DESIRE6G

EMPLOYING DEEP PROGRAMMABILITY AND DISTRIBUTED INTELLIGENCE FOR REAL-TIME 6G NETWORKS

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the European Union

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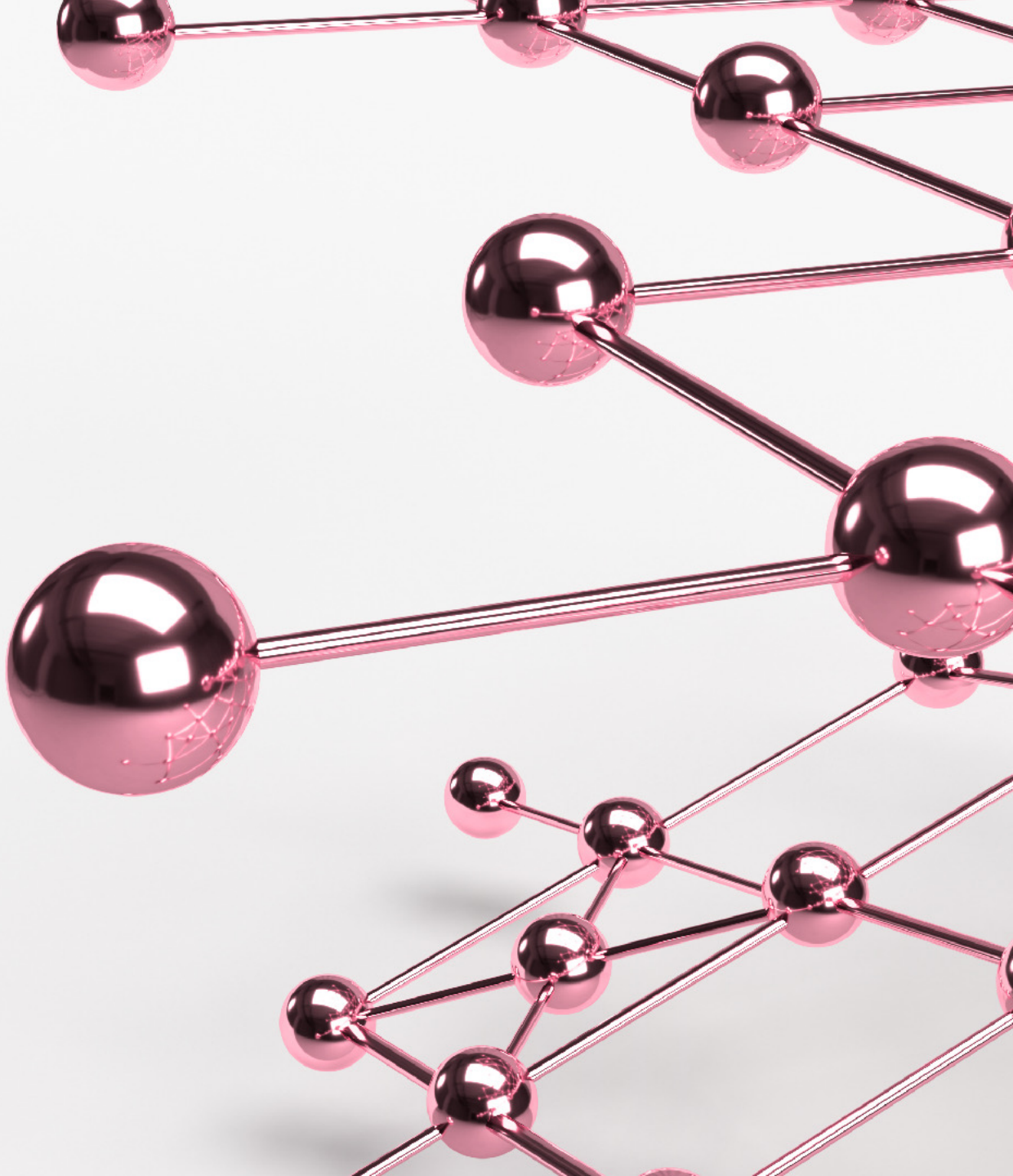

