



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

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The 6G series workshop by Hexa-X-II
03/06/2024



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Outline

- 01 Overview
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Overall Concept

ADROIT6G proposes disruptive innovations 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 Name:** ADROIT6G
- ▶ **Stream:** B0101 SNS-JU Call-1
- ▶ **Project website:** www.adroit6g.eu
- ▶ **Project Coordinator:** Prof. Ch. Verikoukis (ISI/ATH)
- ▶ **Technical Managers:** Prof. V. Vasiliou (CYENS) and Dr. J.Vardakas (IQU)
- ▶ **Total budget:** 5,967,436 euros
- ▶ **Duration:** 36 Months, **Begin:** 1/1/2023



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.

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.

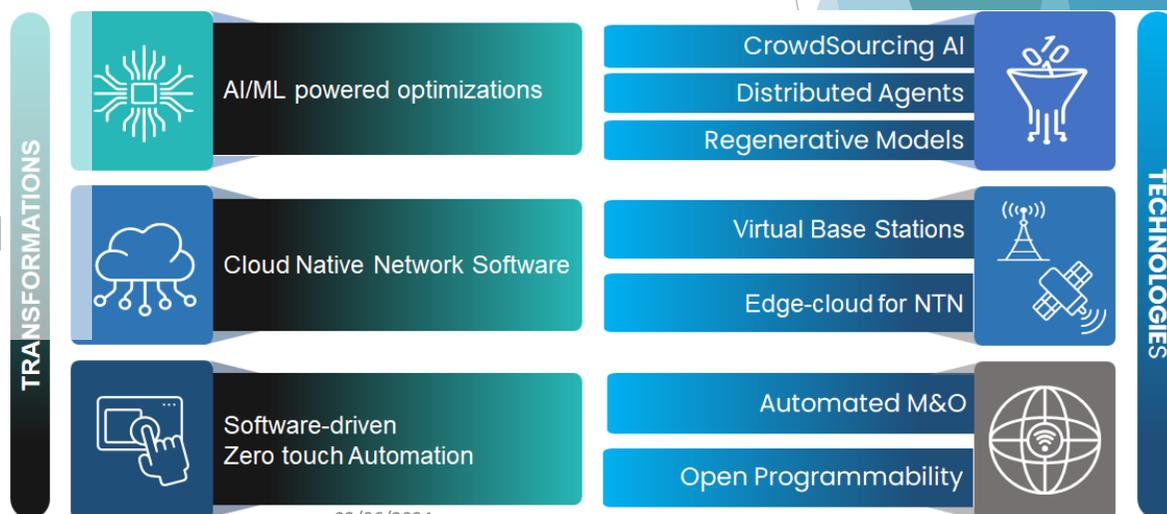
O7: Extend and demonstrate the use of decentralized AI for Device-to-Device communications.

O8: Support data plane acceleration.

