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Hexa-X-II WS

Hexa-X-II: 6G architectural framework and enablers

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Hexa-X-II

hexa-x-ii.eu

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Objective



- This presentation aim to show the high-level view of the 6G architecture and 6G platform
- We will show:
 - Hexa-X-II 6G E2E blueprint, including exposure, radio and security
 - 6G architecture framework for new 6G services AI, Sensing and Compute
 - Show Hexa-X-II view on migration and flexible topologies

Overarching 6G system blueprint

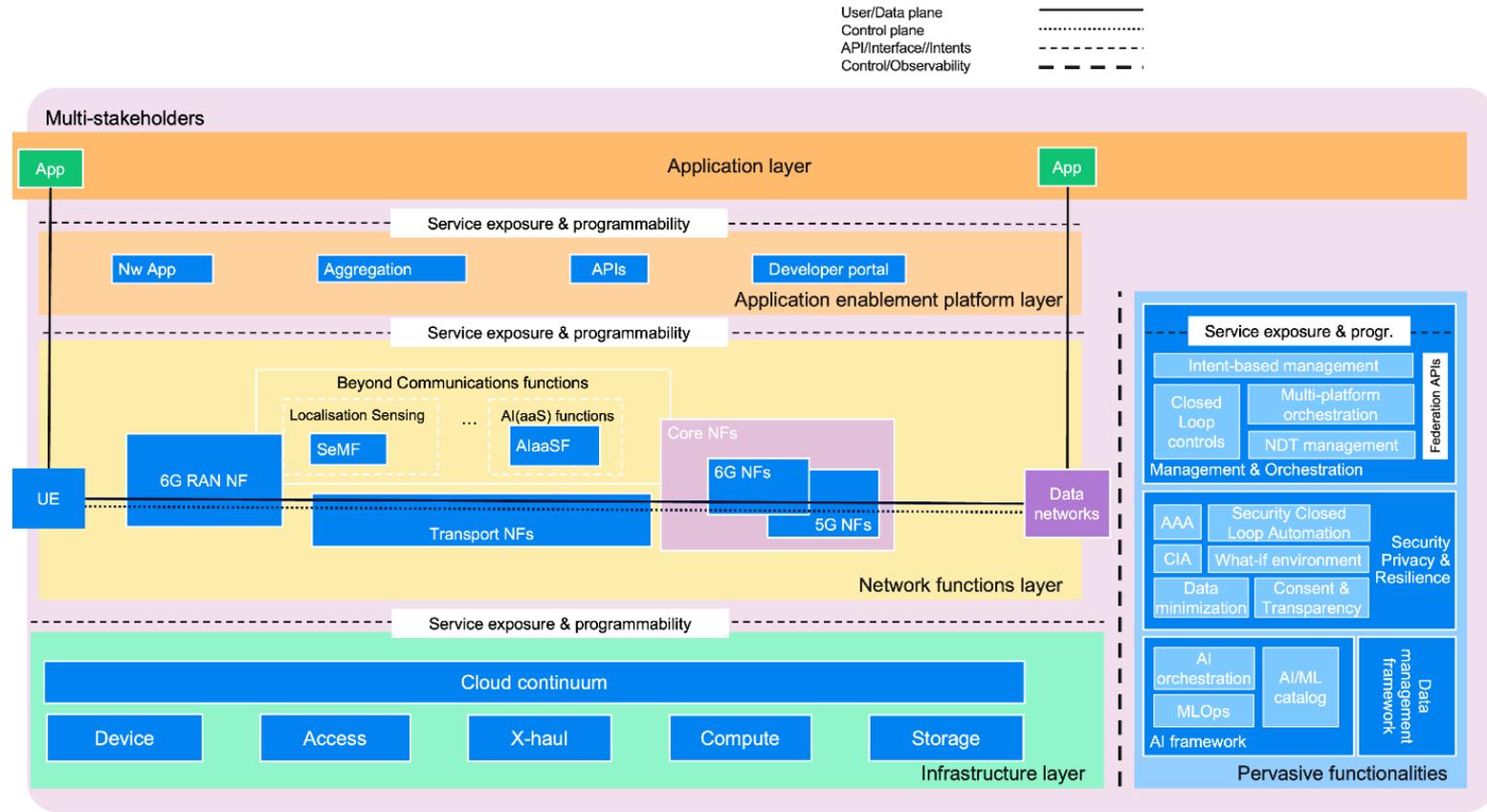


Application & application enablement platform layers

- 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



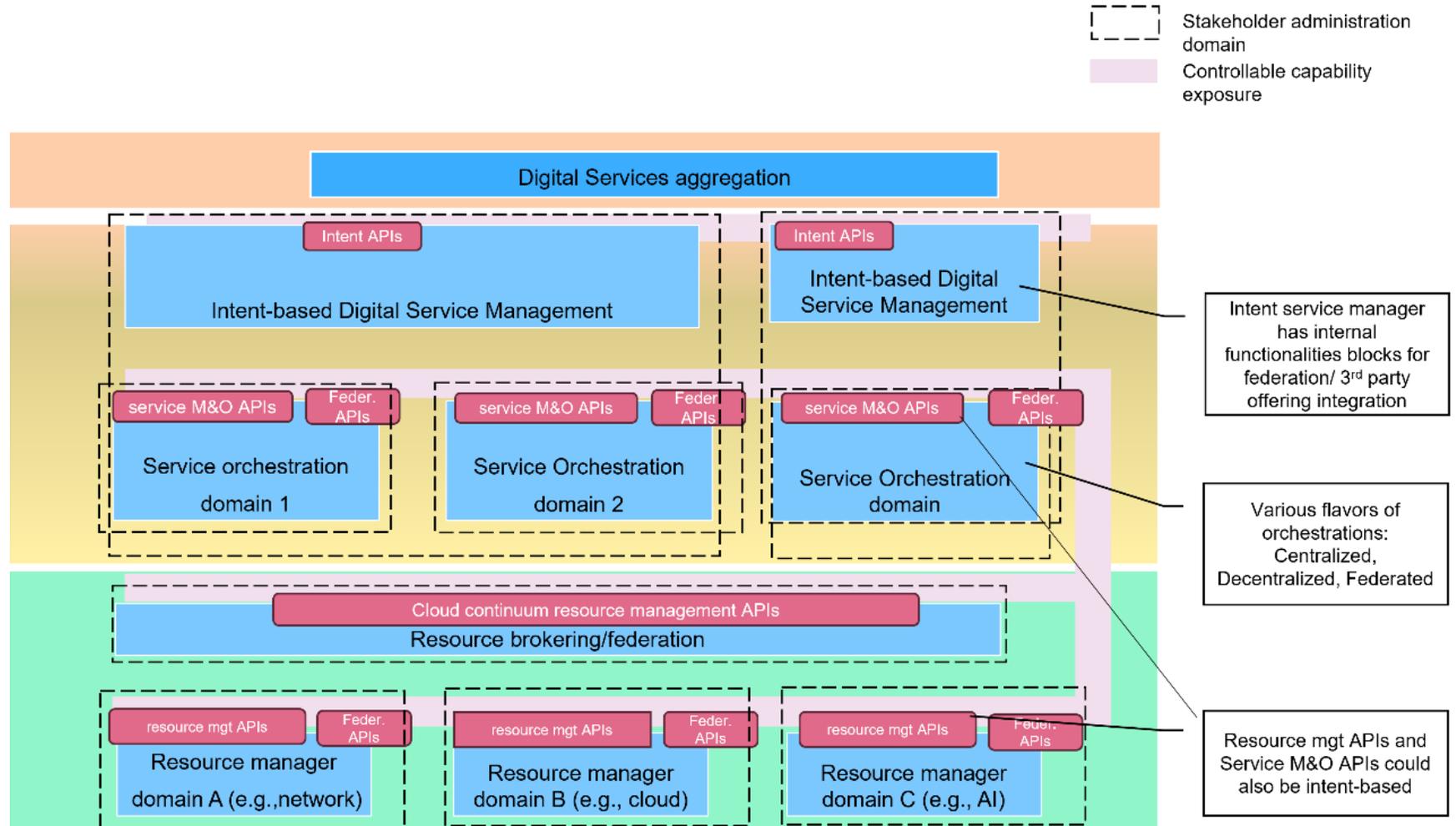
Pervasive functionalities

- **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 on multi-stakeholder support



- Single federation interface/APIs supporting various models (peer to peer/brokering)
- Controllable capability exposures (of services, M&O and federation capabilities)
- Same Intent APIs on NBI or E/WBI for service requests



System view on radio protocols



New 6G RAT

- Radio protocols simplification, tighter coordination between protocols layers and their operations, and more adaptiveness in the radio interface operation for (new) service provisioning.

