ADROIT6G - AI-Enabled Open Architecture for Future NTN-Enabled 6G Networks

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ETSI Conference on "Non-Terrestrial Networks, a Native Component of 6G"

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6G SNS

Outline

01   **Project Overview**

02   **Concept & Innovations & Objectives**

03   **ADROIT6G Architecture**

04   **Proof of Concepts**

05   **Innovation Streams**

Project Overview

- **Project Name:** ADROIT6G

- **Stream:** B0101

- **Project website:** www.adroit6g.eu

- **Project Coordinator:** Prof. Ch. Verikoukis (ISI/ATH)

- **Technical Manager:** Prof. V. Vasiliou (CYENS)

- **Total budget:** 5,967,436 euros

- **Duration:** 36 Months (started at January 2023)

@adroit6g

Overall Concept
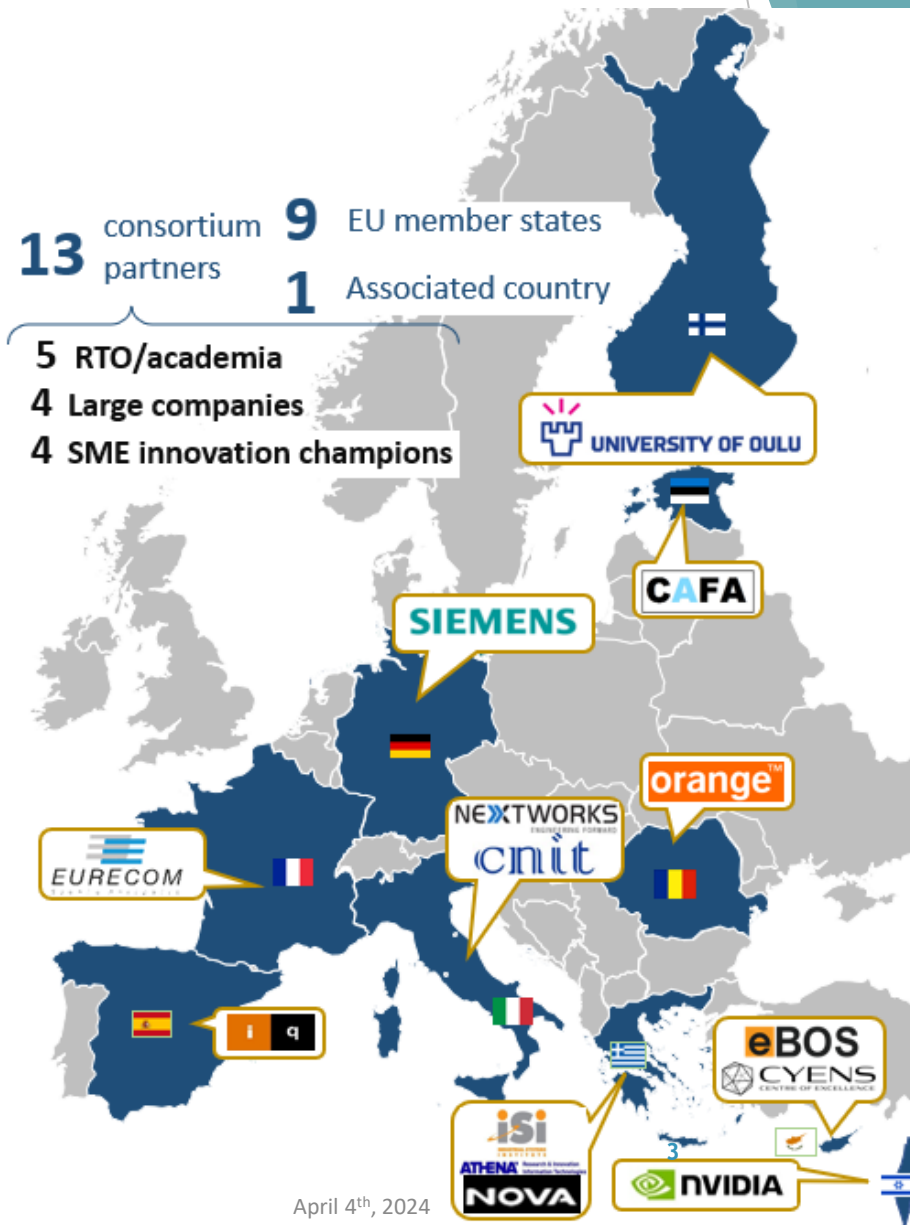
➤ ADROIT6G proposes disruptive innovations in the architecture of emerging 6G mobile networks that will make fundamental changes to the way networks are designed, implemented, operated, and maintained.