DEEP PROGRAMMABILITY & SECURE DISTRIBUTED INTELLIGENCE FOR REAL-TIME END-TO-END 6G NETWORKS

Project coordination:
University of Amsterdam

Technical coordination:
Ericsson Hungary

Duration:
01/01/2023 - 31/12/2025

Total Cost:
6.227.919€

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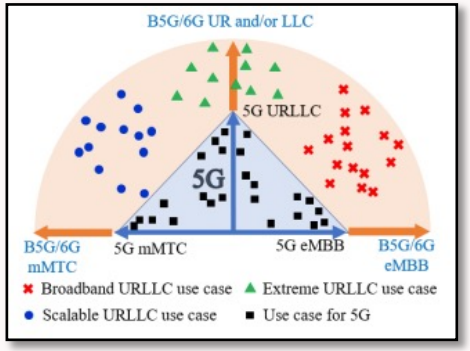
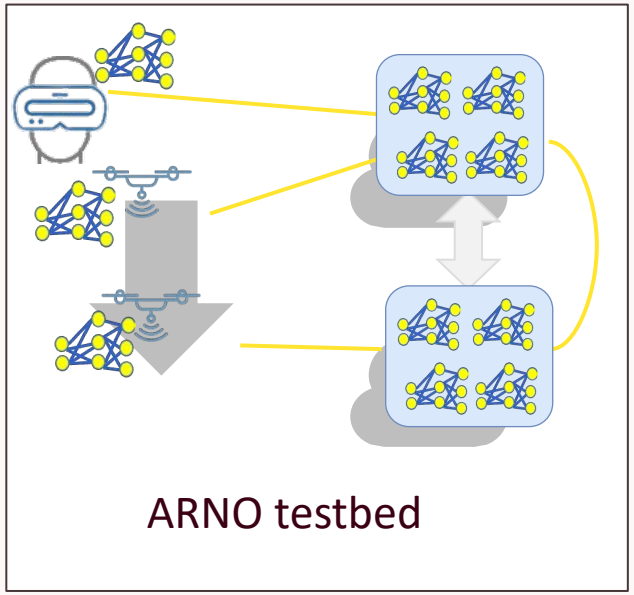
PROJECT SCOPE & OBJECTIVES

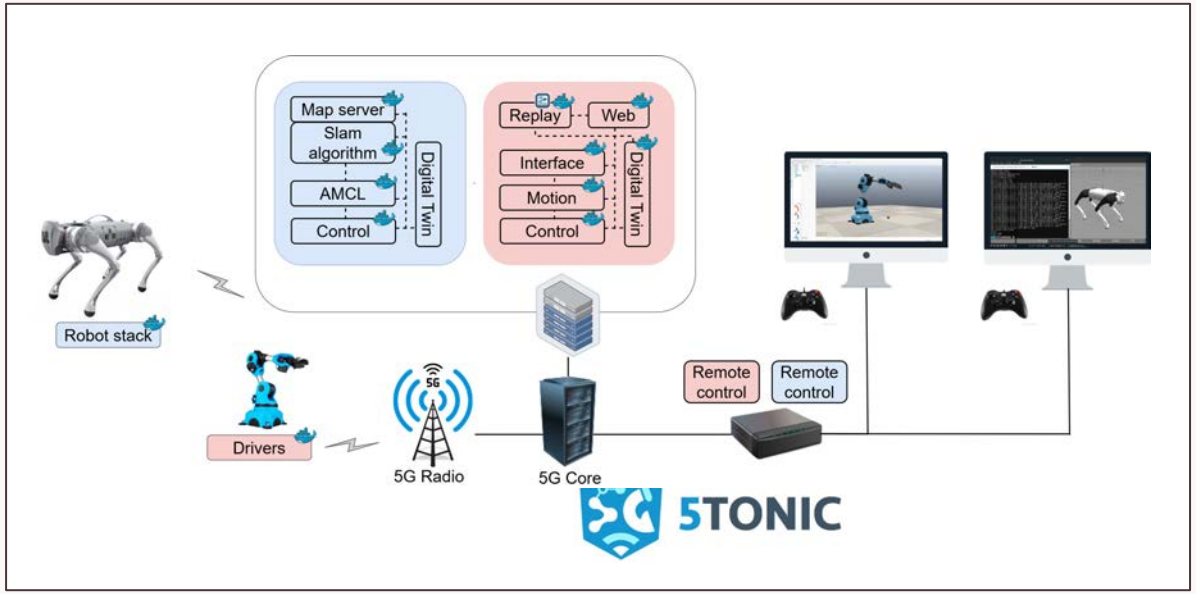
- Zero-touch control, management & orchestration platform, with native integration of AI, to support eXtreme URLLC requirements over a performant, measurable & programable data plane.
- Use cases: AR and a Digital Twin application at two distinct experimental infrastructures.