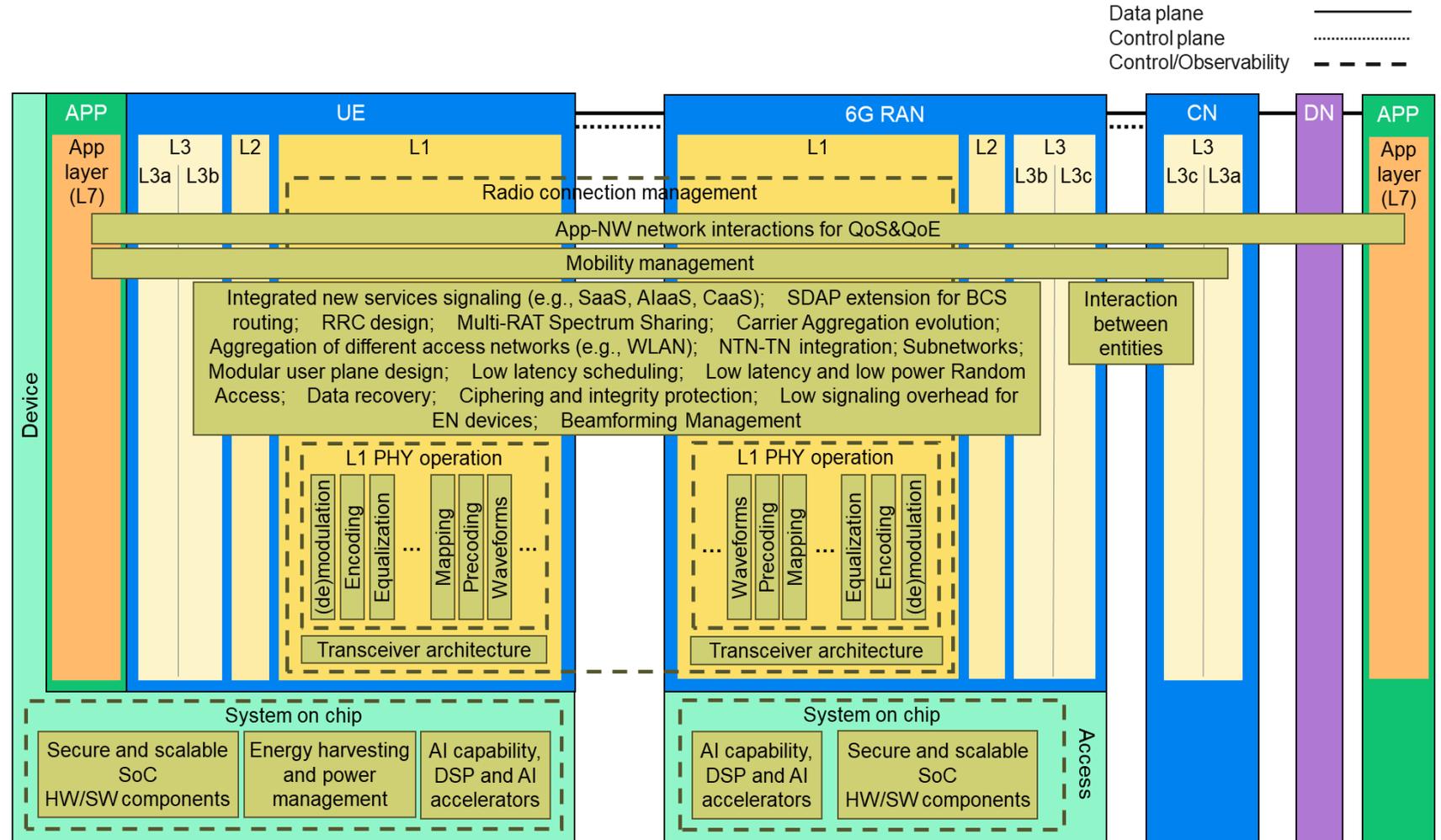
Radio protocols innovations in:

- Control plane, user plane, mobility procedures, application-network interaction for service differentiation and QOS/QOE management

Integration of new services signaling (JCAS, AlaaS, and CaaS)

6G Transceiver Architecture

6G System-on-Chip (SoC)



System view on Security, Privacy & Resilience (SPR)

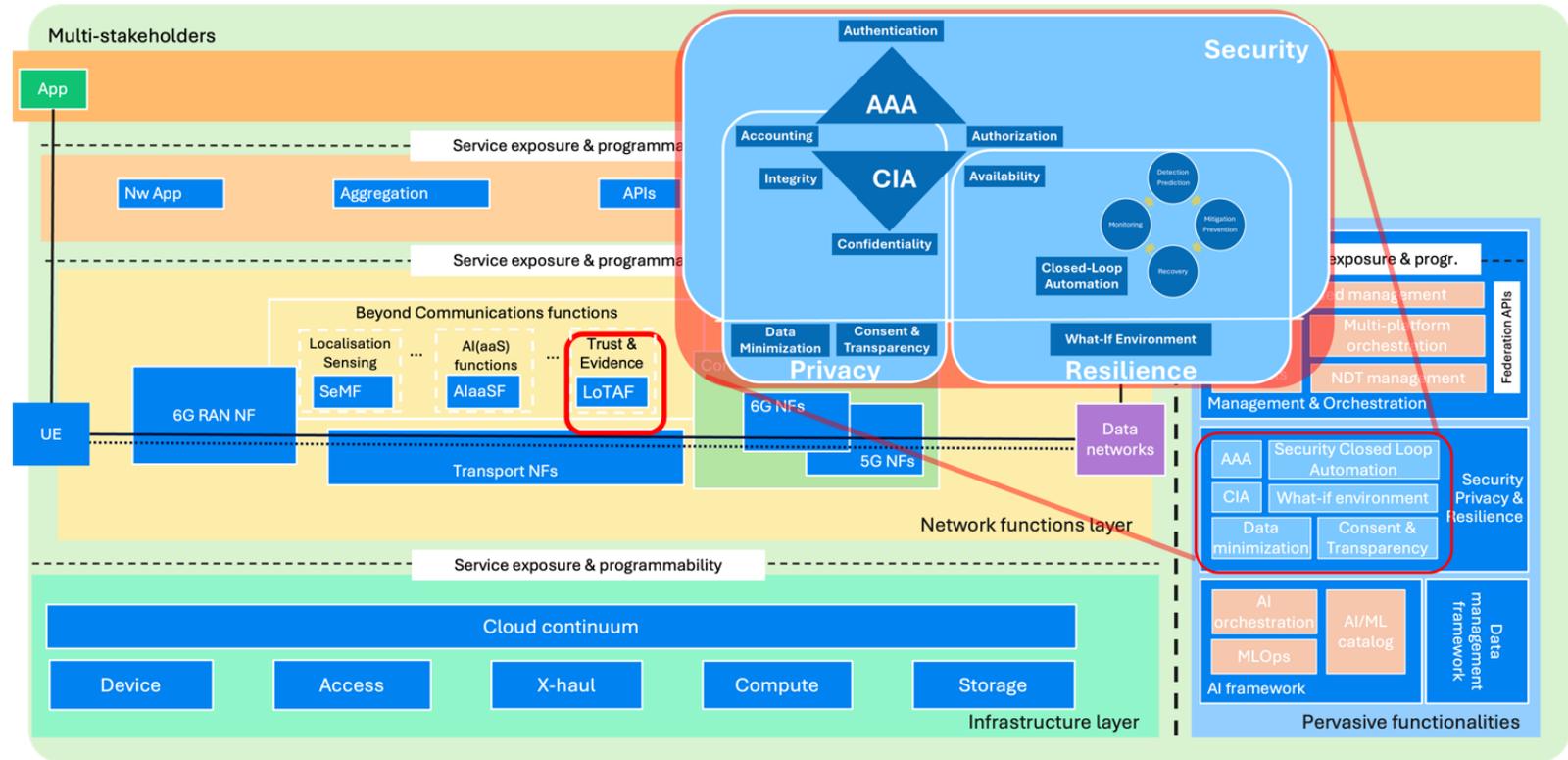


SPR controls featuring confidentiality, integrity, availability, authentication, authorization, privacy and resilience.

Bidirectional relationship between enablers and security controls

Applied across different layers of the 6G system

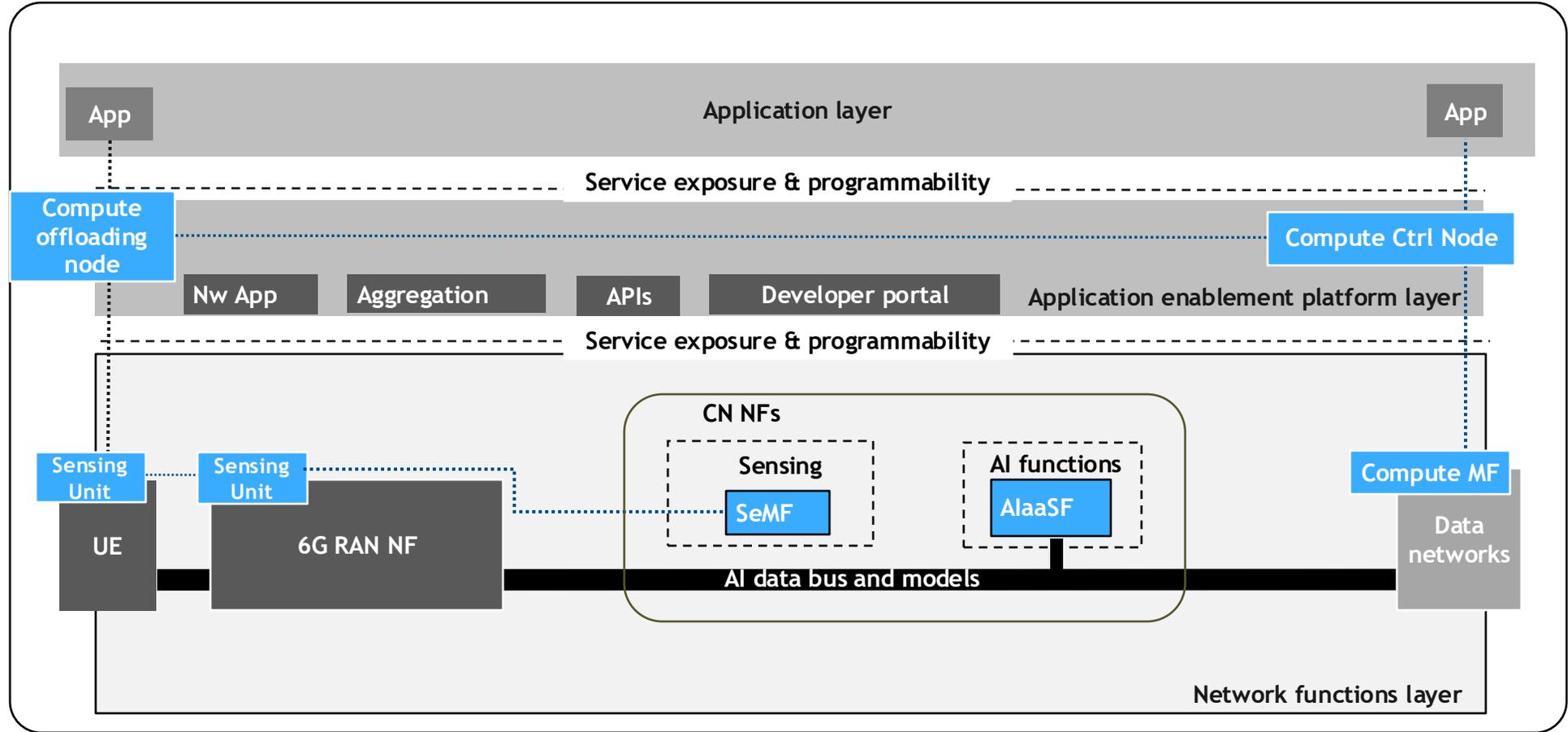
- **System-level resilience:** security closed-loop automation
- **Physical layer security:** physical anomaly detection, physical layer deception, etc
- **Trustworthy AI:** Secure and privacy-enhanced machine learning, etc
- **Trust fabric:** Attestation capabilities, transition to quantum safe crypto, LoTAF and notary services



