



ADROIT6G: Distributed Artificial Intelligence-driven open and programmable architecture for 6G networks

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6G series workshop by Hexa-X-II
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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**.



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

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

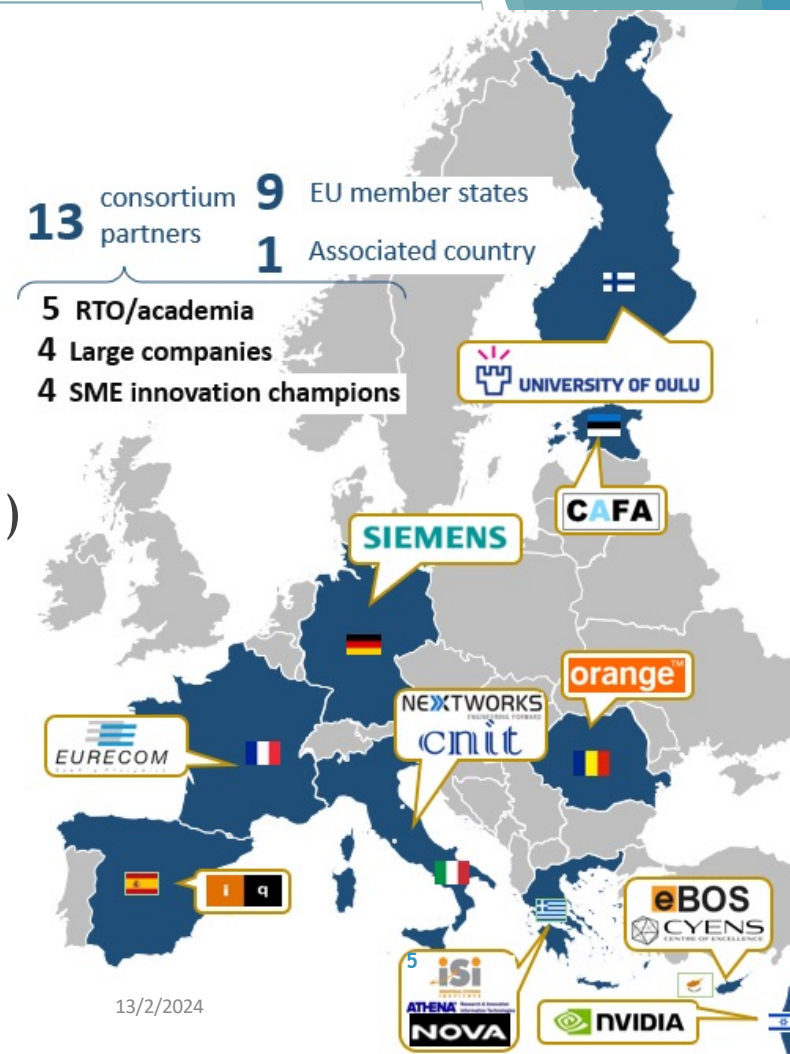
O6: Enable Non-Terrestrial Networks connectivity for highly reliable Industrial IoT Services

