6G E2E architecture, architectural components and enablers

The 6G series workshop by Hexa-X and Hexa-X-II

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  - Global coverage with NTN
- Efficient network enablers
  - Architecture transformation

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- Beyond communication
- Network of networks enabler

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- Flexible enablers
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- Efficient network enablers
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TO BE REMOVED – just for info now

6G architecture direction

Architectural principles

Increased network intelligence

1: Exposure of capabilities to E2E applications

2: Designed for automation

Increased network flexibility

3: Flexibility

4: Scalability

5: Resilience and availability

Increased network efficiency

6: Exposed interfaces are service based

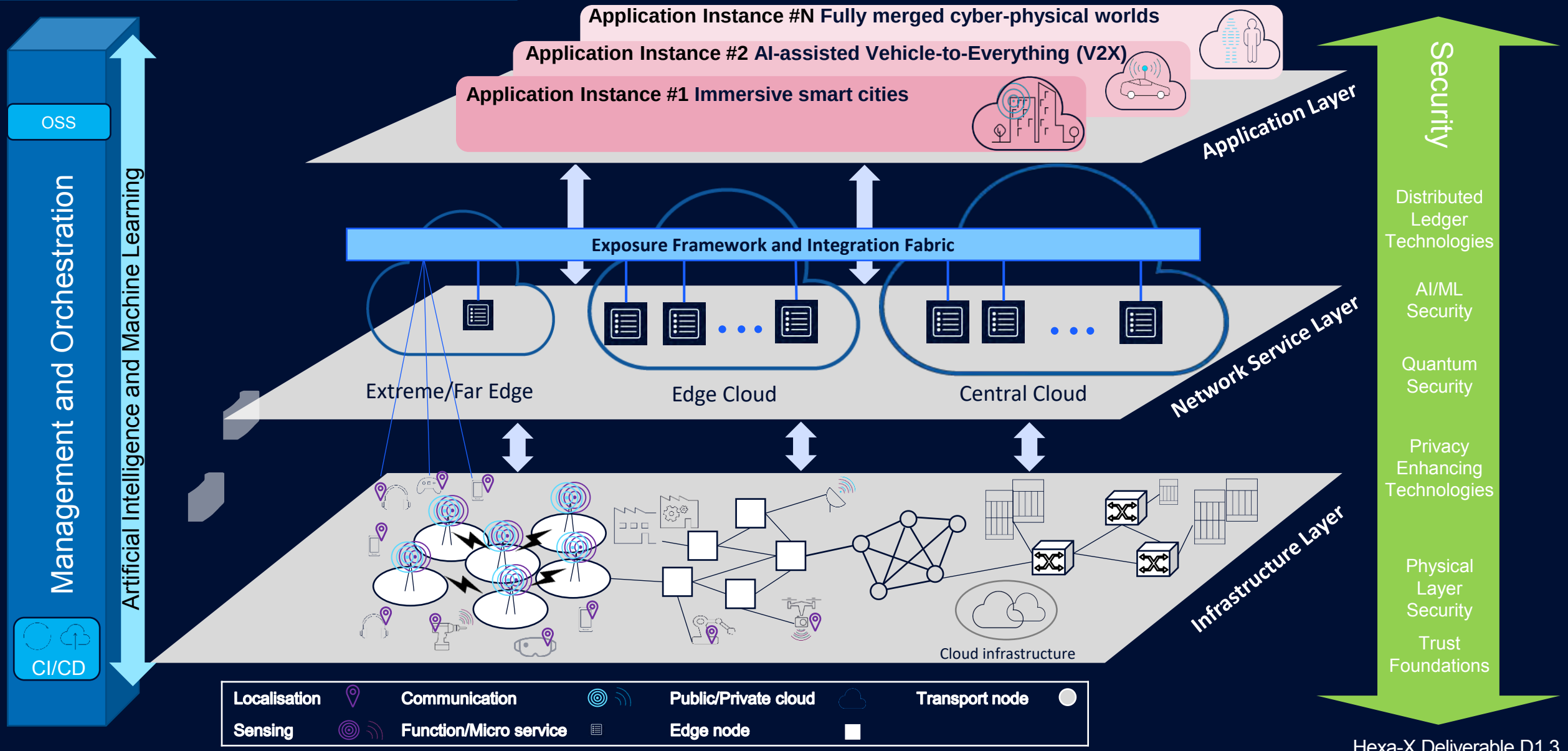
7: Separation of concerns of network functions

8: Network simplification in comparison to previous generations

Architectural enablers

- *Programmability*
- *Network automation, intent-based management*
- *AI-as-a-Service*
- *Integration of sub-networks and non-public networks with public networks*
- *Flexible topologies: D2D, mesh, NTN*
- *Function refactoring*
- *Efficient RAN/CN signaling*

