Final results update from European 6G Flagship Hexa-X-II and specific focus on resilience

SNS CO-OP webinar Sept 2025

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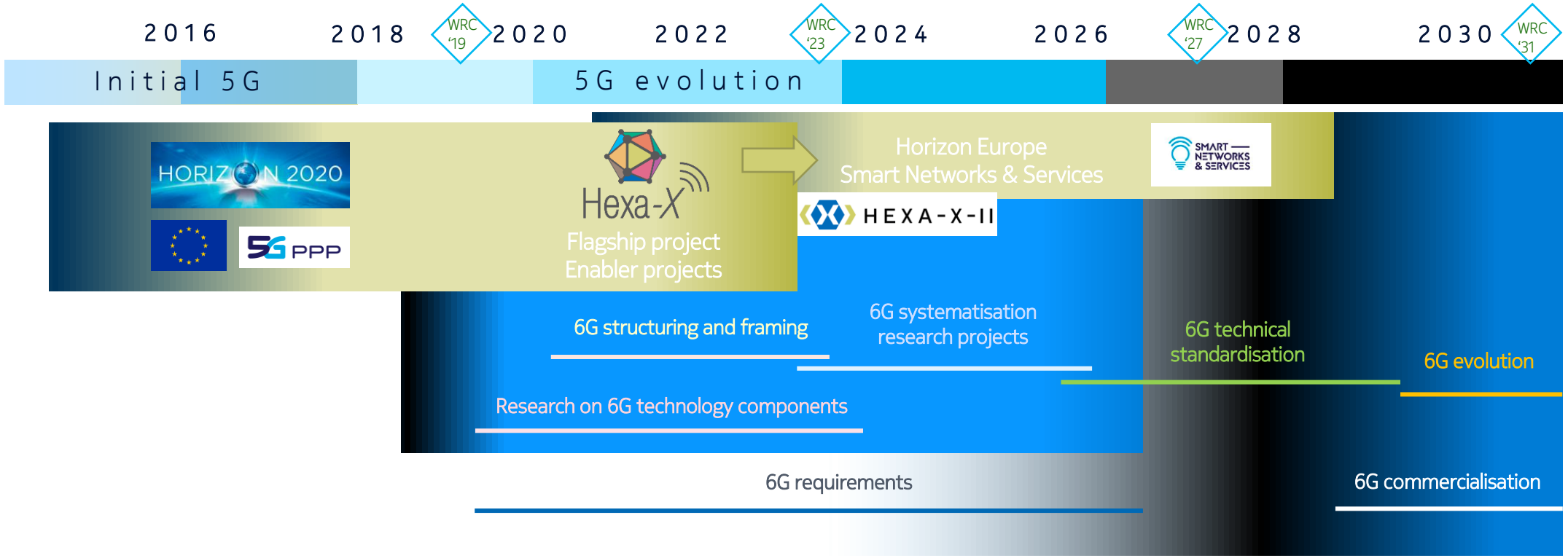
Hexa-X-II

hexa-x-ii.eu

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

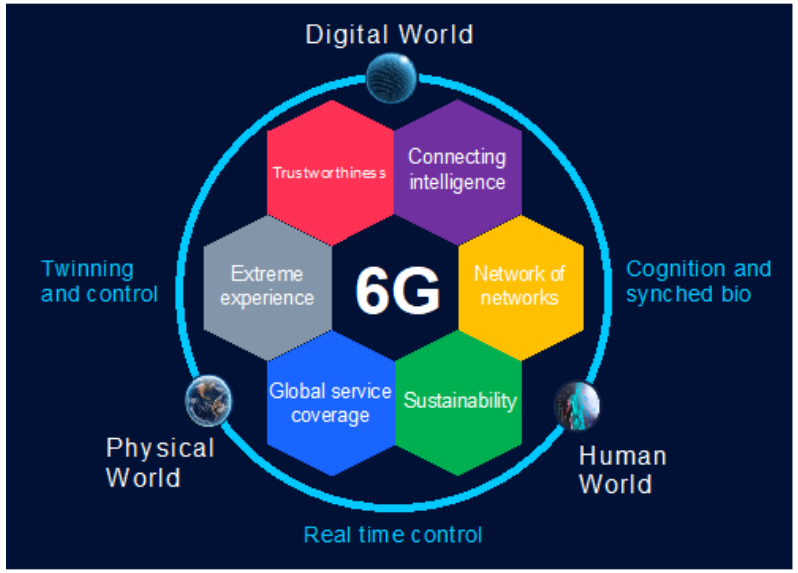
Hexa-X-II European 6G Flagship
Consortium covering the entire value stack