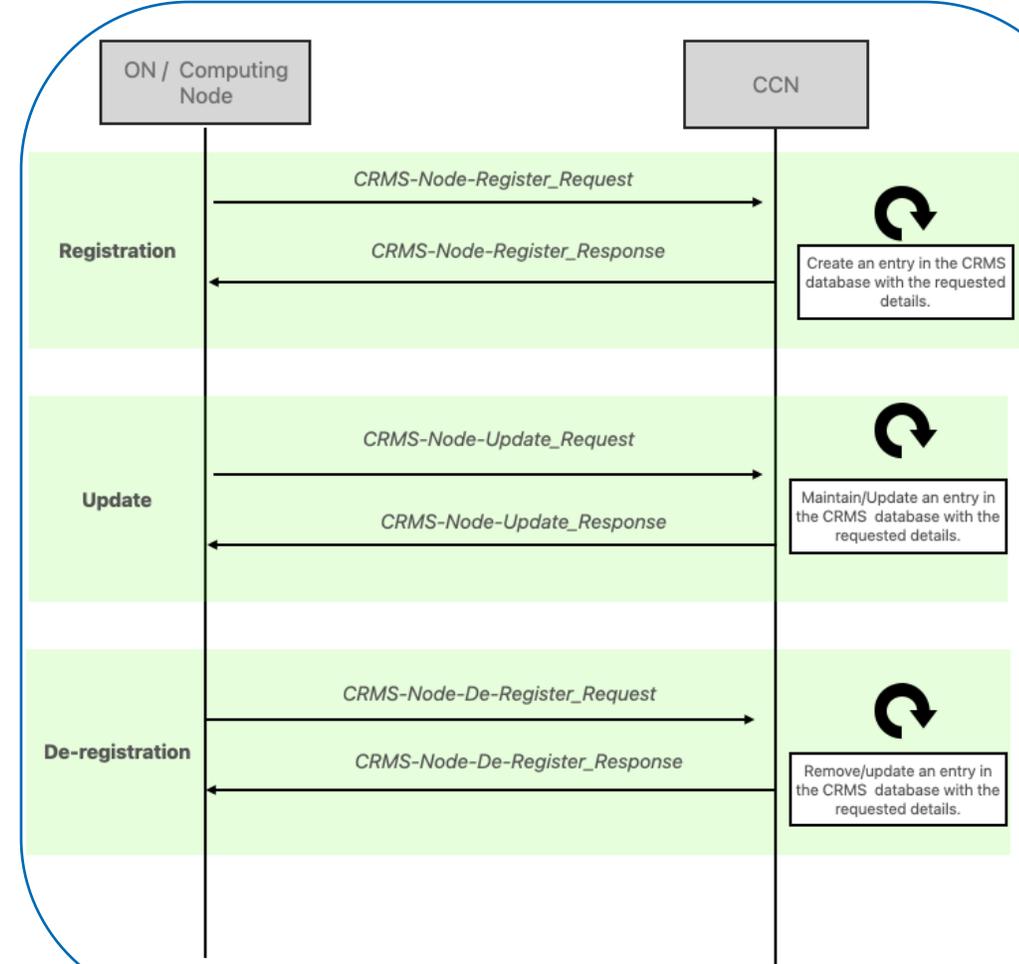
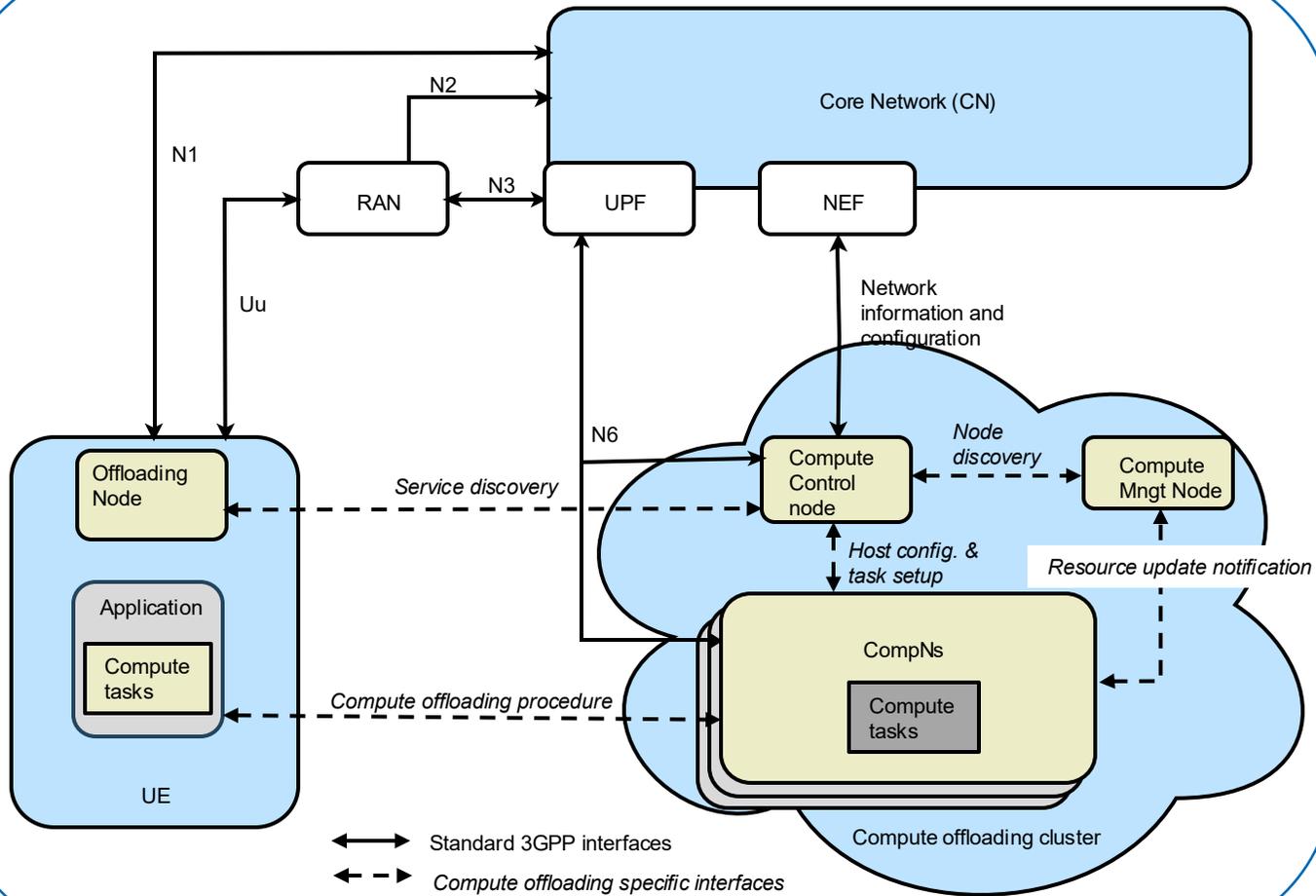
System view of new services