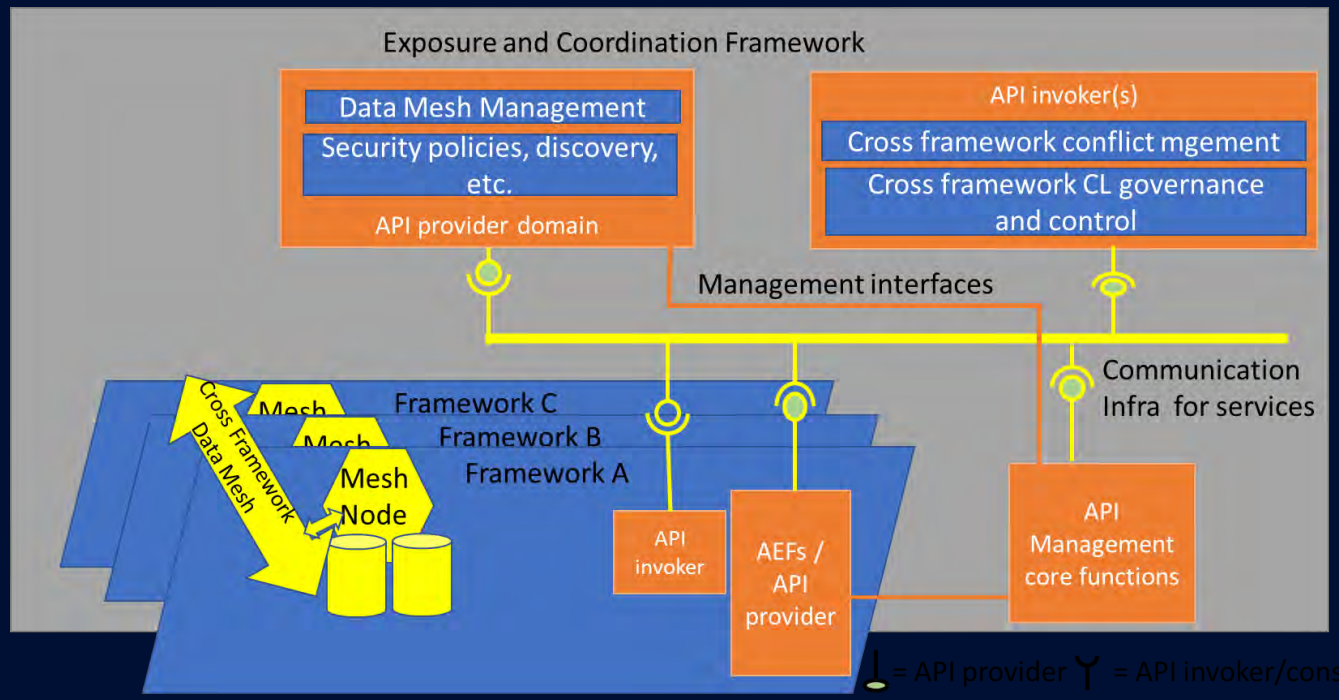
E2E architecture - System view



Intelligent network enablers

Exposure and Coordination Framework (ECF)

- Several frameworks have been introduced for the Hexa-X architecture.
  - Specific purpose, resources, data and services
- A flat SBA style tightly integrated approach between the functions of different frameworks can be applied.
- Integration API management framework defined
- The Exposure and Coordination Framework should contain cross framework governance and control
- CAPIF for API management and Data Mesh for streaming data.