URLLC evolution and new service classes [1]

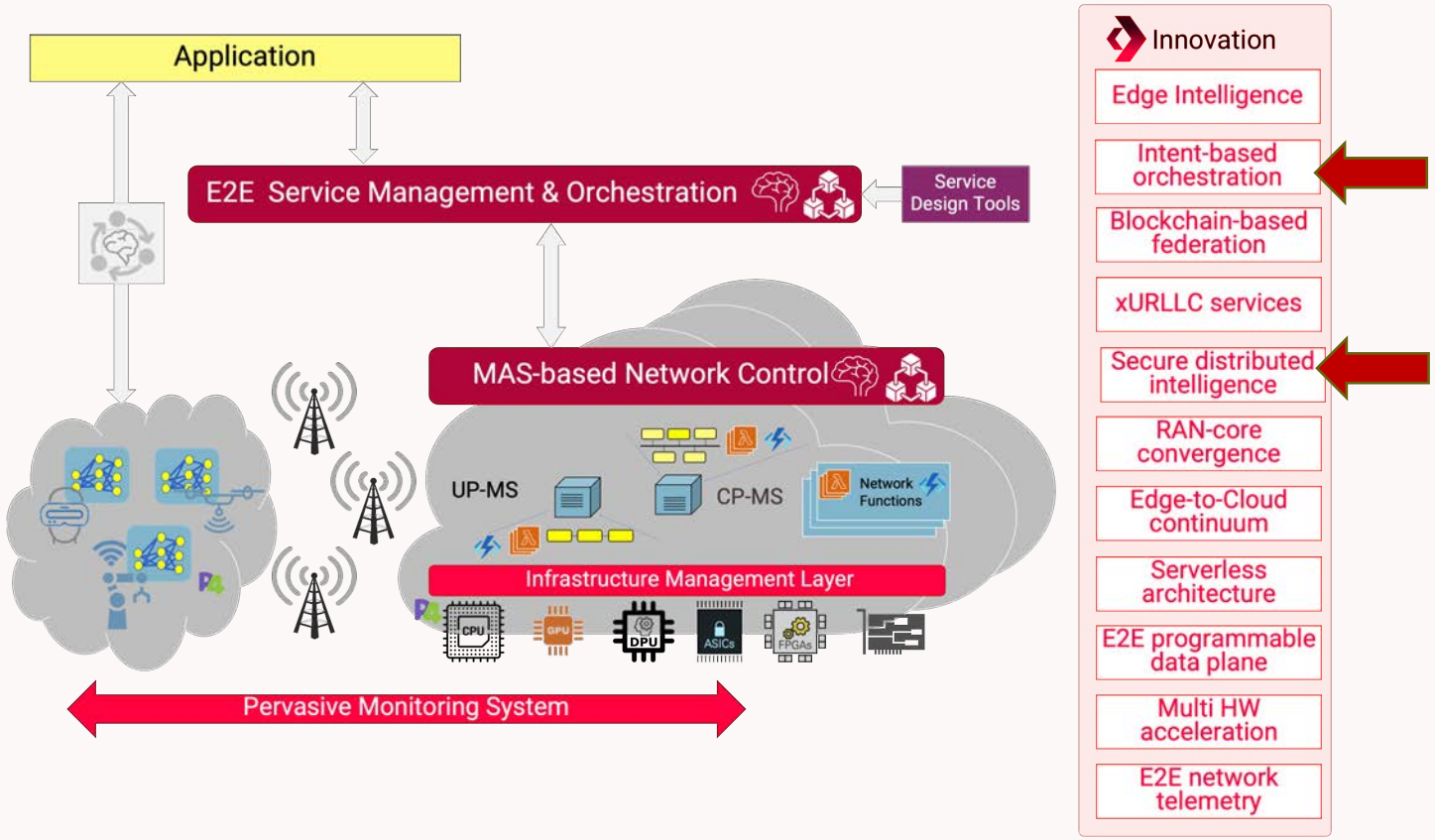


ARNO testbed



[1] Alves H. et al. “Beyond 5G URLLC evolution: New service modes and practical considerations." ITU Journal on Future and Evolving Technologies, 2022.