- Nokia is overall leader
- Ericsson is technical manager

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

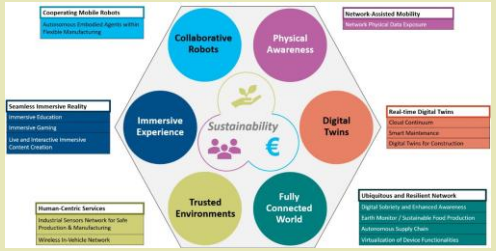
- Created momentum in 6G by bringing industry and academia together at European level with international linkages and impacts
- Use cases:
  - Invited keynote at the beginning of the ITU process
  - Jointly agreed European input to 3GPP SA process strongly based on Hexa-X-II (and Hexa-X) work
    - 5 out of the 6 representative use cases were prepared, presented, and accepted in 3GPP.
- 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

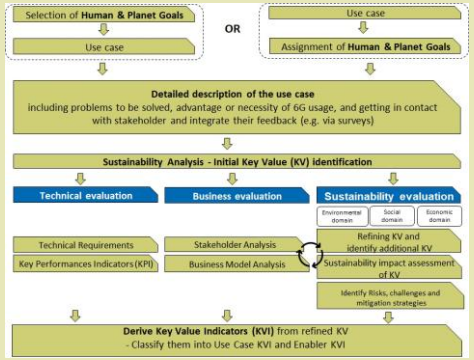
- 21 technical deliverables in Hexa-X-II
- 300+ publications (110 in Hexa-X, more than 200 in Hexa-X-II)
- Key contributor in European level white papers, including 2 on 6G overview, sustainability, KPIs and KVIs
- 2 books:
  - SNS-JU Arch WG + Hexa-X: *Towards Sustainable and Trustworthy 6G: Challenges, Enablers, and Architectural Design* (~100k downloads) – June 2023
  - Submitted a new book recently
- 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

Key achievements from Hexa-X-II

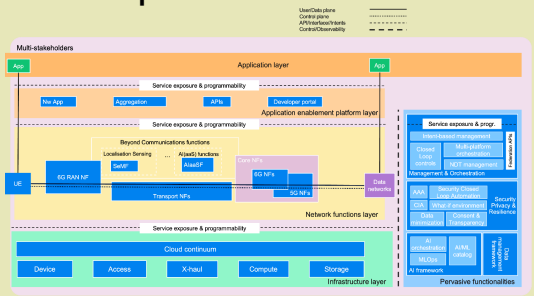
Hexa-X-II 6G use case families



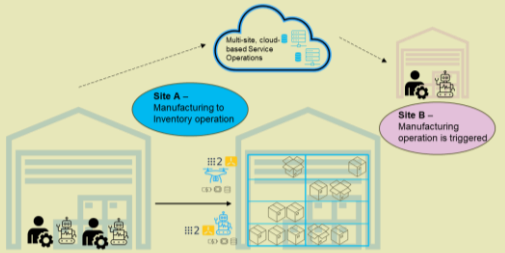
Use case oriented analysis methodology for value of 6G



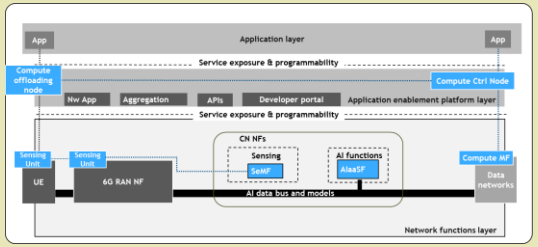
E2E 6G architecture blueprint



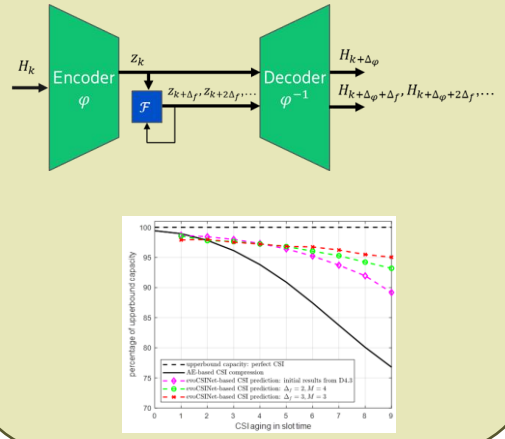
System-level PoCs



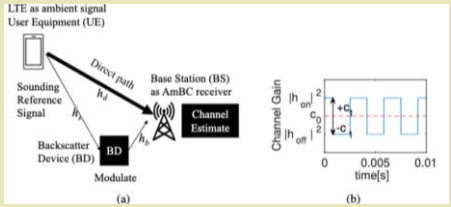
Architecture framework for novel 6G services