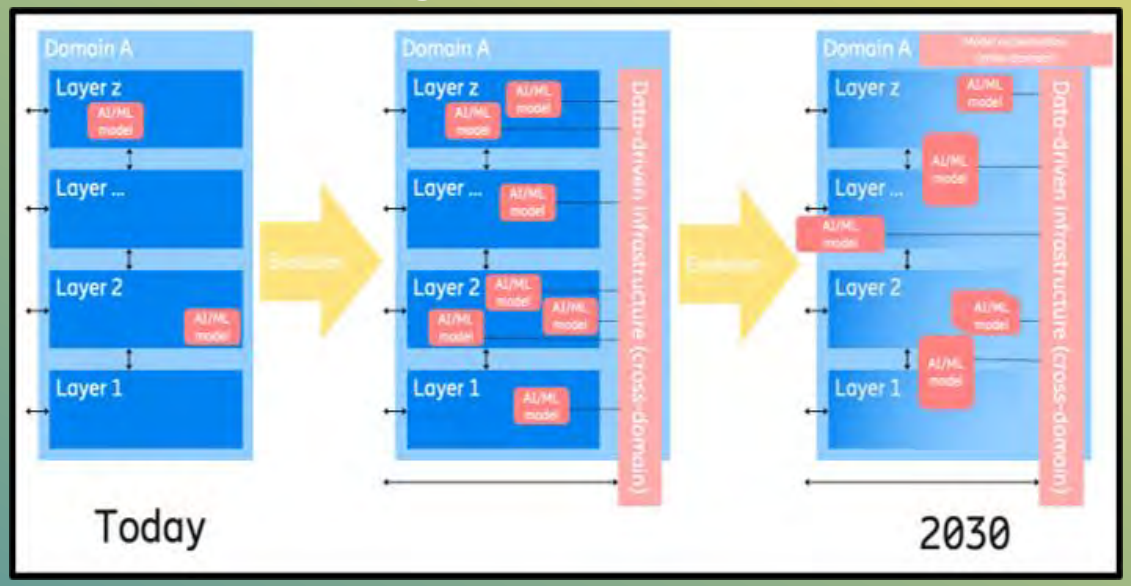
Loose integration of frameworks

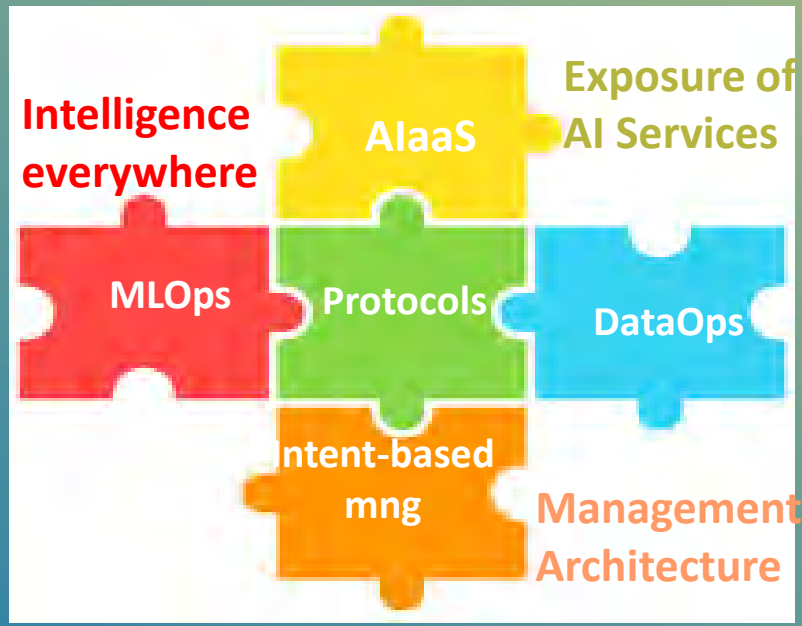
CAPIF = 3GPP Common API Framework

From AI to AI-native

- 3GPP rel.18 marked the start of 5G Advanced where AI-based solutions are increasingly used to improve network performance and enable intelligent network automation.
- Network architecture evolving toward AI-Native
- Hexa-x-II will develop:
  - Intelligence everywhere → MLOps
  - Distributed data infrastructure → DataOps
  - Exposure of AI services → AIaaS
  - Managing all of these → intent based/Zero-touch
  - Protocols to support the AI-native network

