Authors: Nokia, Ericsson, Atos, Intel, Nextworks, Orange, TU Dresden, TIM, UC3M, Univ. Pisa, Wings, OUL

HEXA-X Architectural enablers for 6G

Initial 6G Architectural Components and Enablers

Mårten Ericson

hexa-x.eu

2022-02-04

Introduction

Goals

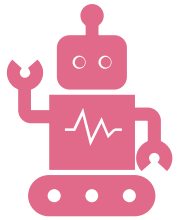
- Full AI integration and network programmability
  - New flexible and adaptable network design
    - Streamline and redesign the architecture

Outline

- Trends and Gaps
- 6G Architecture direction
- Intelligent networks
- Flexible networks
- Efficient networks
- Summary

Trends and gaps

Cloud/SBA/Softwarization

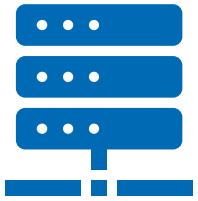


New digital communications – e.g. AI and Sensing

AI for Orchestration

Sustainability and regulations

Network of networks



Programmability

Outline

- Gaps
- 6G Architecture direction
- Intelligent networks
- Flexible networks
- Efficient networks
- Summary

6G Architecture direction

Architecture 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

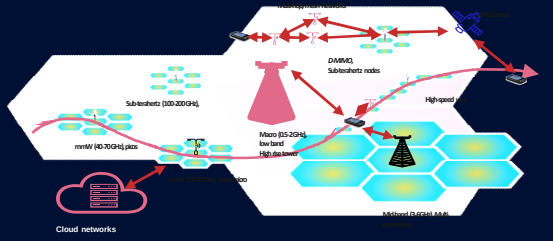
Architectural enablers

- *Programmability*
- *Network automation, intent-based management*
- *AI-as-a-Service*

Programmable nodes and devices

Data driven architecture, analytics, network automation

- *Flexible topologies: D2D, mesh, NTN*
- *Integration of sub-networks and non-public networks with public networks*



Network of networks integration

- *Efficient RAN/CN signaling*
- *Function refactoring*

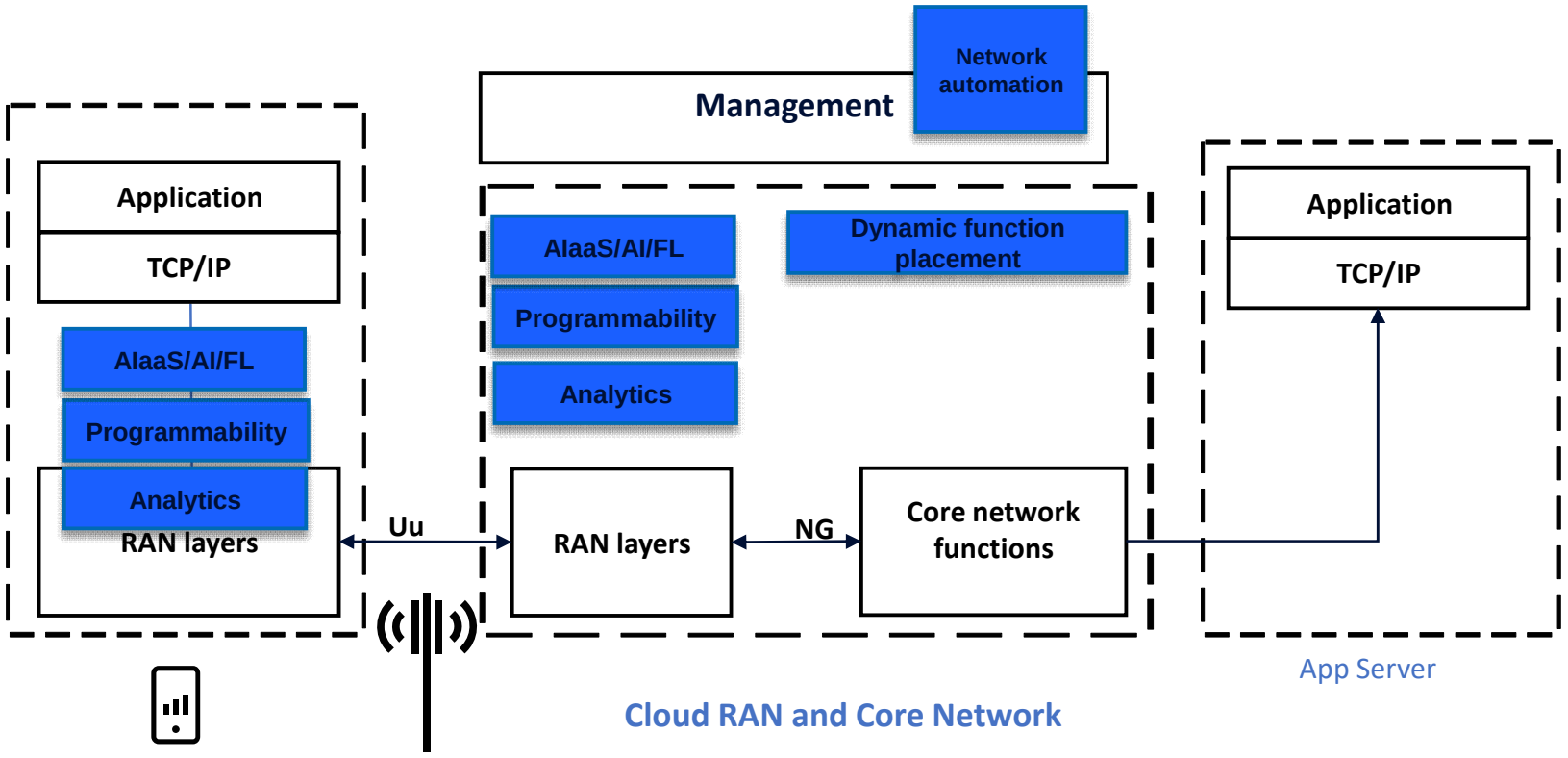
Cloud native RAN and CN, dynamic function placement