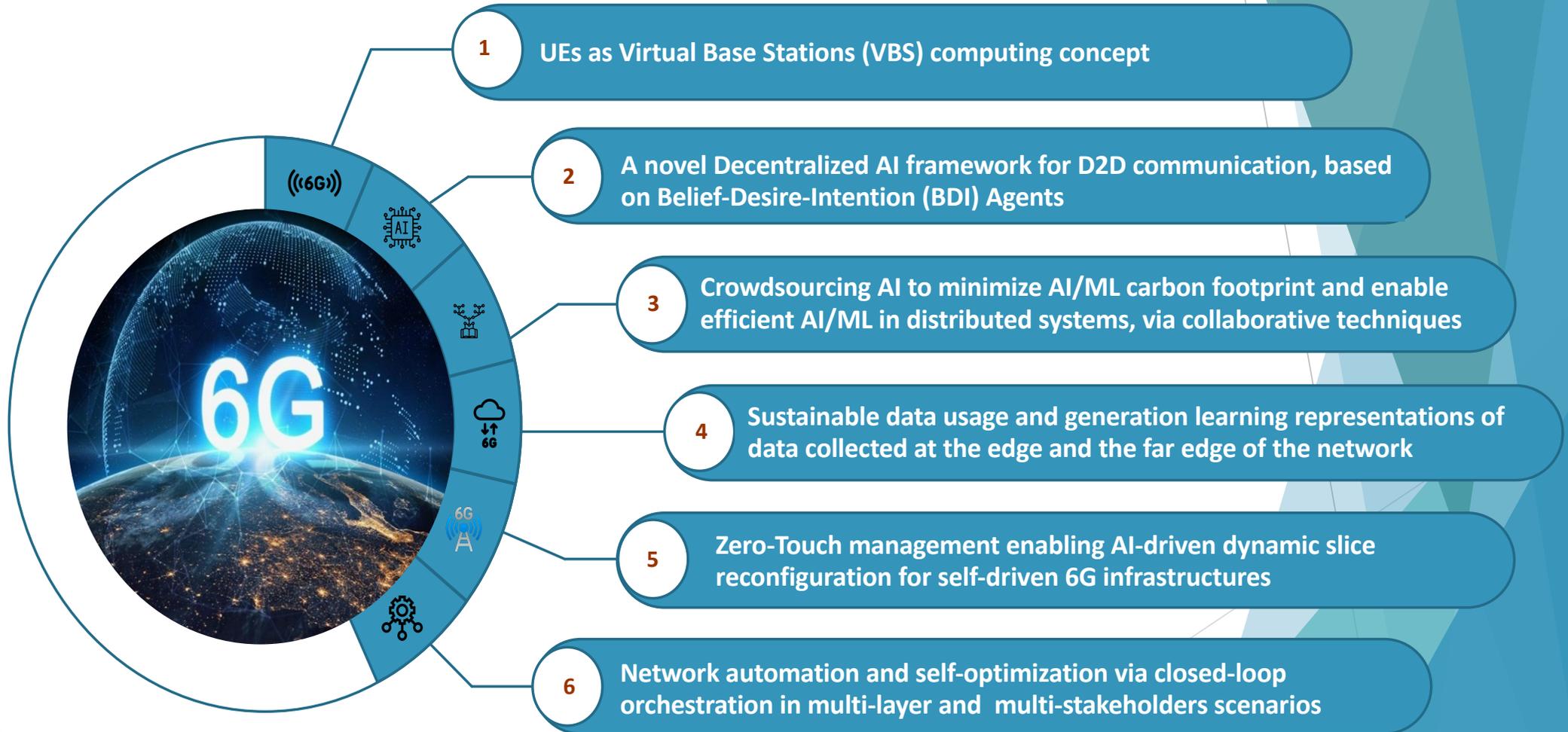
O9: Integrate and demonstrate the potential and user value of ADROIT6G through relevant experimentation, testing, and validation of its innovations in PoCs in lab settings.

ADROIT6G Key Transformations for 6G Evolution:

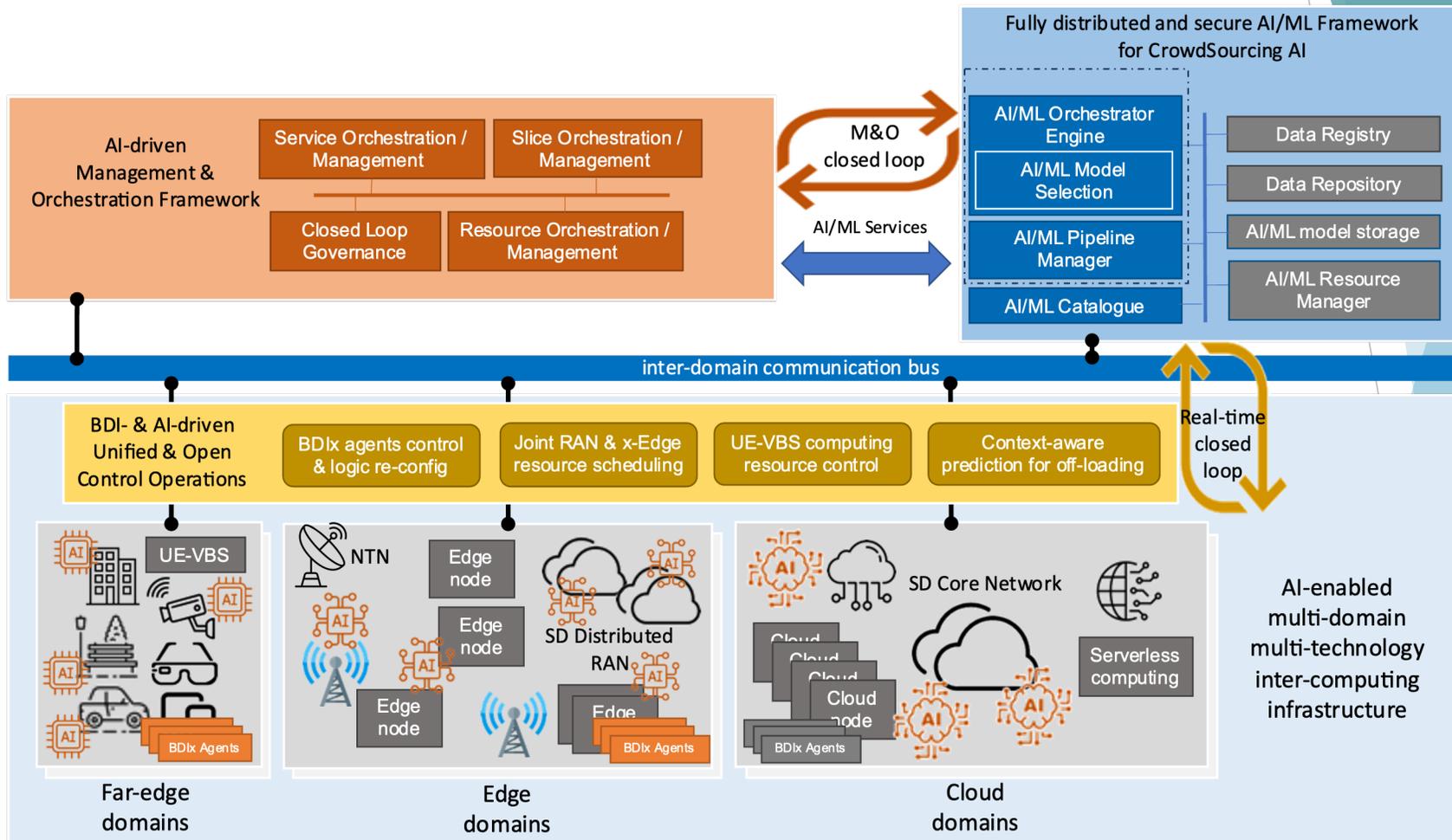
- **AI/ML-powered Optimisations:**
 - Harnessing Distributed Artificial Intelligence.
 - Aim for high performance and full automation.
- **Cloud-native Network Software:**
 - Implementation across various edge-cloud platforms.
 - Integral security in the network user plan.
- **Software-driven Operations:**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

