6G CLOUD

Service-oriented 6G network architecture for distributed, intelligent, and sustainable cloud-native communication systems (6G-Cloud)

6G-Cloud Service-Oriented Architecture

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6G-Cloud Overview

6G-Cloud will research, develop, and validate key technologies to realize an AI-native and cloud-friendly system architecture atop the cloud continuum

- SNS-JU Phase 2 project on system architecture
- Dedicate to service-based architecture and cloud-native aspects of 6G system.
- 12 partners: 2 research institutes, 3 universities, 3 industry companies, 1 operator, 3 SMEs
- Duration: 1/1/2024 – 30/6/2026

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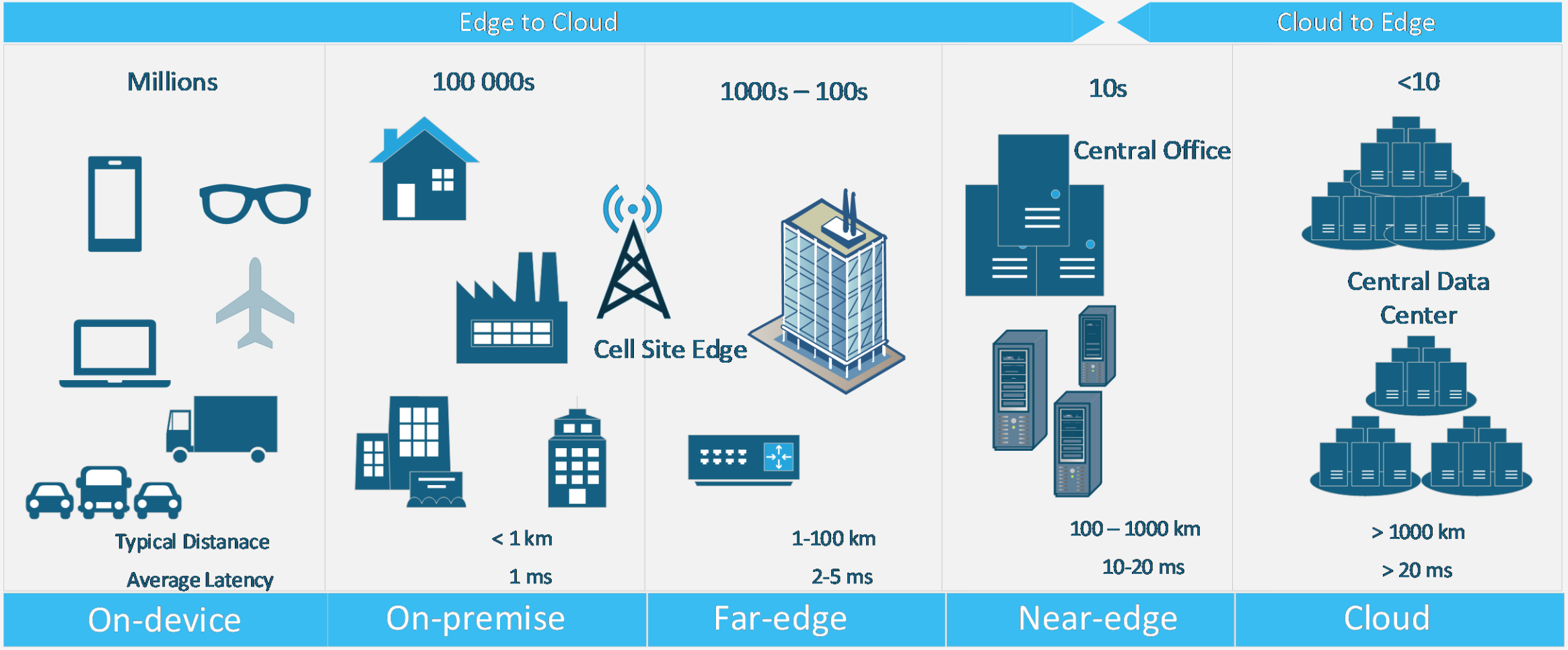
Cloud Landscape in Telecoms



