Session 2

- Technical Enablers and envisioned challenges
  - Chairman: Colin Wilcock
  - Panelists:
    - TERAFLOW: *Ricard Vilalta*
    - RISE-6G: *Emilio Calvanese Strinati*
    - REINDEER: *Liesbet Van der Perre*
    - MARSAL: *Christos Verikoukis*
    - HEXA-X: *Patrik Rugeland*
    - DEDICAT 6G: *Vera Stavroulaki*
    - DAEMON: *Andrés Garcia-Saavedra*
    - AI@EDGE: *Roberto Riggio*
    - 6G-BRAINS: *Yue Zhang*

Main Goals

Today

Status of today's state-of-the-art SDN controllers

- ✗ Mostly monolithic
  - Microservice-based architectures (e.g., µONOS) are planned (not fully-disaggregated yet)
- ✗ Even the best distributed SDN controllers to date may not meet the excessive traffic demands of B5G networks
- ✗ Bridging SDN deployments across multiple transport networks (with multi-access technologies) remains open
- ✗ Mostly semi-automated deployments
- ✗ No multi-operator solution for inter-domain provisioning
- ✗ No integrated security analysis in dataplane
- ✗ Control plane security based on authorization access

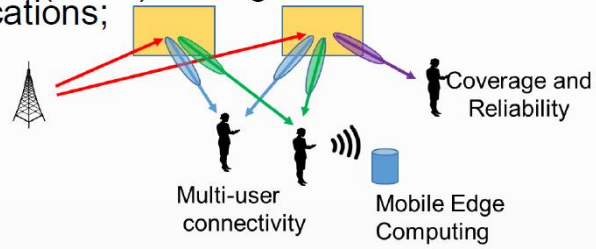
TeraFlow

TeraFlow bridges the gaps of state-of-the-art SDN controllers

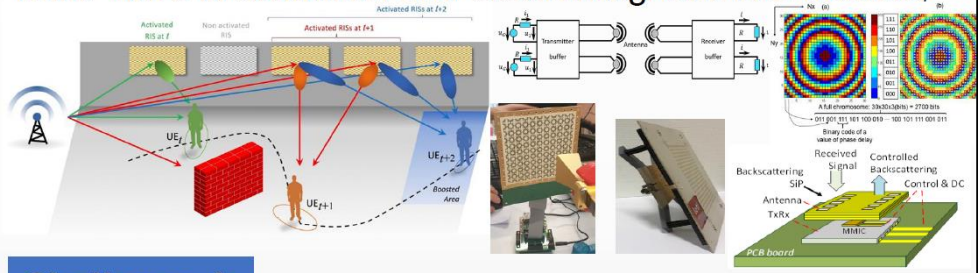
- ✓ Fully-disaggregated cloud-native network OS based on microservices
- ✓ Distributed control plane achieving at least 10x higher flow processing performance
- ✓ Transport-level network slicing for bridging geo-distributed SDN deployments with multi-access technologies
- ✓ Fully-automated (zero touch) deployments
- ✓ Permissioned Distributed Ledger
- ✓ Protection against sophisticated attacks targeting ML components
- ✓ Machine Learning (ML) to detect attacks at the optical, network and transport layers

4 key challenges for RISE-6G

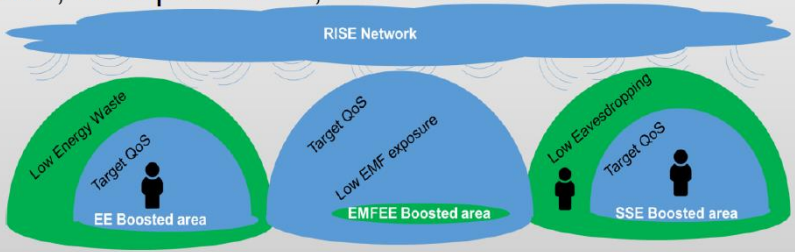
Challenge 1: Definition of novel network architectures incorporating **multiple RISs** and related RIS-Empowered (RISE) strategies for wireless communications;