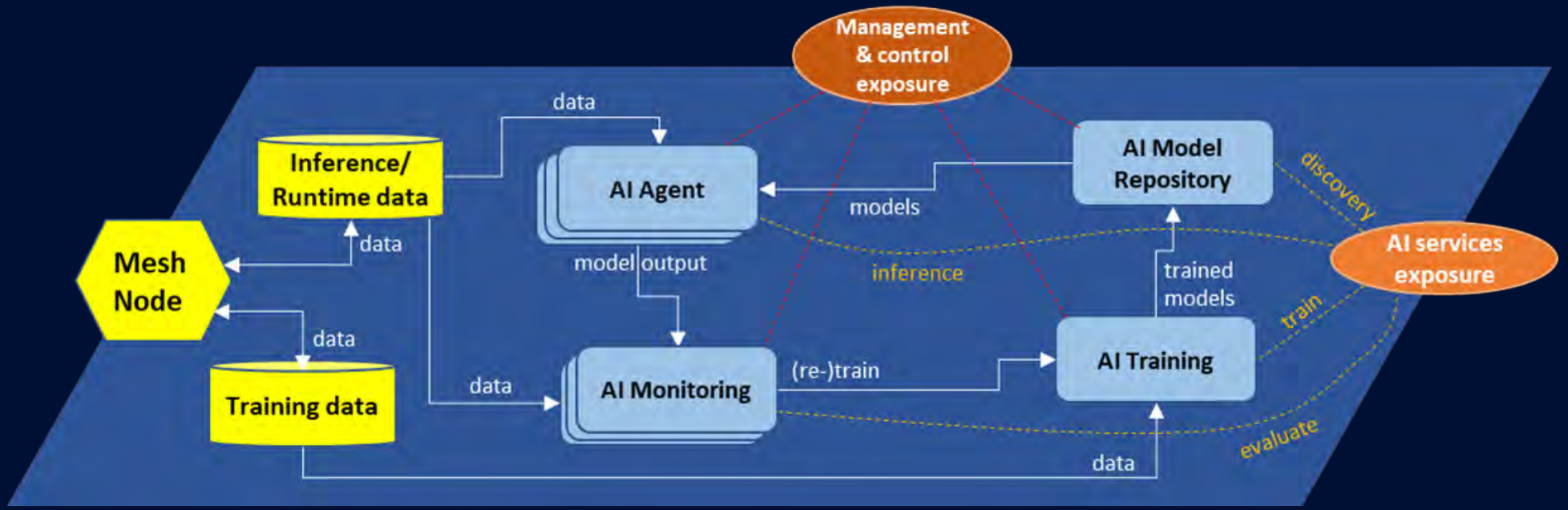
From using AI to AI-Native

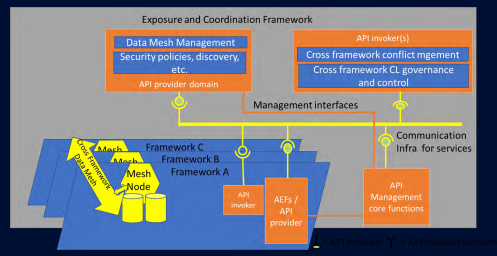




AI as a Service Framework

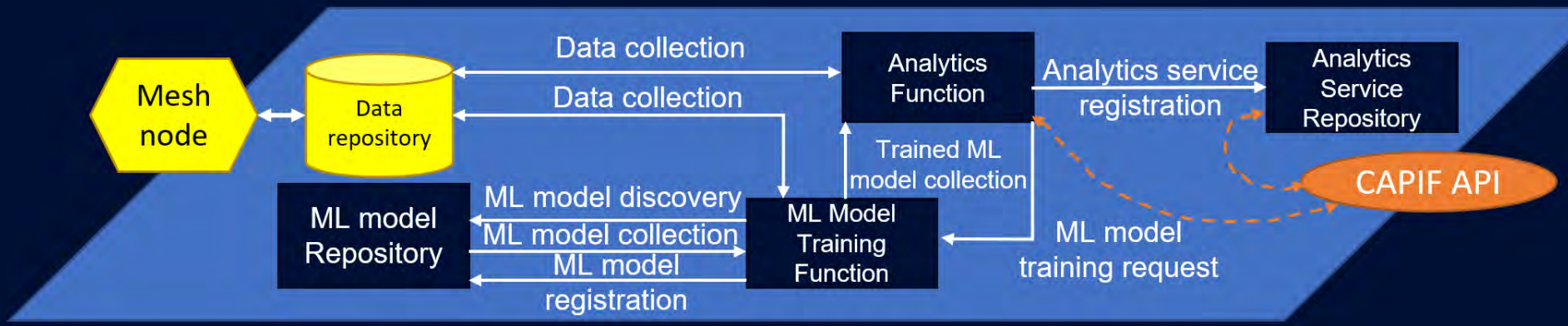
- Common services and functions for consumption of in-network AI capabilities are needed.
- Three main AI related operational workflows supported
  - Training, inference, and monitoring
- Agnostic from AI functions deployment model.
- Enable a unified exposure (through 3GPP CAPIF-like) approach to facilitate AI services consumption.

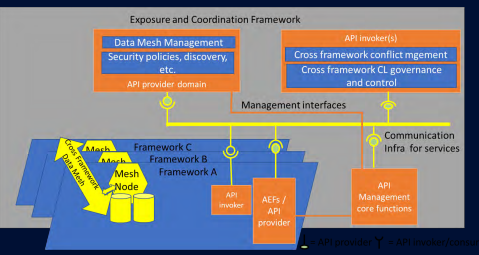




Analytics Framework

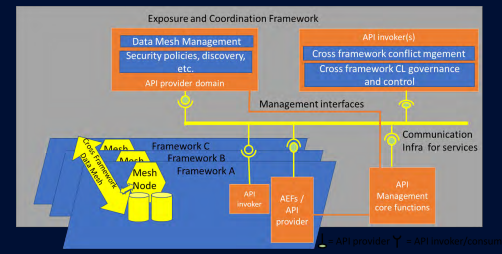
- Currently no consistent analytics framework exists cross-planes and cross-domains.
- Integration of AIaaS and distributed AI agents for the analytic purpose.
- Taking advantages of trained models stored in repositories and input data set by another domain/plane.
- Ability to exchange knowledge and analytics cross-planes and cross-domains.

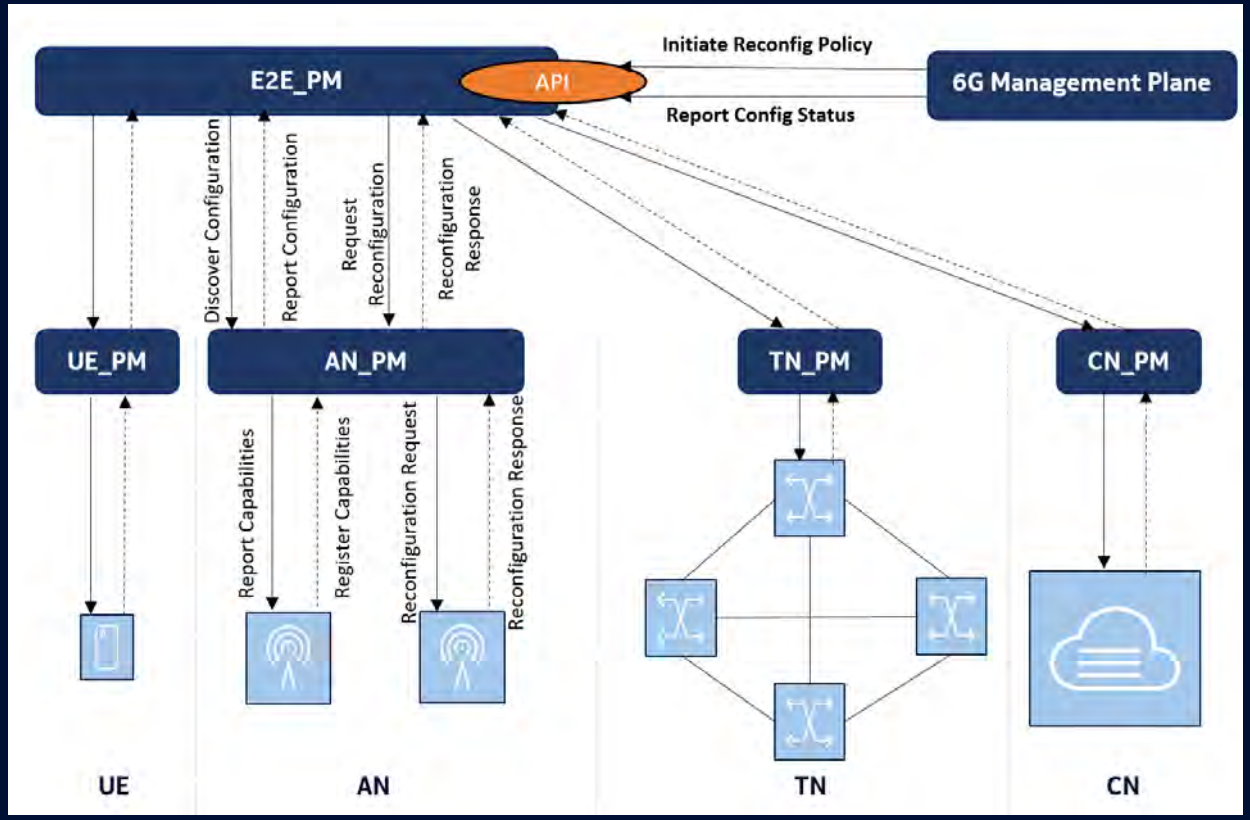




Programmability Framework

- Supporting programmability in the network's infrastructure.
- Local programmability managers: UE, Access, Transport, and Core
  - Discover programming capabilities of underlying infrastructure.
  - Abstract the implementation details of different devices.
  - Establish channels to reconfigure the behavior of devices.
- Central E2E_PM is to interact with local managers and the 6G management plane functions.