DESIRE6G KEY INNOVATIONS



SMO for Non-RT intelligent service/resource management

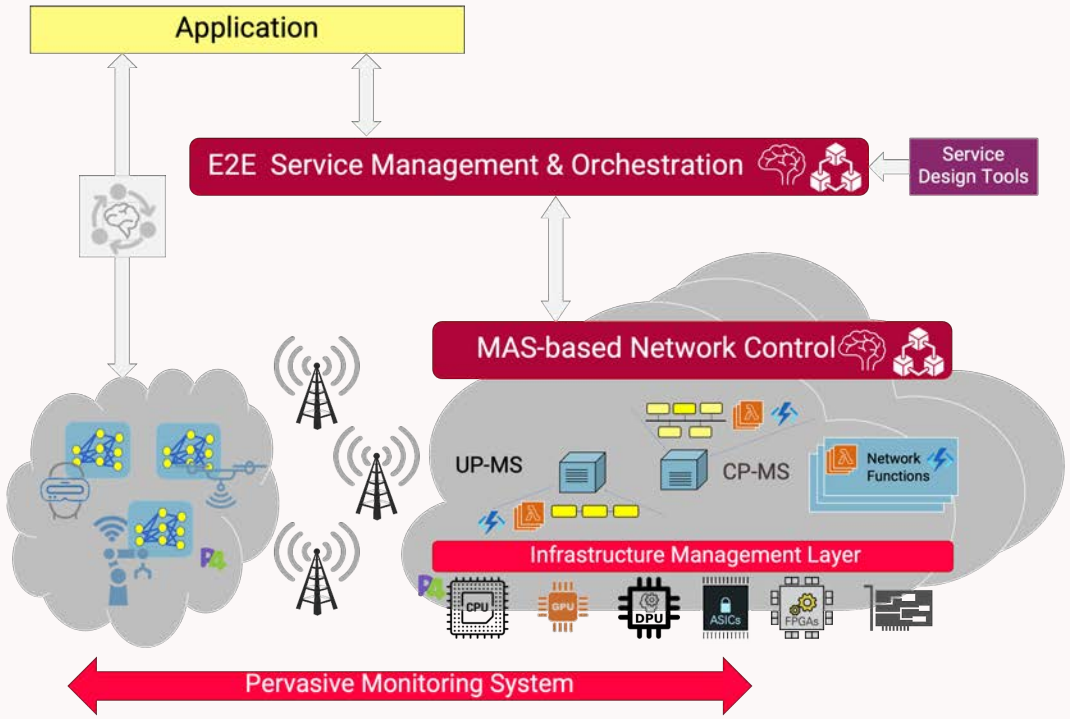
MAS enables NRT distributed control

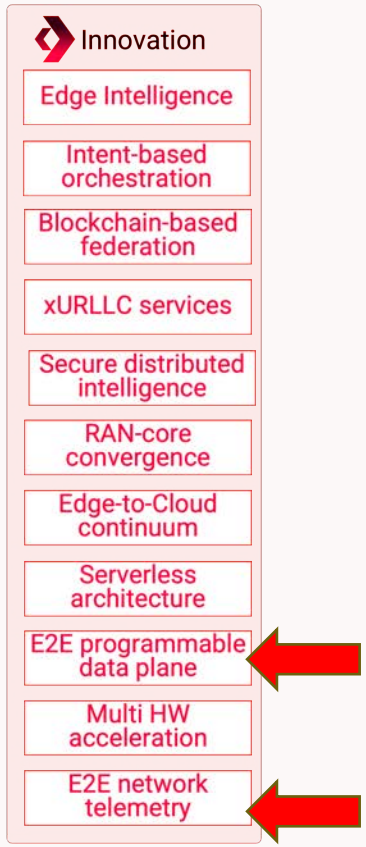
- Telemetry collection
- AI-driven decision making
- Actuation / reconfiguration

➢ MAS challenges: heterogeneity, dynamicity, coordination and cooperation, security etc. [2]