Challenge 2: Characterize the **fundamental limits of RISE networks** in terms of connectivity, localisation, sensing, and sustainability, using realistic and validated radio wave propagation and electromagnetic RIS models;

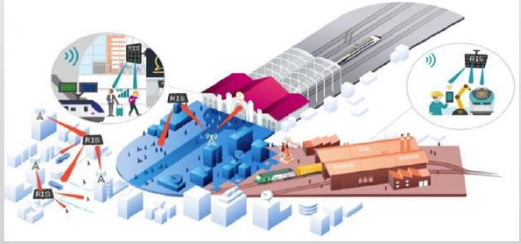


Challenge 3: **Online trade** between **high-capacity connectivity, EE, EMF exposure & localisation accuracy** based on **dynamically programmable wireless propagation environments;** Accommodate specific legislation/regulation requirements on spectrum use, data protection, and EMF

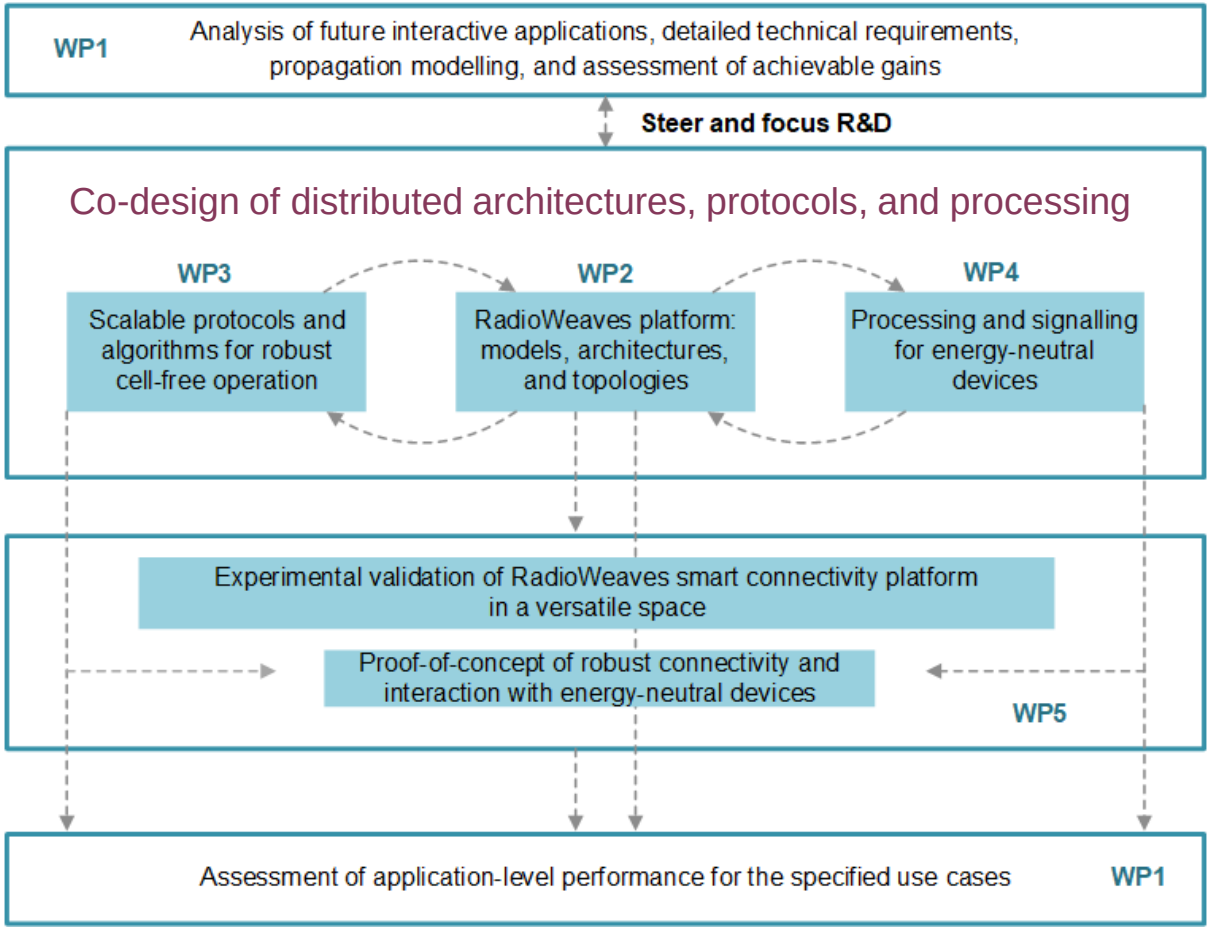