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

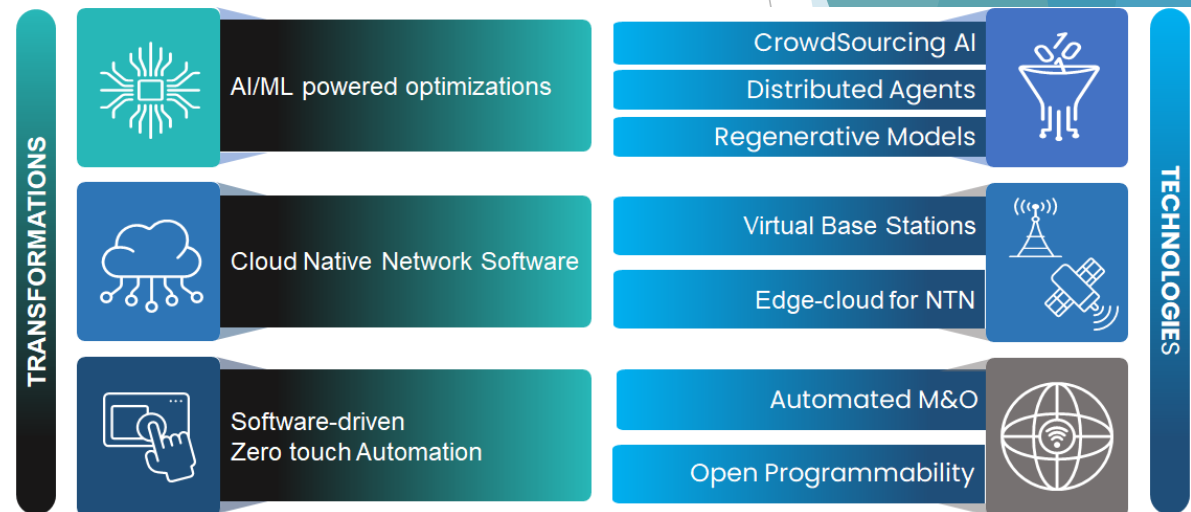
O8: Support data plane acceleration

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

- ▶ 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, Begin: 1/1/2023

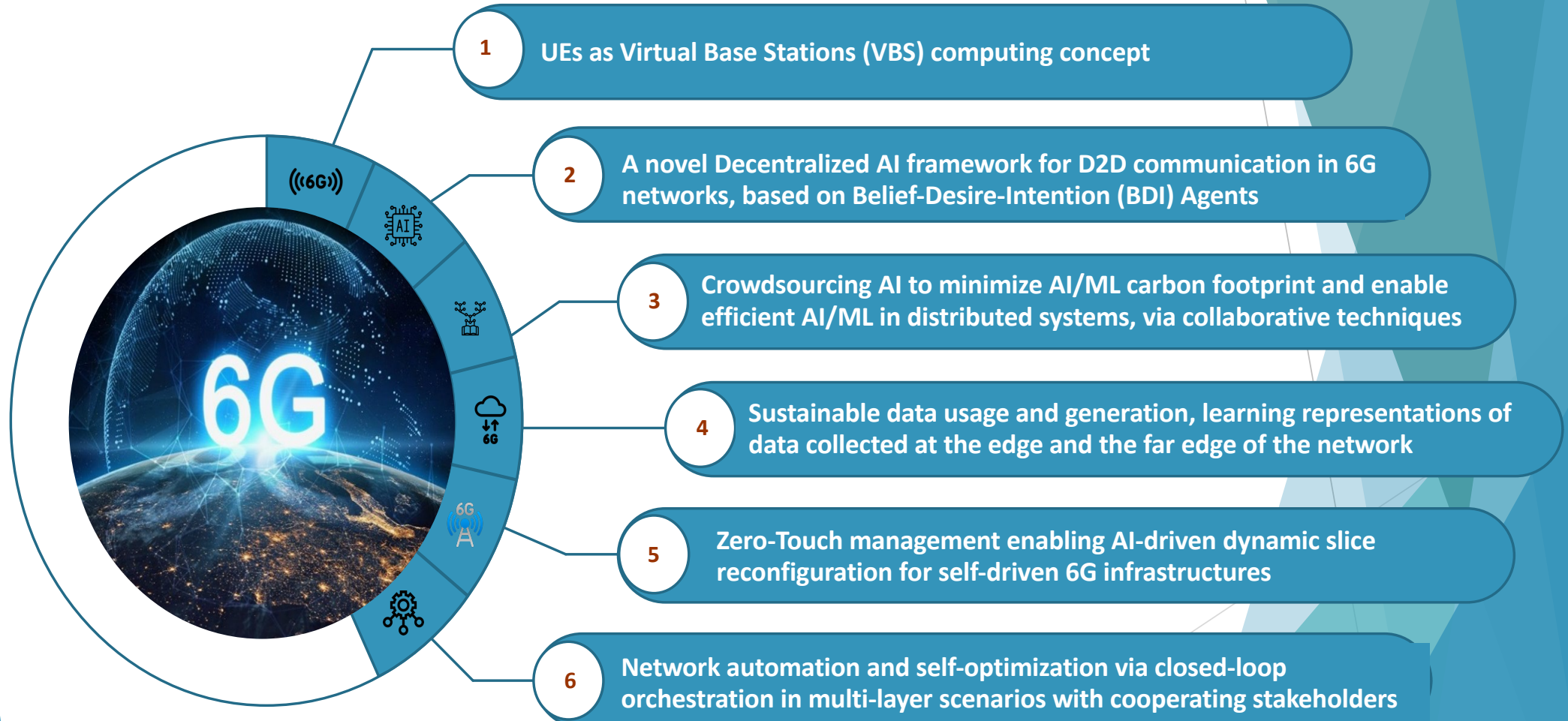


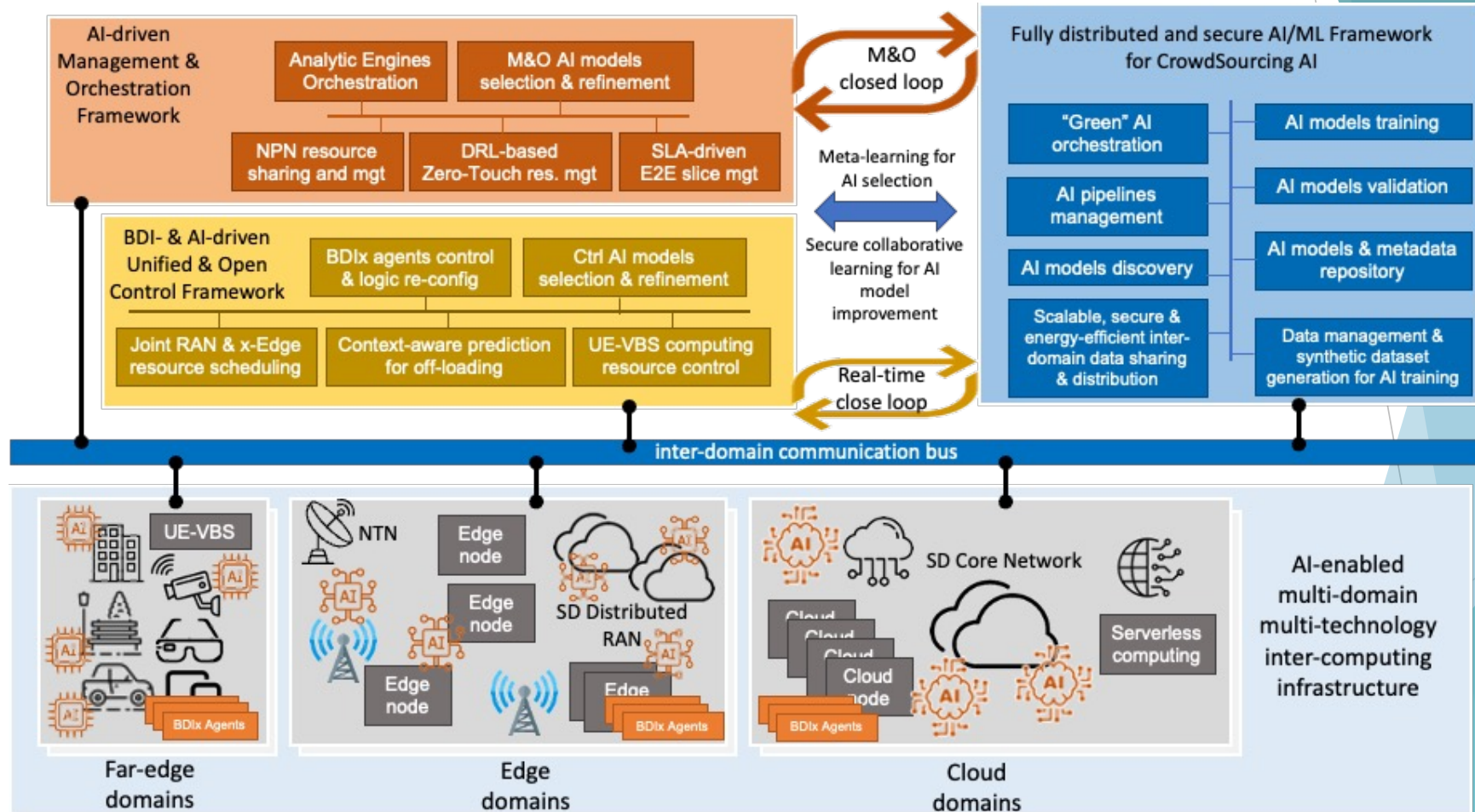
- **Key Transformations for 6G Evolution:**
 - **AI/ML-powered Optimisations:**
 - Harnessing Distributed Artificial Intelligence.
 - Aim for high performance and full automation.
 - **Cloud-native Network Software:**
 - Implementation across various edge-cloud platforms.
 - Integral security in the network user plan.
 - **Software-driven Operations:**
 - Zero-touch operations.
 - Full automation for network and delivered services.