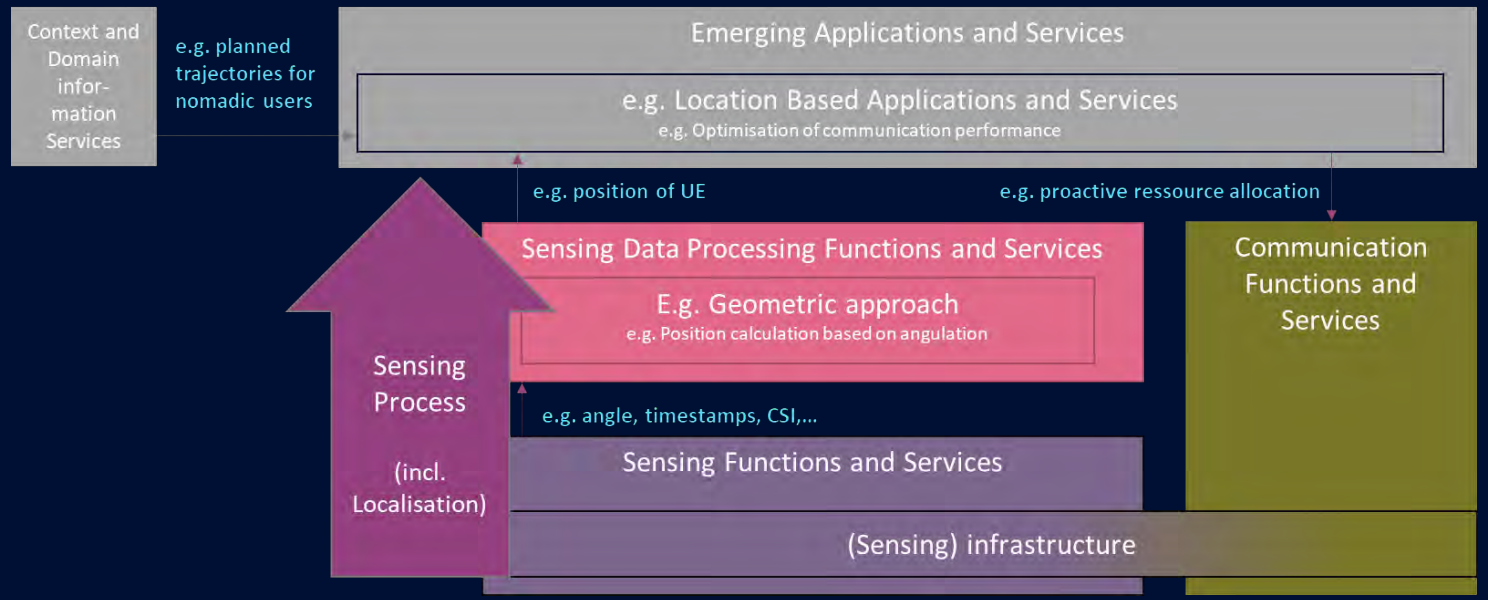


Flexible network enablers

Beyond Communication

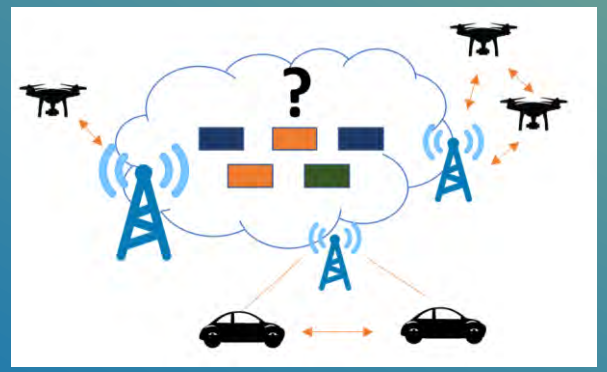
- Localisation: the ability to accurately determine the physical location of a UE.
- Sensing: the ability of the network to detect and interpret physical parameters of the environment.
- Key enablers for ranged of 6G use cases

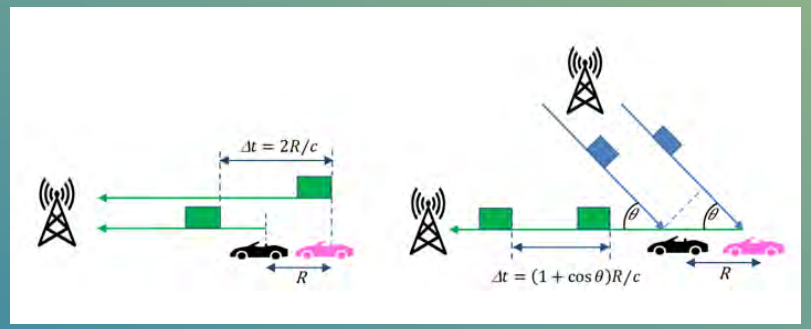
- Sensing Functions and Services
  - Infrastructure and means to configure
  - Generation and collection
  - Estimation of delay/angle parameters
- Sensing Data Processing Functions and Services
  - Data-driven / AI-based
  - Fusion of information
- Emerging Applications and Service
  - Use of absolute / relative location of UEs
  - Context/domain information services