[2] Dorri A et al. “Multi-agent systems: A survey”. IEEE Access. 2018 Apr 30;6:28573-93.

DESIRE6G KEY INNOVATIONS





- In Band Network Telemetry: per flow aggregation, postcards etc.

➢ Challenges: scalability and performance

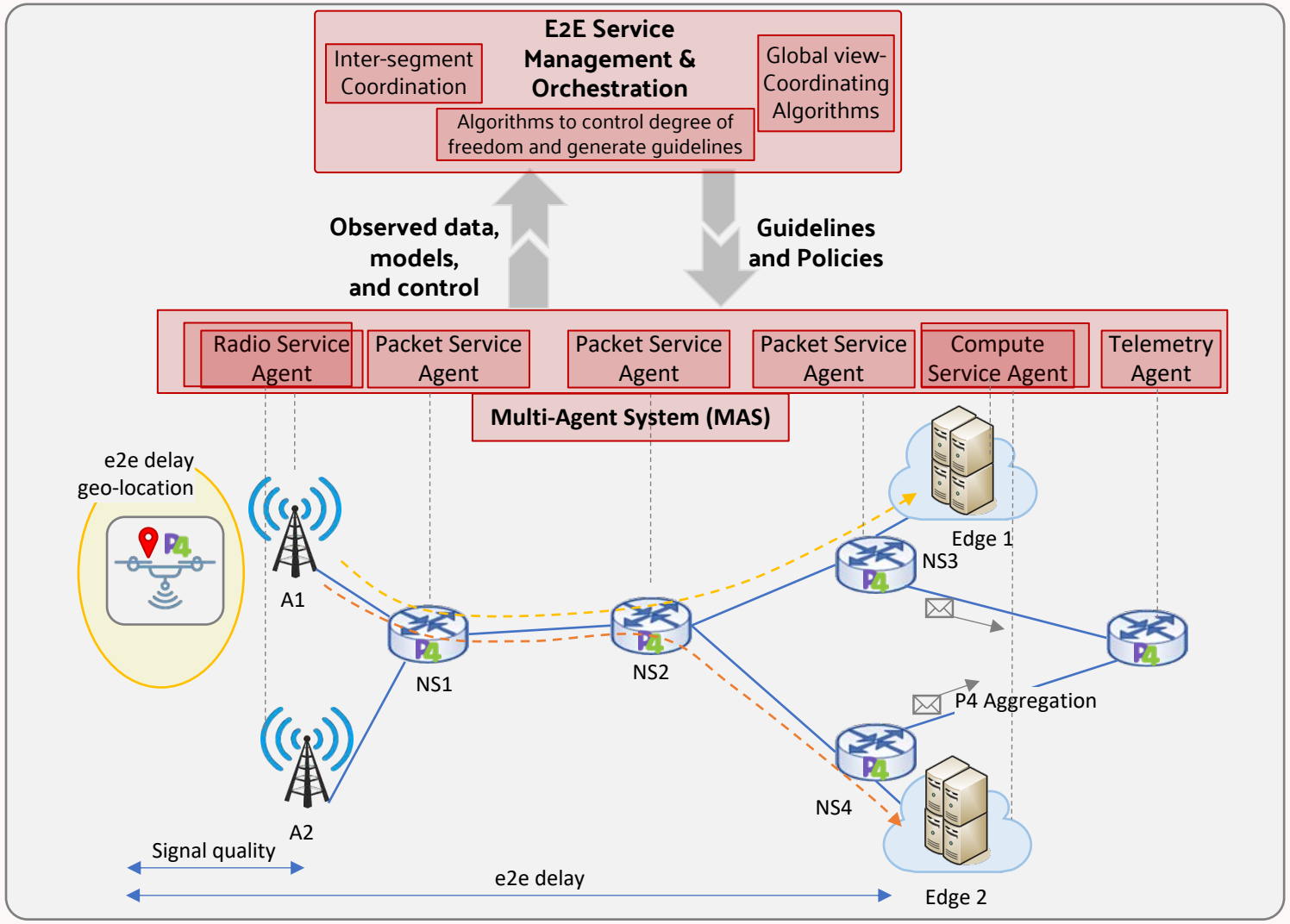
✓ First stage of collection at the PDP
✓ Intelligent telemetry data aggregation
  - e.g., 625:1 compression ratio using AEs [3]

