HEXA-X Architectural enablers for 6G

Initial 6G Architectural Components and Enablers

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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
Al for Orchestration
Sustainability and regulations
Network of networks
Programmability
Outline

• Gaps
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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**

**Flexible topologies: D2D, mesh, NTN**

**Integration of sub-networks and non-public networks with public networks**

**Efficient RAN/CN signaling**

**Function refactoring**

Programmable nodes and devices

Data driven architecture, analytics, network automation

Network of networks integration

Cloud native RAN and CN, dynamic function placement

Energy efficient, Streamline wherever possible
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Intelligent Networks overview of enablers

Cloud RAN and Core Network

- Application
  - TCP/IP
  - AlaaS/AI/FL
  - Programmability
  - Analytics
  - RAN layers

Management

- Network automation
- Dynamic function placement

Core network functions

App Server

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

- New AI entities to enable AlaaS 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
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Flexible Networks overview of enablers

RAN layers

Application

TCP/IP

Management

Ad-hoc NW control

6G Multi-connectivity

Node discovery

L1/2 mobility

RAN layers

Core network functions

Cloud RAN and Core Network

Campus/private networks

Flexible D2D mesh/centralized

NTN Aerials HAPs

Network of networks
Network of networks

- **Background/Motivation**
  - WP5 has an objective to find architectural solutions that support 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
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Efficient Networks overview of enablers

- Application
- TCP/IP
- RAN layers

Management
- SBA
- Function refactoring
- Cloud native signaling
- CaaS signaling

Core network functions

Cloud RAN and Core Network

App Server

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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.
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.
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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