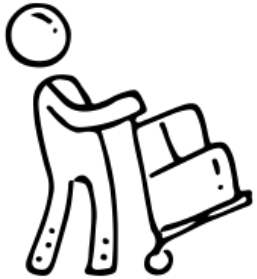
Challenge 4: Design, development/engineering, integration, and trial of RISs solutions, as well as low-complexity and highly scalable RISE wireless connectivity solutions at system level, for the practical demonstration of ad hoc performance-boosted areas.

Extreme Coverage Enhancement at Train Station



Accurate Indoor Localisation for Continuous Broadband Connectivity with AGVs at logistic industrial premise





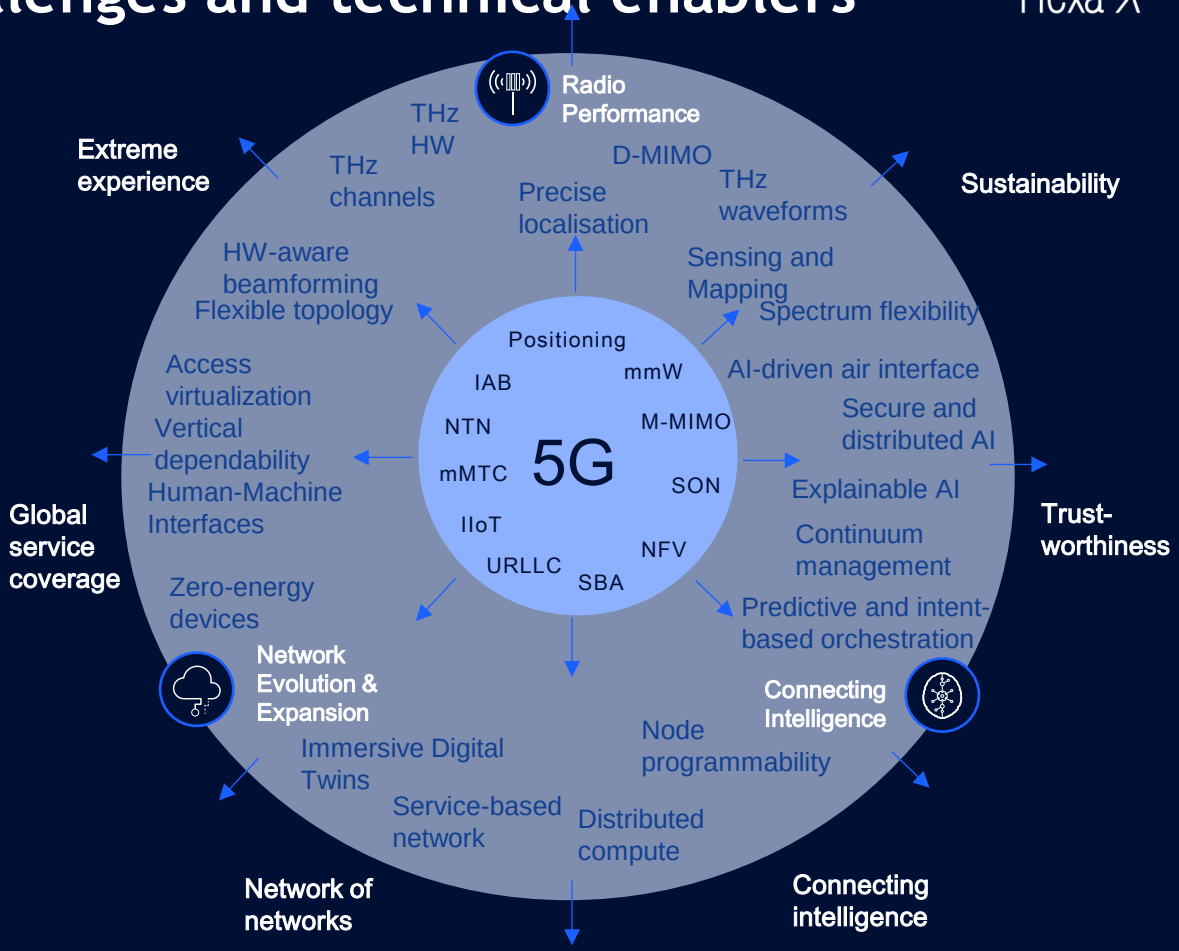
Hard ‘real-life’ problems: Synchronization, calibration, coordination, …

