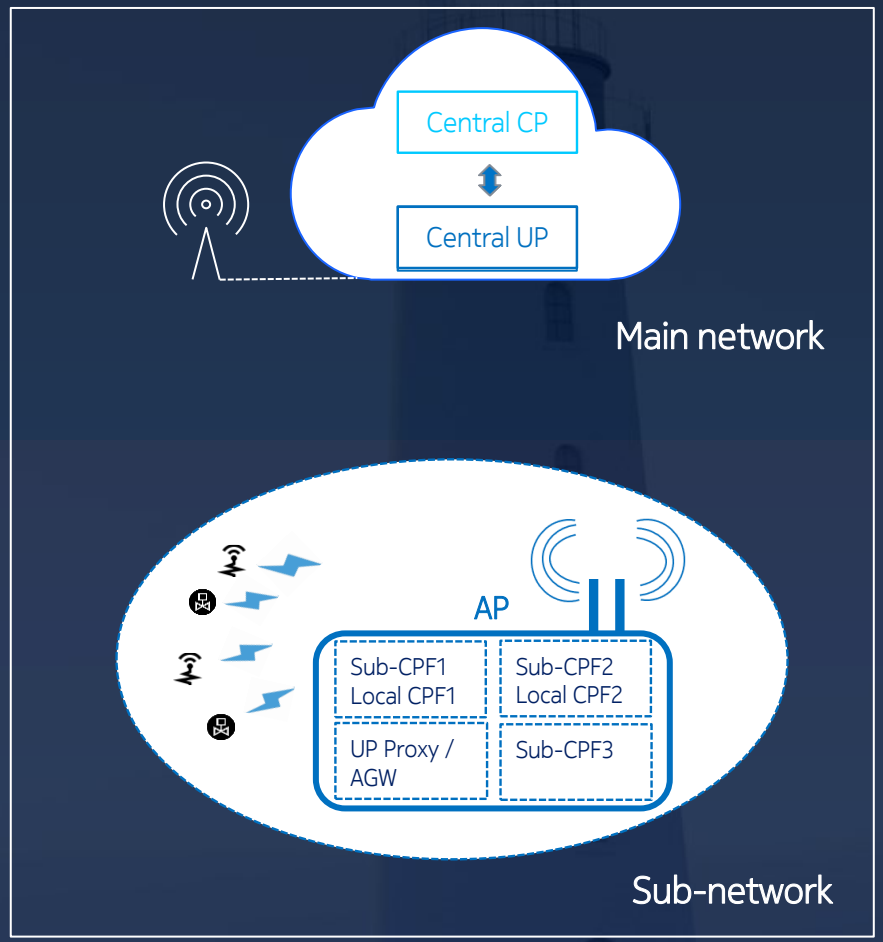
- *Resiliency through Autonomous subnets, Information Centric networking (ICN), fallback, AI in Radio Resource Management, opportunistic re-optimization of networks*
- *Security and Trustworthiness (including multicloud)*

6G Network of Networks

- *Flexible*
- *Reliable*
- *Secure*

6G Access and Network of Networks – 6G sub-Networks





Local specialized performance in co-operation with wide area functionality

WP4 – Automation & Simplification – Objectives

Task 4.1: Management & Orchestration

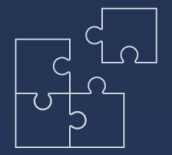
- *Developing data-driven reconfigurable and robust resource management and control in 6G architectures with high level of network security*

Task 4.2: Digital Twins & Extended Reality (XR)

- *Developing and leveraging (real-time) digital twins including required 6G interfaces and compression as well as support of XR applications in 6G*

Task 4.3: Distributed Applications & Artificial Intelligence

- *Development of methods & tools to enable distributed applications that include the usage of neural networks, distributed over network devices*



Task 4.4: Sustainability & Trustworthiness

- *E2E energy minimization / sustainability*
- *Trustworthy / reliable / explainable AI in mobile networks*

Automation & Simplification – Digital Twins

A **Geospatial Digital Twin Type 1** is a (photo-realistic) digital twin of, e.g., buildings, machines, and can be used for simulation.

A **Digital Shadow (DS)** is a virtual replica of a real-world system, where changes of the real-world are updated in the DS (one way).

A **Network Digital Twin Type 1 (NDT)** is a digital shadow, whose physical counterpart is a communication network.

A **Geospatial Digital Twin Type 2** is a **real-time** digital twin of the environment.

A **Digital Twin** (DT) is a virtual replica of a real-world system, on which operations can be performed (bidirectional).

A **Network Digital Twin Type 2 (NDT)** can additionally make operational decisions and drive those on the physical system.