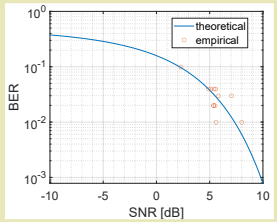


AI-based air interface

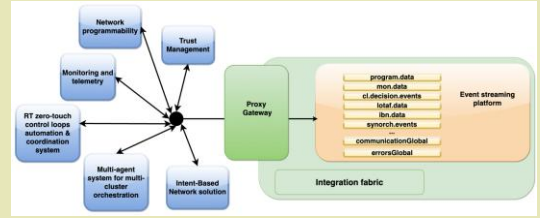


Zero energy devices



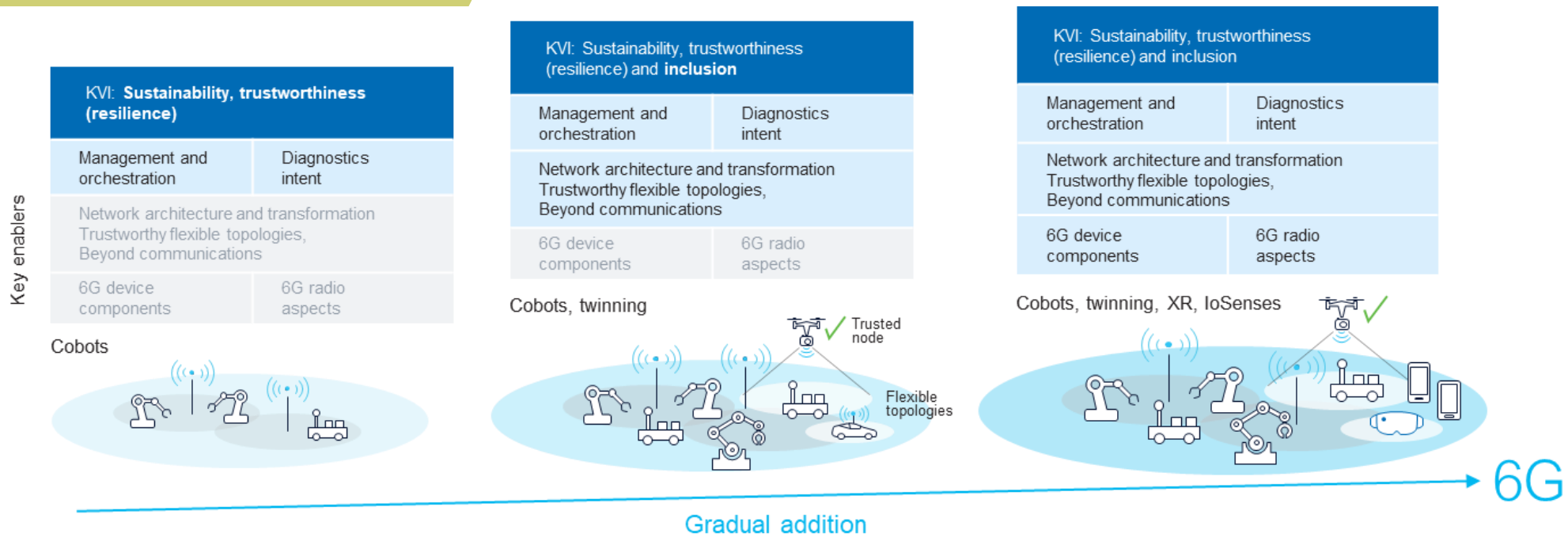


Integration fabric



New integration/exposition of 6G capabilities based on an event-driven approach

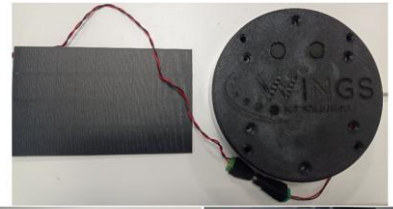
System-PoCs outline

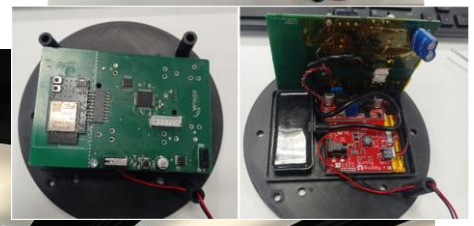


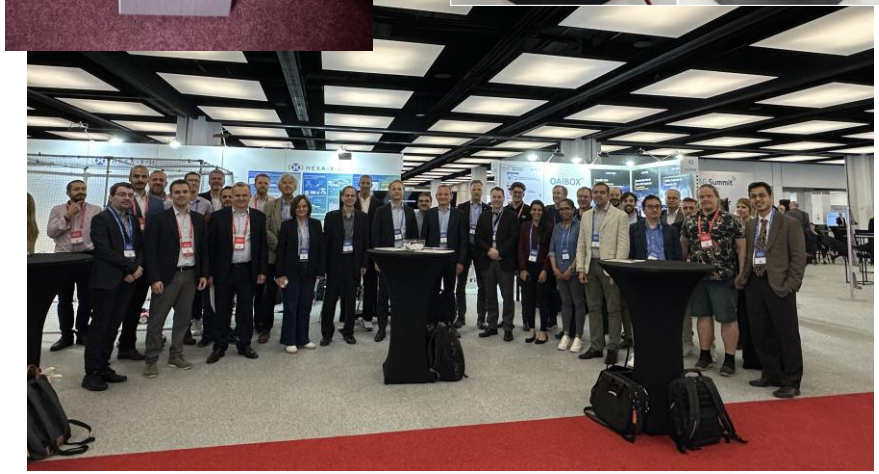
- **Three waves.**
- PoC A: Foundation layer – Domain-centric, trust-driven Management and Orchestration (M&O)
- PoC B: Expanded scope – Beyond communication services, flexible topologies, multi-domain, intent-based management
- PoC C: Full scope – Exposure APIs, closed-loop automation, energy harvesting 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.

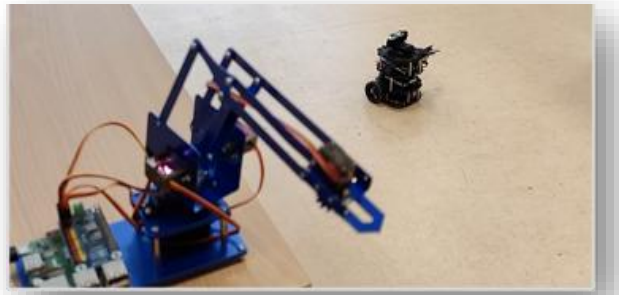
Hexa-X-II EuCNC 2025 PoCs

- Best booth award!
- 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
  - 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