Energy efficient, Streamline wherever possible

Outline

- Trends
- Gaps
- 6G Architecture direction
- Intelligent networks
- Flexible networks
- Efficient networks
- Summary

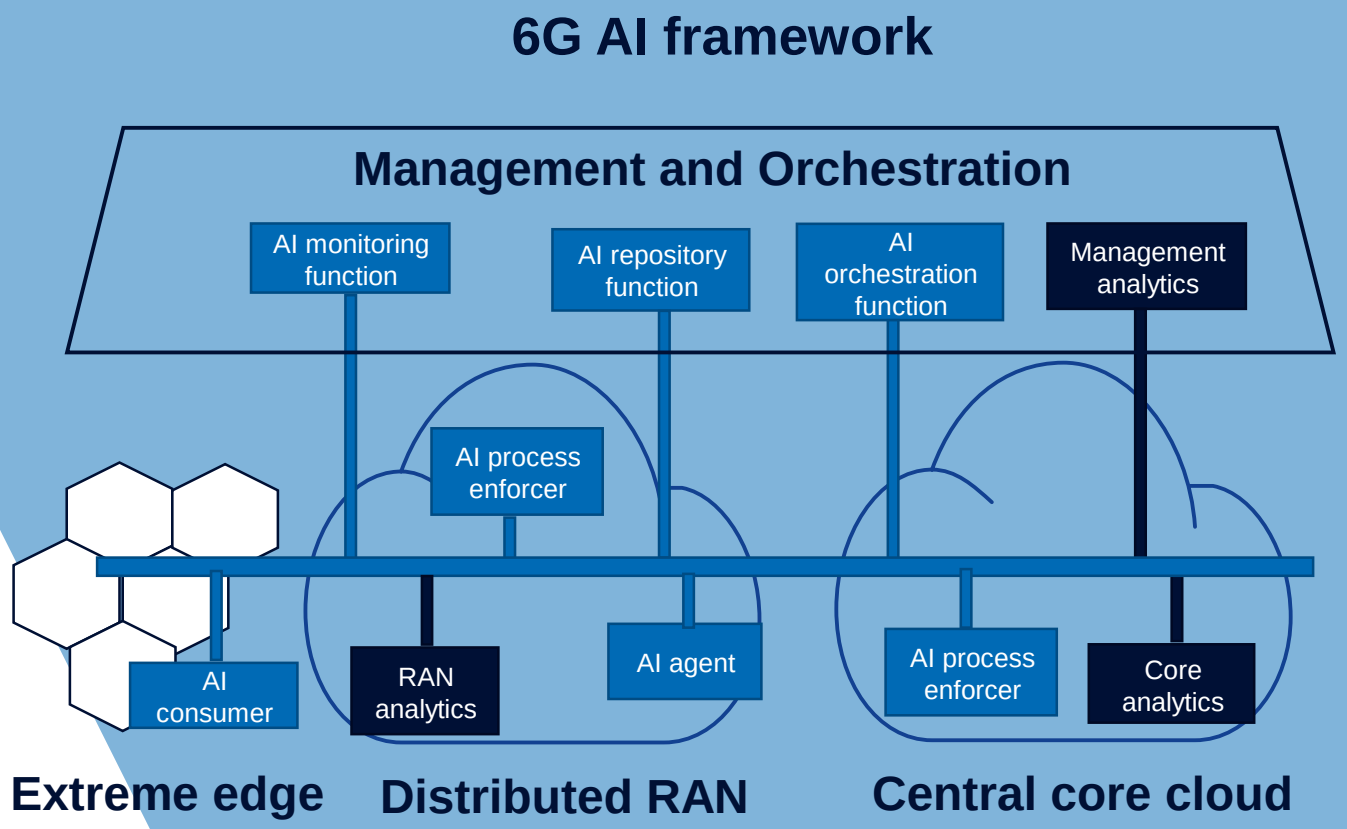
Intelligent Networks overview of enablers