➤ Adopting a fully **distributed AI-driven dynamic** paradigm with **functional elements** automatically **deployed on-demand** as **virtual functions** in **cloud-native environments**, across the **far-edge, edge and cloud domains**, operated by **different stakeholders**.

Project Innovations
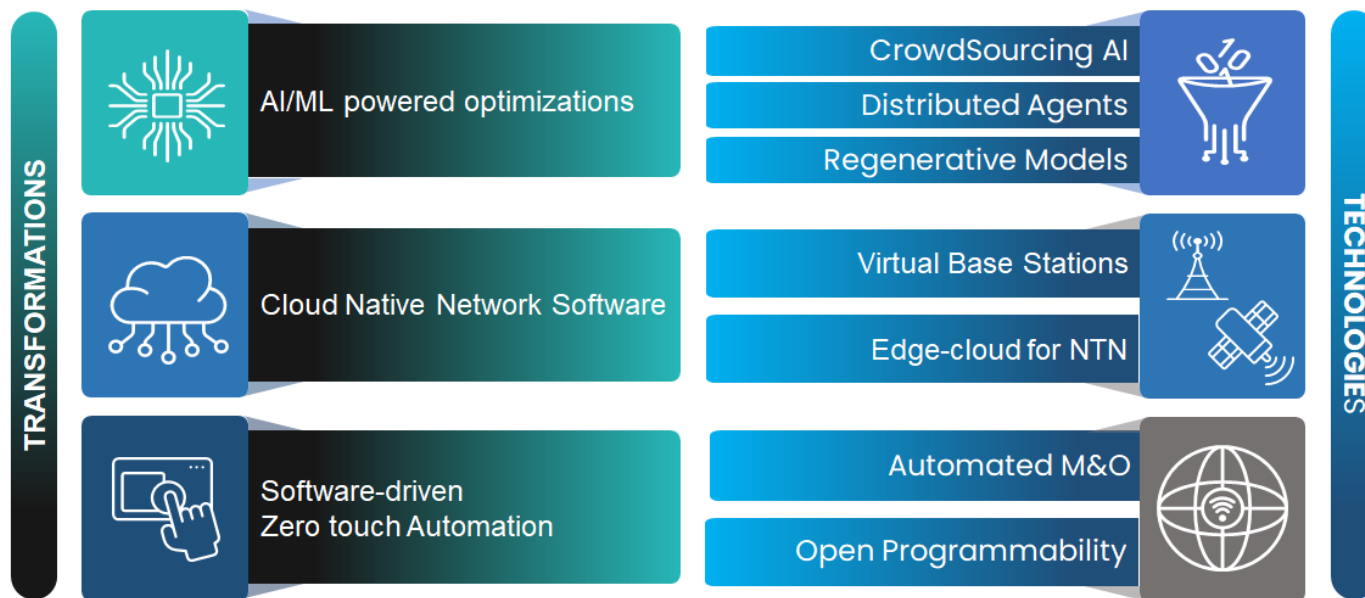
- ➤ **Key Transformations for 6G Evolution**:

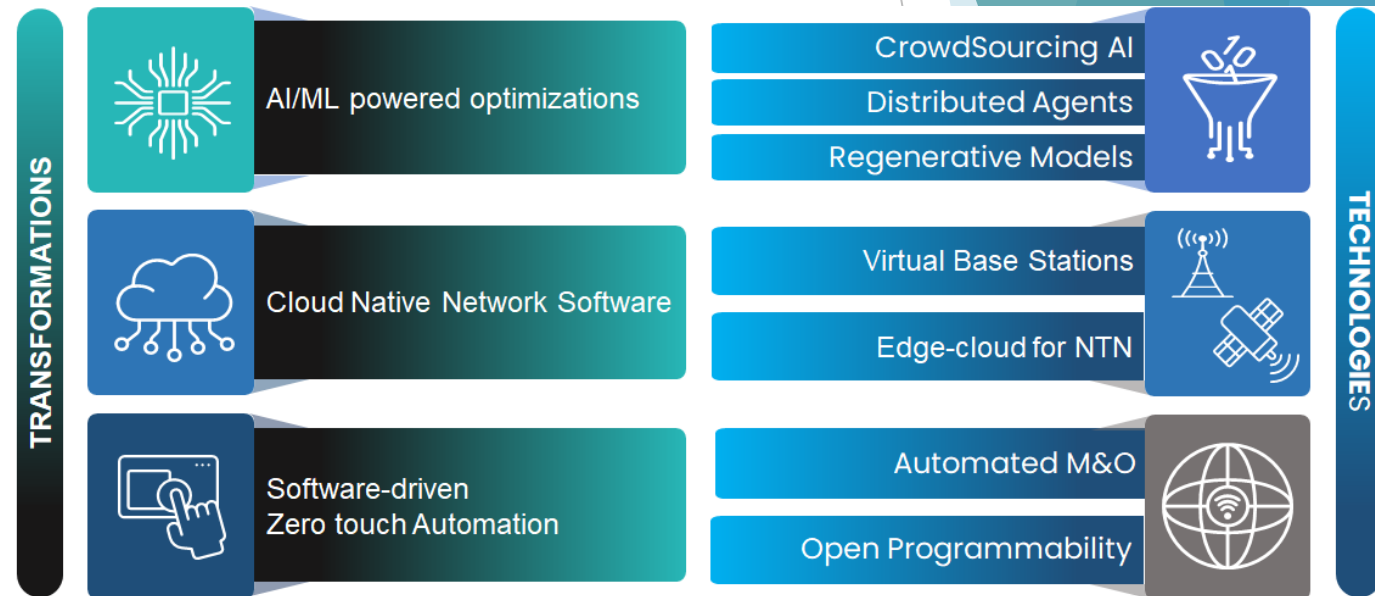 1. **AI/ML-powered Optimisations**:
     - o Harnessing Distributed Artificial Intelligence.
     - o Aim for high performance and full automation.

  2. **Cloud-native Network Software**:
     - o Implementation across various edge-cloud platforms.
     - o Integral security in the network user plan.

  3. **Software-driven Operations**:
     - o Zero-touch operations.
     - o Full automation for network and delivered services.

Project Objectives

O1: Propose a novel 6G system architecture that integrates a distributed AI framework for combined communication, computation and control and empowers the convergence of networks and IT systems to enable new future digital services.

O2: Create an AI-driven Management & Orchestration and control framework for 6G Networks.

O3: Architect a distributed and secure CrowdSourcing AI

O4: Develop energy-aware models for multimodal Representation Learning

O5: Evolve the cellular infrastructure to allow the true integration of deep-edge devices in communication and computation functions

O6: Enable Non-Terrestrial Networks connectivity for highly reliable Industrial IoT Services

O7: Extend and demonstrate the use of decentralized AI for Device-to-Device communications

O8: Support data plane acceleration

O9: Integrate and demonstrate the potential and user value of ADROIT6G through relevant experimentation, testing, and validation of its innovations in PoCs in lab settings