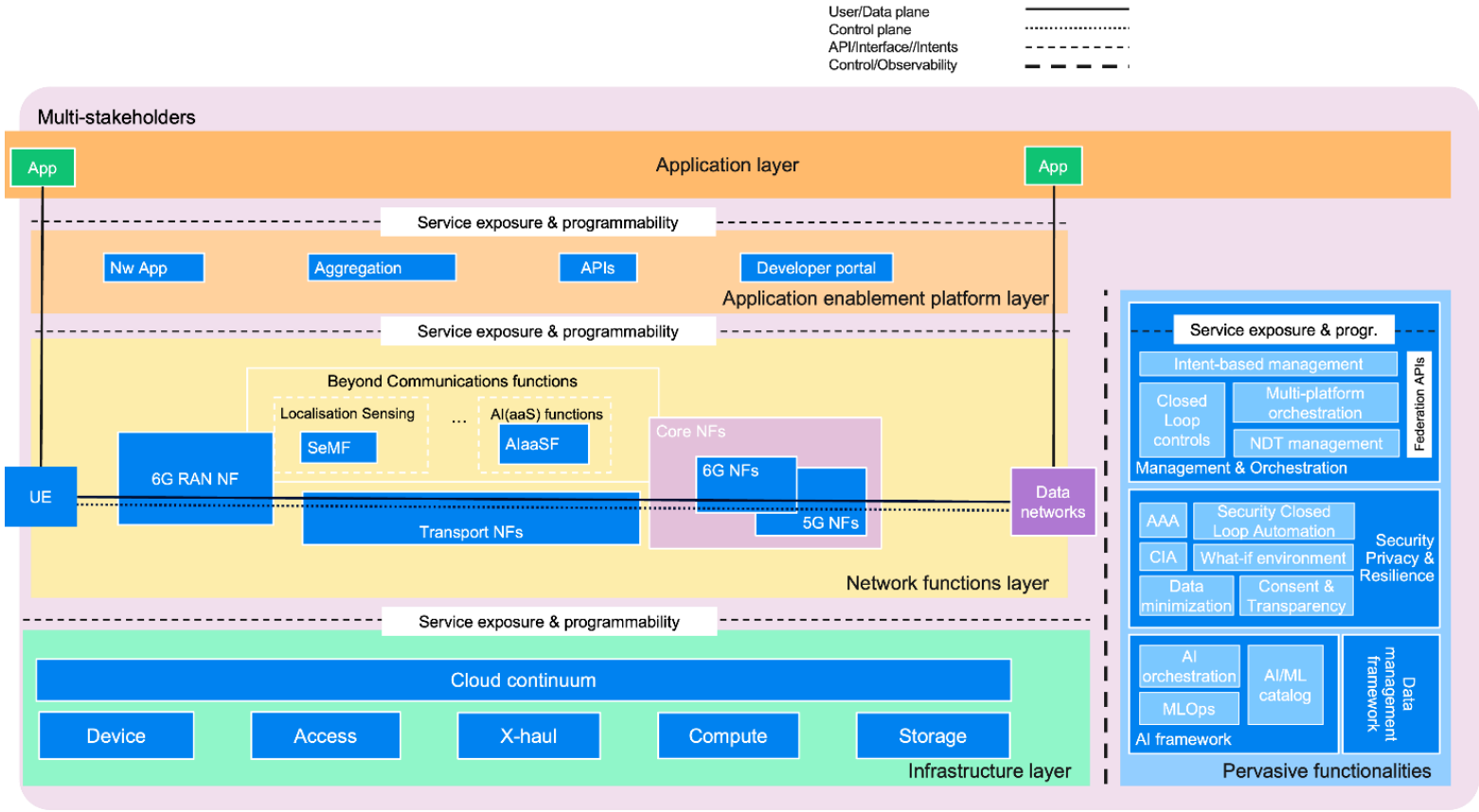
Overarching 6G system blueprint

Application & application enablement platform layers

- A unified platform for developers and third-party applications to leverage 6G capabilities.

Network & infrastructure layers

- Simplified transition to 6G: 6G devices connect to a single 6G RAT, extended Core leveraging 5G functions while introducing beyond communications capabilities
- Flexible networks incl. multiple access (like NTN), new 6G device categories.
- Cloud continuum: scalability over distributed infrastructures incl. extreme edge devices