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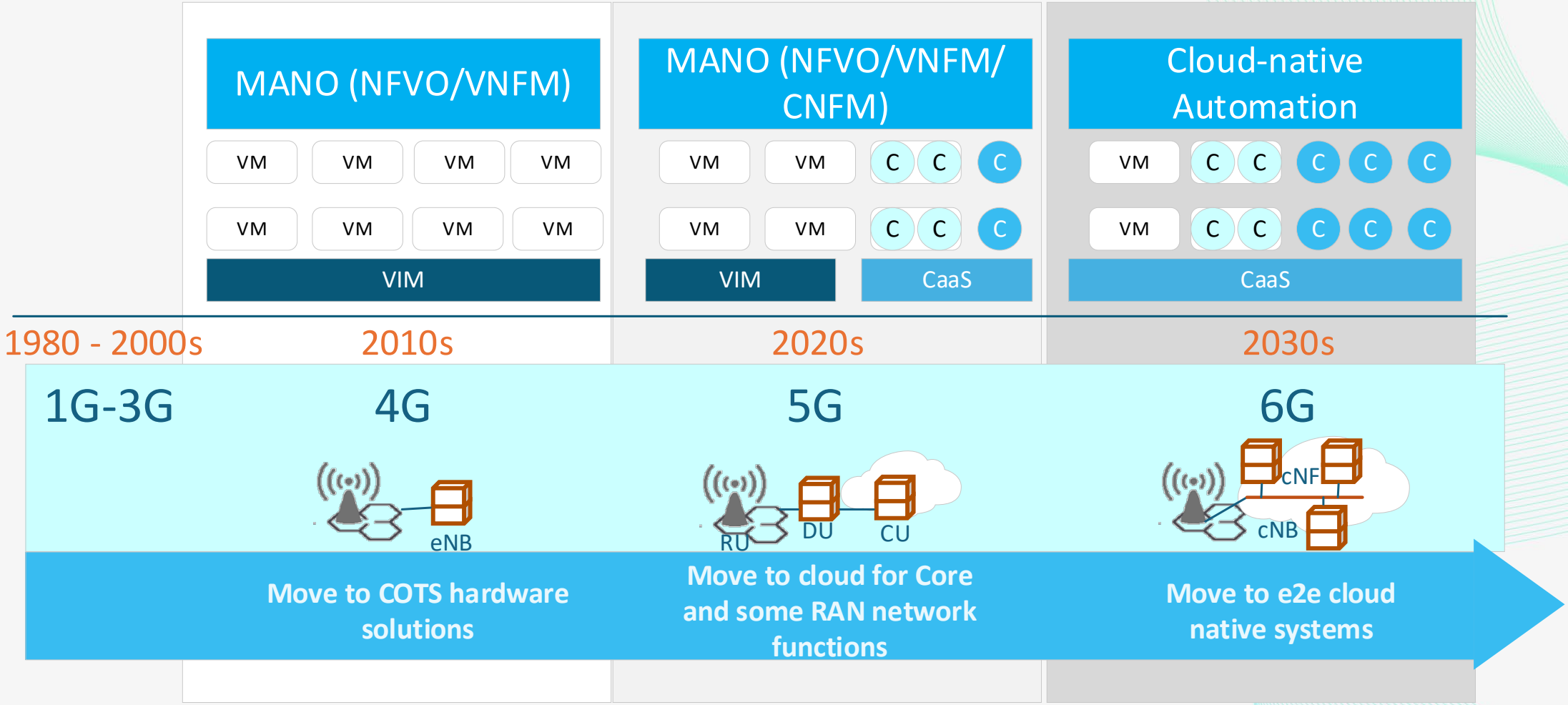
Evolution toward Cloud Native Mobile Network



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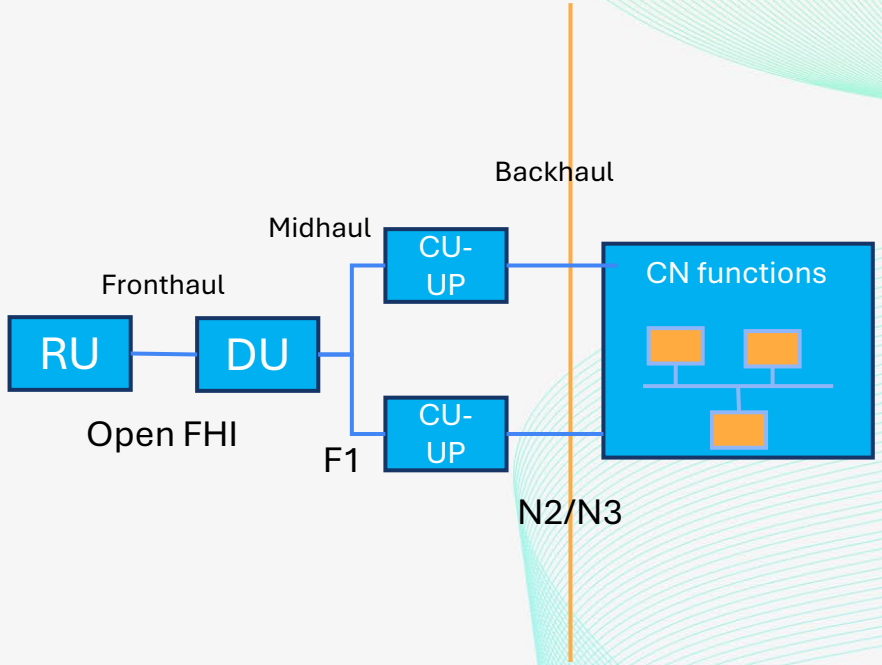
Limitation of 5G Architecture

- 5G RAN architecture has little concern for virtualized RAN deployment
  - Defined as Reference Point Architecture (RPA)
    - Use point-to-point interfaces to connect RAN components and nodes.
    - Based on appliance-centric deployment model, not cloud-based deployment model
- 5G Core Network is defined as a service-based architecture with API interfaces and virtualized network functions



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Key Concerns in 6G Architecture Evolution

- Leverage the power of cloud infrastructure for 6G network realization, deployment and service provision
  - Need for **cloud continuum framework** to integrate edge and central clouds from multi-stakeholder.