Challenges and Innovation

- Extend NG-RAN with Cell-Free.
- mmWave fronthaul for Cell-Free.
- SDN towards FMC.
- Fully elastic edge computing- Edge infrastructure with DC structured in two tiers.
- Policy-driven privacy and security in multi-tenant infrastructures.

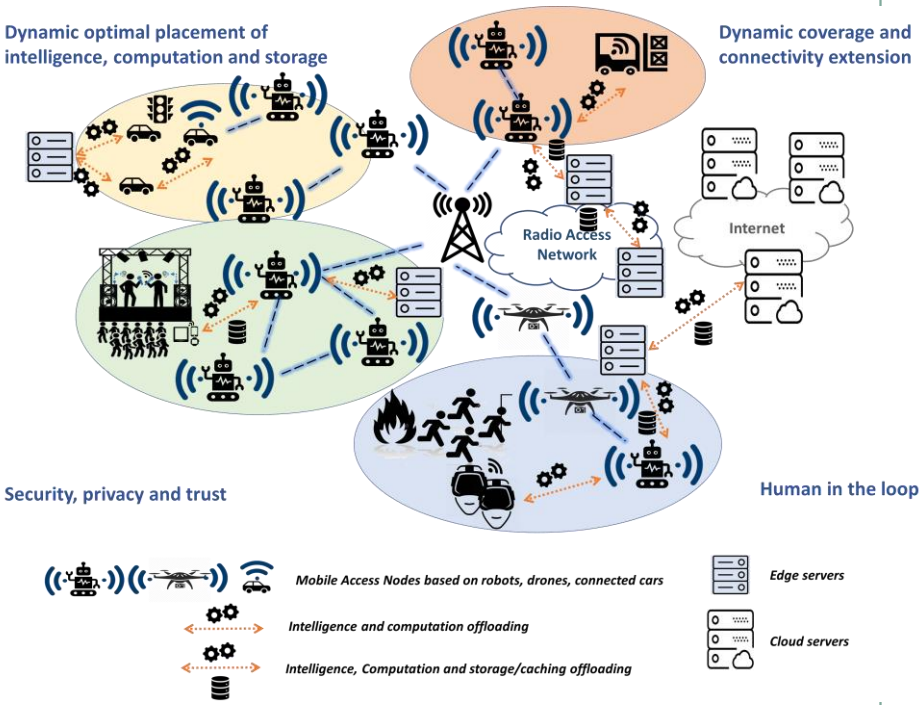
- Disaggregate the traditional cell-free CPU in DUs and a CU→ 3GPP.
- mmWave Hybrid MIMO solution with beam-steering and beam-sharing support for FH.
- Cell-free integrated with ORAN.
- Data–Driven for optical cluster formation using DDPG.
- Optimize the functionality of the MEC via a distributed representation learning and Q-Learning.
- Elastic Edge Computing notion to disaggregate and dynamically migrate applications functions across the edge-RAN to the core cloud.
- Dynamic slicing using CNN and flow-level, to trigger predictive slice reconfiguration across domains.
- Blockchain-based for network slicing in multi-tenant.
- Obfuscating sensitive/private information.
- Representation Algorithms based on the Embedding Propagation method for the provision of data protection, integrity assurance and malicious traffic detection.
- HW Integration