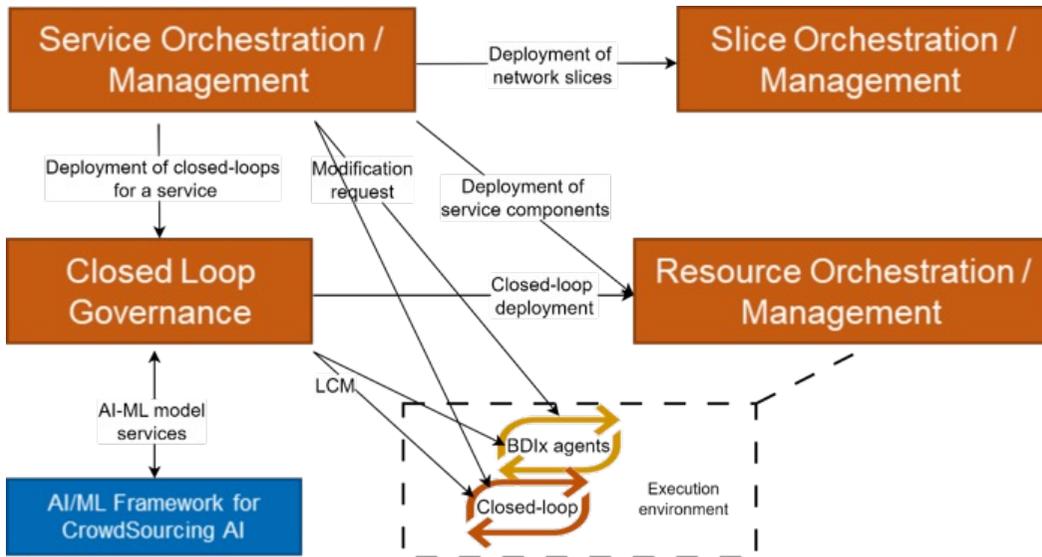


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General Architecture





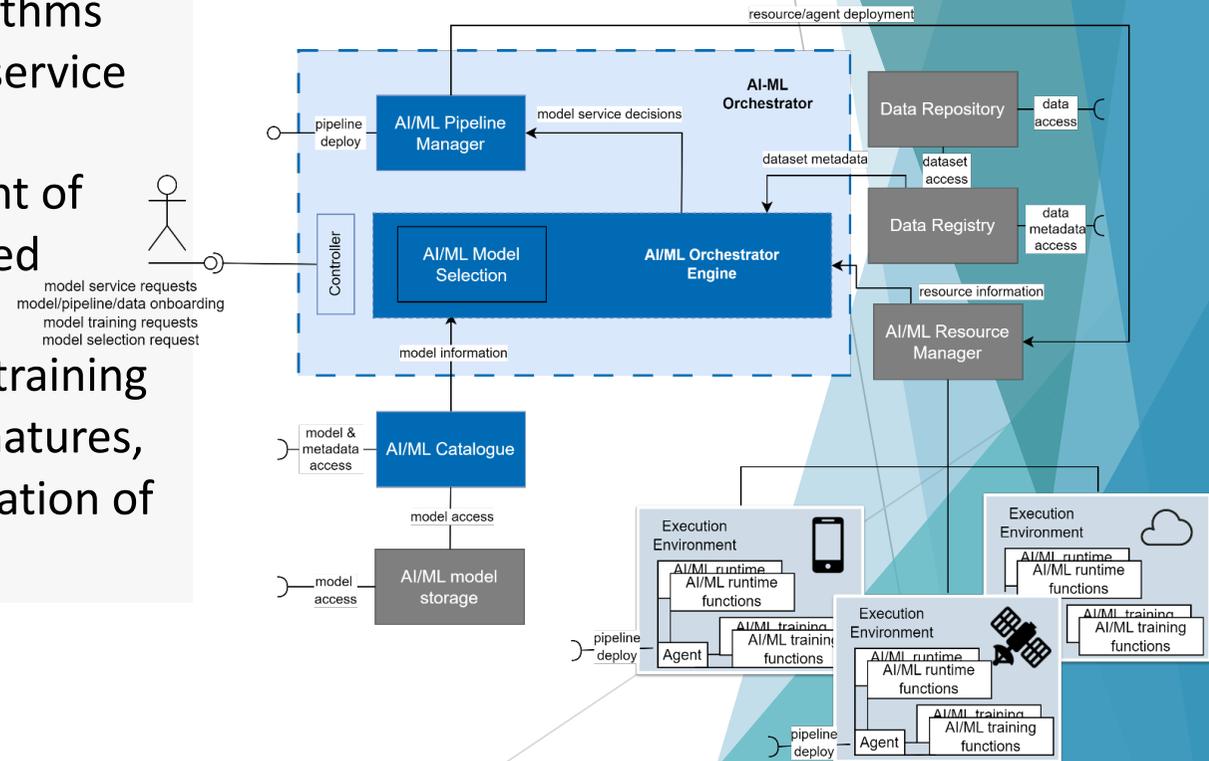
- Closed-loop governance:** innovative modules for the interaction with the Crowdsourcing AI or model automation. Extends the concepts in ETSI GS ZSM 009-2 for deploying and overseeing a diverse range of closed-loops. It also handles function splitting, resource allocation, migration, and scaling actions of closed-loop functions.

- Slice & Resource Orchestration and Management:** Learning rate FL policy that manages and orchestrates heterogenous network slice-related computing resources deployed in the ADROIT6G physical infrastructure.

- Service Orchestration and Management:** lifecycle management of vertical services, including orchestration of components communication services and network slices (3GPP TR 28.801).

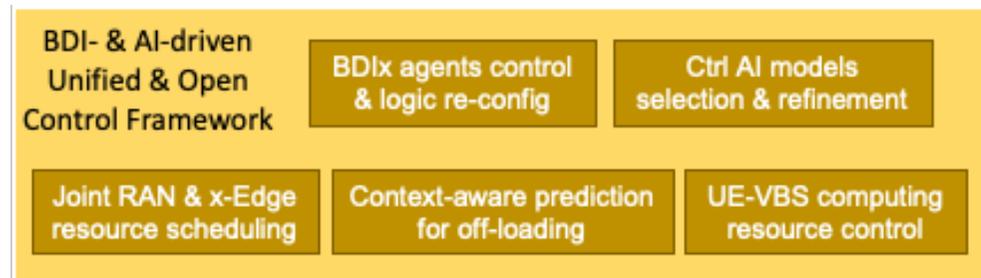
Fully Distributed & Secure AI/ML Framework for CrowdSourcing AI