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



Compute offload architecture framework

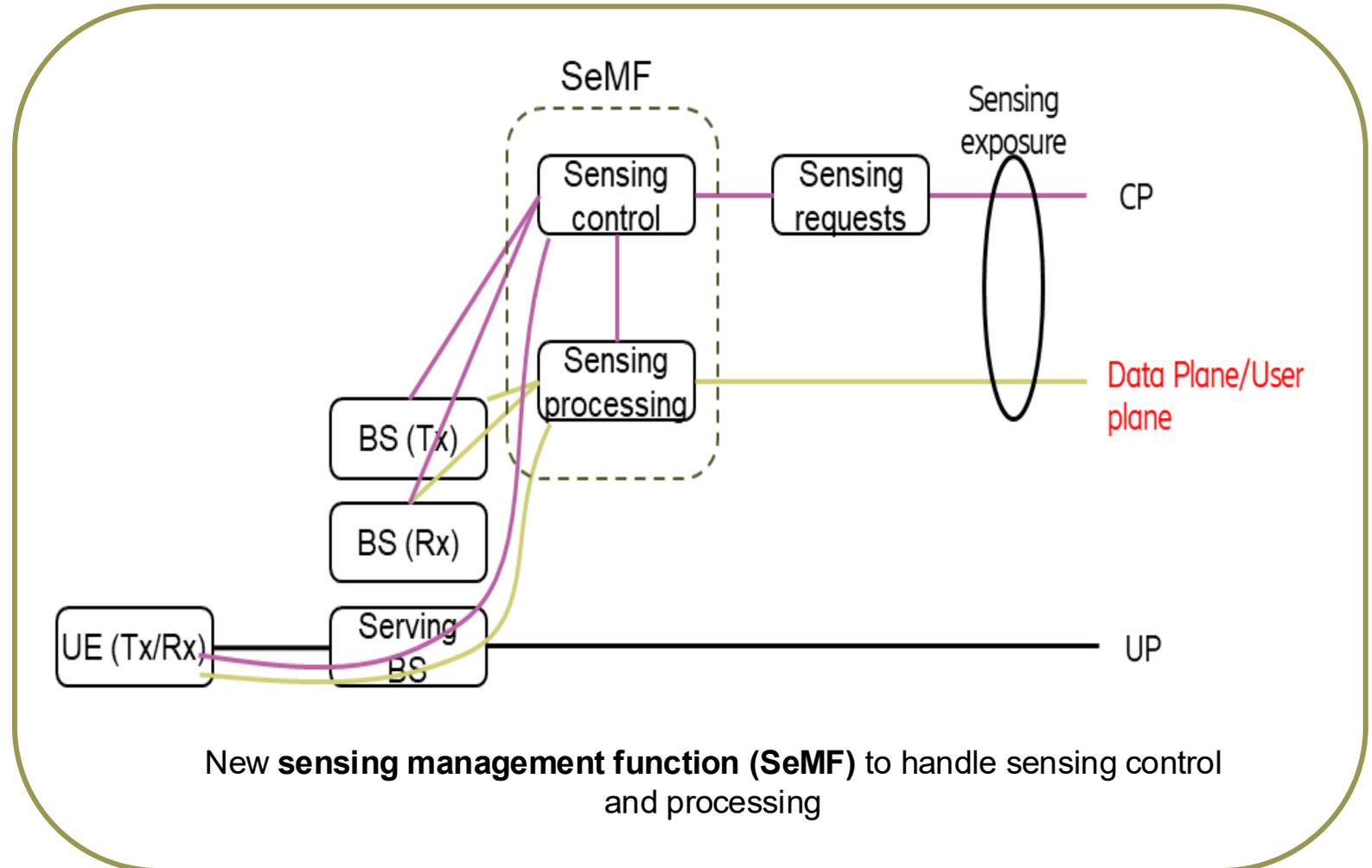


JCAS framework

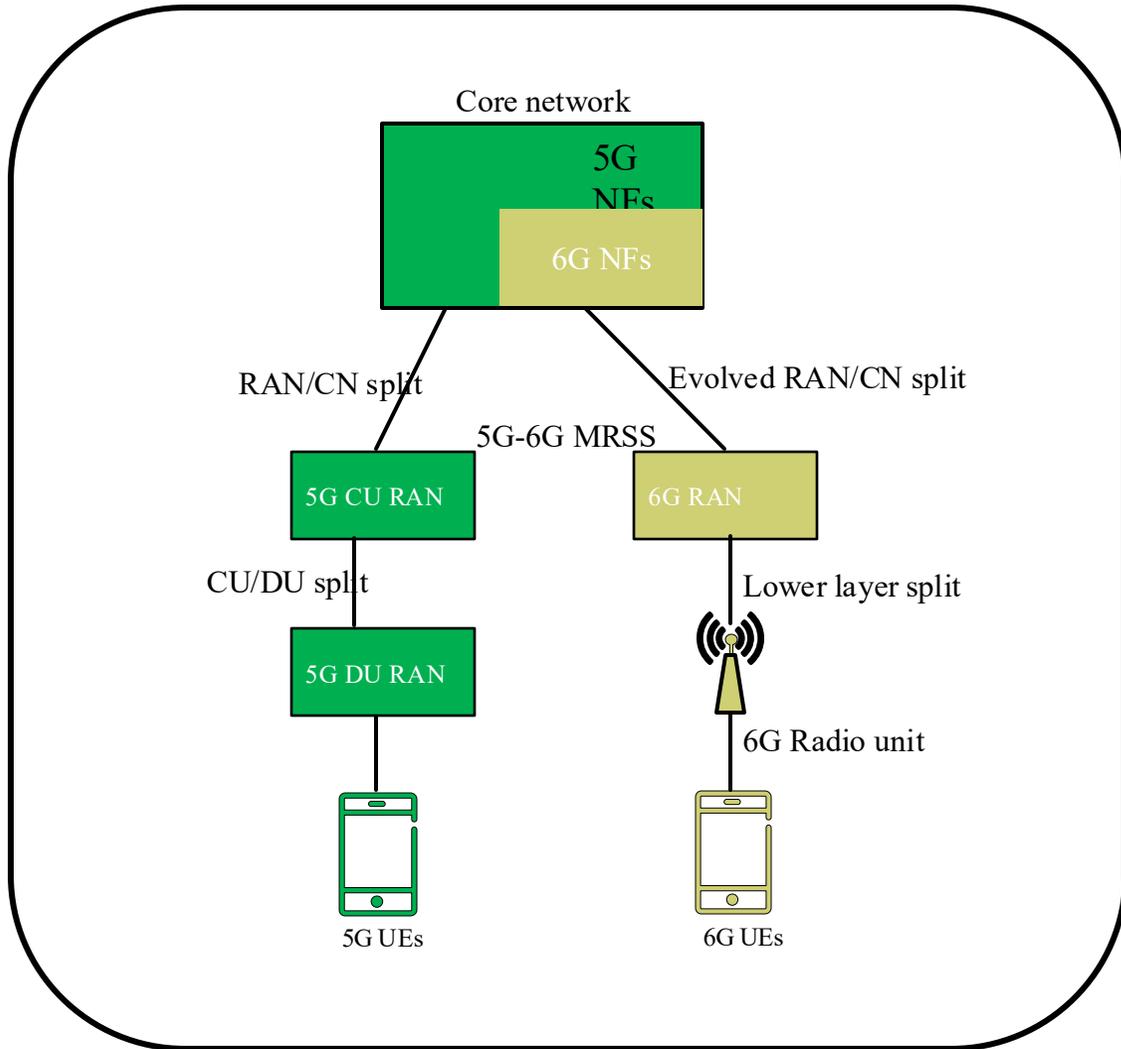
Sensing functional view



1. Sensing request
2. Sensing control
3. Sensing Units perform sensing
4. Send data to Sensing processing
5. Expose the data to app/user/NF

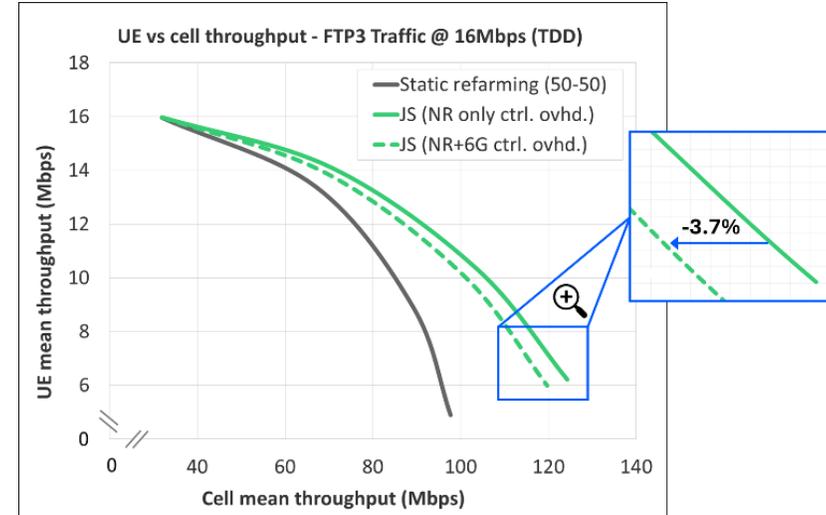


5G-6G migration and interworking methods



MRSS between 5G and 6G:

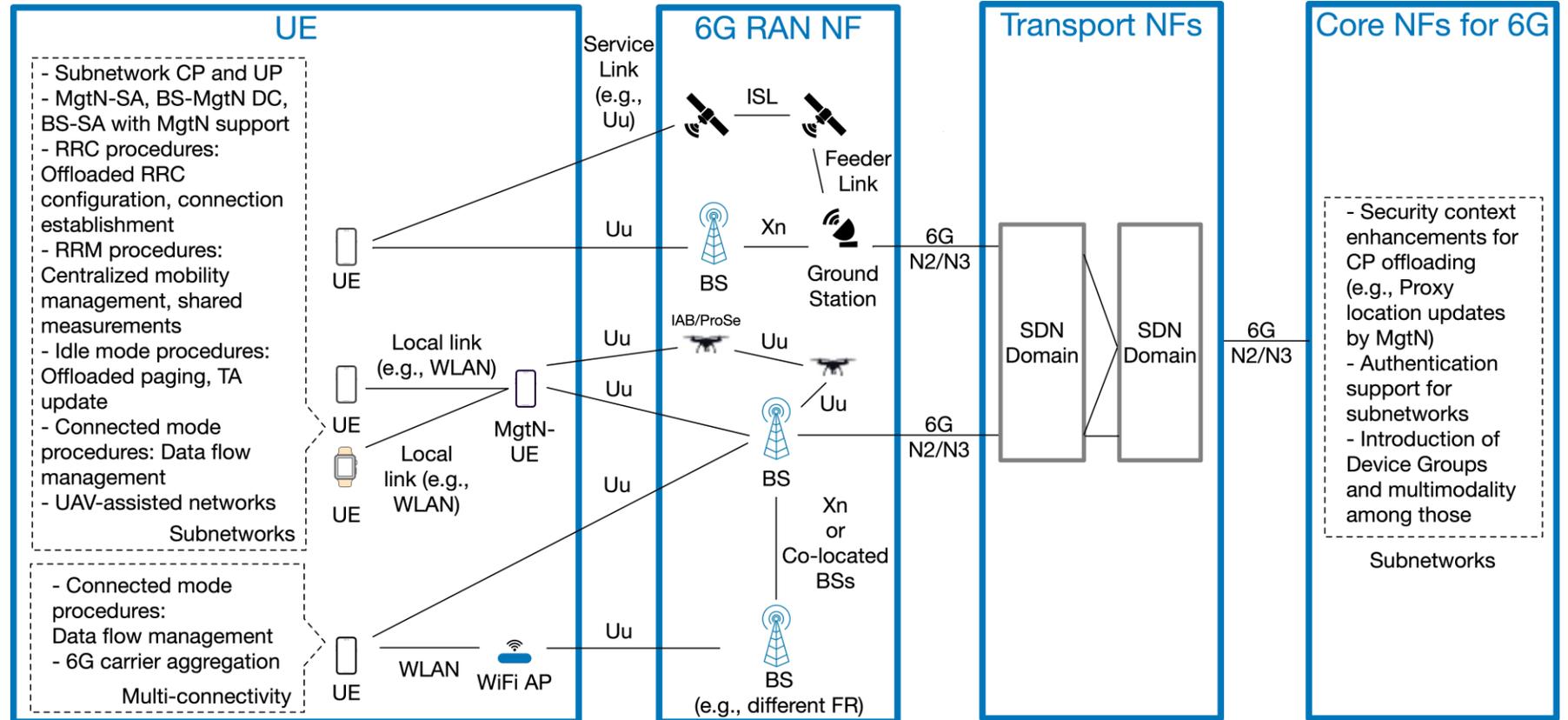
- minimal overhead
- Smooth / granular use of spectrum
- Worst case scenario 10% overhead
- Unloaded case very low overhead on 5G (~1.5%)



