Update from Hexa-X-II and global alignment

EuCNC & 6G Summit June 2025

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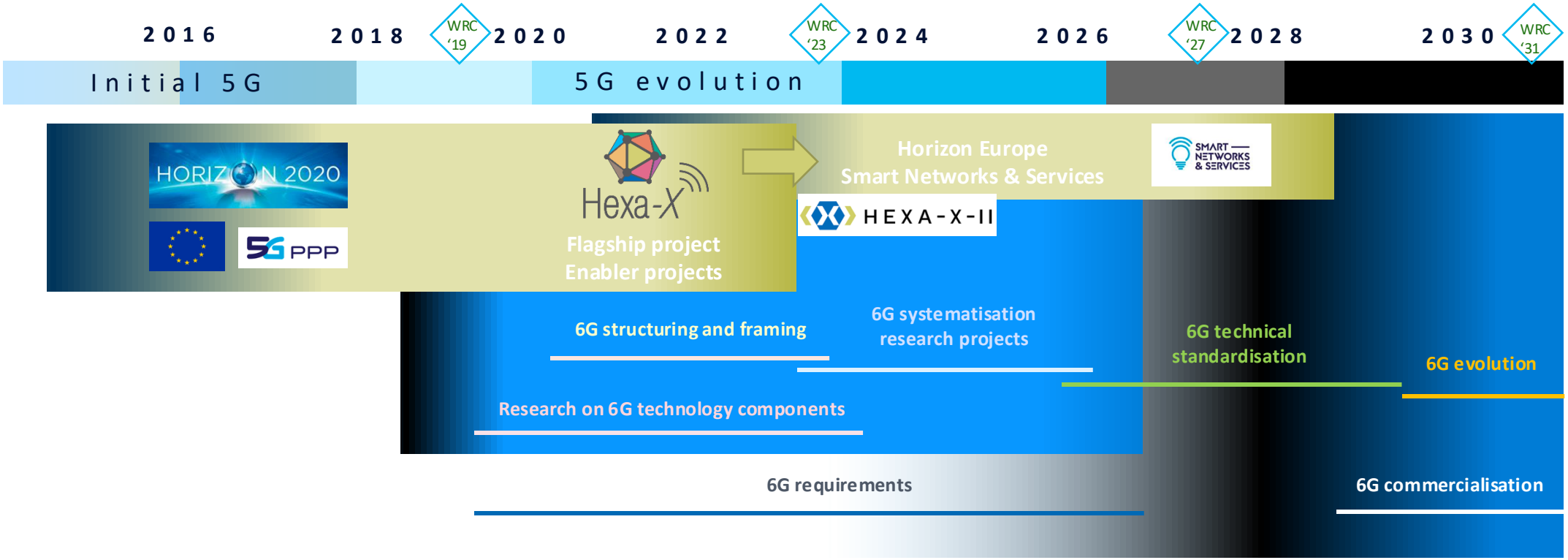
Hexa-X-II