Hexa-X Research challenges and technical enablers



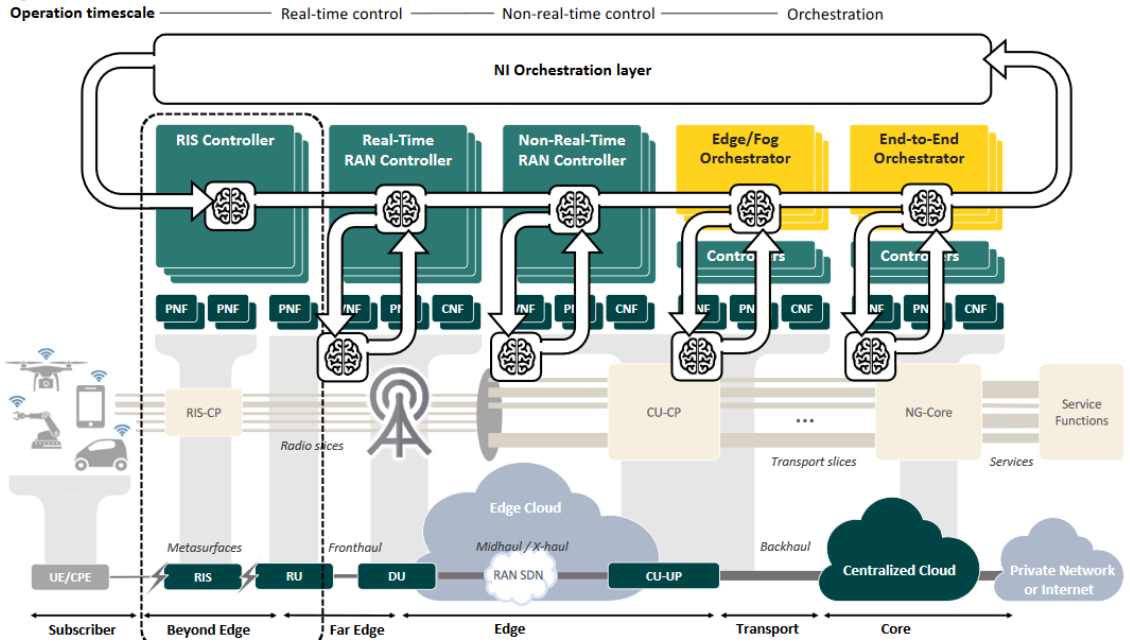
DEDICAT 6G Technical challenges

- Mechanisms for dynamic distribution of intelligence and storage in conjunction with predictive caching
- Mechanisms for dynamic coverage and connectivity extension
- Security, privacy and trust assurance especially for mobile edge services
- Applications with novel interaction between humans and digital systems through innovative interfaces and devices (AR, smart glasses, connected cars, robots, drones)
- Proof of concept, demonstrations, validation of the proposed solutions through system level simulations, lab-based testing of implemented functionality as well as application in experiments in realistic environments.