- **AI/ML-Powered Optimisations Across the Network:**
 - **Shift to Distributed AI:** Transitioning from the standard centralized AI model to distributed AI solutions, encompassing both Federated and Decentralized Learning.
 - **Crowdsourcing AI Framework:** A pioneering concept introduced to provide domains and applications with optimal AI models, emphasizing energy efficiency, carbon footprint reduction, and secure AI/ML operations.
 - **BDI Agents:** Utilizing Believe-Desire-Intention agents as a means of decentralized learning, operable throughout the edge-cloud spectrum.
 - **Distributed Representation Learning:** Employing generative models from multimodal data to conserve resources.

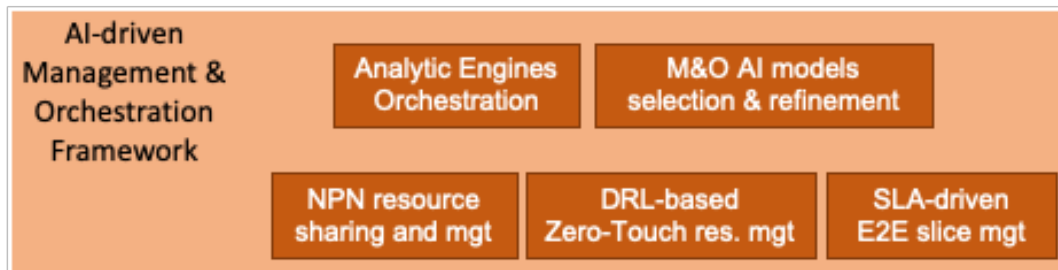
- **Transition to Cloud-Native Network Software:**
 - **Cloud-Native Cellular Infrastructure:** Modernizing cellular infrastructure to function seamlessly in cloud-native environments.
 - **UE as Virtual Base Stations (UE-VBSs):** Leveraging User Equipment as Virtual Base Stations to facilitate far-edge network component deployment.
 - **Edge Cloud Deployments & NTN:** Ensuring seamless integration between cellular and satellite communications.
- **Software-Driven, Zero-Touch Operations:**
 - **Adaptable Model:** Recognizing the unpredictability of future solution needs and emphasizing a model that supports dynamic collaboration and adaptation.
 - **Automated Management & Orchestration (M&O):** Transforming M&O into a fully automated solution, distributing all M&O functions and employing the Distributed AI framework for optimal closed-loop control.





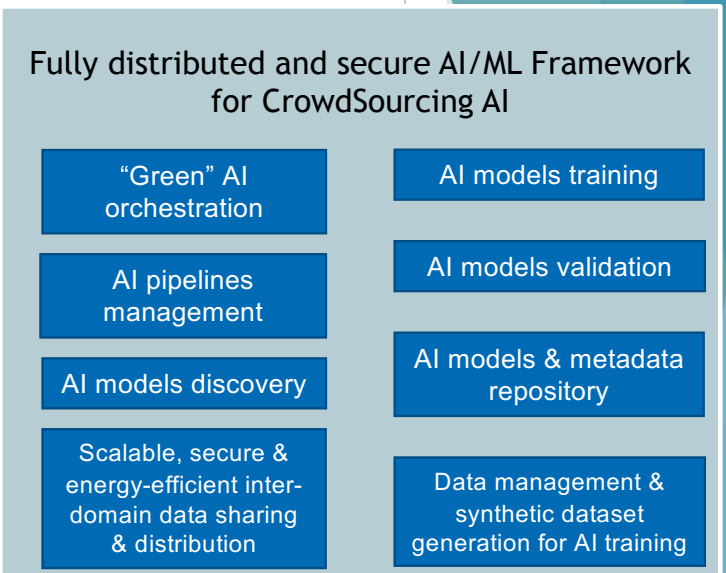
•AI-Driven Management and Orchestration Framework:

- Handles end-to-end, automated management of the network infrastructure.
- Features multi-tenant network slice composition across domains.
- Coordinates slice subnet sharing, lifecycle of virtual functions, and resource allocation per SLAs.
- Extends slice management for integrated public and non-public networks.
- Service-driven strategies for user plane function management at MEC.



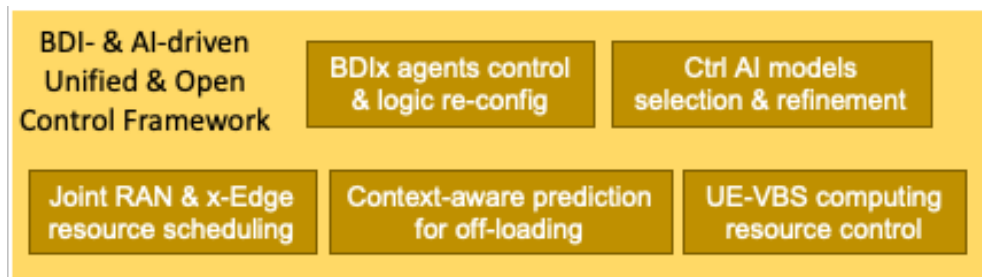
- **Fully Distributed & Secure AI/ML Framework for CrowdSourcing AI:**
 - Provide AI mechanisms to support the M&O and control frameworks.
 - Facilitates energy-efficient provisioning, AI model training, and discovery using meta-learning.
 - M&O and Control frameworks help validate and refine the AI models.
 - Manages data distribution with secure information sharing and synthetic dataset generation.

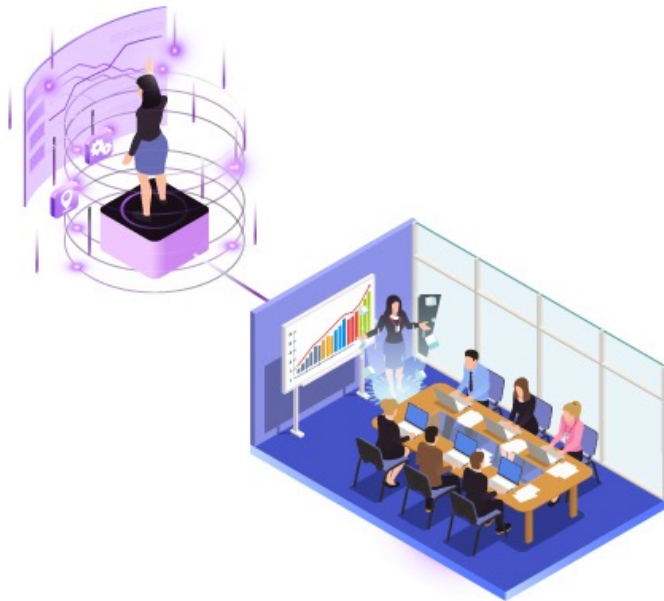
The ADROIT6G architecture provides a holistic approach, integrating AI-driven management, advanced control mechanisms, and distributed AI/ML for optimised network operation.



• **BDIx & AI-Driven Unified and Open Control Framework:**

- Manages real-time loops for network automation.
- Allocates resources dynamically based on current conditions and predictions.
- Handles resource congestion, scheduling, computation off-loading, and VM/content allocation.
- Oversees the BDIx agents, their re-configuration, and UE as Virtual Base Station (UE-VBS) resources.