hexa-x-ii.eu

Hexa-X-II European 6G Flagship
Consortium covering the entire value stack

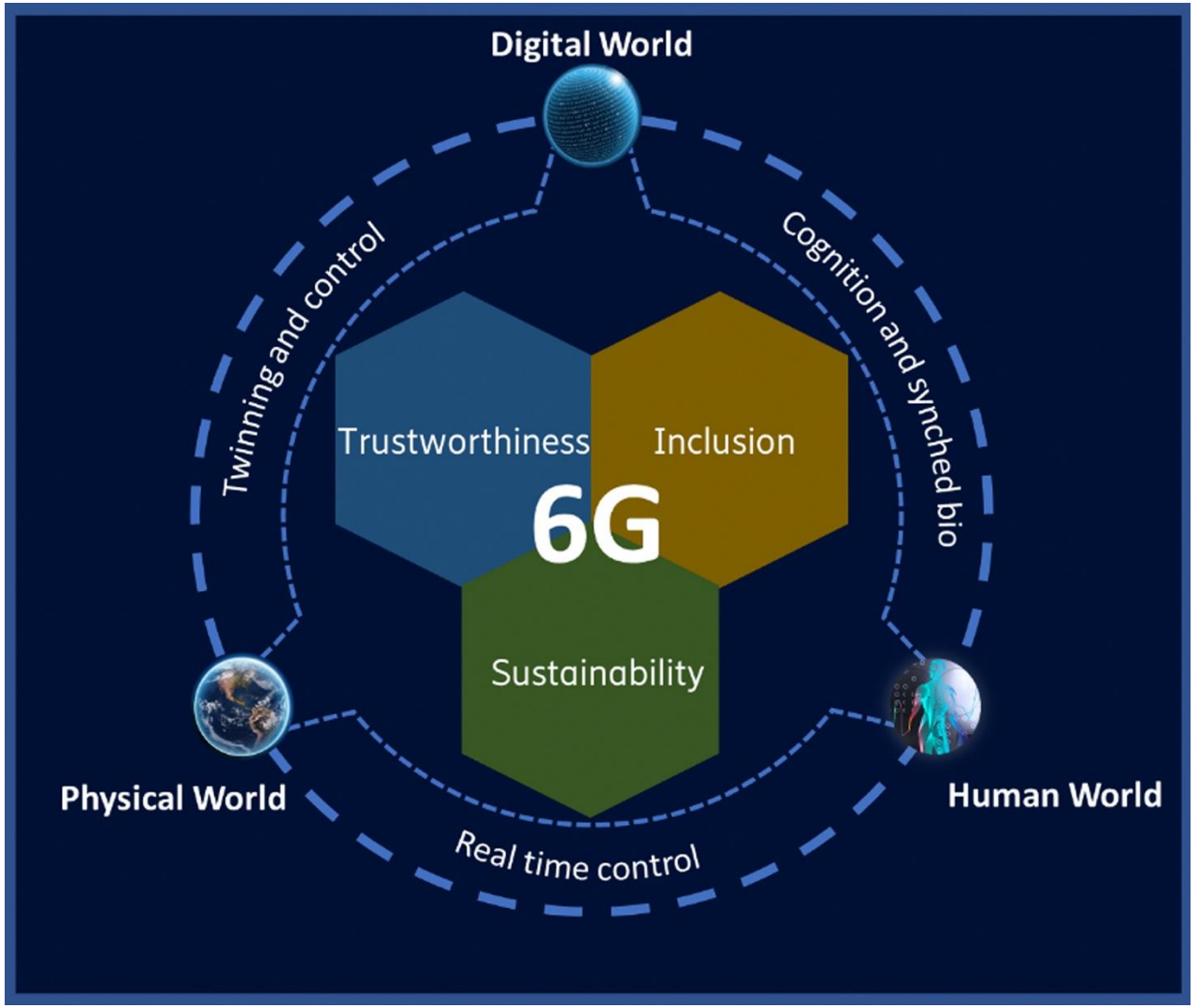
- Nokia is overall leader
- Ericsson is technical manager

Timeline


2016
2018
WRC '19
2020
2022
WRC '23
2024
2026
WRC '27
2028
2030
WRC '31
Initial 5G
5G evolution
HORIZON 2020
5G PPP
Hexa-X
Flagship project
Enabler projects
Horizon Europe
Smart Networks & Services
SMART NETWORKS & SERVICES
HEXA-X-II
6G structuring and framing
6G systematisation research projects
6G technical standardisation
6G evolution
Research on 6G technology components
6G requirements
6G commercialisation

Hexa-X vision on 6G

- Connecting the physical, digital and human world
- Key values:
  - Sustainability
  - Inclusion
  - Trustworthiness
- Research challenges:
  - Connecting intelligence
  - Network of networks
  - Sustainability
  - Global service coverage
  - Extreme experience
  - Trustworthiness



UN Sustainable development goals as basis

Overall objectives of Hexa-X-II

A holistic flagship towards the 6G platform and system to inspire digital transformation for the world to act together in meeting needs in society and ecosystems with novel 6G services

Hexa-X

Hexa-X & Horizon-2020 candidate enablers

HEXA-X-II

- 6G use cases, services, and requirements → Value for society
- 6G system blueprint and platform → Global dissemination impact
- 6G technology readiness → Strategic autonomy