- Unify management and resource orchestration for cloud and network resources
  - Need for **management and resource orchestration framework** to integrate communication and computation resources

- Move cloud-native design to radio access network for end-to-end cloud-native 6G networks
  - Realize an **end-to-end 6G service-based architecture** atop multi-stakeholder cloud environments.

- Utilize the intelligence to manage network complexity and provide unparallel network automation
  - Design **AI/ML framework** to provide unified AI/ML life-cycle management and AI/ML workflow.

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Service-based Architecture Motivation

- **Service based architecture** defines network functions as services, which can be combined to form network entities and nodes through unified API interfaces and effective message exchange mechanism.
  - Provide scalable processing capacity and CI/CD capability.
  - Suitable for implementing atop cloud infrastructure.
  - Simplify deployment and network upgrade.
  - Facilitate multi-vendor integration.
- Service base architecture (SBA) vs reference point architecture (RPA)
  - The SBA employs a unified procedure across various types of NFs for the same functionality, and a single set of APIs provided by an NF can be accessed by all other NFs.
  - The RPA employs different interfaces for each pair of NFs, requiring duplicate procedures across different types of NFs for the same functionality.

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Challenges to Bring SBA to RAN

- Strict real-time and low-latency needs
  - RAN operations require ultra-low latency, and microservice communication can hinder time-sensitive tasks.
- Limited edge resources
  - Base stations and distributed RAN nodes have less computing power, memory, and energy than centralized core data centres.
- Diverse and distributed environment
  - The decentralized and varied nature of radio technologies makes service orchestration and quality management more complex.
- Increased signalling overhead
  - Adjusting SBA protocols in a changing radio environment may introduce extra overhead and performance issues.
- Heightened security and trust requirements
  - Distributed microservices at edge nodes need strong security, isolation, and authentication to safeguard against vulnerabilities.

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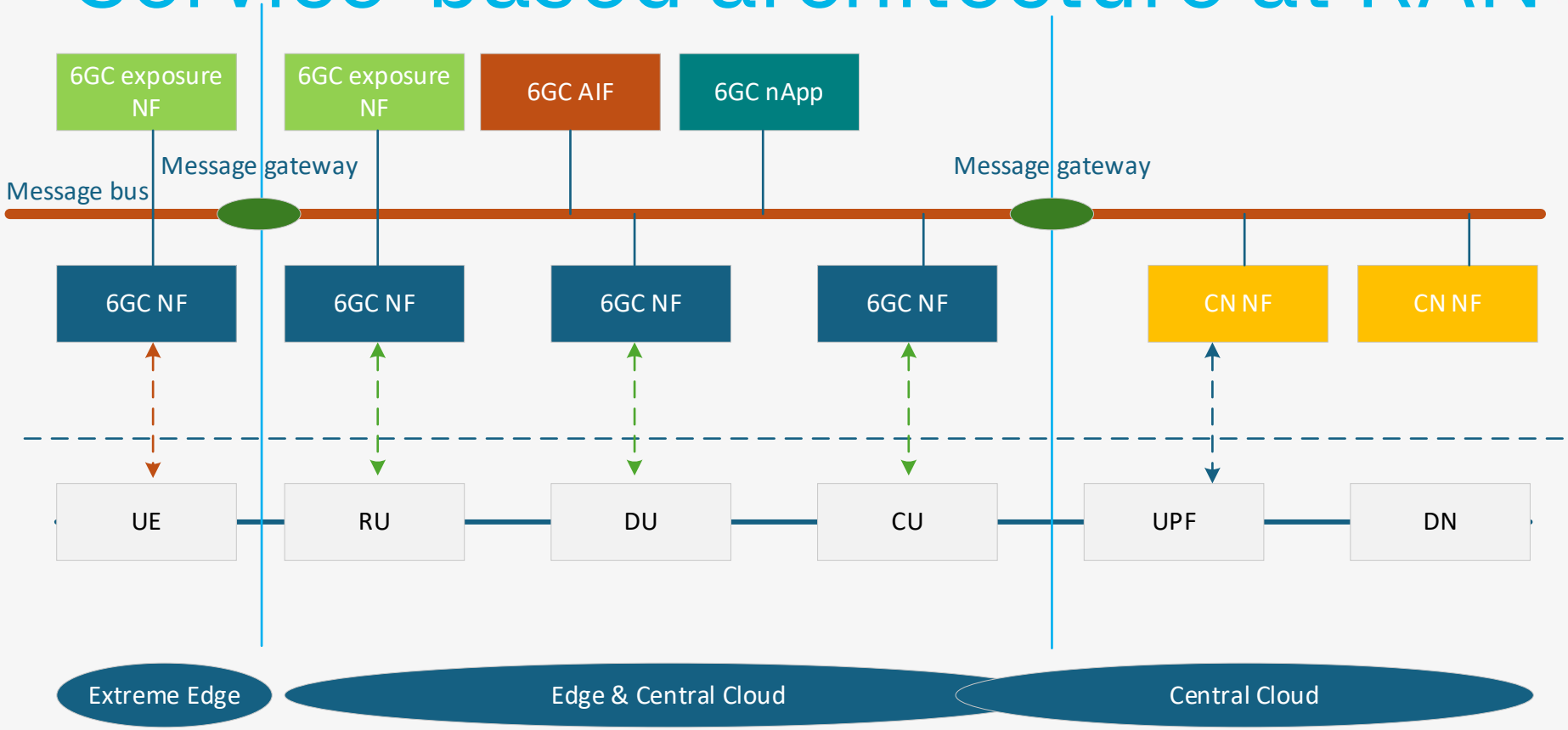
Service-based architecture at RAN in 6G-Cloud