6G Architecture for Joint Communication and Sensing

- Sensing is a technique that relies on 6G radio to detect position and mobility of an object
  - Not necessarily connected to the network
  - Can be used in-network
  - Or exposed to 3rd party

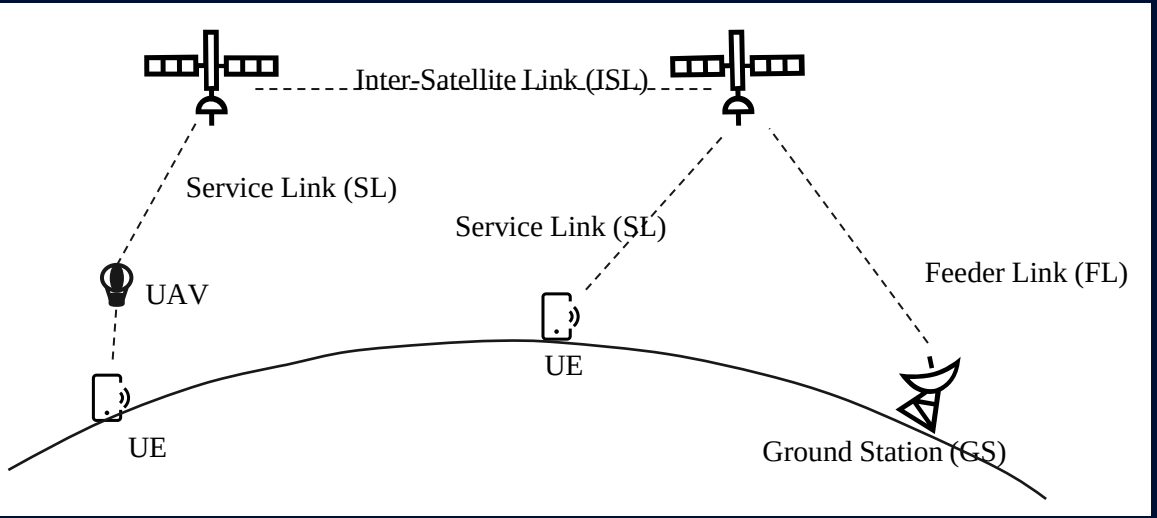


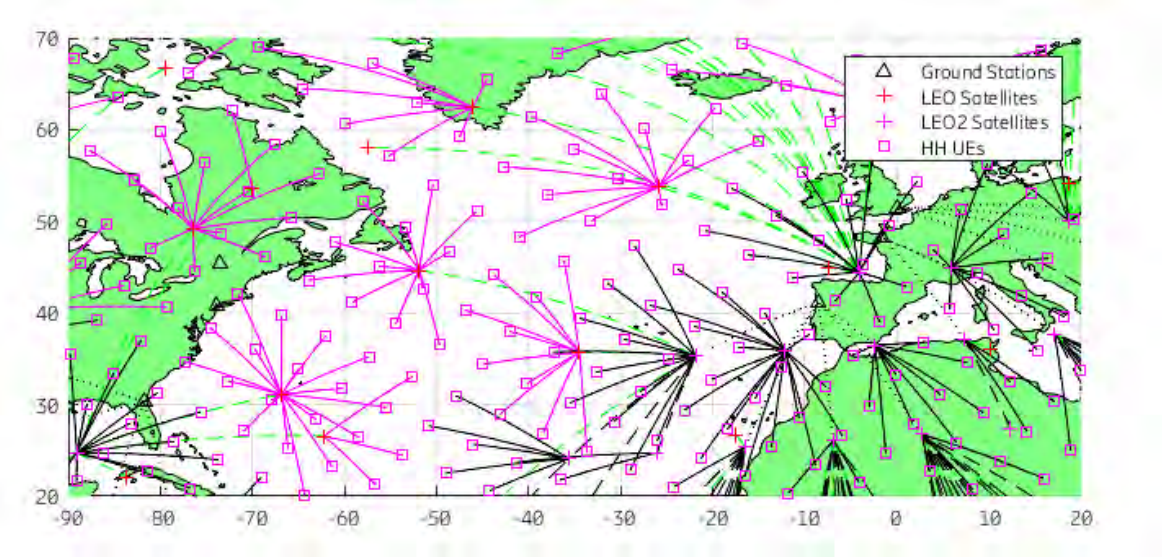


- 6G JCAS functionality:
  - Interfaces and protocols for actual sensing
  - Network functions for data collection/processing/aggregation
  - Protocols to collect sensing data among devices and NW nodes
  - Exposing sensing data
  - Privacy and security
  - Designing how the data collection, aggregation and labeling should be exposed between the consuming functions in core and in 3rd applications.

NTN and Global Coverage

- The digital inclusion is one of the goals of 6G
- 6G need solutions for global service coverage, connecting remote places, etc
- Global service coverage is possible assuming an architecture that allows inter-satellite-link (ISL) hops.
- Hexa-X investigated two scenarios:
  - UE directly connected to satellite platform
  - UE connects to NTN via unmanned aerial vehicle
- To achieve 100% availability for a very low population, more than 600 satellites (with ISL) in low earth orbit are needed.