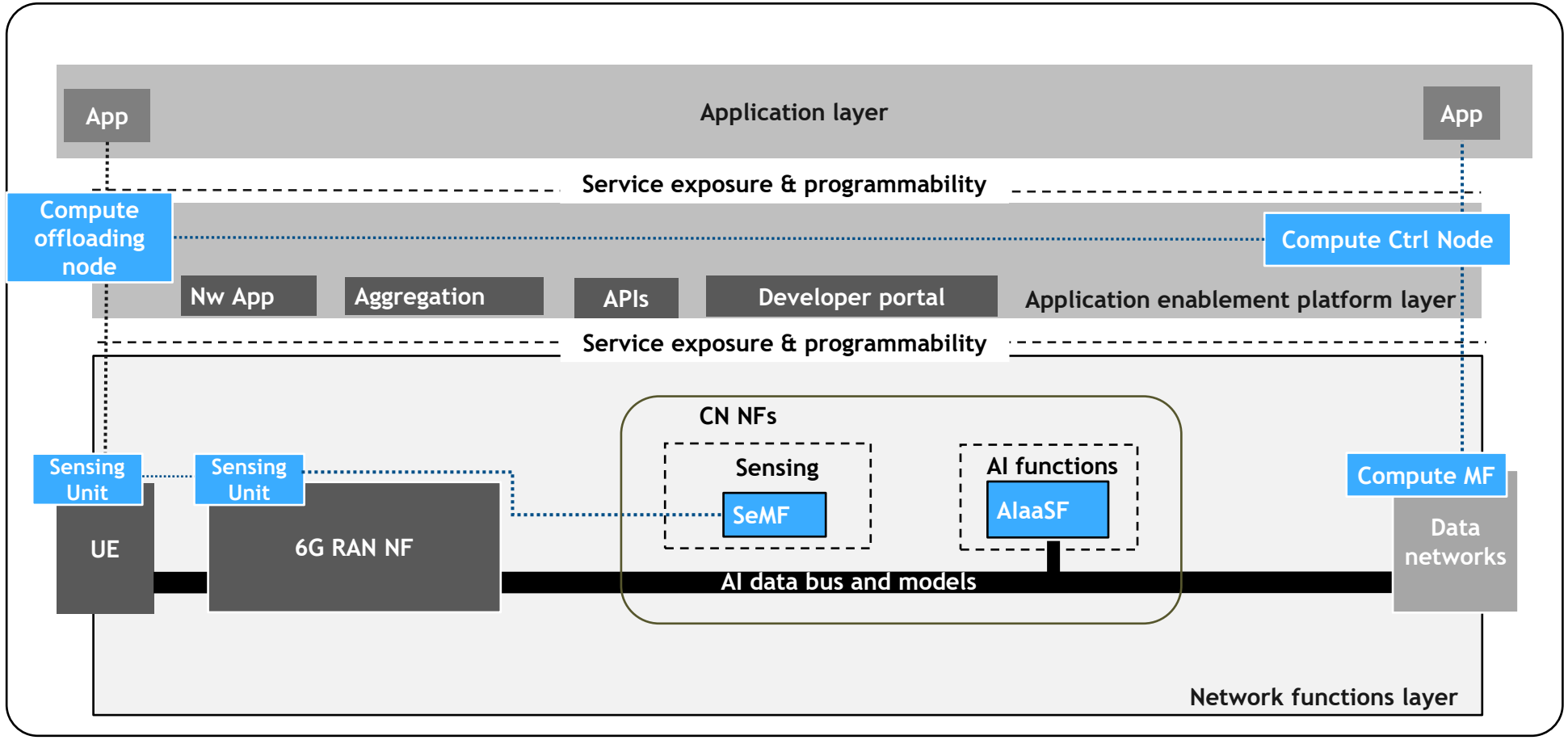


Pervasive functionalities

- Full automation with economic and environment efficiency
- Trustworthiness with security and privacy addressing 6G delta threats
- Data-driven, massive AI usage, built-in network