Initial 6G AI framework

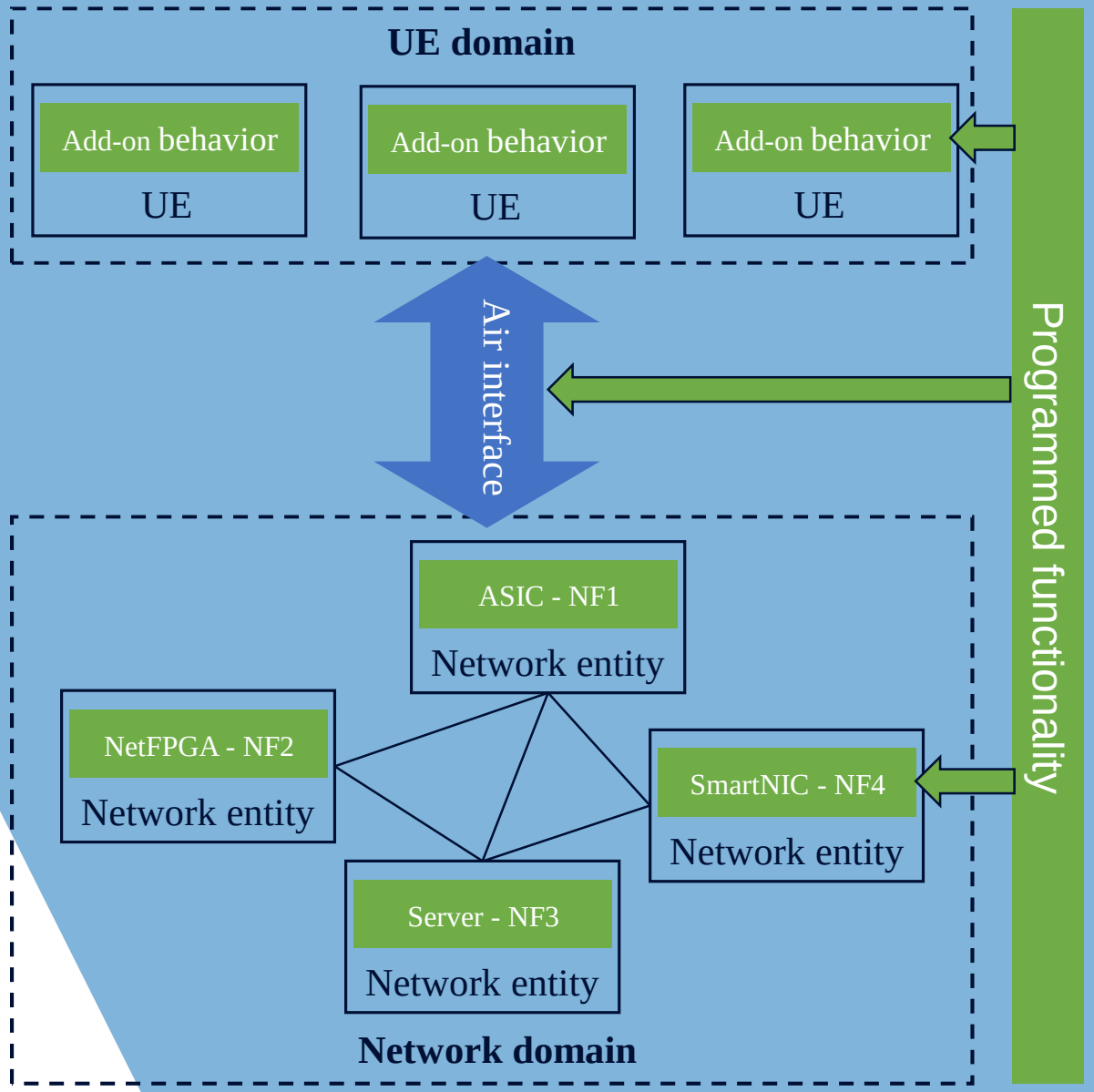
- Data driven architecture: enable seamless transfer of **analytics** across planes and domains is required.

- New **AI entities** to enable AIaaS e.g., discovery, selection, operation monitoring of the AI agents instantiated at the network nodes and devices