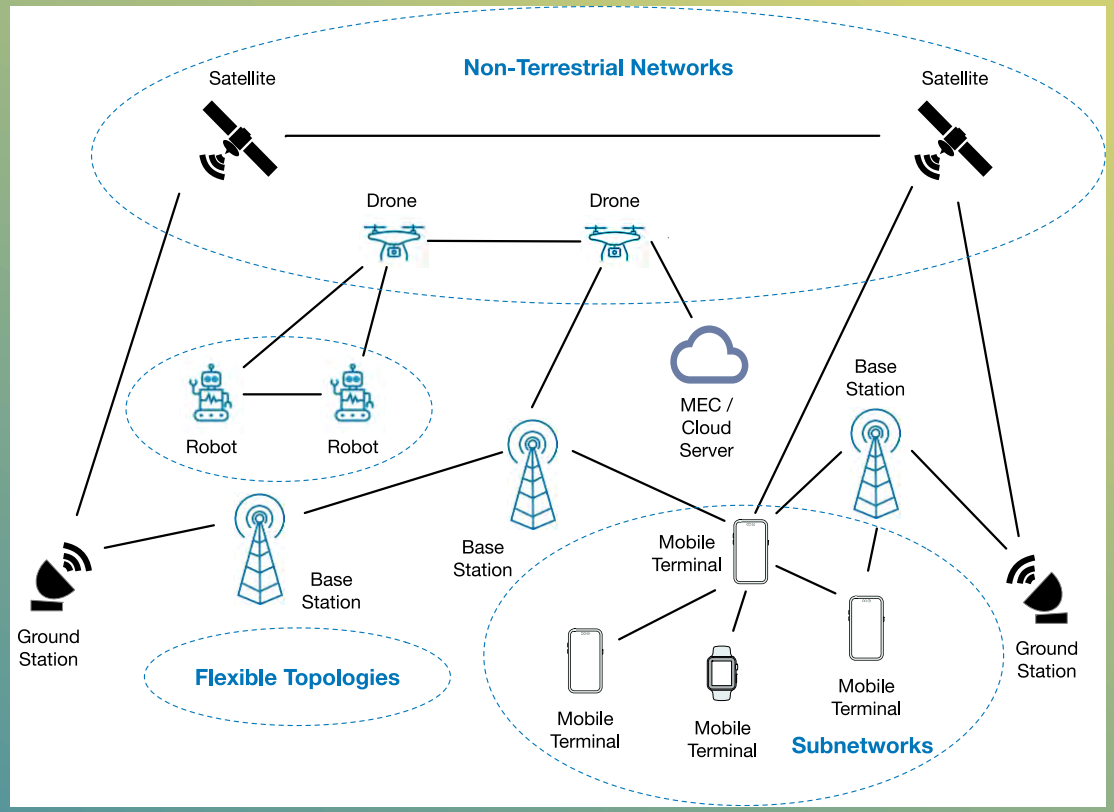


Network of networks

- Hexa-x-II has the aim to create a seamless and ubiquitous communication system by integration of multiple subnetworks e.g.:
  - Sub-networks
  - Aerial networks
  - Non-terrestrial networks

- This contributes to the goals of 6G networks, such as extreme coverage, reduced complexity, increased reliability and more efficient management of network resources

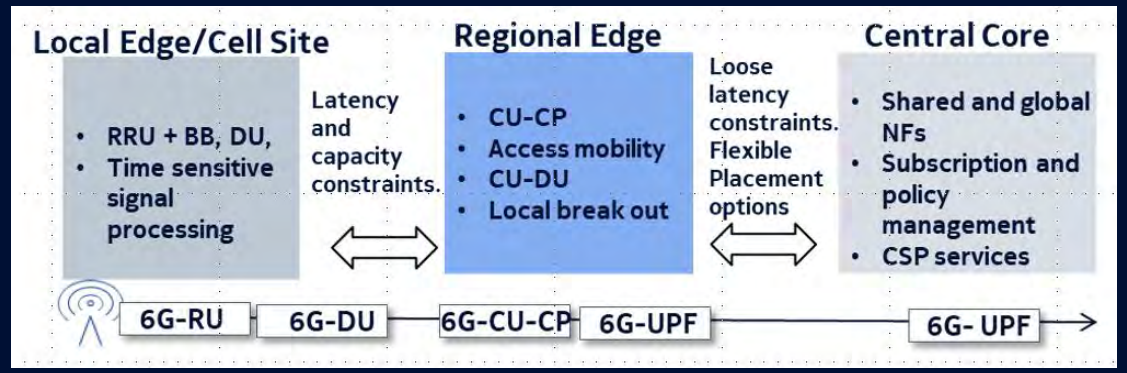
- Hexa-x-II will study e.g.
  - Study the architecture of subnetworks formed by multiple user-owned
  - Research the new roles and responsibilities of the nodes as well as the coordination between the nodes
  - Investigate NTN architecture options
  - Design unified decision-making and resource allocation frameworks for the subnetworks