SNS stream B projects

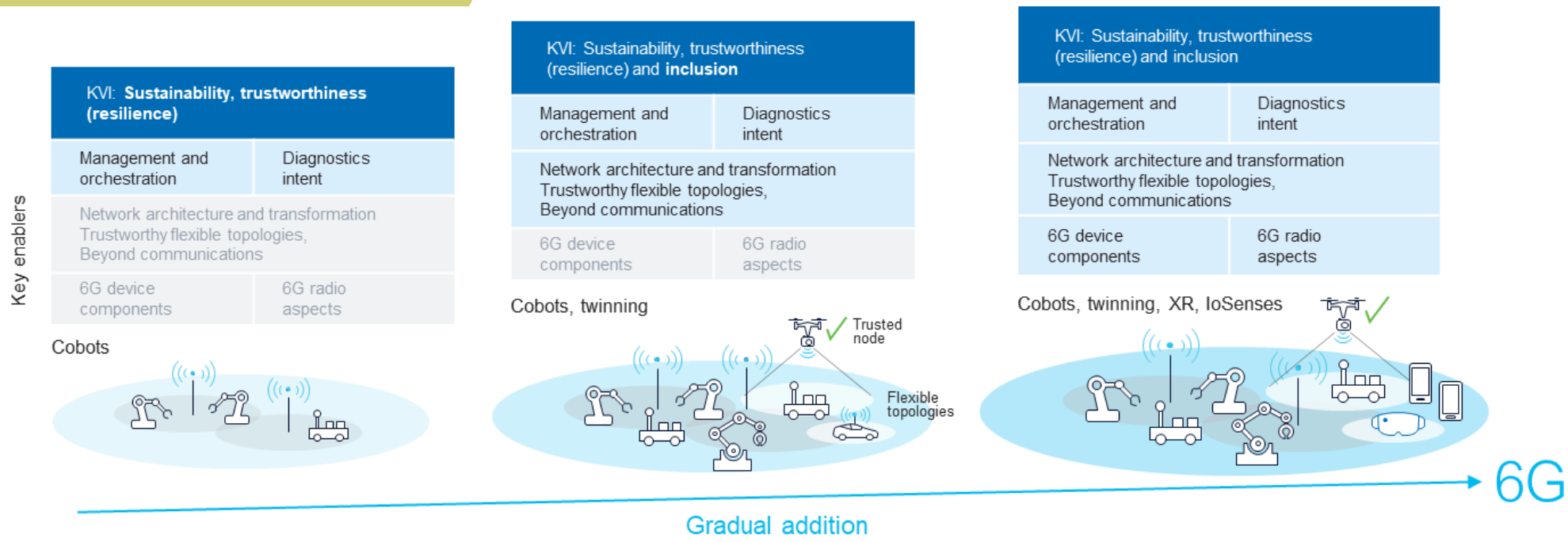
Hexa-X and Hexa-X-II: Globally most influential 6G projects so far

- Created momentum in 6G by bringing industry and academia together at European level with international linkages and impacts
- Use cases:
  - Invited keynote at the beginning of the ITU process
  - Jointly agreed European input to 3GPP SA process strongly based on Hexa-X-II (and Hexa-X) work
    - 5 out of the 6 representative use cases were prepared and presented in 3GPP. 4 accepted, the 5th expected to be accepted very soon
- Laying down vision for 6G and widely disseminating it
- Key Value & Indicators: new sustainability analysis and use case methodology introduced
- Interactions with global initiatives through e.g., workshops:
  - Europe (EC, 6G-IA, SNS-JU project, National initiatives)
  - US (Next G Alliance)
  - Asia (IMT-2030 PG, B5GPC/5GMF/XGMF, 5G/6G Forum, ETRI, ITRI, IITH)
- Strong analysis of the resulting requirements for 6G
- 100+ technical enablers for 6G
  - Strong alignment with the start of 3GPP RAN work
- 6G E2E system view including architecture
- Strong basis for further work on sustainability, including environmental, social and economic sustainability

Wide impact via dissemination and other actions

- 21 technical deliverables in Hexa-X-II
- 300+ publications (110 in Hexa-X, more than 200 in Hexa-X-II)
- Key contributor in European level white papers, including 2 on 6G overview, sustainability, KPIs and KVIs
- 2 books:
  - Hexa-X + SNS-JU Arch WG: *Towards Sustainable and Trustworthy 6G: Challenges, Enablers, and Architectural Design* – June 2023
  - Hexa-X-II + 9 SNS-JU projects: another book to come out
- Around 280 std contributions (120 in Hexa-X, 157 in Hexa-X-II)
- Many workshops by Hexa-X-II in cooperation with others
  - e.g., 5 iterations of '6G workshop series' at EuCNC & 6G Summit, joint workshops on architecture, NTN, sustainability, sensing, …
- Impacts in std expected
  - Architecture, sustainability, NTN, …
- WiTaR (Women in Telecommunications and Research) started from Hexa-X and continued to be supported by Hexa-X-II and many others, 30 projects have joined to support
- 60+ patents (33 in Hexa-X, 30 in Hexa-X-II by May 2025)
- Website with more than 4k visits (Hexa-X-II), LinkedIn channel with more than 1.4k followers
- Youtube channel with more than 140k impressions