- Introduce service-based control plane (CP) functions to RAN.
- Some DU an CU CP will be implemented as 6GC (6G-Cloud) NFs.
- RAN CP becomes extendable by SBA design. AI functions, control apps and exposure NFs can be added in CI/CD approach to the network.
- User plane (UP) functions in RAN keep the RPA design.

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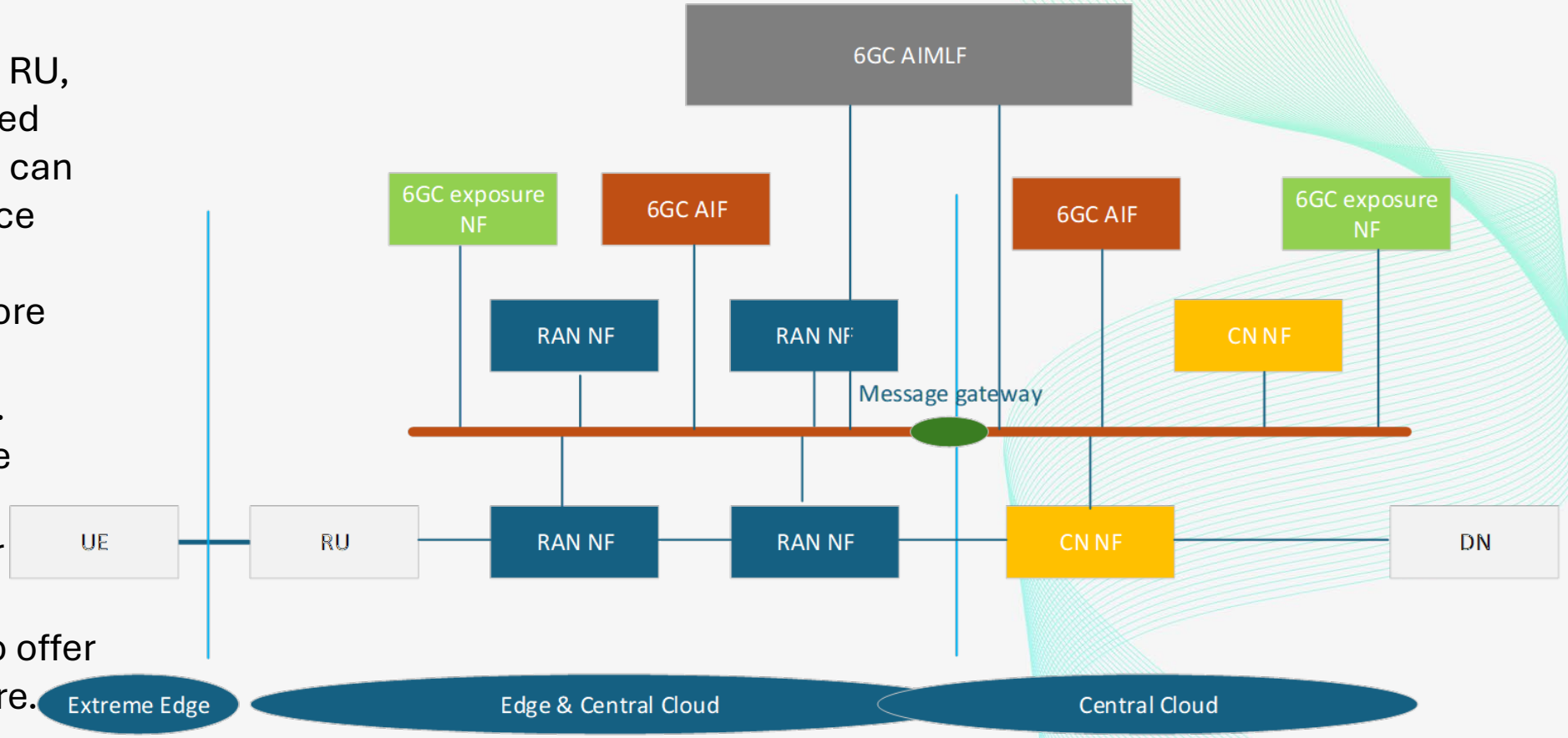
SBA RAN integrated with SBA Core Network