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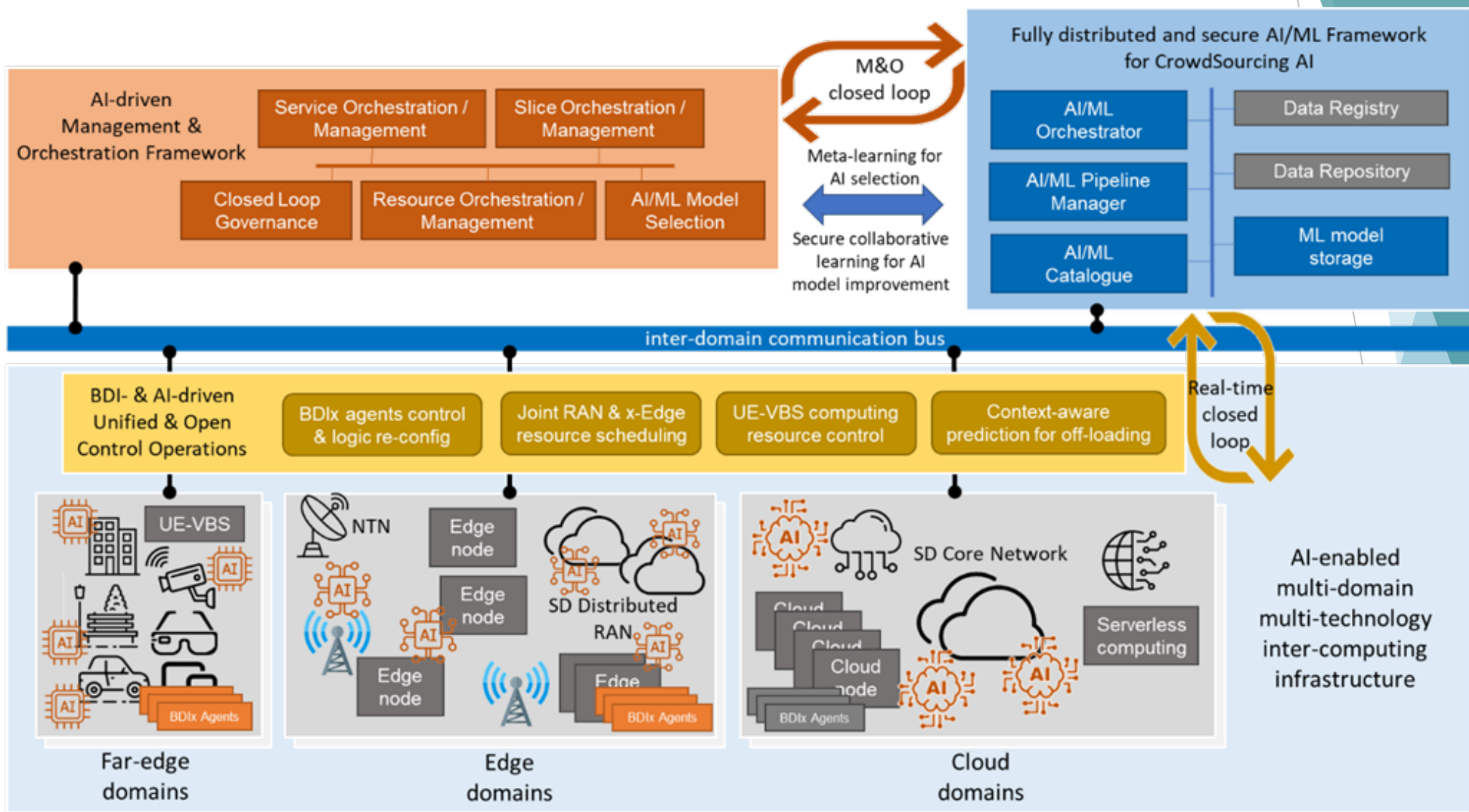
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