Merging the worlds by integrated and spatial twinning for the industrial metaverse

Making it real – Mobility Metaverse

6G-ANNA Proof of Concept from Bosch & Nokia

6G sub-networks

- Local sub-networks operated in co-ordination with wide area policies (interference management, traffic authorization)
- Protocol proxy / AGW converts internal to external protocols

Integrated and Spatial Digital Twinning

From digital shadows to integrated real-time digital twins of physical environments, sensors, and networks

PoC demonstrated i.a. at Digital Gipfel

(summit on digital transformation organized by German government)

November 20, 2023 in Jena, Germany

Thank You!

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6G Platform WG7 “Architecture” lead

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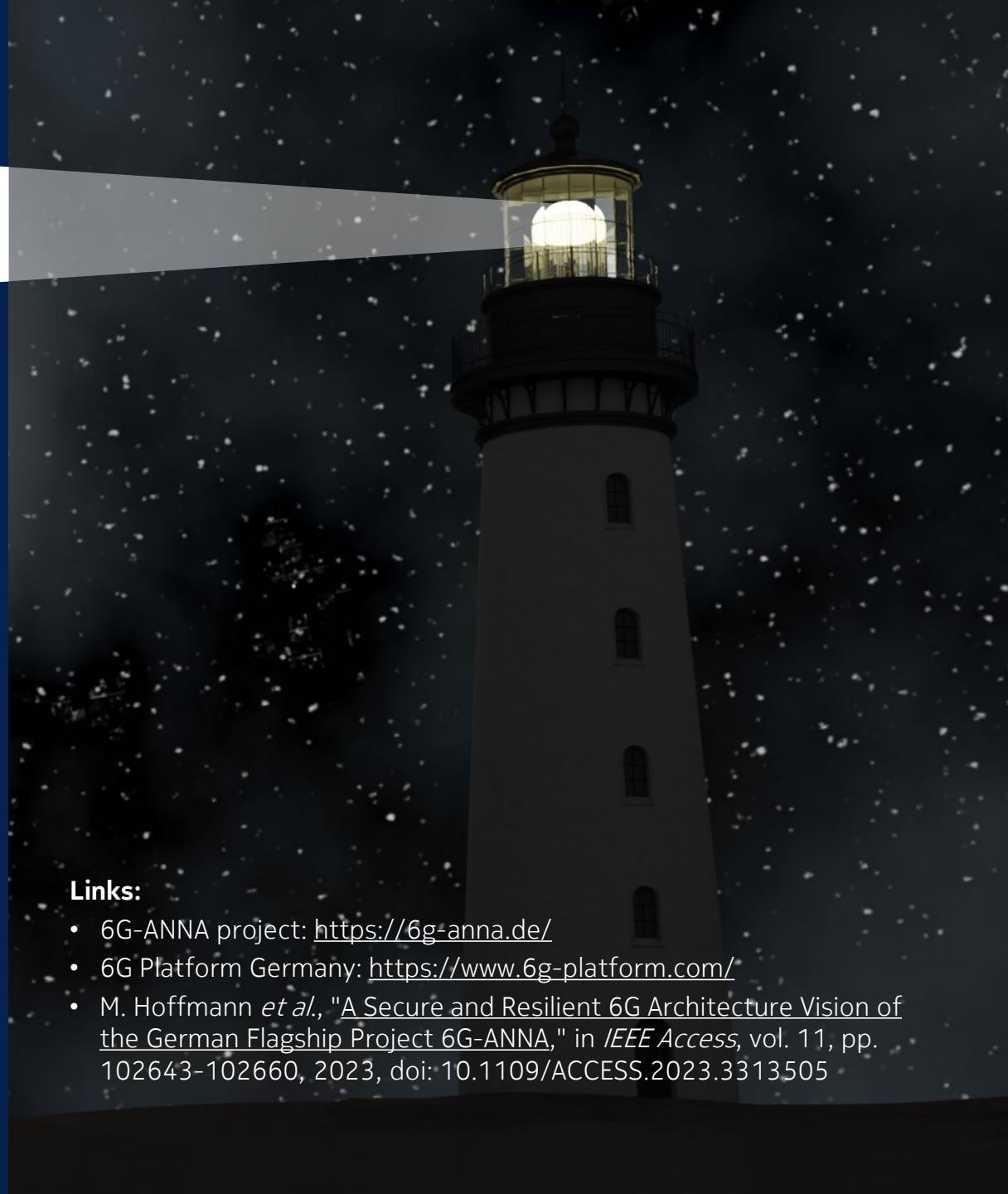

Links:

- 6G-ANNA project: https://6g-anna.de/
- 6G Platform Germany: https://www.6g-platform.com/
- M. Hoffmann *et al.*, "A Secure and Resilient 6G Architecture Vision of the German Flagship Project 6G-ANNA," in *IEEE Access*, vol. 11, pp. 102643-102660, 2023, doi: 10.1109/ACCESS.2023.3313505