- In this design, except NFs at RU, all other RAN NFs have unified service-based interface and can communicate through service bus.
- Service buses of RAN and core network can communicate through a message gateway.
- RAN NFs and CN NFs can be deployed at the same cloud cluster, and grouped to offer customized e2e services.
- AIMLF is AI/MF framework to offer AI as service to RAN and Core.



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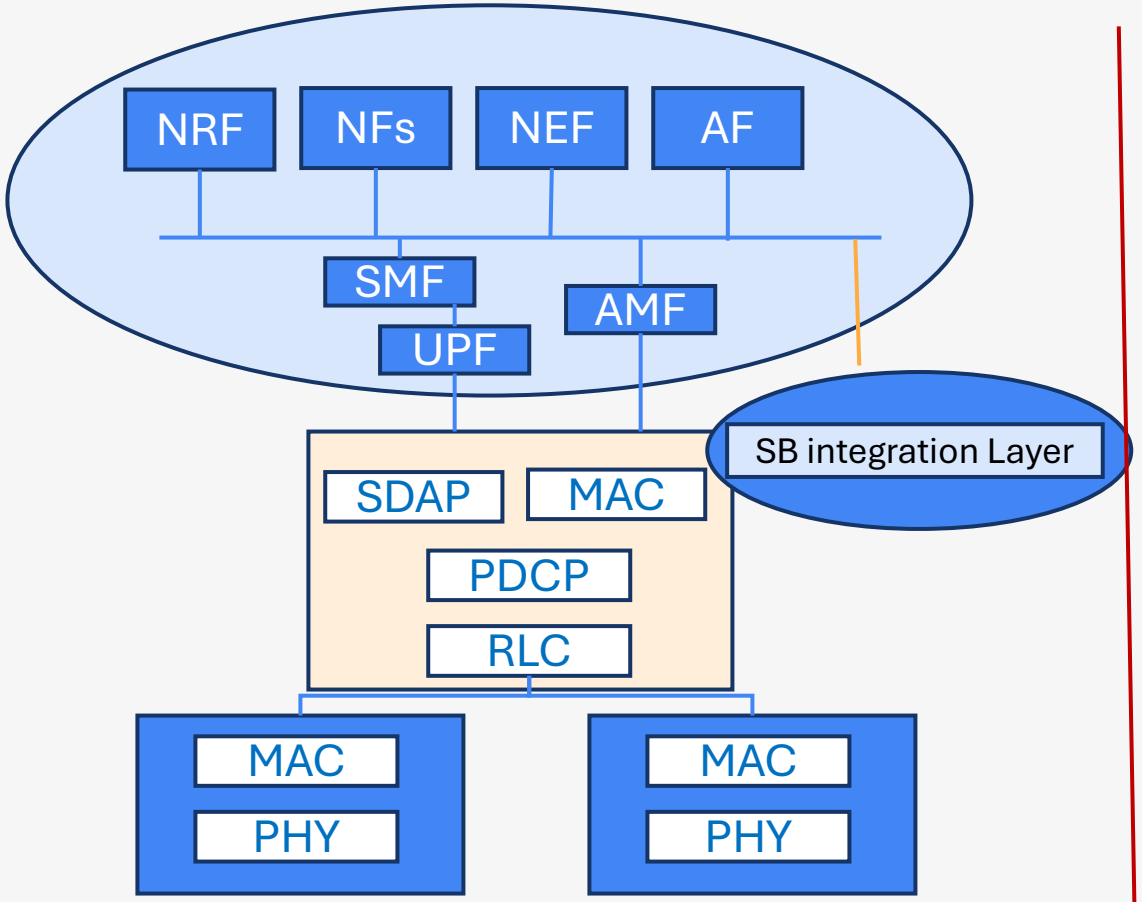
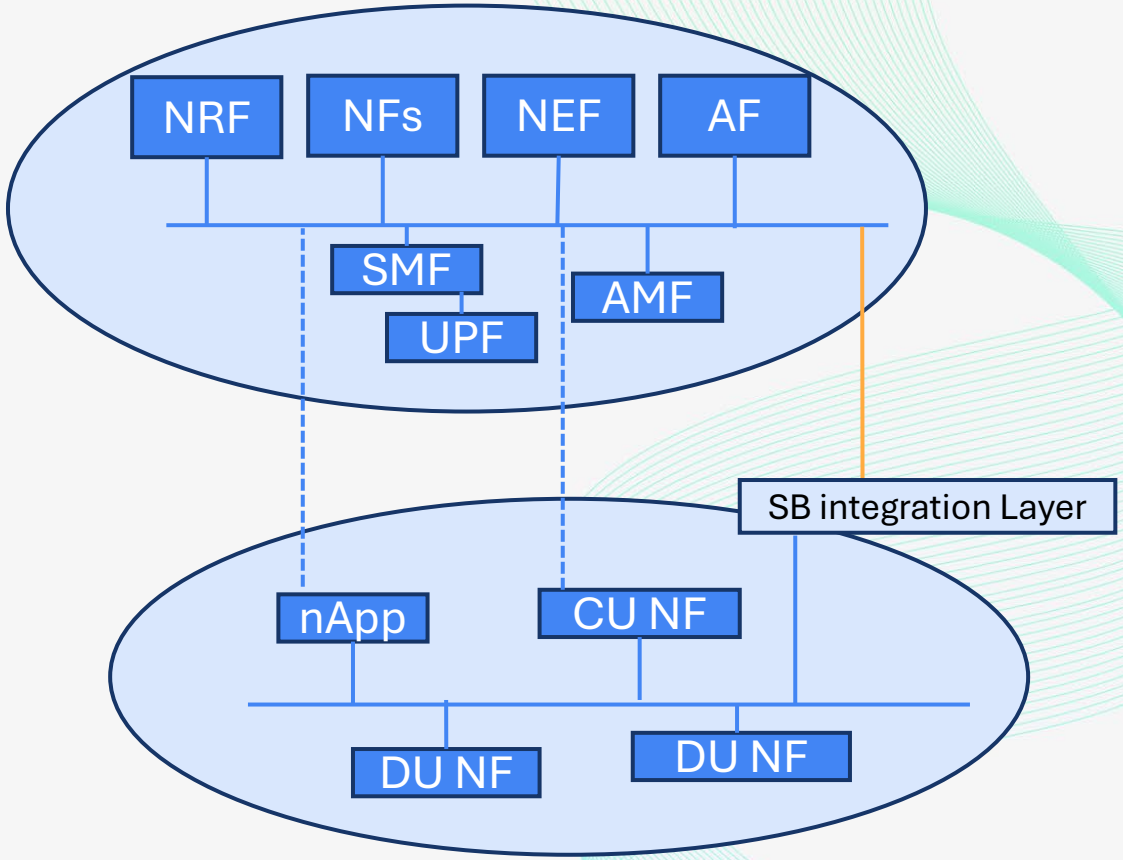
Other SBA RAN-CN Convergence options in 6G-Cloud