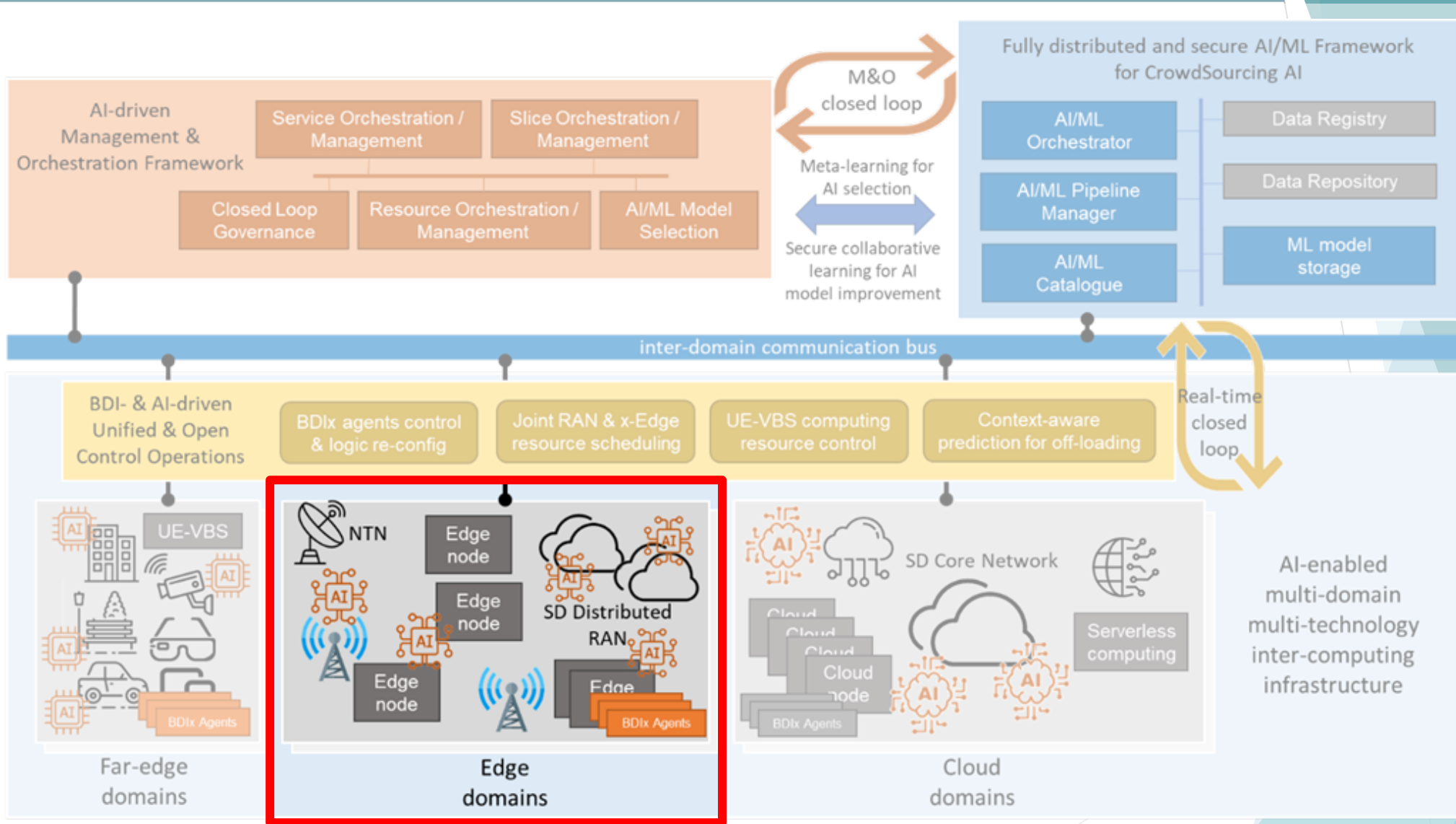
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General Architecture