Flexible, customized packet processing operations and protocol support

Network Telemetry

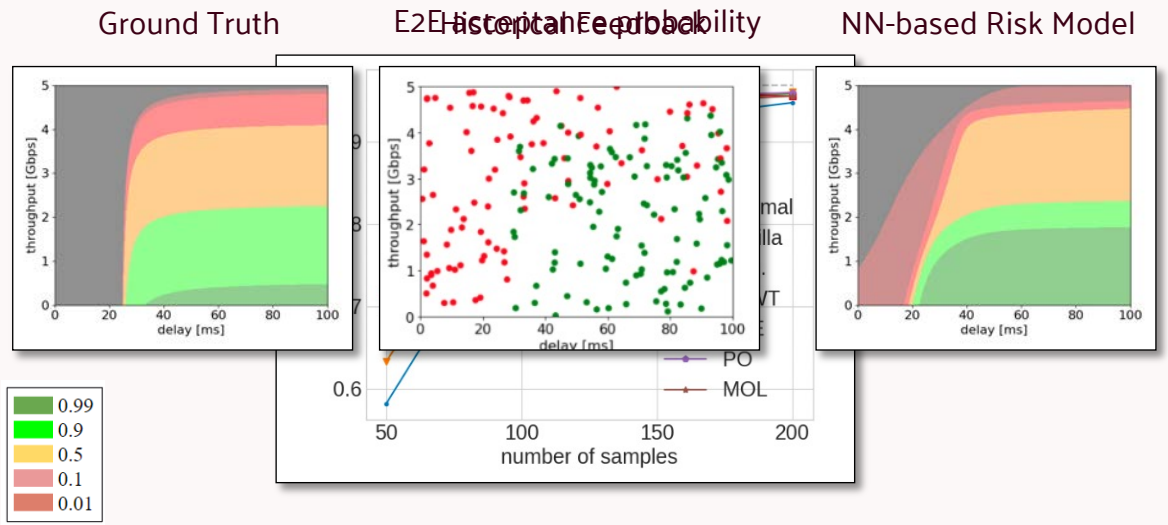
[3] L. Velasco et al., "Is intelligence the answer to deal with the 5 V's of telemetry data?," OFC, 2023.