Network and UE Programmability

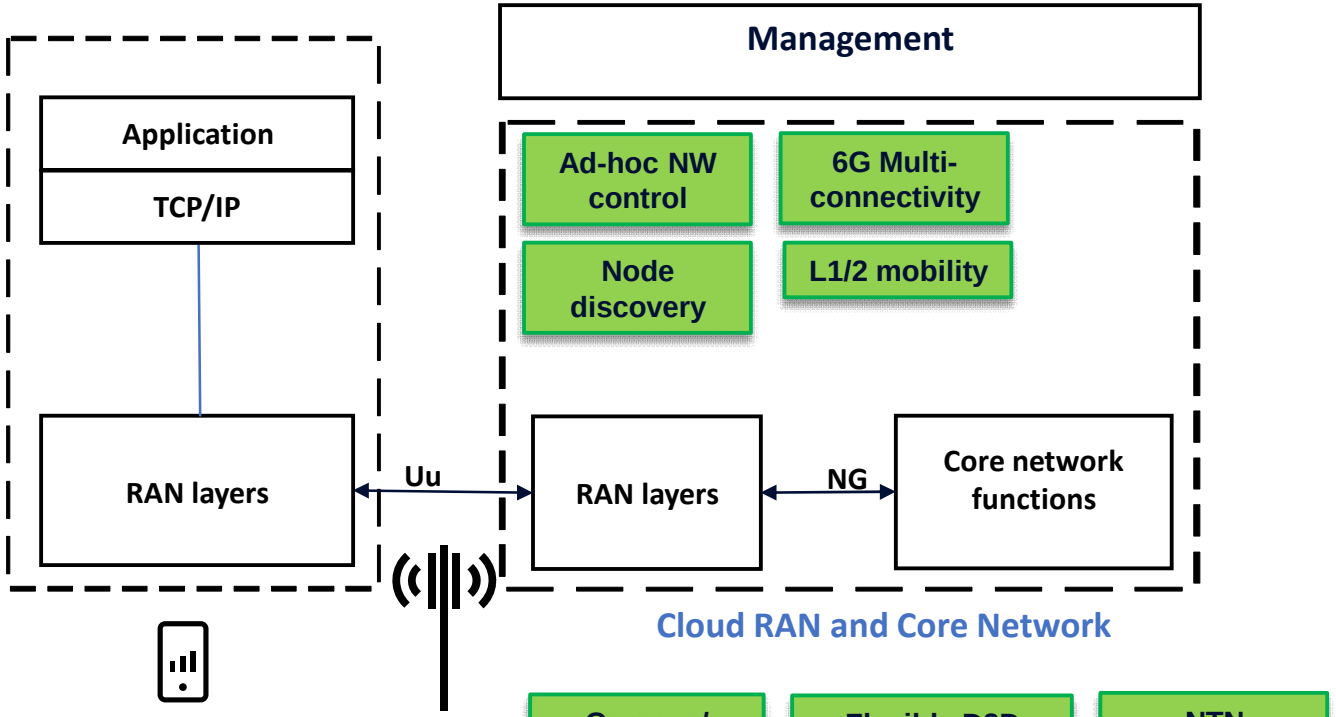
- Benefits: TTM, flexibility, adaptability to new environments
- **Network programmability:**
  Model the average packet processing latency on different P4 devices and make placement decisions accordingly
- **Programmable UEs:**
  Can be used for tailored industry sensors/IoT devices connected to a dedicated network



Outline

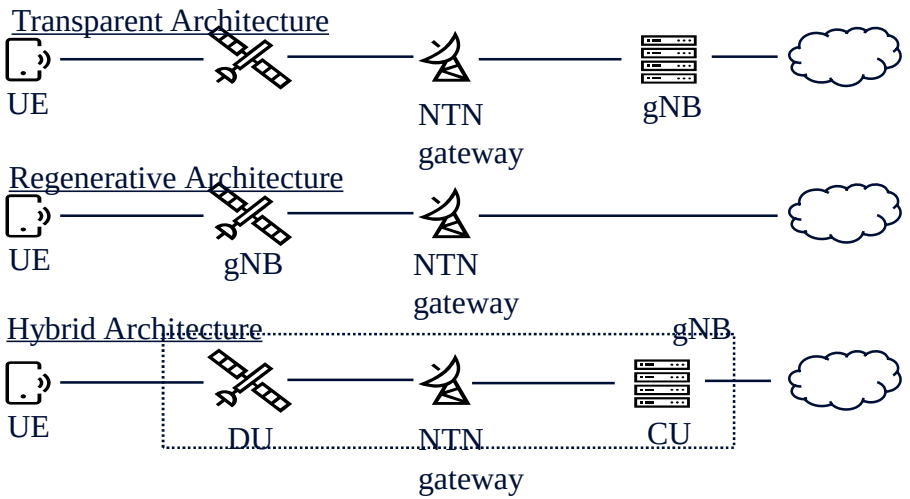
- Trends
- Gaps
- 6G Architecture direction
- Intelligent networks
- Flexible networks
- Efficient networks
- Summary