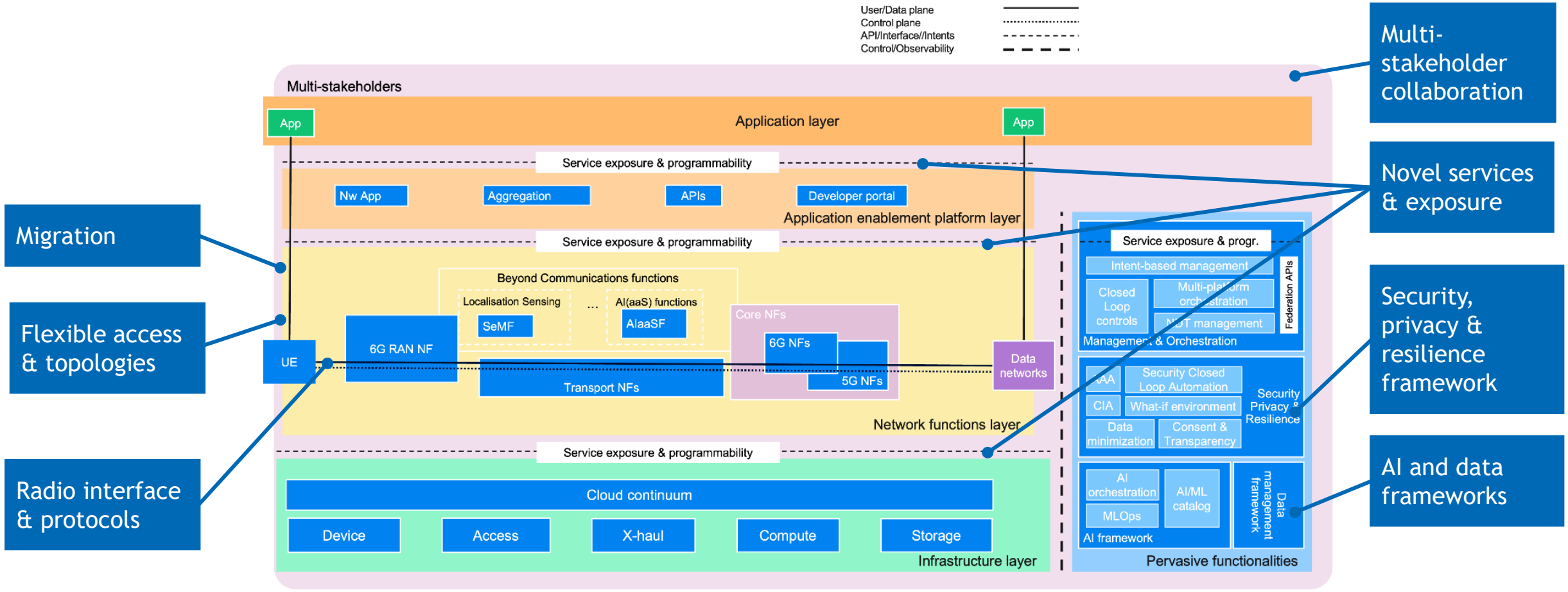
System view of new services

- **Sensing**: Sensing Units and Sensing Mngt function
- **AIaaS** functions: AI data and model bus
- **Compute**: Offloading nodes (ON), Control Node (CCN) and Compute mngt function (CMF)



Summary

Combining a holistic system blueprint with detailed views of specific aspects



Summary of design principles: Top priorities

Principle 1
Support and exposure of 6G services and capabilities

Principle 2
Full automation and optimization

Principle 3
Flexibility to different network scenarios

Principle 4
Network Scalability