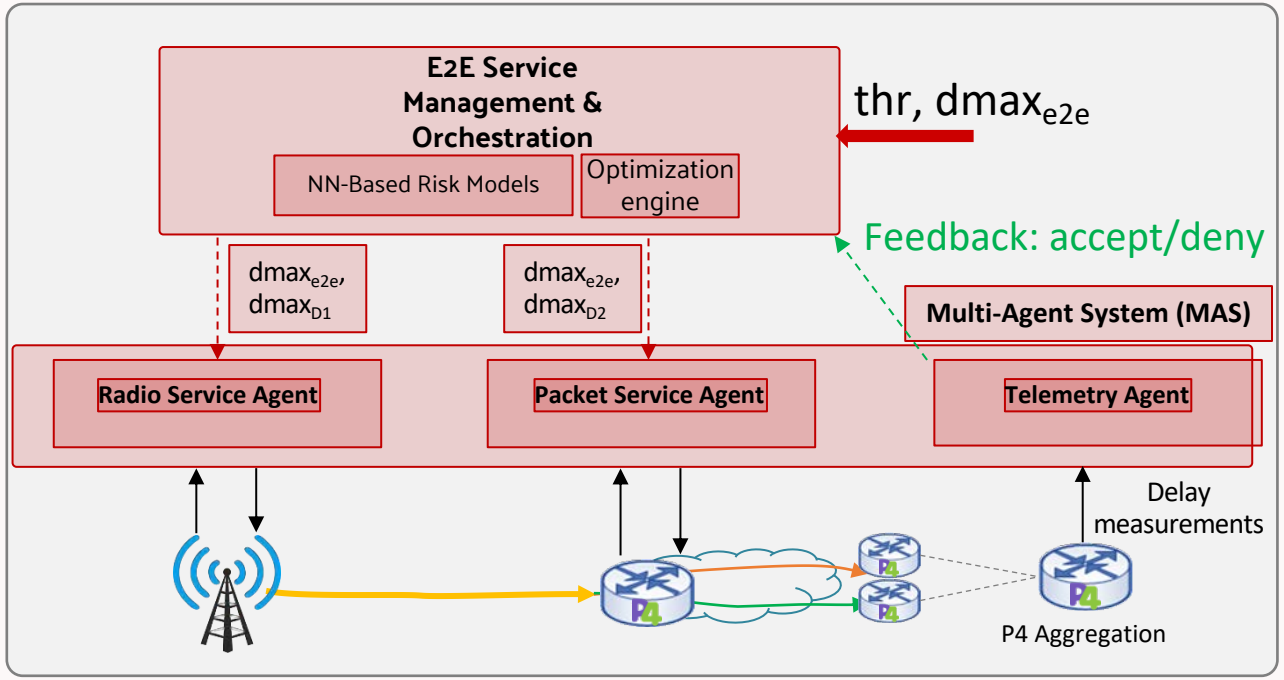
EARLY RESULTS: D6G ILLUSTRATIVE SCENARIO



EARLY RESULTS: SLA DECOMPOSITION

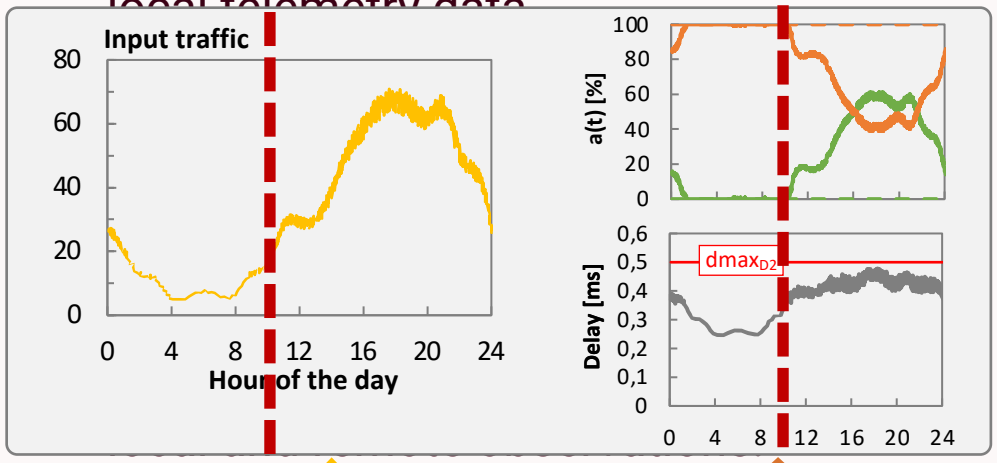
- SMO decomposes E2E SLA into partial SLAs for each segment (e.g., RAN, transport), such that the probability to be accepted by all segments are maximized.
- Behavior of each segment is modelled by an NN-based risk model given its historical feedback on admission control.