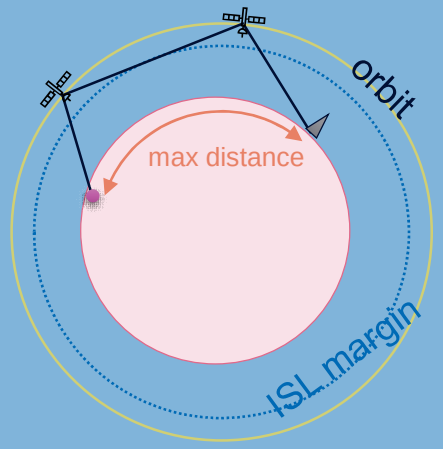
Flexible Networks overview of enablers

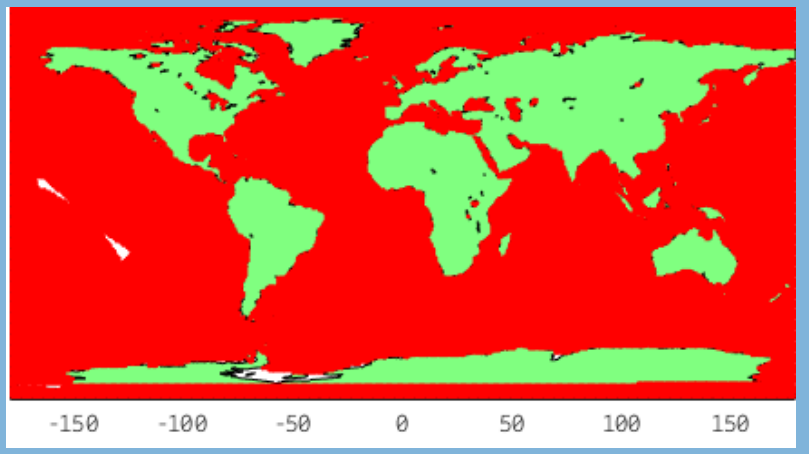


Network of networks

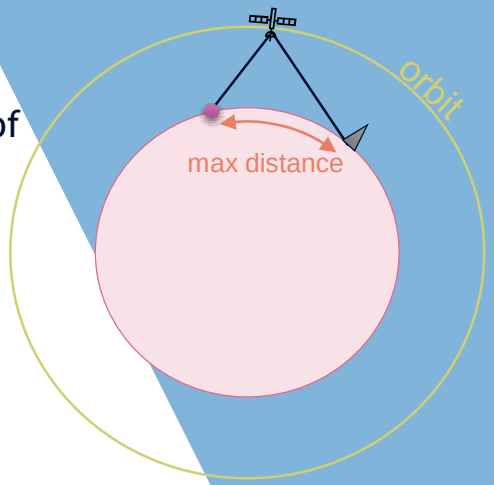
- Background/Motivation
  - WP5 has an objective to find architectural solutions that supports full global coverage
  - Develop a campus network including aerial LANs/Satellites
- Solution
  - Develop an NTN architecture capable of efficient of inter-satellite-link hops

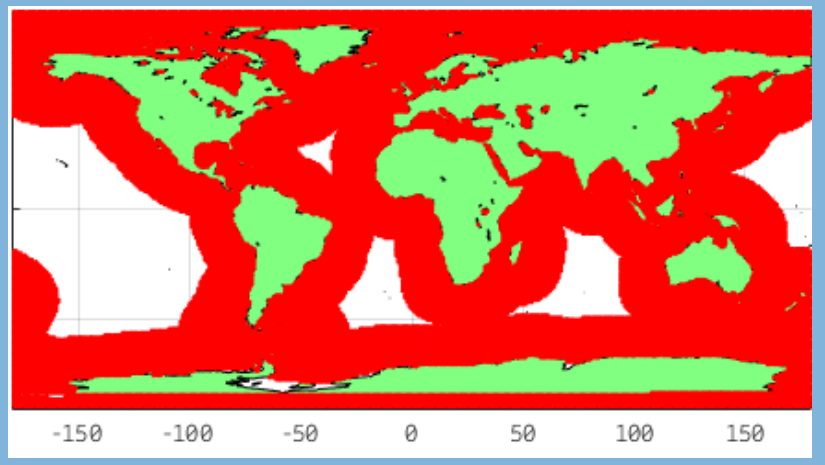






More hops and Inter-Satellite Links (ISL) are needed to achieve Global Coverage

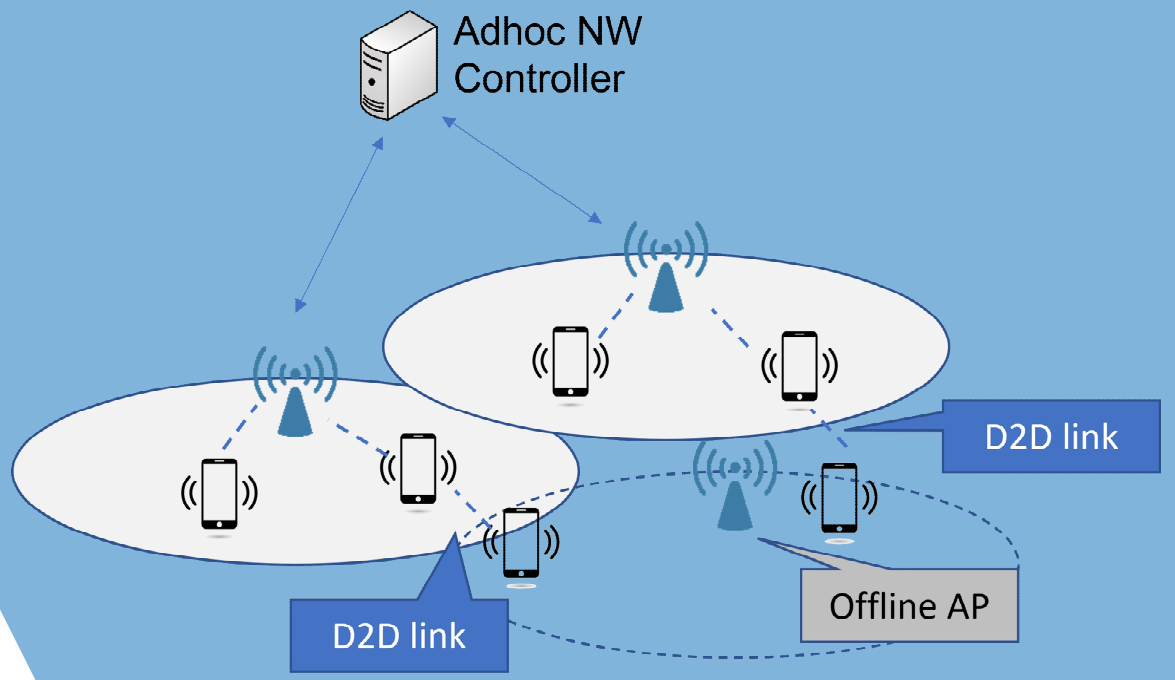




With LEO@600 km constellation and GSs on the continent it is impossible to reach all point in the ocean with no ISL