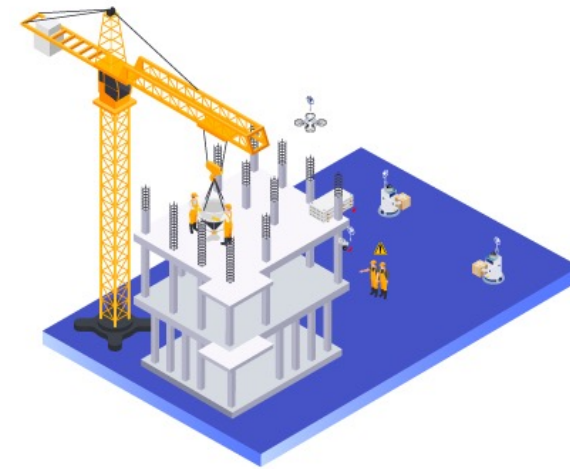




Immersive XR - Holographic Teaching Extreme eMBB

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

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Collaborative robots (cobots) in construction Extreme URLLC & Extreme mMTC

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).

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Terrestrial 6G IIoT Extreme mMTC

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.

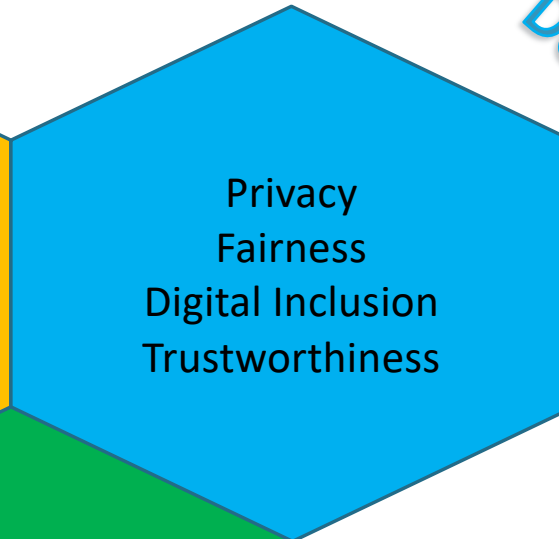


NTN for low-bitrate IIoT Extreme mMTC

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.

Service class focus	All service classes	PoC 1	PoC 2	PoC 3
		Extreme eMBB	Extreme mMTC	Extreme URLLC + Extreme mMTC
Network-level KPIs	5G KPIs (baseline)	6G KPIs	6G KPIs	6G KPIs
Peak throughput (Gbps)	<20	>1000	Not critical	Not critical
Experienced upload throughput (Gbps)	<0.1	<1	Not critical	Not critical
Experienced download throughput (Gbps)	<0.2	<2	Not critical	Not critical
Maximum bandwidth (GHz)	<1	<100	Not critical	Not critical
Application latency (ms)	<10	<1	Not critical	<0.1
Jitter (μ s)	N/A	<100	<100	<1
Energy efficiency (Tb/J)	N/A	nominal	high	nominal
Device density (devices/m ²)	<1	Not critical	<10	<10
Reliability (packet error rate)	10 ⁻⁵	10 ⁻⁷	10 ⁻⁶	10 ⁻⁹
Positioning accuracy (cm)	<50 in 2D	Not critical	<100	<1 in 3D
Visualised user experience	50Mbps, 2D	10Gbps, 3D	Not critical	Not critical
QoE (MOS)	N/A	>4.3	>4.3	>4.3

Innovation



Democracy



Ecosystem

▶ **Contributions to the ETSI ENI WG**

- ▶ Crowdsourcing AI solution to minimize AI/ML carbon footprint and enable efficient AI/ML training and inference in distributed systems.

▶ **Contributions to the ETSI ZSM and ETSI MEC WG**

- ▶ Distributed closed loop automation in AI-driven Management & Orchestration frameworks for multi-stakeholder ecosystems.

▶ **Contributions of the UE-VBS Computing Continuum concept to 3GPP SA1 group**

- ▶ Consider standardization of BDI Agents for Self-Organizing UE-VBS.

▶ **Contribution to the 3GPP SA2 group**

- ▶ Consider contribution of the NTN / 6G integration solution from Terrestrial 6G IIoT PoC.

Thank You!!!



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