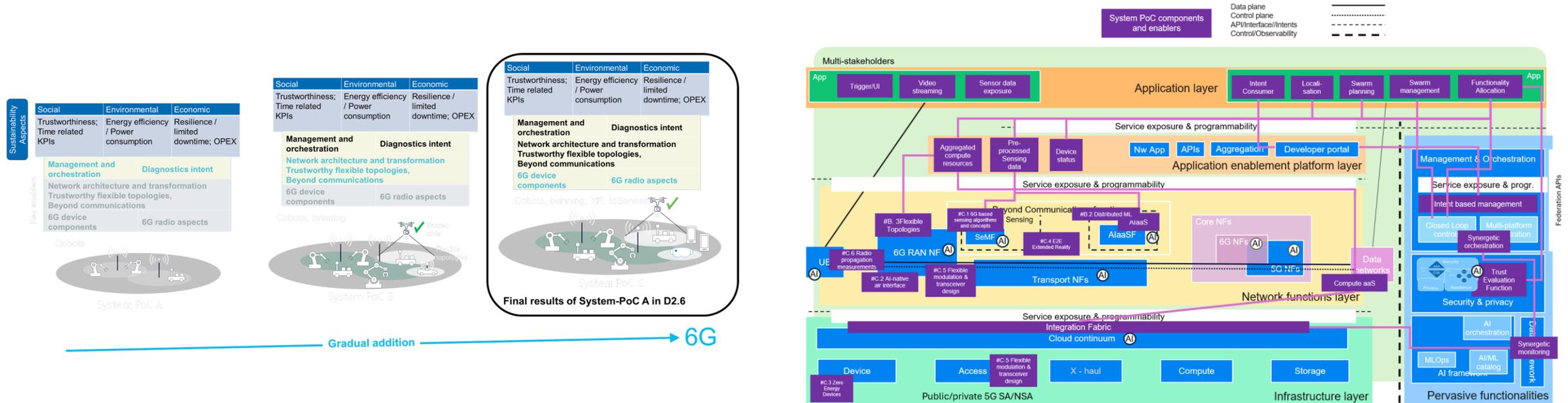
System view on new accesses and flexible topologies



- TN-NTN
- Subnetworks
- UAV-based Multi-hop Backhaul
- Multi-connectivity
- Context aware transport



Final E2E system-level validation



Experimental-based assessment for collaborative robots UCs

PoC components mapping to the E2E system blueprint

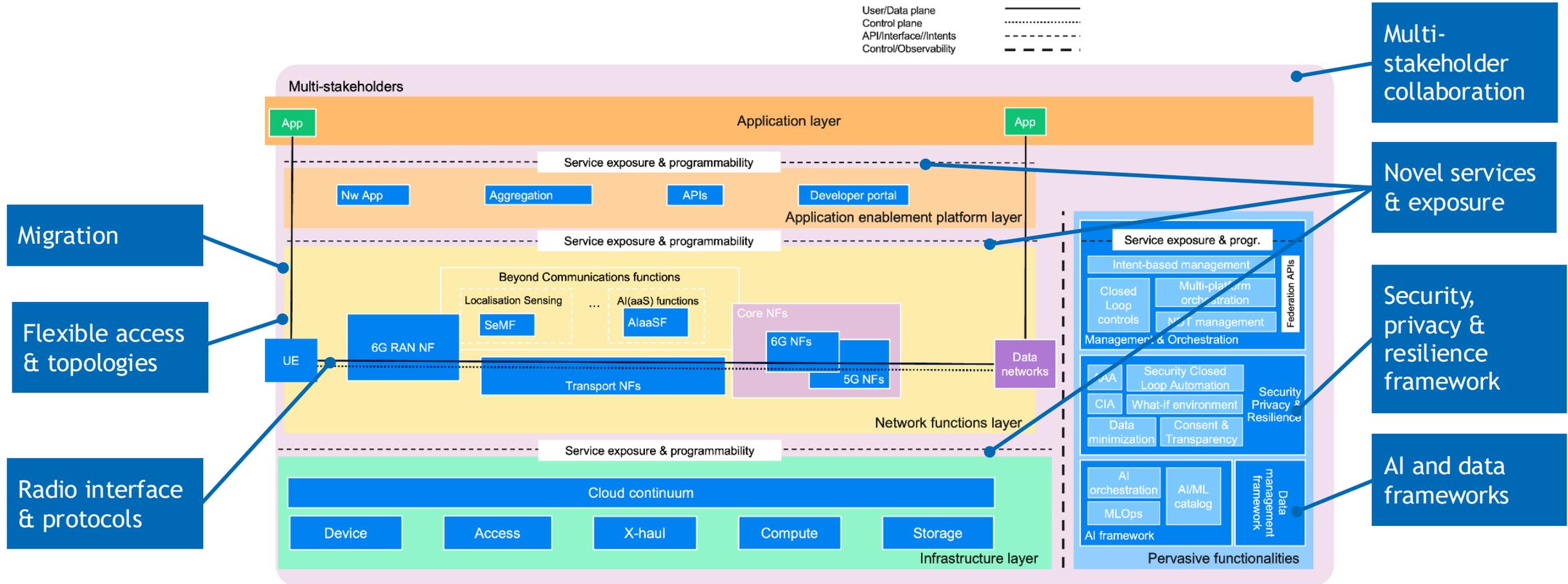
Demonstrations of the feasibility of a truly sustainable and intelligent 6G system.

- **Performance:** critical KPIs like increased coverage, enhanced capacity, and reduced latency.
- **Sustainability including trustworthiness, and inclusion:** integrating mechanisms for energy-aware service orchestration, trust assessment, and multi-stakeholder support through OpenAPIs and standardized service exposure

Summary



Combining a holistic system blueprint with detailed views of specific aspects



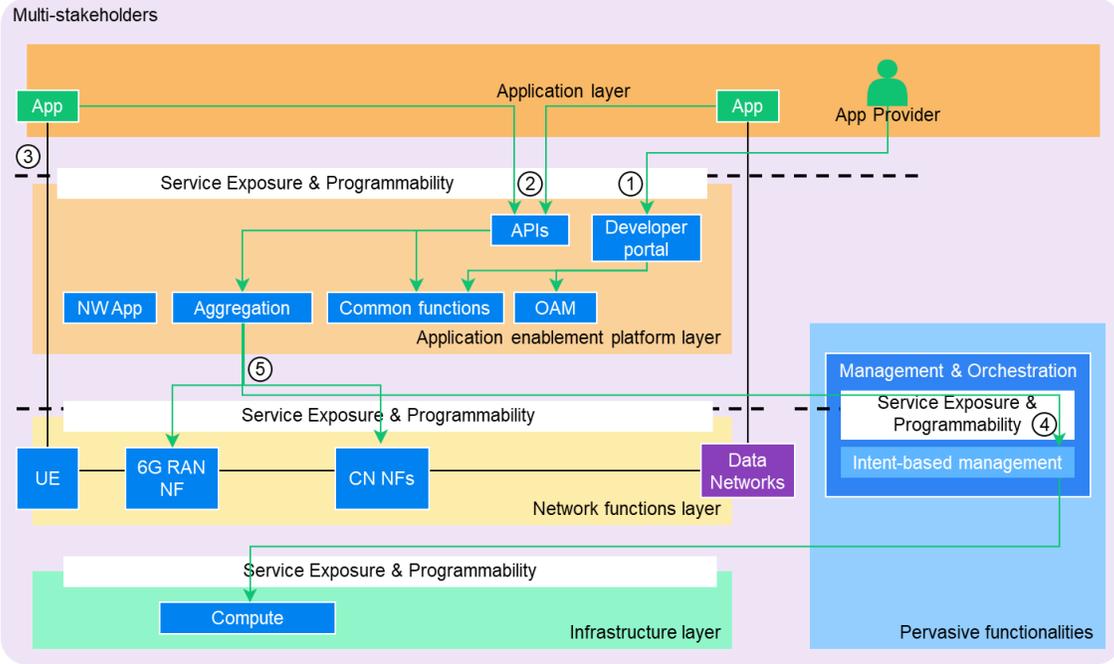


Back-up

System view on new 6G services & exposure framework

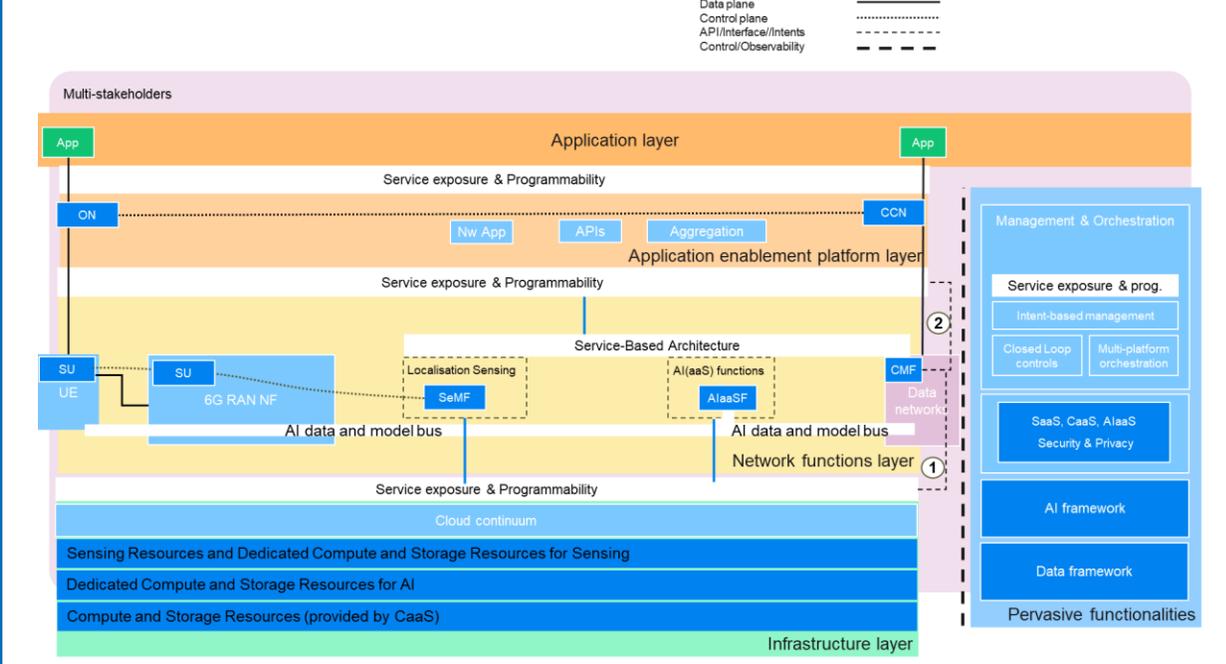


Exposure-centric view



- Resources for the developer ecosystem, abstracted API (e.g. CAMARA), commercialization functions
- Support various access channels (over the top, through user-network interface, via transport protocols)
- New 6G services exposure, including network programmability capabilities