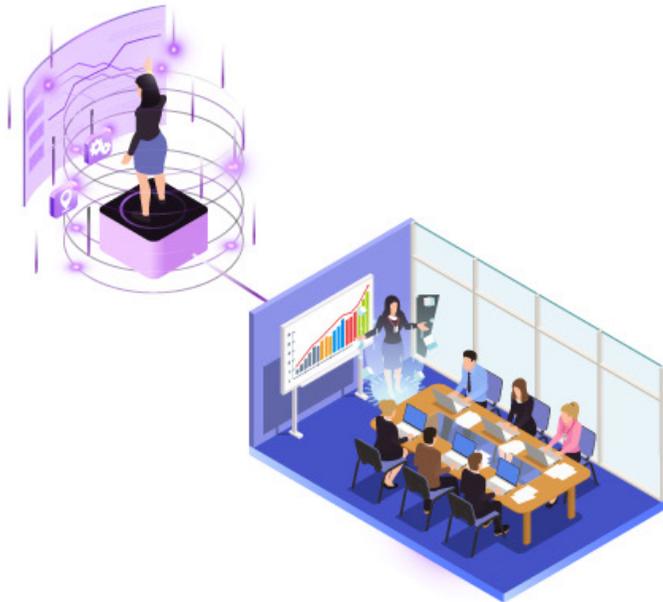
- **AI/ML Orchestrator Engine:** determines the orchestration approach for each requested AI/ML task.
- **AI/ML Model Selection:** contains the algorithms and methods of model selection based on service and resource requirements.
- **Pipeline Manager:** manages the deployment of training and runtime AI/ML functions defined through pipelines.
- **AI/ML Catalogue:** contains information on training runs, data used, training results, model signatures, model specific execution environments, location of saved model versions.



BDIx & AI-Driven Unified and Open Control Framework

- Manages real-time and near-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.

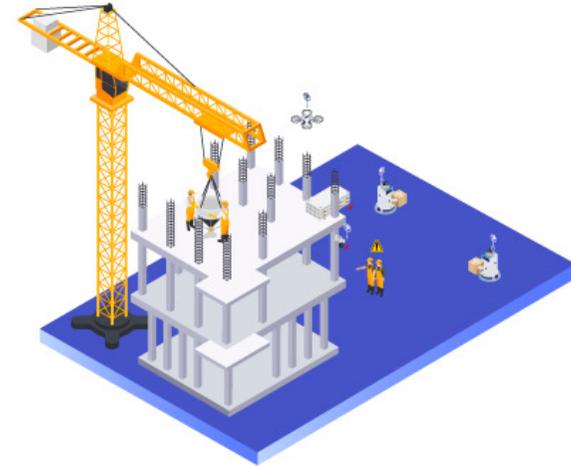




Immersive XR - Holographic Teaching Extreme eMBB

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.

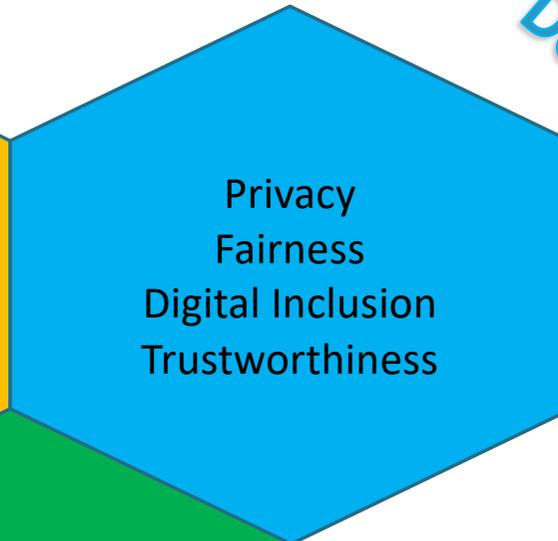


NTN for low-bitrate IIoT Extreme mMTC

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.

Two Demos

**Federate Zero Touch 6G Vision: Real Time Visualization
Platform for SLA-Driven Network Slicing Solutions (IQU & ISI/ATH)**

**AI/ML framework and closed loops for automated service
operation and network slice performance prediction (NWX & ORO)**





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Thank You!!!



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