DAEMON concept: NI-native architecture

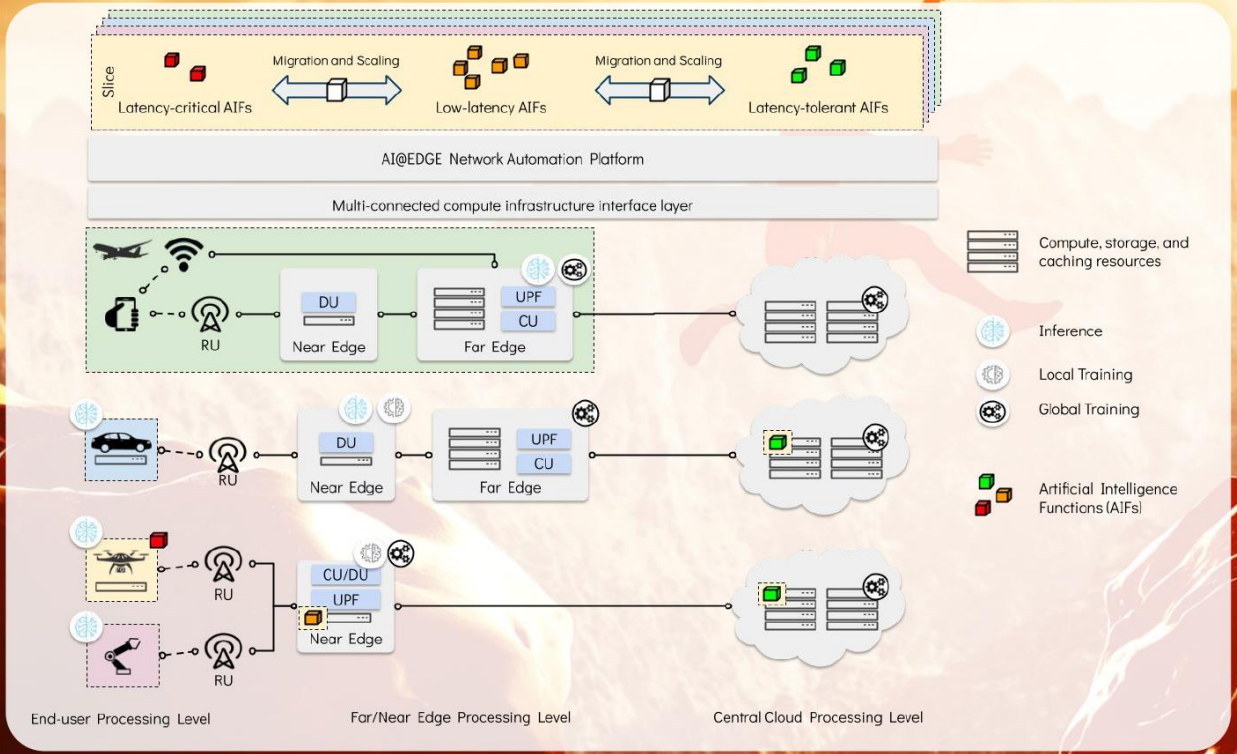
- Integrating ideas from O-RAN, 3GPP and ETSI
- **Network Intelligence (NI)** instances located in network orchestrators, controllers and network functions



Network functionality	Micro-domain	Timescale
RIS control	Beyond Edge	Real-time
Multi-timescale Edge resource management	Edge, Transport	Real-time
In-backhaul support for service intelligence	Transport	Real-time
Compute-aware radio scheduling	Far Edge	Real-time
Energy-aware VNF placement	Edge, Transport, Core	Orchestration, Non-real-time
Self-learning MANO	Transport, Core	Orchestration
Capacity forecasting	Edge, Transport, Core	Orchestration, Non-real-time
Automated anomaly response	Edge, Transport, Core	Orchestration, Non-real-time