Flexible Topologies: D2D, Mesh Networking

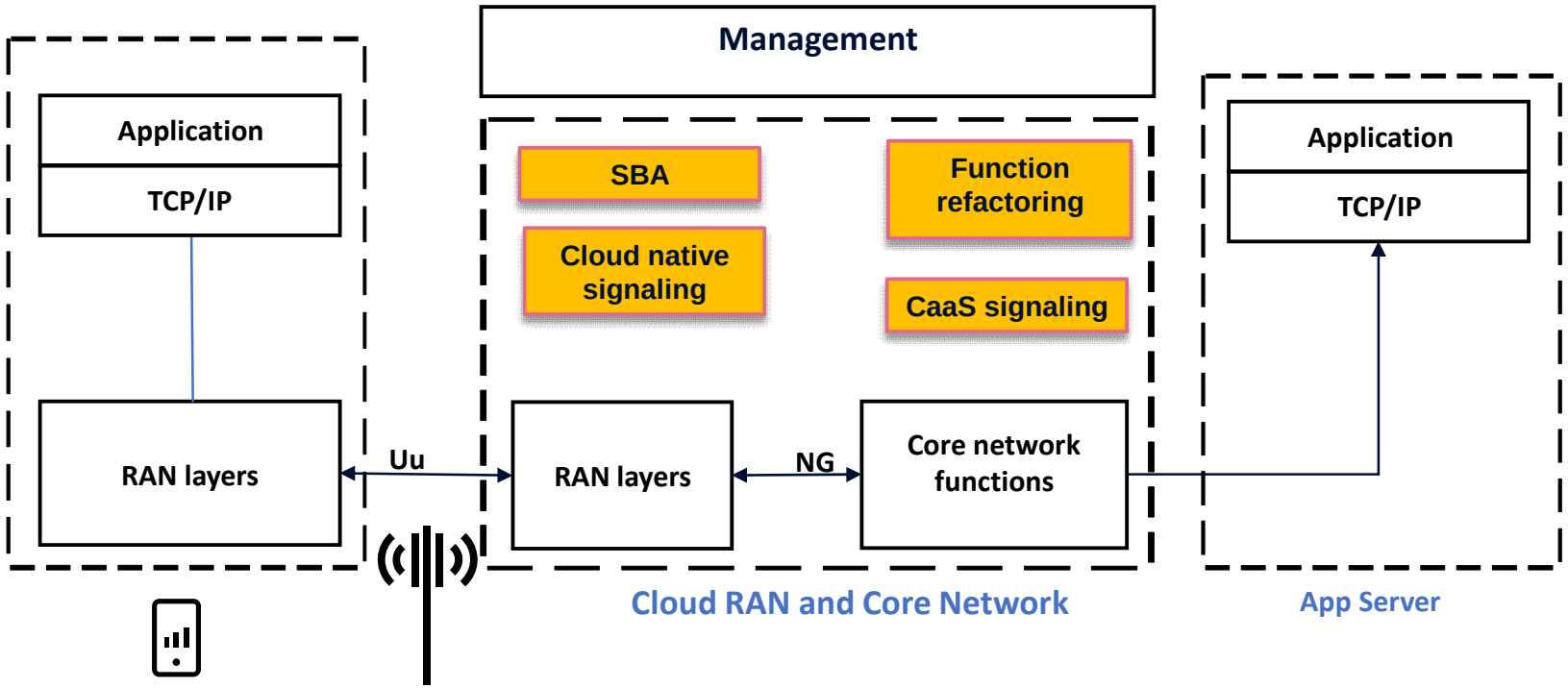
- Background: Mesh networks as one solution for e.g., verticals requiring lower latency better coverage/reliability etc.
- Solution
  - Selection of best connectivity options
  - Leverages on networking technologies like D2D, mesh networks
  - Disaggregated devices: close cooperation with edge
  - Discovery and selection of best possible and "trusted" nodes depending on connect-compute capabilities



Outline

- Trends
- Gaps
- 6G Architecture direction
- Intelligent networks
- Flexible networks
- Efficient networks
- Summary