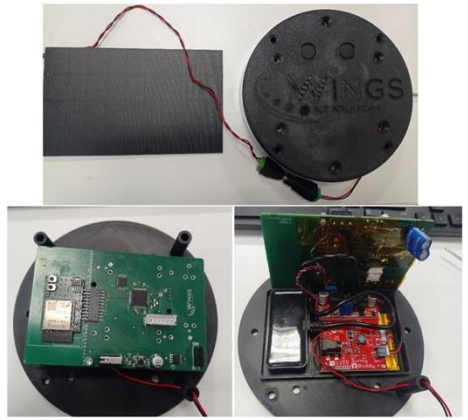
System-PoCs outline

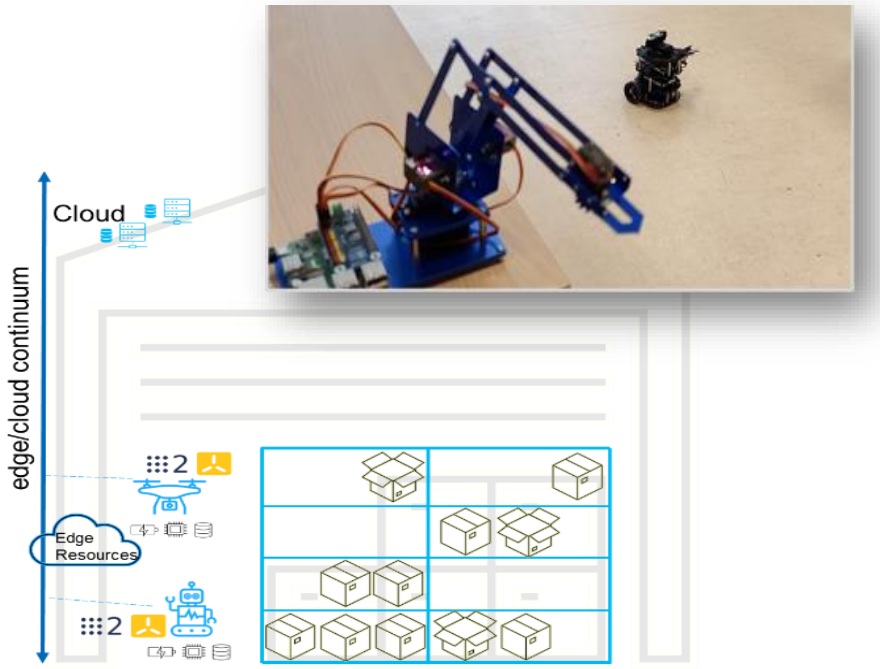


- **Three waves.**
- PoC A: Foundation layer – Domain-centric, trust-driven Management and Orchestration (M&O)
- PoC B: Expanded scope – Beyond communication services, flexible topologies, multi-domain, intent-based management
- PoC C: Full scope – Exposure APIs, closed-loop automation, energy harvesting devices, 6G radio
- KVIs: Trustworthiness and resilience through Trust Evaluation Functions (TEF) and Level of Trust Assessment Functions (LoTAF), Environmental sustainability/reduced energy consumption (functionality allocation optimisation, device-level optimisations, flexible topologies, energy harvesting), Inclusion via exposure APIs and intent-based interfaces to business users, advanced XR interfaces, Financial sustainability though synergetic orchestration, flexible topologies, evaluation of trade-offs, cost-aware deployment decisions.

Visit our booth, see Hexa-X-II EuCNC 2025 PoCs

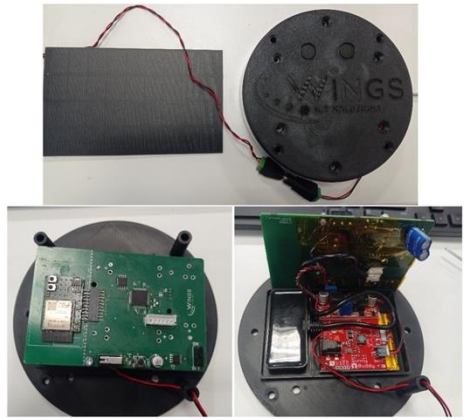
- Physical demos
  - Cobot-powered industrial operations leveraging networks beyond communication, energy harvesting devices and flexible network topologies
  - AI-assisted multi-agent service orchestration, featuring mobile vehicle robot, robotic arm and NUC unit
- Video demos
  - 6G-based sensing algorithms and concepts with real-time performance
  - Predictive automation in intent-driven cobot-based service
  - Intent-based connectivity service provisioning with Teraflow SDN
  - Video of over-the-air measurements for the AI-Native Air Interface
  - ML-based channel state feedback compression
  - End-to-end Extended Reality testbed KPIs
  - Flexible modulation and transceiver design