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NTN-based communication and computing

- NTN domain (namely Satellite networks) is part of underlying networking infrastructure in a tight integration its terrestrial counterpart.
  - Considers different strategies for an TN-NTN integration, interworking, and convergence.
  - Applies distinct satellite topologies, within both groundstation-based and Direct-to-Device (D2D) deployment models.
- Satellite communication has a two-fold objective in ADROIT6G:
  - Provide space-based connectivity to expand coverage into remote or underserved areas
  - Provide a supplementary link for backup, failover, or resilience purposes.
- A new perspective to the computing stratum with Space-based Edge/Clouds
  - Combine the strengths of global reach and low latency satellites with distributed processing and scalability of Edge/Clouds.
  - Expand the processing & storage capabilities beyond traditional terrestrial options.
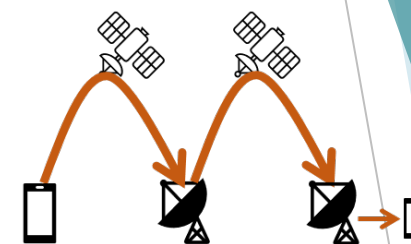
a) Bent-Pipe Topology
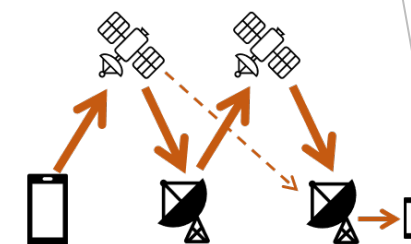
b) Regenerative Topology

c) ISL Topology

Proofs of Concept
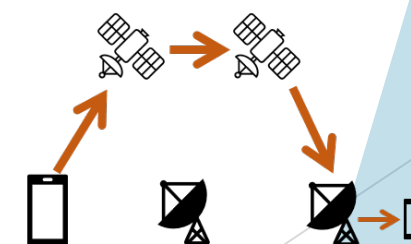
Immersive XR - Holographic Teaching
A teacher provides the lecture at home/office, while the students attending physically the class, can watch the teacher's holographic entity delivering the lesson
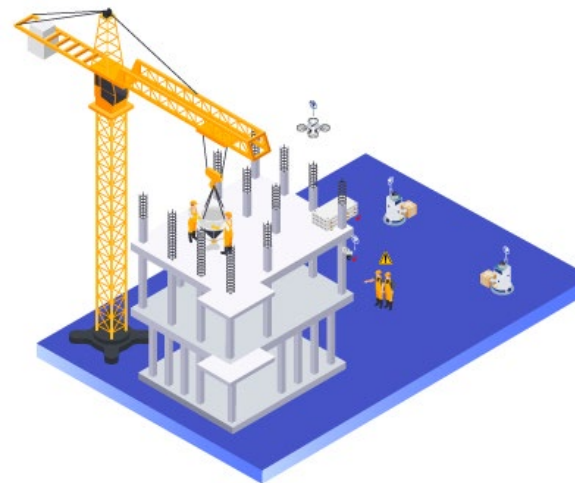
Collaborative robots (cobots) in construction
Robots and drones that need to coordinate actions with each other in a construction site. Coordination will be conducted in three dimensions, to avoid collision and enable collaboration of robots in the air (drones).

Proofs of Concept

Terrestrial 6G IIoT

In a production line of an **automotive manufacturing process** sensors and actuators (i.e., IIoT devices) communicate with each other, and taking actions in sub-millisecond time intervals, within a confined area, executing different robotic functionalities.

NTN for low-bitrate IIoT

Trackside IIoT devices and **on-train terminals**, that send data to a remote cloud. Edge Cloud components on the devices, in satellites and in the remote data centre pre-process and route data and perform control depending on the application logic and in case of issues in the communication path.

Innovation Streams

1   UEs as Virtual Base Stations (VBS) computing concept

2   A novel Decentralized AI framework for D2D communication in 6G networks, based on Belief-Desire-Intention (BDI) Agents

3   Crowdsourcing AI to minimize AI/ML carbon footprint and enable efficient AI/ML in distributed systems, via collaborative techniques

4   Sustainable data usage and generation, learning representations of data collected at the edge and the far edge of the network

5   Zero-Touch management enabling AI-driven dynamic slice reconfiguration for self-driven 6G infrastructures

6   Network automation and self-optimization via closed-loop orchestration in multi-layer scenarios with cooperating stakeholders

7   NTN-based communication and enhanced NTN-based computing

Thank you for your attention!

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