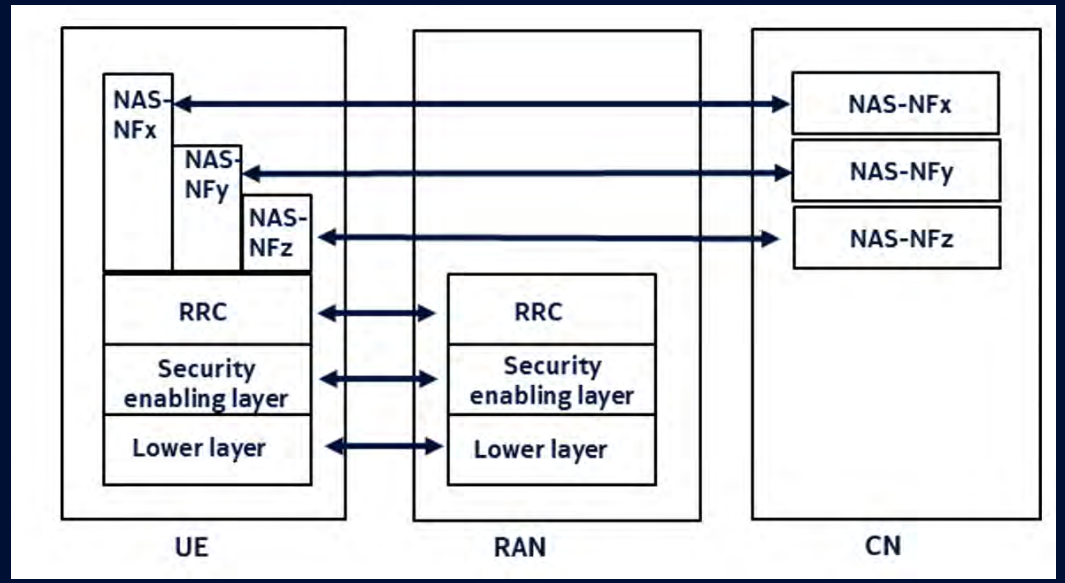


Efficient network enablers

Function elasticity

- Network function placement is limited by cloud capabilities and latency requirements.
- Need to scale across cloud continuum covering core and distributed cloud.
  - Changes to some existing nodes, e.g., the AMF, may be needed for efficient communication between nodes.
- Distributed NF implementations and distributed NAS
- Ability to direct communication with RAN and Core NFs
- Full cloudification of RAN and Core NFs combined with dynamic function placement bring efficiencies in terms of performance (e.g., less signaling), scalability and flexibility.

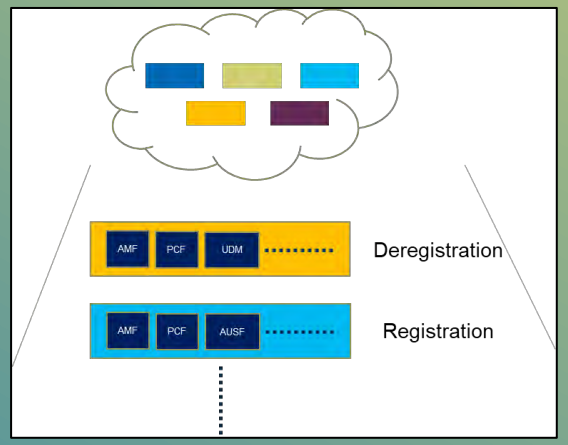




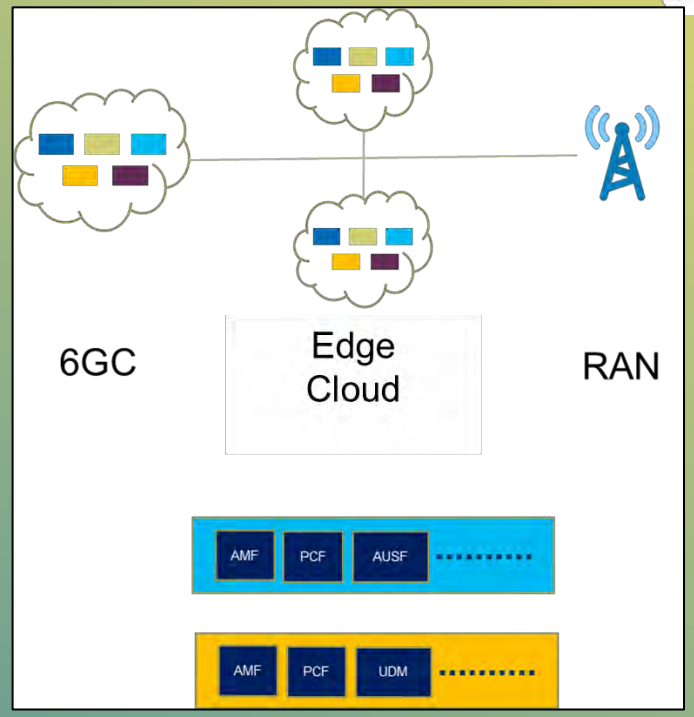
Efficient architecture – modular design

- Hexa-x-II will continue the work in Hexa-x with the efficient network and modular design
- The goals are:
  - increased flexibility
  - optimized signaling
  - more efficient resource usage.

- Hexa-x-II will develop Network functions that
  - minimizes the dependencies between different modules
  - Maximize functionalities within a module
  - Streamlines the signaling between NFs and nodes
  - Develop metrics to be able to measure the benefits of the new architecture
    - E.g. overhead, delay, energy consumption, flexibility



Modular design - Optimized network function composition



Streamlined network function interfaces & interaction

Conclusion

- 6G is expected to provide a wider range of services beyond only communication to users and different applications.
- 6G will act as a platform providing a flexible set of functionalities to the applications, dependent on the current and future needs and requirements.
- The goals of both Hexa-X and Hexa-X-II are to develop 6G x-enabler fabric and the KVIs for a vision of connecting intelligence, sustainability, trustworthiness, inclusion, and extreme experience.
- While the focus in Hexa-X is to find and develop the different enablers, Hexa-X-II also need to develop a 6G blueprint, i.e., a reference architecture.

HEXA-X-II

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