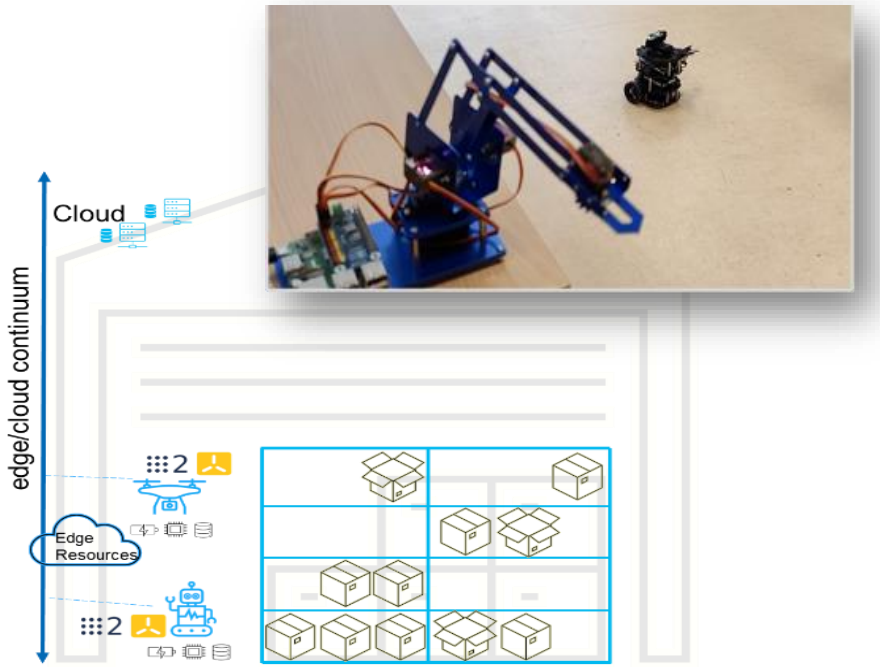




Proof points of the PoCs

- Energy efficient functionality allocation mechanism 50.9% energy savings and a 43% increase in trustworthiness for resource allocation.
- Dynamic Flexible Topologies ensured seamless communication in scenarios with compromised connectivity.
- Intent-based service provisioning demonstrated promising results for intent deployment latency of cobot-based surveillance applications.
- AI-Assisted Orchestration minimized E2E latency for latency-sensitive applications with hybrid deployment strategies.
- Advanced sensing, compute offloading, and collaborative AI mechanisms enabled dynamic processing and interpretation of data across the cloud continuum.
- Real-time radio performance, intelligent resource orchestration, and sustainable device operation combined to address diverse application scenarios such as collaborative robotics, immersive XR, and autonomous system control.
- Show that E2E 6G system can meet critical KPIs: increased coverage, enhanced capacity, and reduced latency.
- Demonstrated the feasibility and maturity of the Hexa-X-II 6G architecture.