Efficient Networks overview of enablers



Efficient cloud RAN/CN signaling - Separation of concern

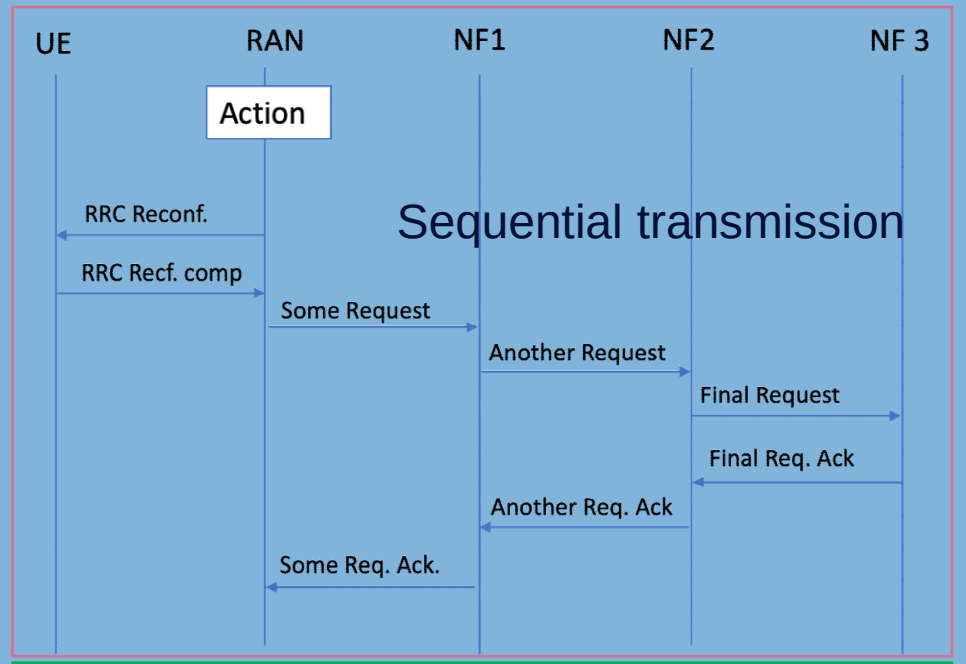
Background

Streamline architecture for more efficient signaling.

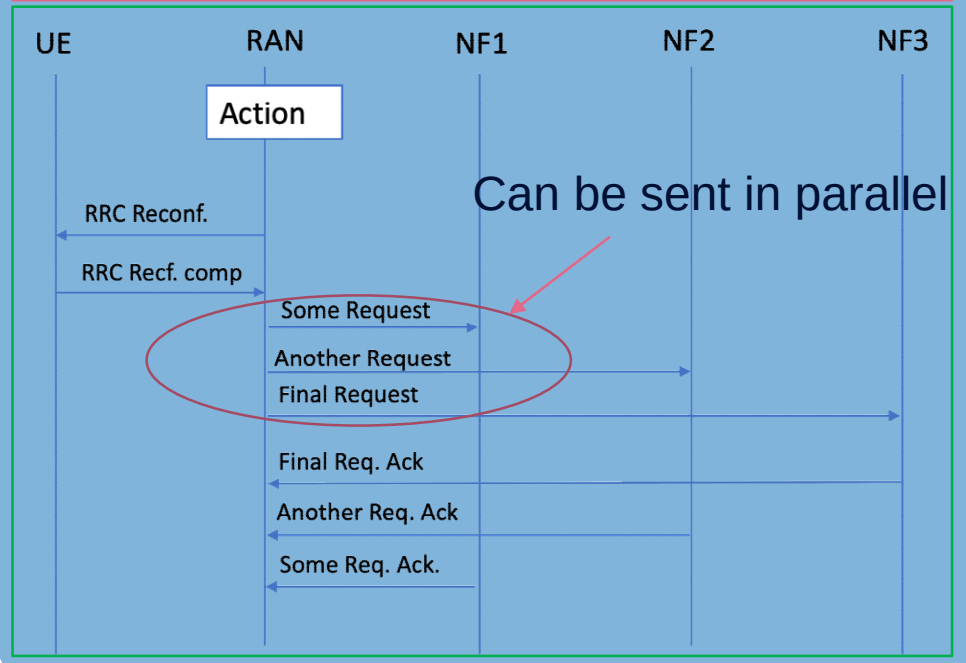
Problem: Current signaling in CN is hierarchical and occurs in sequence. This takes time and may limit adding additional NFs.

Solution: Future: signaling can be carried out in parallel for better scalability and flexibility – functions need to be more separated