Principle 5
Resilience and availability

Principle 6
Persistent security and privacy

Principle 7
Internal interfaces are cloud optimized

Principle 8
Separation of concerns of network functions

Principle 9
Network simplification in comparison to previous generations

Principle 10
Minimizing environmental footprint and enabling sustainable networks

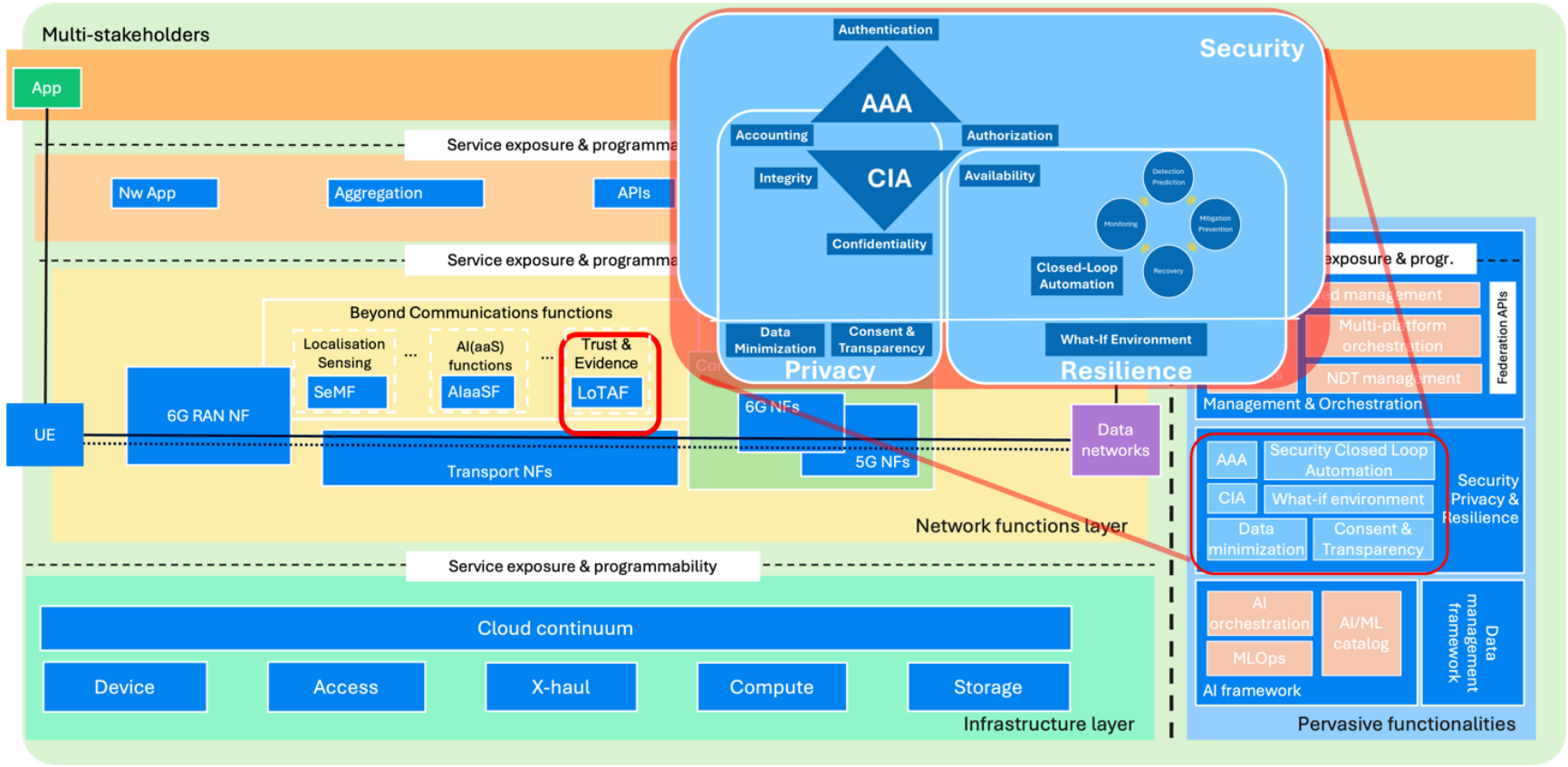
- System requirements: Resilience and Security: include redundancy, self-healing mechanisms, cryptographic protocols, confidential computing, and AI-enabled automated responses to enhance resilience and security