Option 1: SBA in RAN via SBIL



Option 2: SBA extension in RAN under SB-RAN

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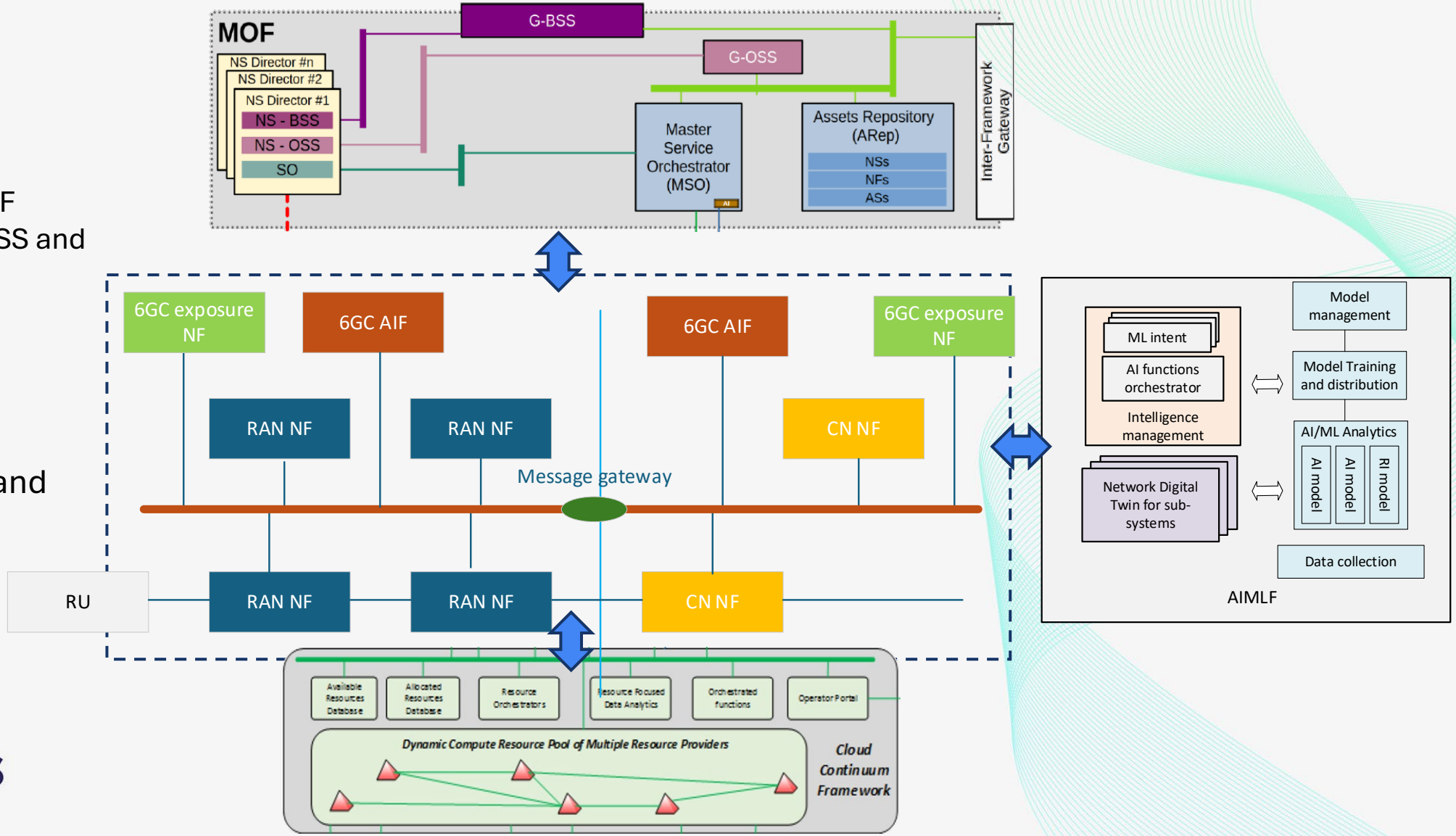
Management and Service Orchestration

- Management and Orchestration Framework (MoF)
  - Provide service orchestration, NF management, BSS and OSS functions
- Cloud Continue Framework (CCF)
  - Provide Cloud resource management and orchestration functions
- AI/ML Framework (AIMLF)
  - Provide AI as services