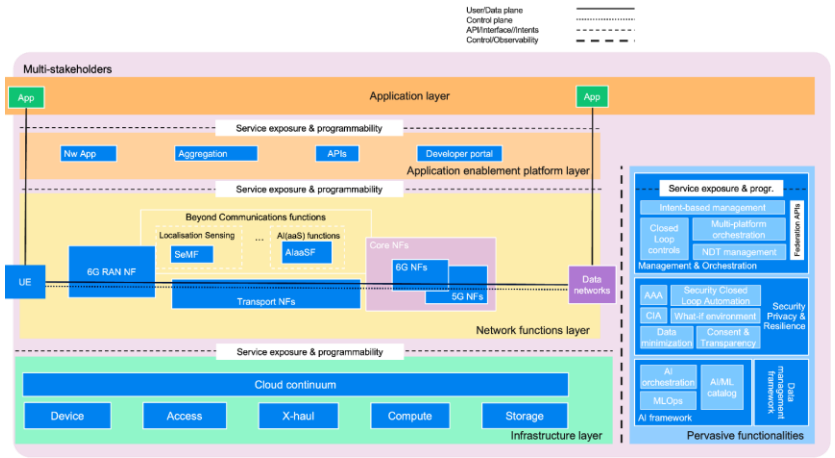




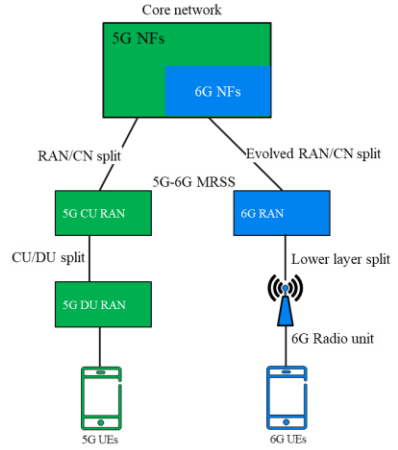
Technical components

Key components – 6G architecture

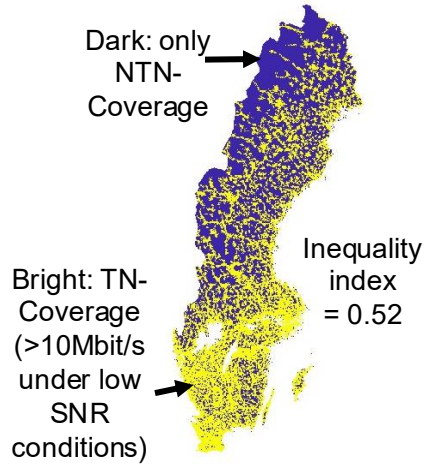
End-to-end architecture blueprint



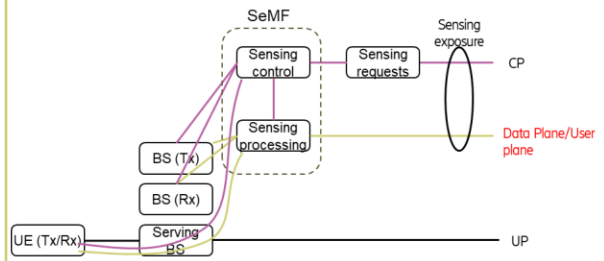
Migration from 5G to 6G



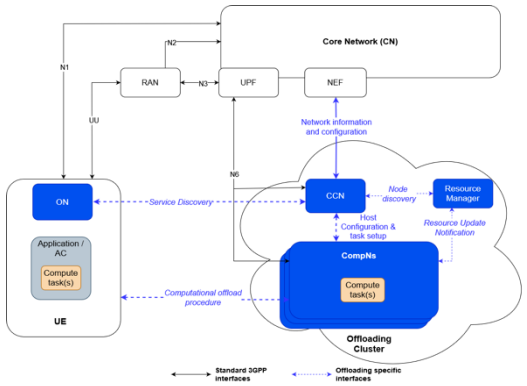
NTN coverage



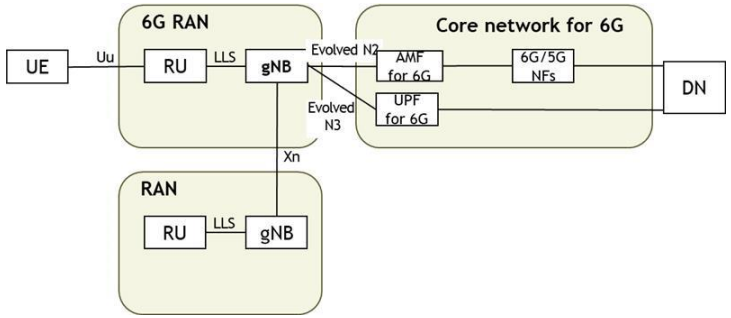
Sensing



Compute offloading



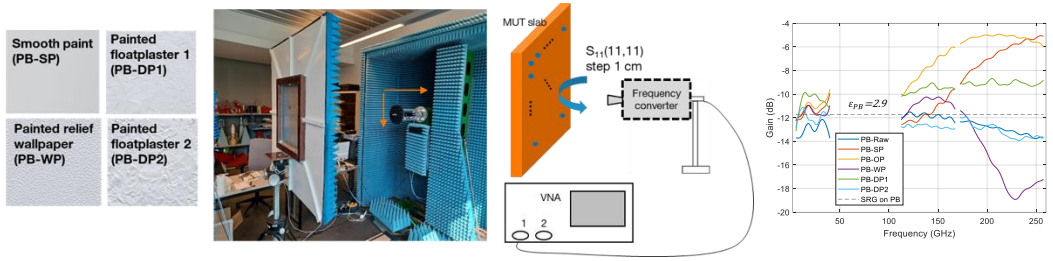
RAN/CN interfaces



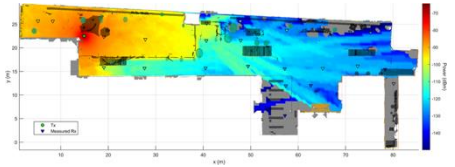
Key components – 6G radio

Channel modeling at sub-THz

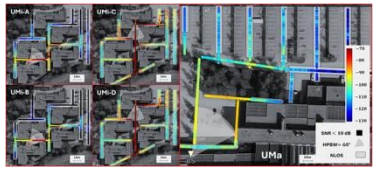
Material reflection



Coverage analysis at 140 GHz

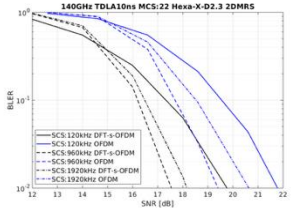


Coverage analysis at 15 GHz

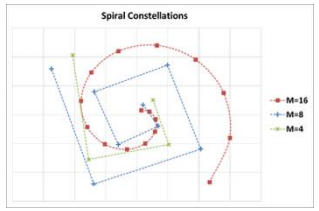


Waveforms

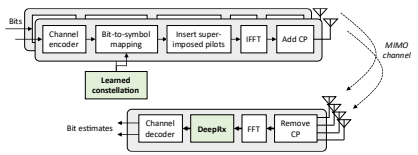
NR waveforms at sub-THz



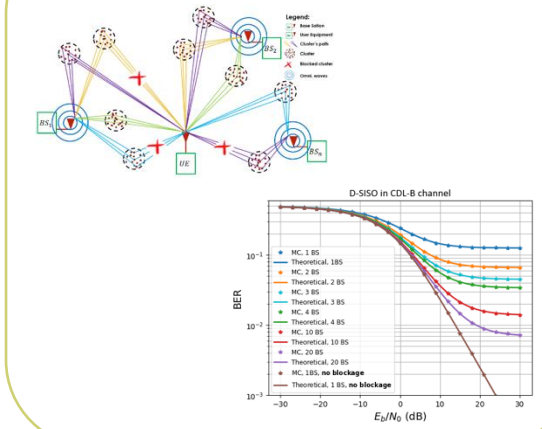
Polar constellation



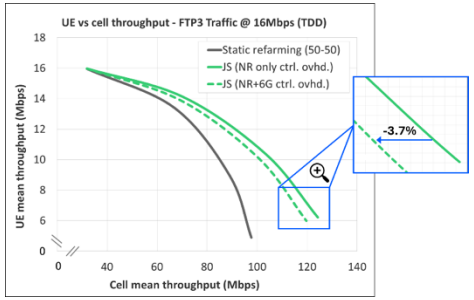
AI learned waveform for MIMO



D-MIMO

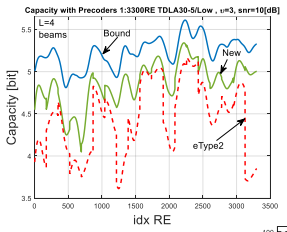


MRSS

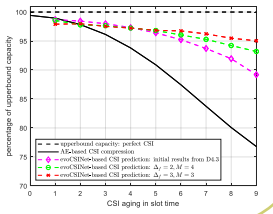


AI based air interface

CSI compression

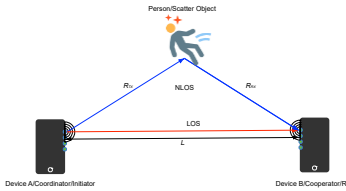


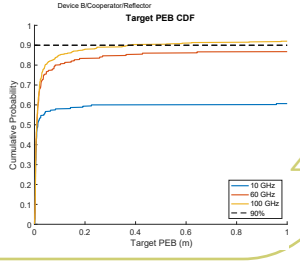
CSI prediction



JCAS

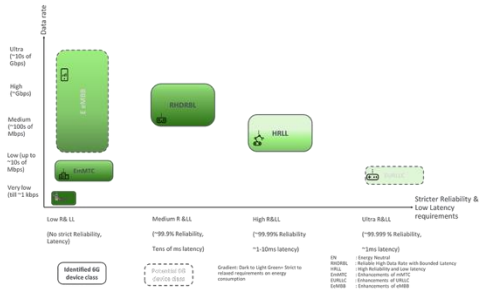
Bi-static sensing



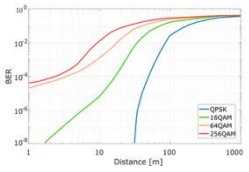


Key components – 6G devices

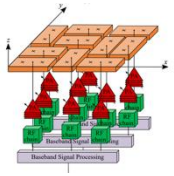
Update to device classes