System view on Security, Privacy & Resilience (SPR)

SPR controls featuring confidentiality, integrity, availability, authentication, authorization, privacy and resilience.

Applied across different layers of the 6G system

- **System-level resilience:** Ensuring closed-loop automation for security management.
- **Multi-stakeholder ecosystem:** Addressing security challenges with proper isolation and trust mechanisms.
- **New 6G services:** Securely exposing services and capabilities provided by the 6G platform with strong authentication, authorization, and quantum-safe cryptography.
- **LoTAF and notary services**



AAA: Authentication, Authorisation and Accounting
CIA: Confidentiality, Integrity and Availability

Assessment on Security Considerations for 6G Enablers

- Bidirectional relationship between Hexa-X-II enablers and SPR controls

Enablers support SPR objectives (Security, Privacy, and Resilience)

WP	ENABLERS
WP2	Data recovery mechanisms; Ciphering & integrity protection; Enhanced Special Cell (SpCell) change with UE initiation; Pcell recovery; Data-driven mobility Intent and TLA management LoTAF; Notary service;Trustworthy AI
WP3	MLOps; DataOps; Intent-based management (Zero Touch) Multi-connectivity JCAS protocols, signalling, and procedures
WP4	Trustworthy radio solutions Security and privacy (jamming attack detection, key generation for encryption, etc.)
WP5	Secure and scalable SoC architecture tailored for trustworthy AI/ML
WP6	3rd-Party resource control separation system; User-centric service provisioning system; Trust management functionalities Secure AI/ML-based control for intent-based management system Real-time zero-touch control loops governance and coordination (for recovery & security); Privacy protection for data analytics system

Enablers rely on SPR controls for their functionality

WP	ENABLERS
WP2	Radio protocols for beyond communication; Data fusion mechanisms based on telemetry data; Intent Conflict Administration; Human-machine intent interface design; Declarative Intent Reconciliation; Intent Reporting; 3rd party services
WP3	AIaaS; Architectural means and protocols 6G Network modularization E2E service design in modular 6G network of networks Exposure and data management, integration and orchestration of extreme edge resources in the computing continuum multi-domain/multi-cloud federation
WP4	RIS-assisted transmission
WP5	RIS system integration; Energy-aware protocols RAN scope dedicated connectionless design Energy-aware tinyML applications
WP6	Multi-agent system for multi-cluster orchestration Decentralised orchestration All the overall functionalities in the smart management framework [HEX225-D65]. Network programmability system

Collectively, a unified framework for enhancing privacy, security, and resilience

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
- D2.6 – Final end-to-end system evaluation results of the 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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