- 3x NI operation timescales
- 5x micro domains
- **9x NI challenges**

Technical Challenges & Breakthroughs



AI/ML for closed loop automation

Privacy preserving, machine learning for multi-stakeholder environments

Distributed and decentralized connect-compute platform

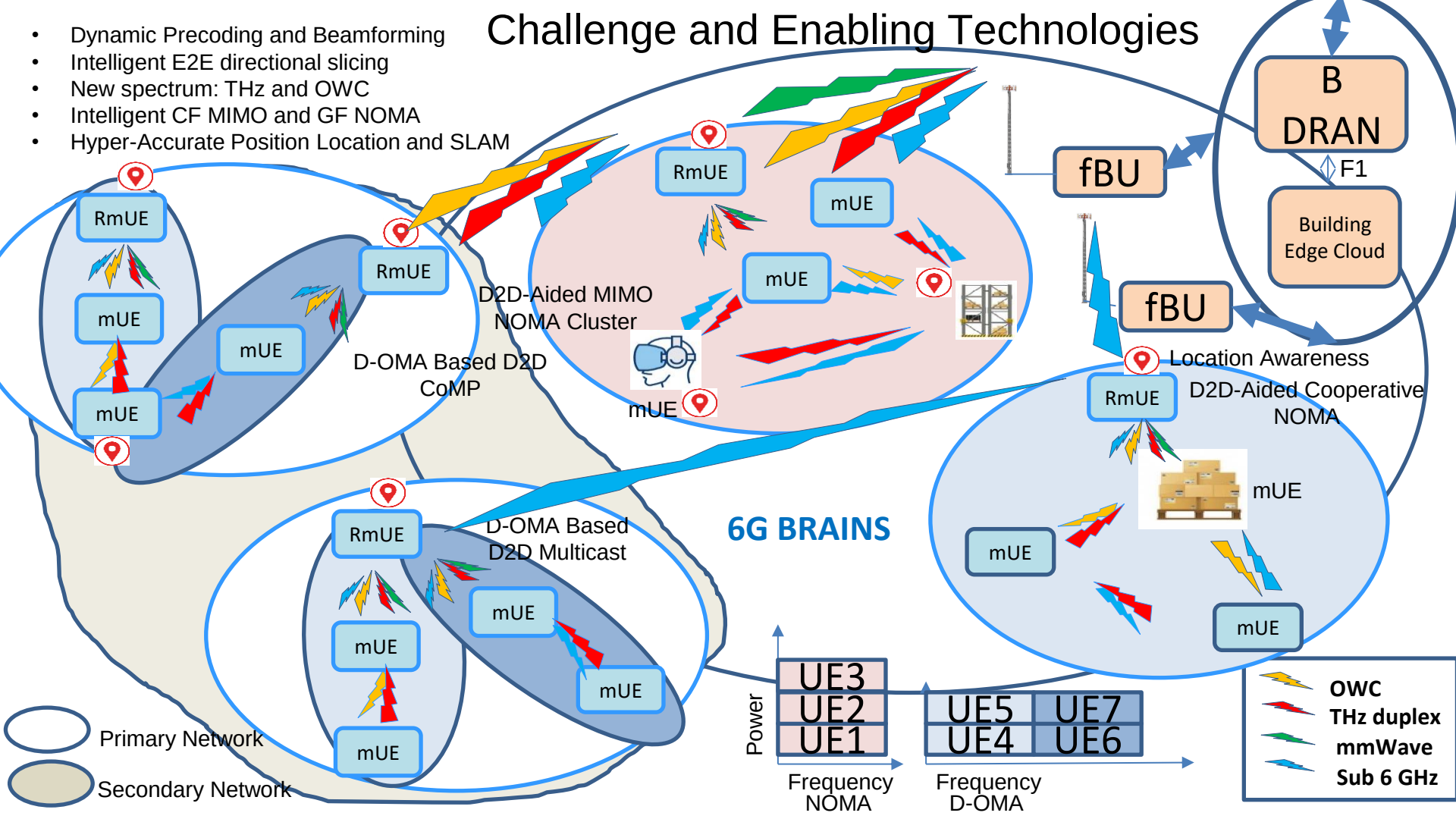
Provisioning of AI-enabled applications

Hardware-accelerated serverless platform for AI/ML

Cross-layer, multi-connectivity and disaggregated radio access

Challenge and Enabling Technologies

- Dynamic Precoding and Beamforming
- Intelligent E2E directional slicing
- New spectrum: THz and OWC
- Intelligent CF MIMO and GF NOMA
- Hyper-Accurate Position Location and SLAM



Session 2 Discussions

- Technical Enablers and envisioned challenges
  - Chairman: Colin Wilcock
  - Panelists:
    - TERAFLOW: *Ricard Vilalta*
    - RISE-6G: *Emilio Calvanese Strinati*
    - REINDEER: *Liesbet Van der Perre*
    - MARSAL: *Christos Verikoukis*
    - HEXA-X: *Patrik Rugeland*
    - DEDICAT 6G: *Vera Stavroulaki*
    - DAEMON: *Andrés Garcia-Saavedra*
    - AI@EDGE: *Roberto Riggio*
    - 6G-BRAINS: *Yue Zhang*