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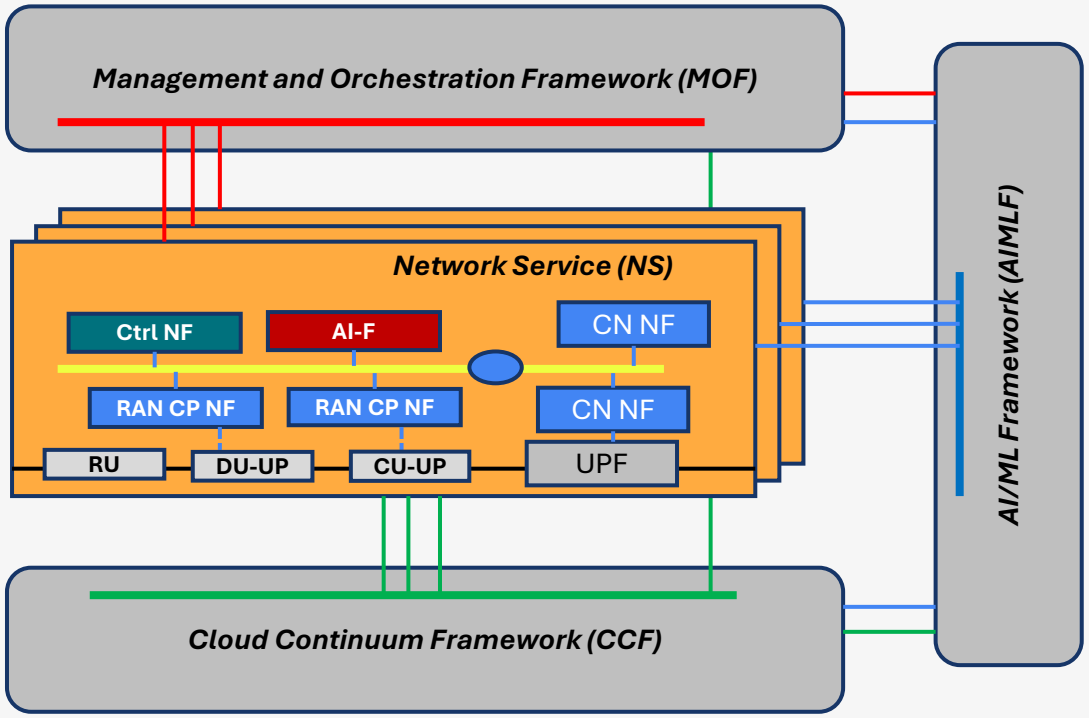
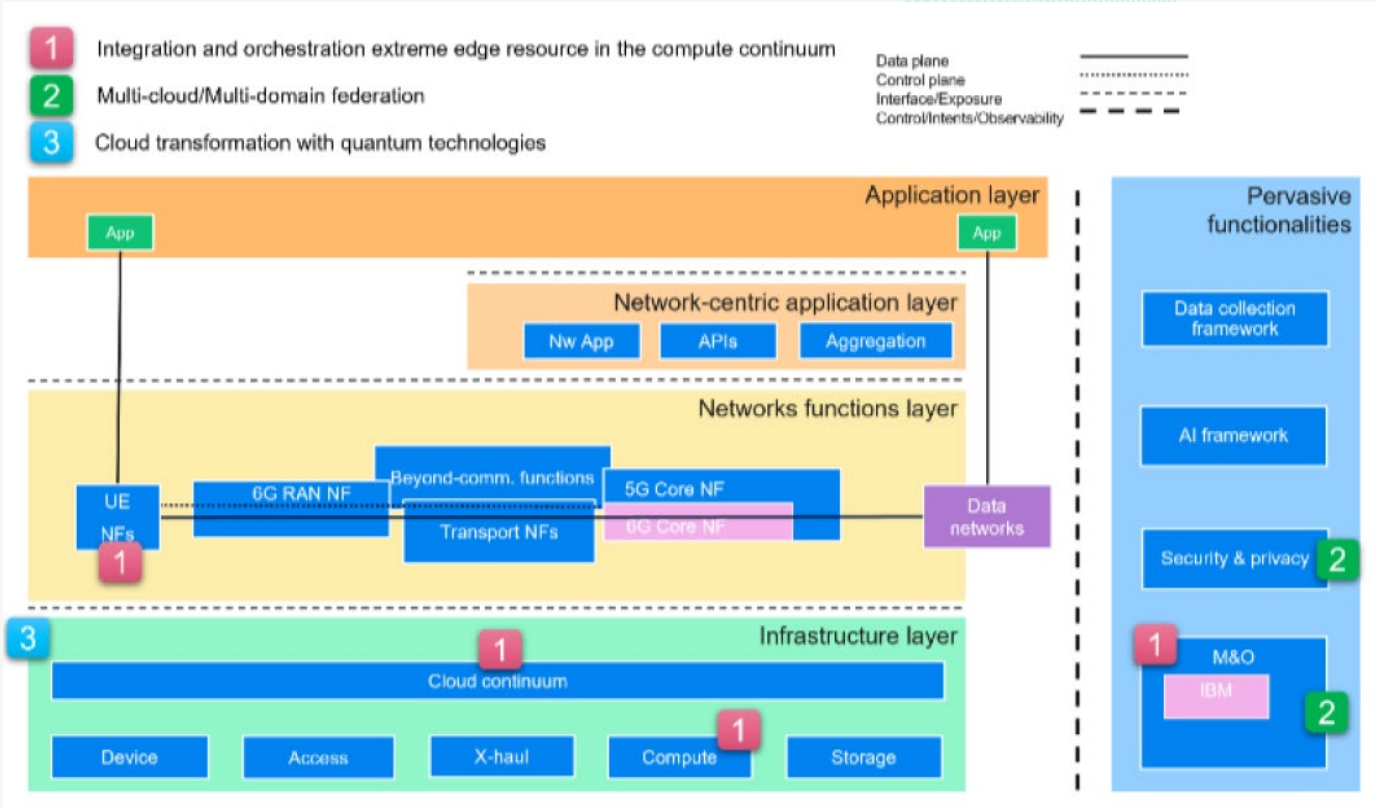
Comparison with Hexa-X II System Blueprint



6G-Cloud Frameworks



Hexa-X II System Blueprint

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Summary: Key Innovations of 6G-Cloud Architecture

- True **E2E service-oriented 6G network design** covers end-user terminals through RAN and core to edge applications
- AI-driven **Cloud Continuum Framework** and business interfaces for a multistakeholder environment
- AI-driven distributed **Management and Orchestration Framework** able to cooperate with the Cloud Continuum concept
- 6G native **AI/ML Framework** capable of monitoring and updating **AI-driven functions** in real-time
- Generic mechanisms for dynamic integration of "**virtualized networking solutions**" to form a "**Network-of-Networks**" in a multistakeholder environment.

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www.6g-cloud.eu

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