Integrated new services view

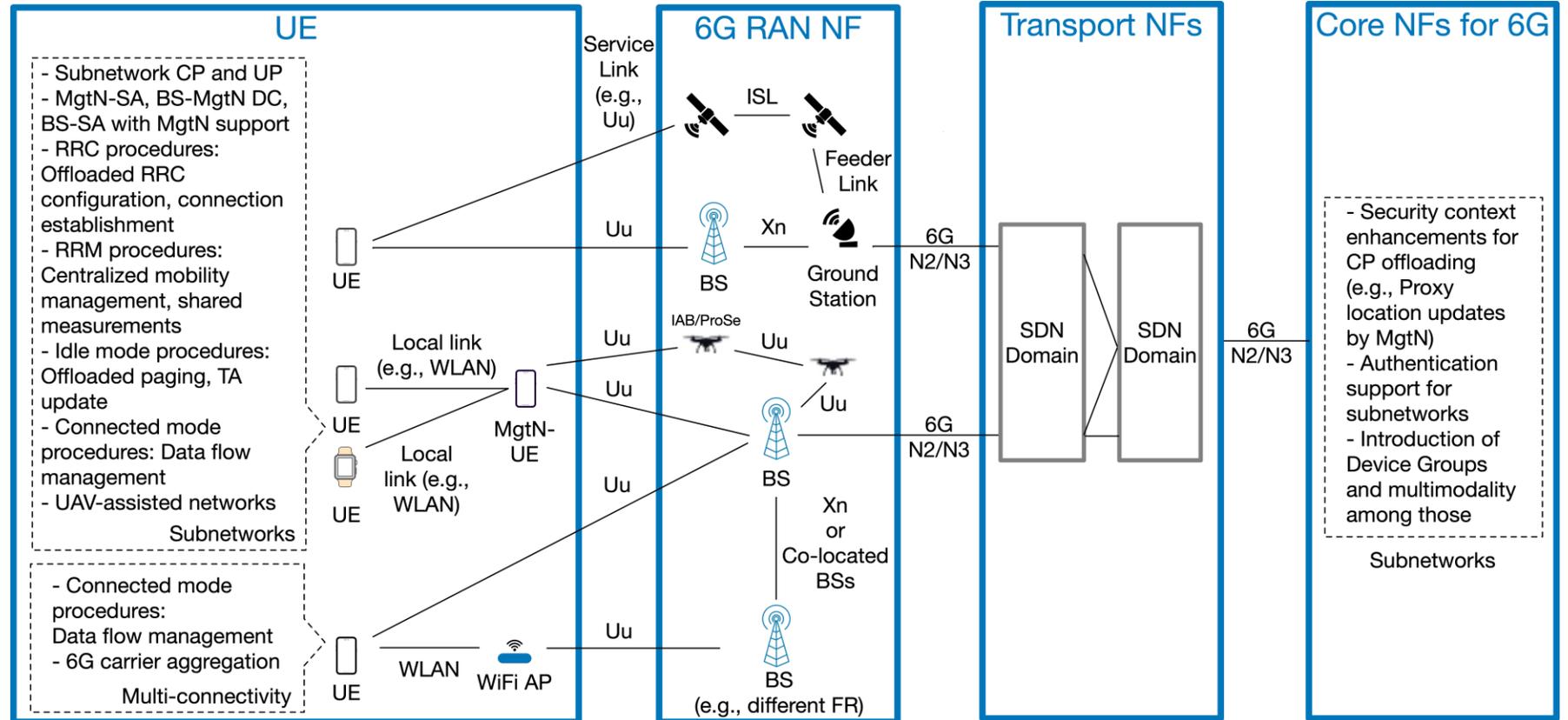


- Sensing functions: UE and RAN as sensing units (SU), controlled by a Sensing management Function (SeMF)
- AI functions: AI integrated in network, AlaaS (AI/ML LCM exposed to applications), MLOps
- Compute offloading: loose integration via on top Offloading Node (ON) and Compute Offloading Control Node (CCN)
- Compute Management (CMF) - In-network compute resource

System view on new accesses and flexible topologies



- TN-NTN
- Subnetworks
- UAV-based Multi-hop Backhaul
- Multi-connectivity



AlaaS

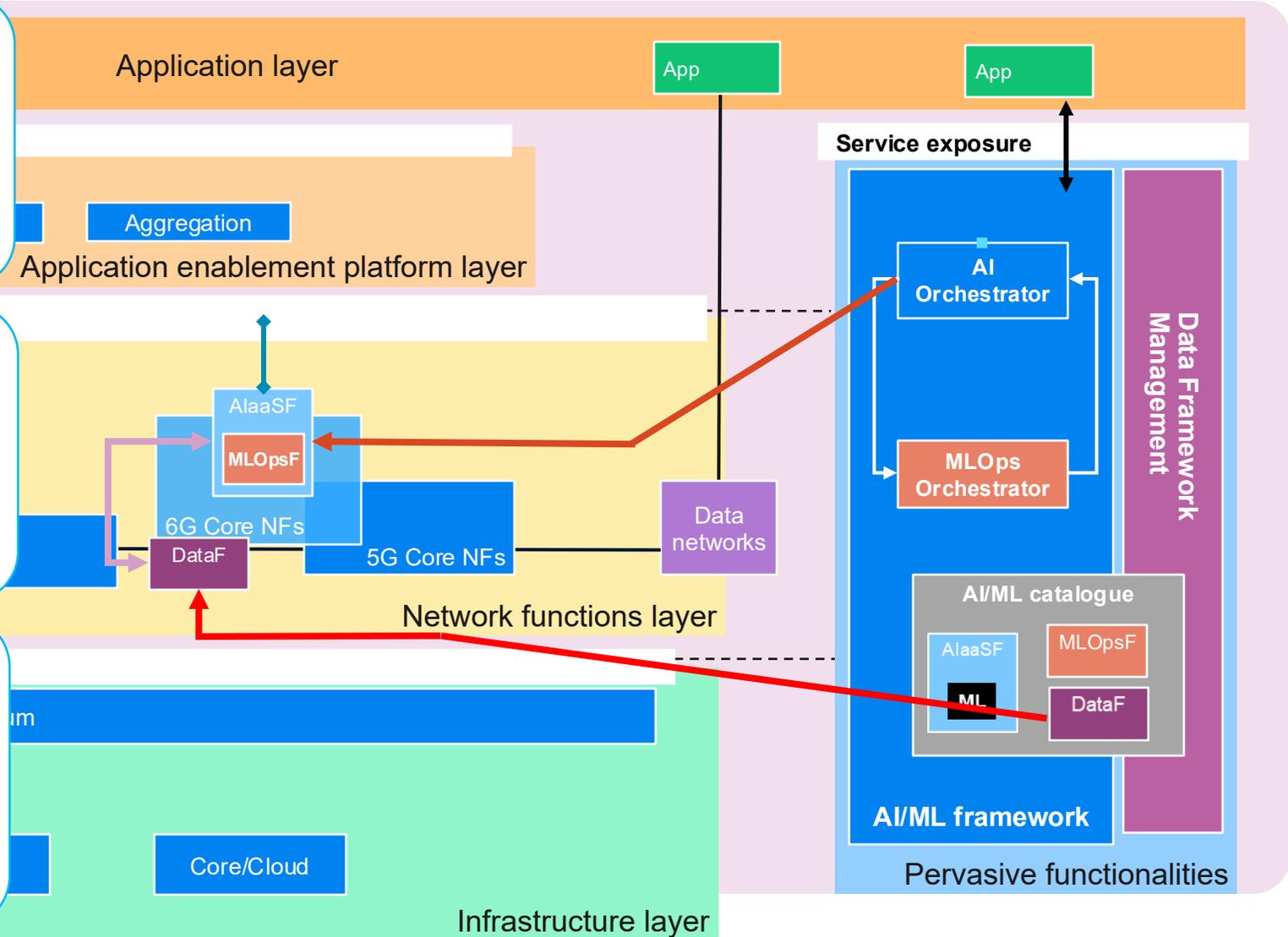
AI/ML enablers in the AI/ML Framework (Omit this slide?)



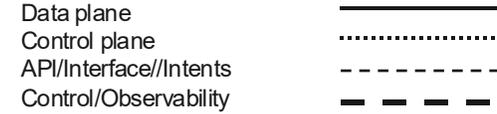
- **AlaaS**
 - “one-stop shop” solution to ease the deployment, operation and execution of AI/ML services
 - Exposure through a set of open APIs

- **MLOps:**
 - automate AI/ML models lifecycle management
 - acts as an enabler for AlaaS by optimizing AI services throughout their lifecycle.