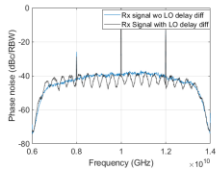
Sub-THz transceivers



RTD-based devices

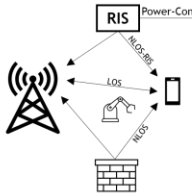


Antenna array integration

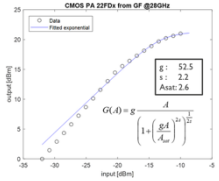


Phase-noise reduction

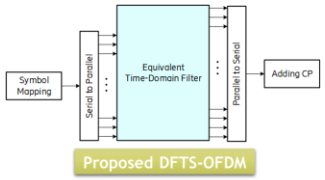
FR1/FR2/FR3 transceivers



RIS analysis

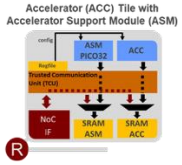


PA models in FR2

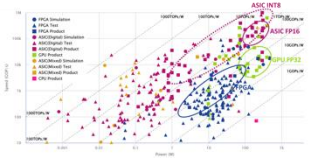


Low complexity DFTS-OFDM implementation

SoC



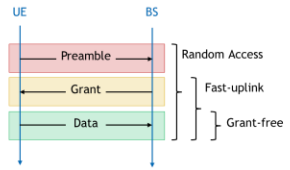
HW accelerator integration



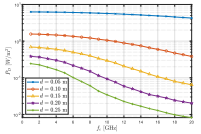
AI/ML accelerators

Ultra-low power devices

ZED prototypes

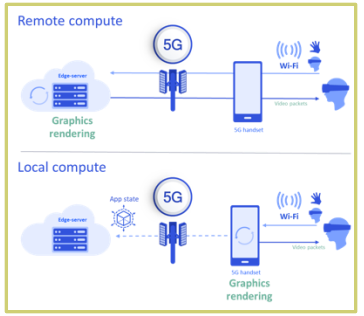


Lightweight protocols

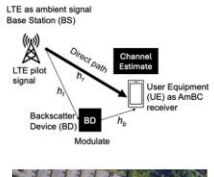


RF WPT

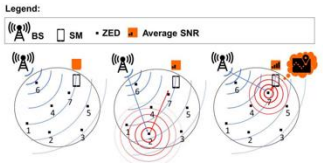
PoC



Scalable Extended Reality



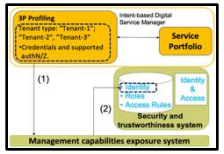
Cellular-backscattered ZEDs



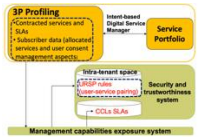
ZED indoor positioning

Key components - Management & orchestration

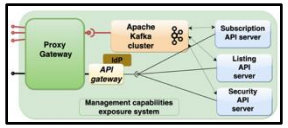
Specific systems



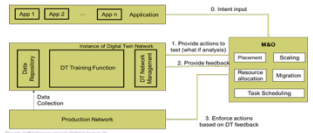
3rd party resource control separation



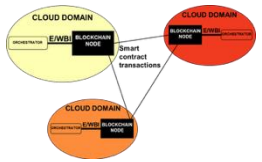
User-centric service provisioning system



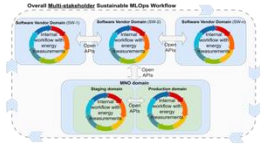
Management capabilities exposure



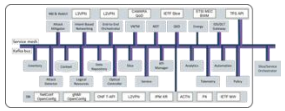
NW DT creation mechanism



Federated orchestration



Sustainable MLOps

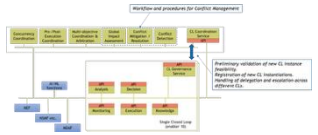