current



future

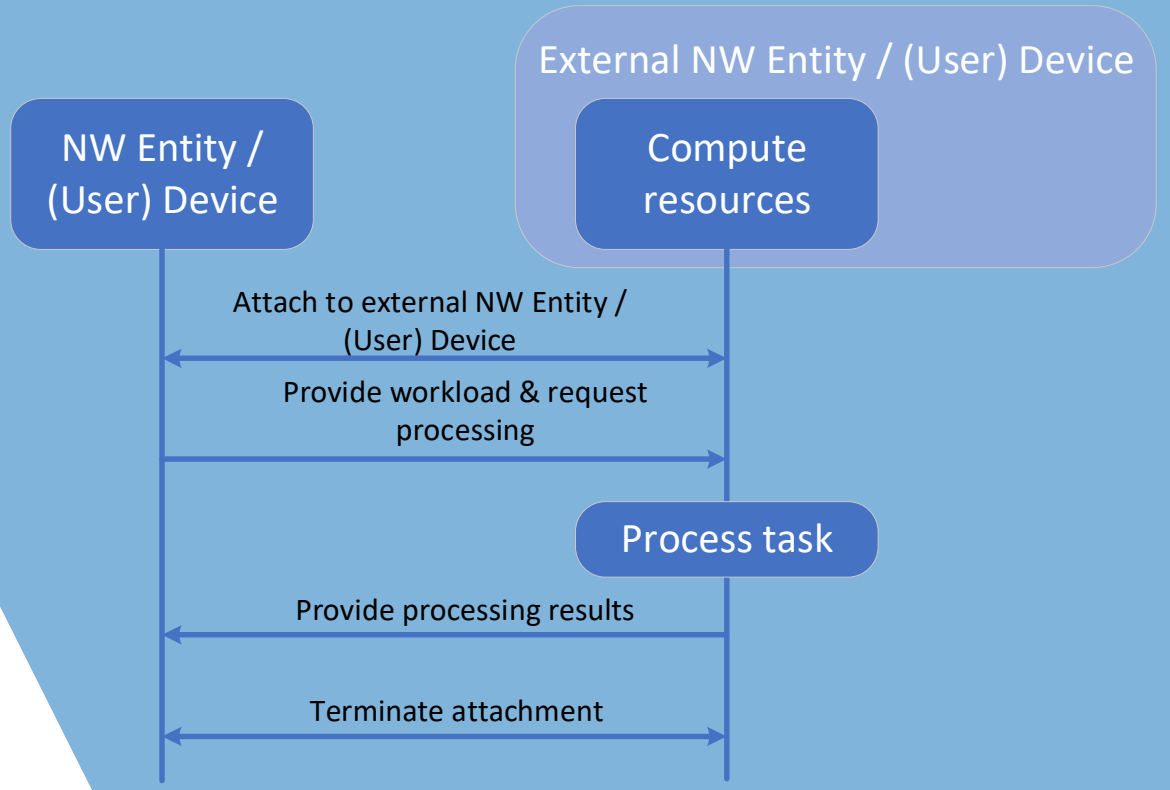


Architectural support of Compute-as-a-Service (CaaS)

Background/problem

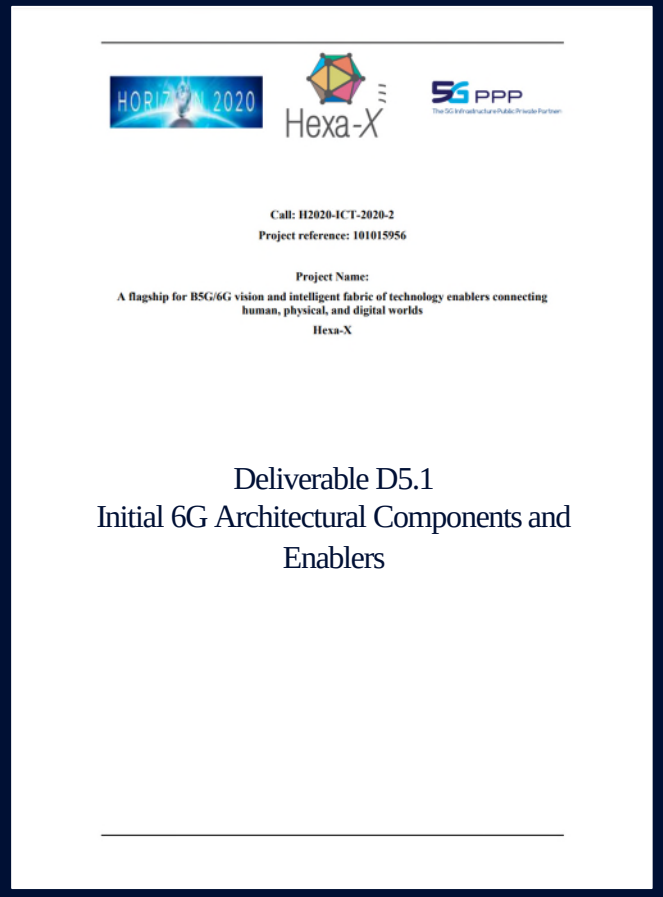
- Devices or nodes may need to delegate resource-intensive processing tasks to more powerful compute nodes
- The compute nodes can offer the services to other nodes and devices.
- Selection of compute nodes may be based on:
  - dependability (reliability, availability)
  - network energy efficiency

etc.



Outline

- Trends
- Gaps
- 6G Architecture direction
- Intelligent networks
- Flexible networks
- Efficient networks
- Summary



Call: H2020-ICT-2020-2
Project reference: 101015956

Project Name:
A flagship for B5G/6G vision and intelligent fabric of technology enablers connecting human, physical, and digital worlds
Hexa-X

Deliverable D5.1
Initial 6G Architectural Components and Enablers

Summary

Initial 6G AI architecture concept (data driven architecture)

AIaaS is based on a set of interconnected AI agents

- Seamless transfer of analytics across planes and domains is required
- New architecture entities for supporting AIaaS aim to enable the discovery, selection, operation monitoring of the AI agents
- Initial concept protocols for AI/federated learning

Network of networks (flexible networks)

Full integration of NTN (Satellites and High-Altitude Platforms)

D2D and mesh networks of device to enable devices to communicate directly in an infrastructure-less

Separation of concerns for a cloud native RAN and Core network (efficient networks)

Virtualization enables flexible deployment

- For example, we may reduce latency by placing functions close to the UE
- Separation of concerns, i.e. make network function more independent to simplify signaling

(Major) Next steps

- Framework for:
  - AI/AIaaS (and analytics) including FL and continuum orchestration
  - UE and network programmability
  - Streamlining the functions and signaling for a cloud native network
  - Network of networks, e.g., D2D mesh networks, NTN, campus networks

- KPIs to investigate
  - How to improve network convergence time and AI communication overhead
  - How to increase the reliability and flexibility for network of networks