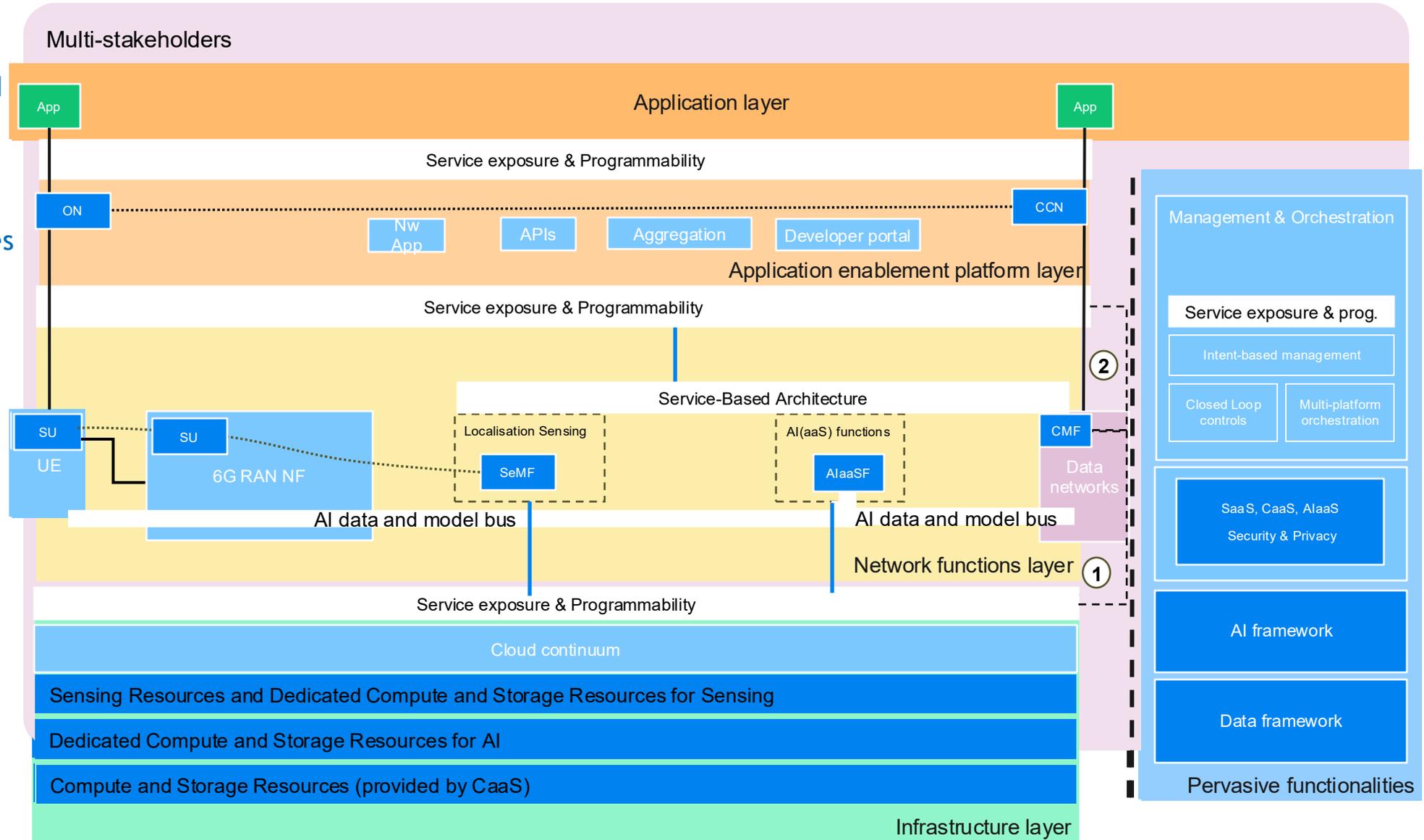
- **DataOps:**
 - to efficiently distribute and manage data for AI services
 - MLOps and DataOps work in synergy to streamline AI/ML lifecycle.



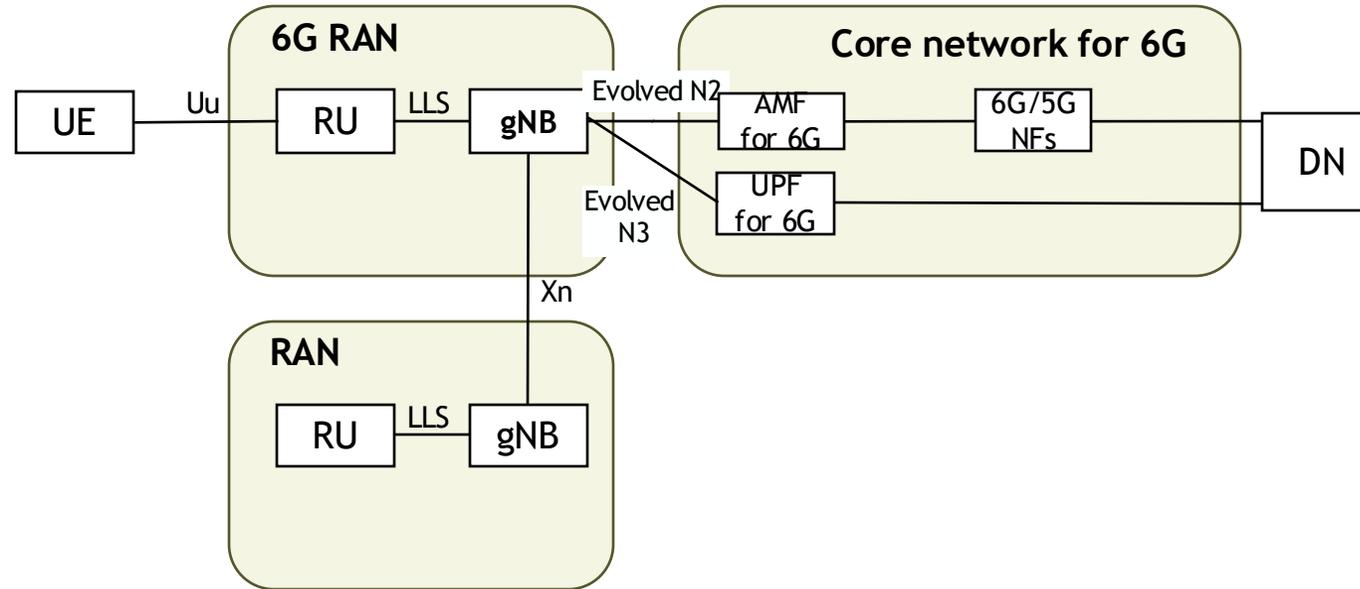
System view of new services



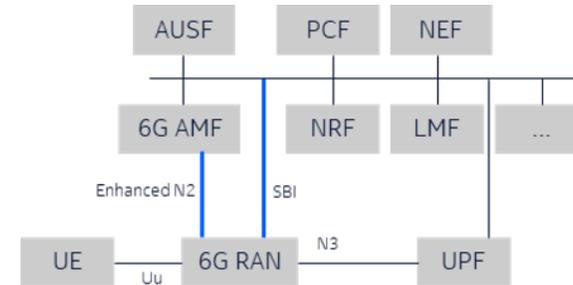
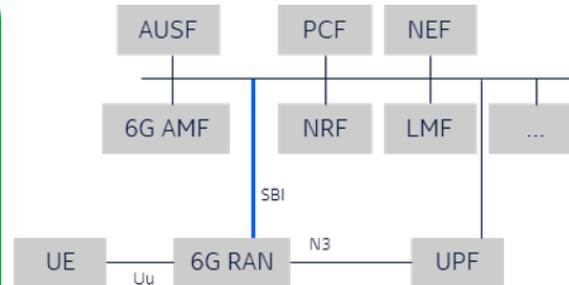
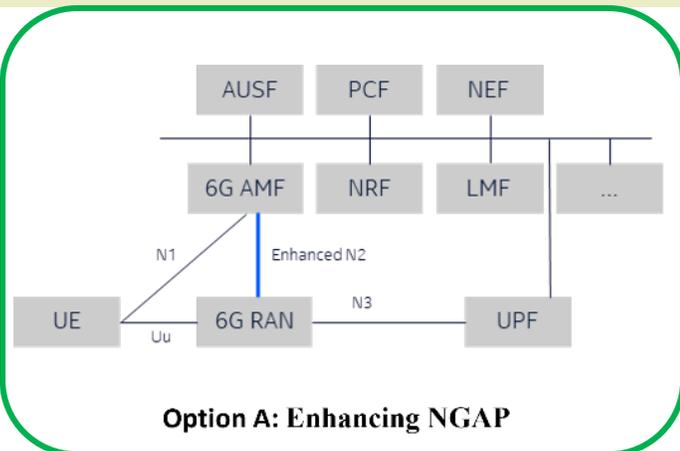
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RAN and CN interfaces



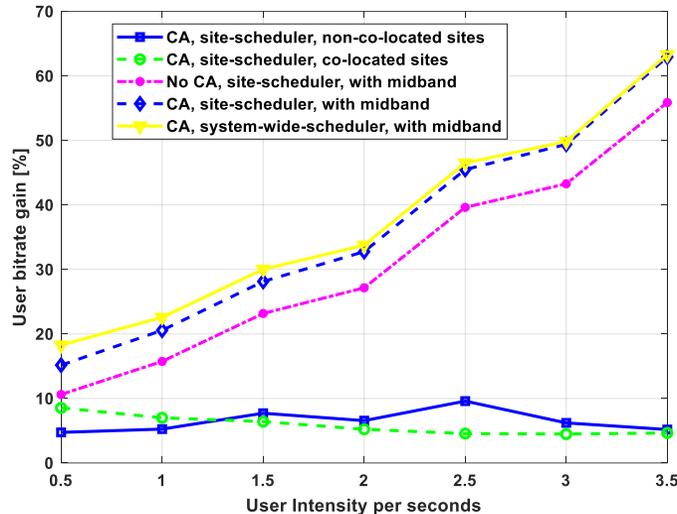
6G RAN CN interface options



Flexible Topologies - 6G multi-connectivity and NTN



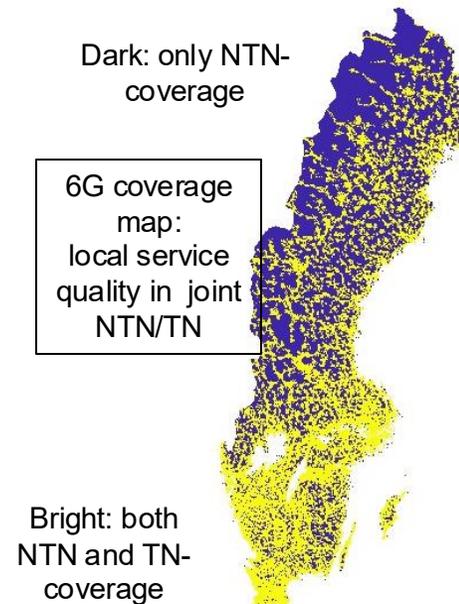
Carrier aggregation evaluations for 6G



Carrier aggregation user throughput gains depends:

- Carriers need to be similar in terms of coverage, capacity and bandwidth
- Traffic model e.g. size of packet to download
- Aggregation only works if carriers are “equal” (indirectly we mean that DC is not so useful)
- Only one “multi-connectivity” solution is needed in 6G and it should be based on CA

NTN/TN coverage maps

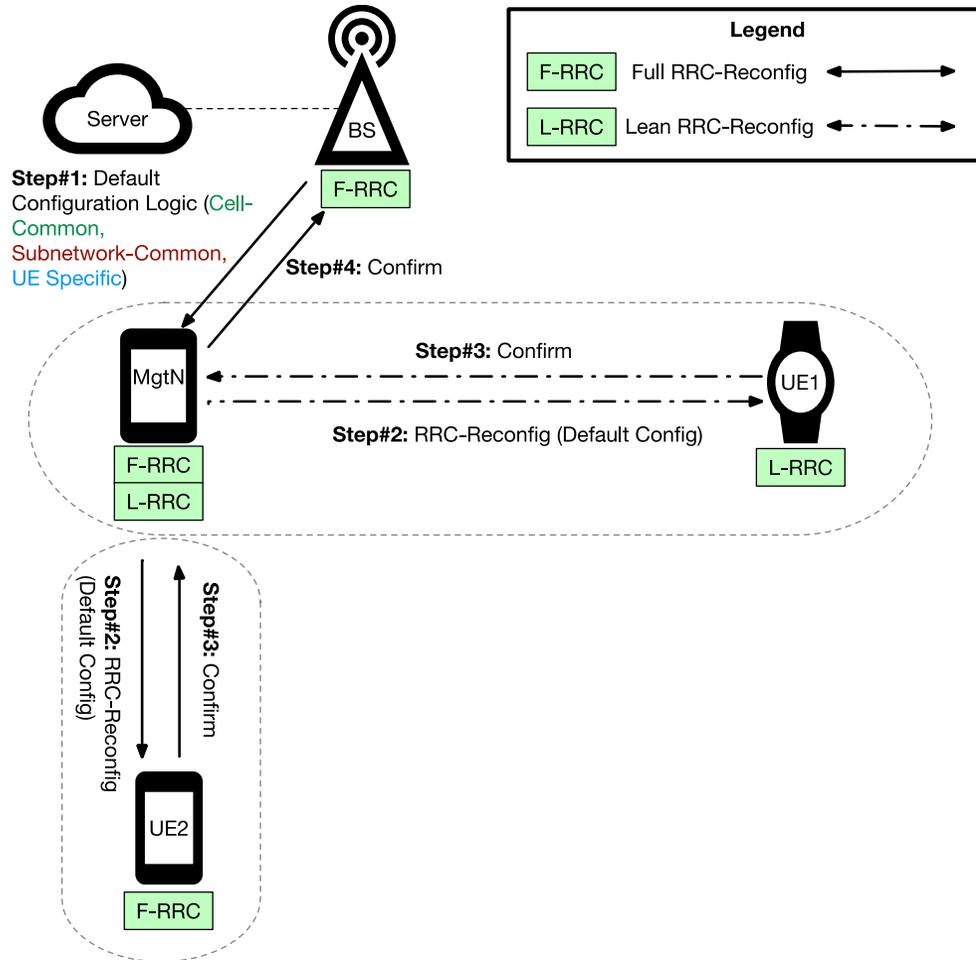


A new coverage inequality index measure reflects for an NTN/TN-served large-scale region the rural-urban service fairness

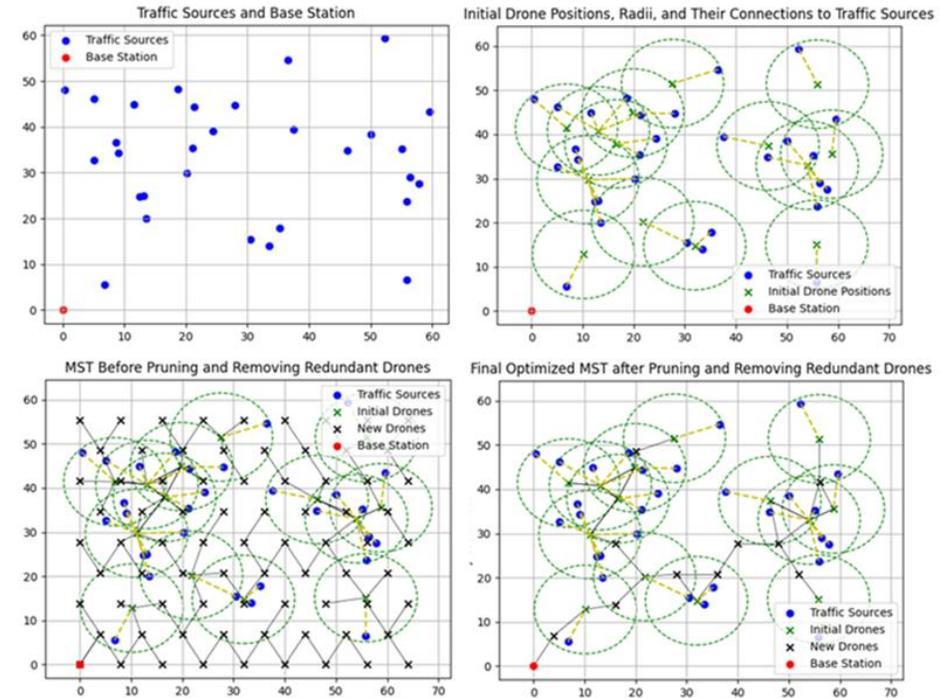
Flexible Topologies - subnetworks



Subnetworks configuration procedures

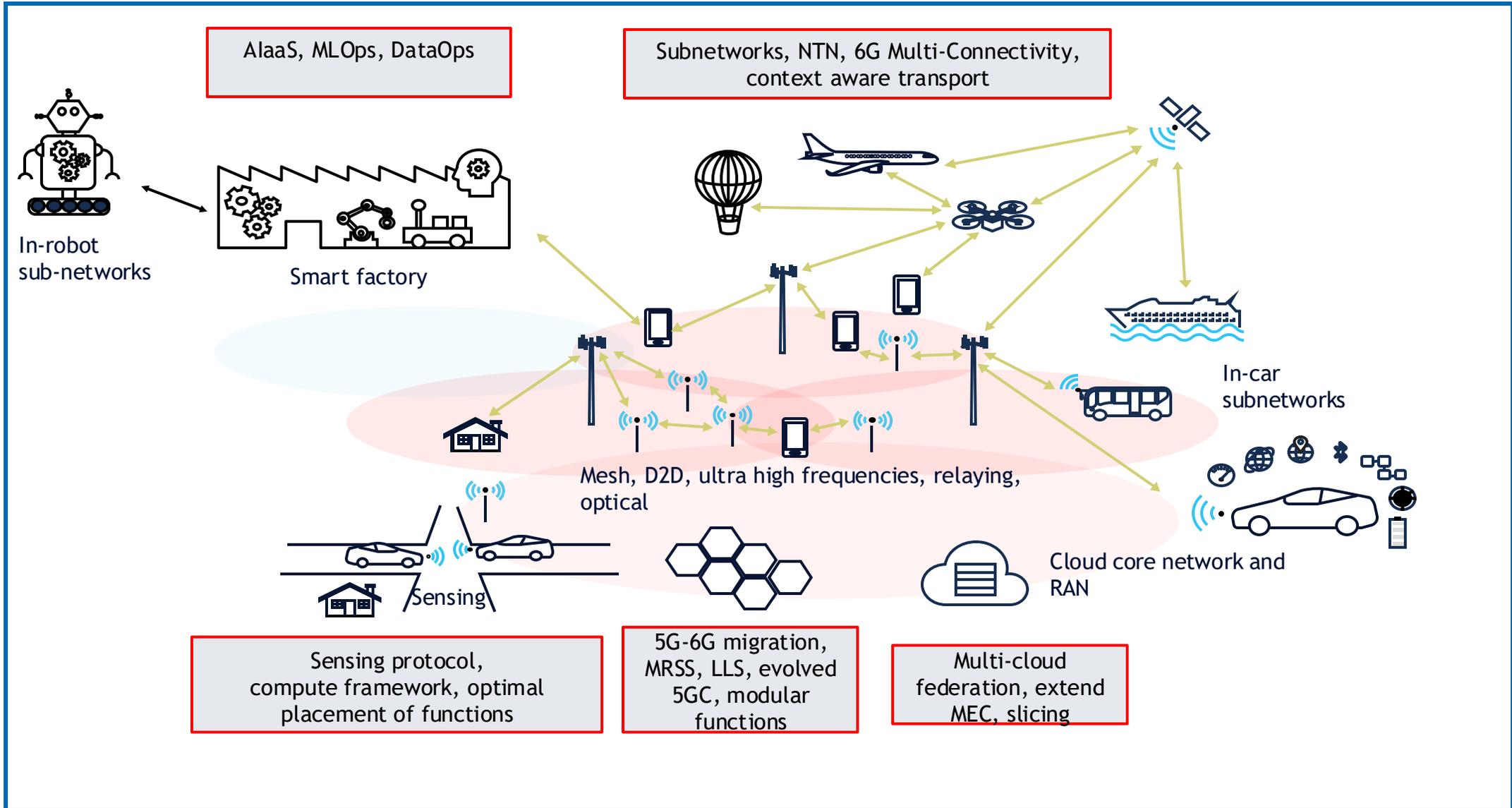


UAV assisted subnetwork



- **UAV control and management systems**
- **Integrated with existing network infrastructure**
- **Dynamic deployment and real-time optimization of UAV-assisted topologies.**

6G Architecture enabler summary





HEXA-X-II.EU //   



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6GSNS

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