Network programmability

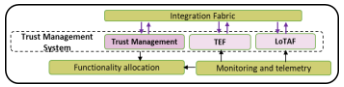
Privacy protection for data analytics

Overall functionality

Monitoring and telemetry

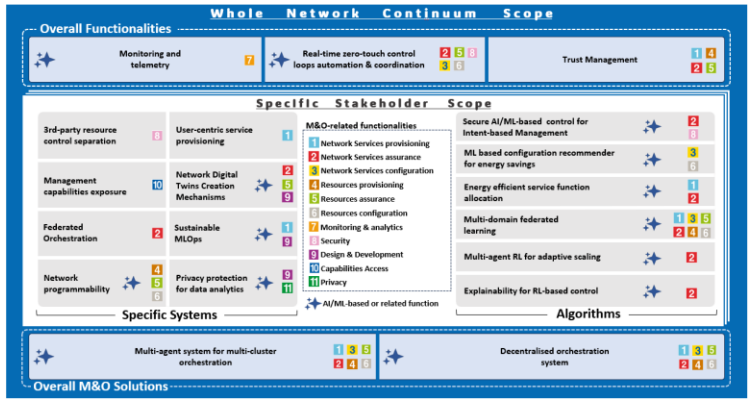


Closed loop coordination

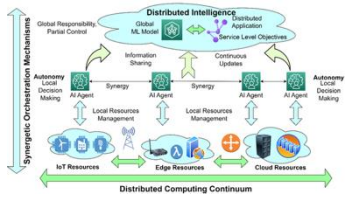


Trust management

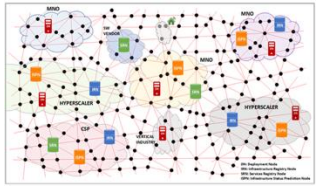
Smart management framework



Overall M&O solutions

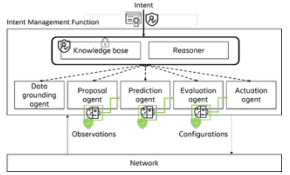


Multi-agent for multi-cluster orchestration

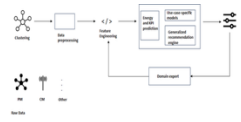


Distributed orchestration system

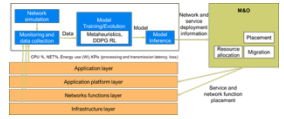
Algorithms



Secure AI/ML-based control for IBM

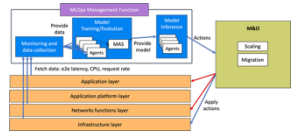


ML-based recommender for energy savings

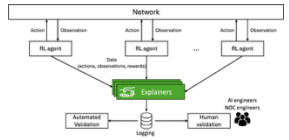


Efficient NW and service function allocation

Multi-domain federated learning



Multi-agent RL for adaptive scaling



Explainability for RL-based control

Hexa-X-II results from https://hexa-x-ii.eu/results/

- D1.4 – 6G value, requirements and ecosystem
- D2.5 – Final overall 6G system design
- D3.5 – Final architectural framework and analysis
- D4.5 – Final design of 6G Radio solutions and Promising Radio Innovations
- D5.5 – Final design of enabling technologies for 6G devices and infrastructure
- D6.5 – Final Design on 6G Smart Network Management Framework

HEXA-X-II.EU //

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6GSNS

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