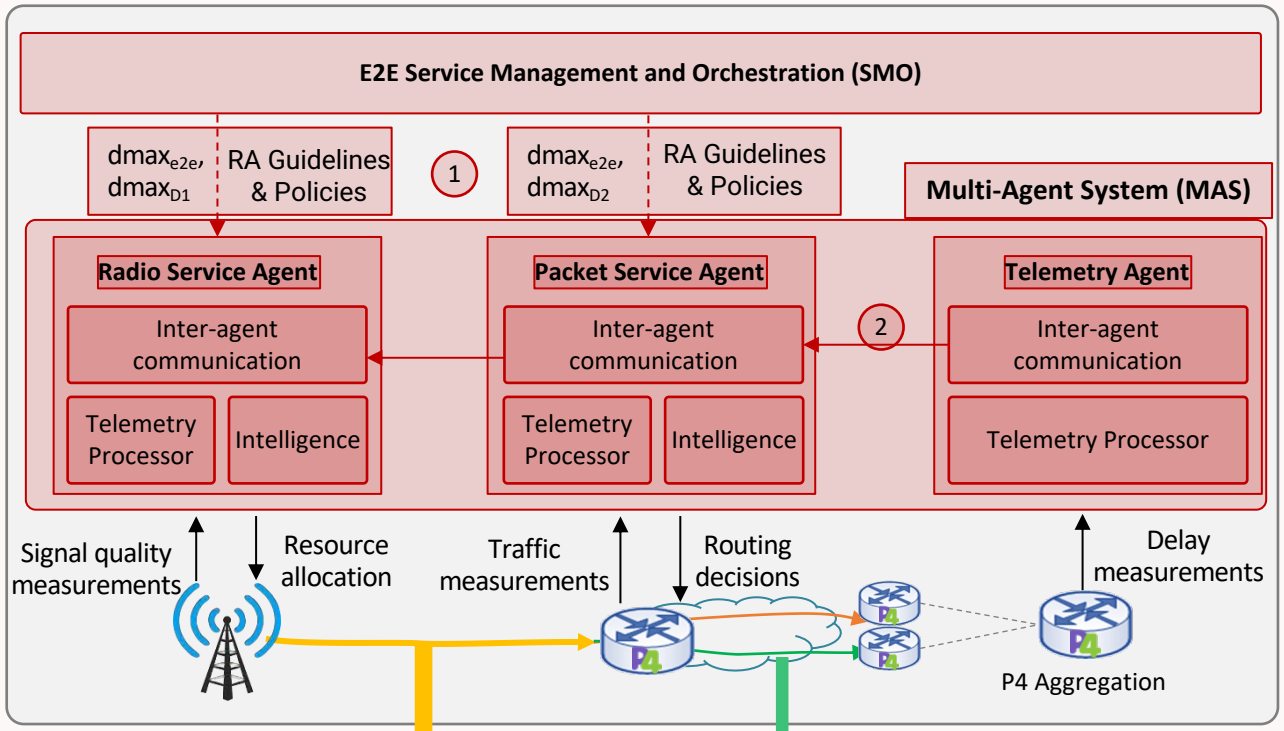




EARLY RESULTS: SERVICE INSTANTIATION & ASSURANCE

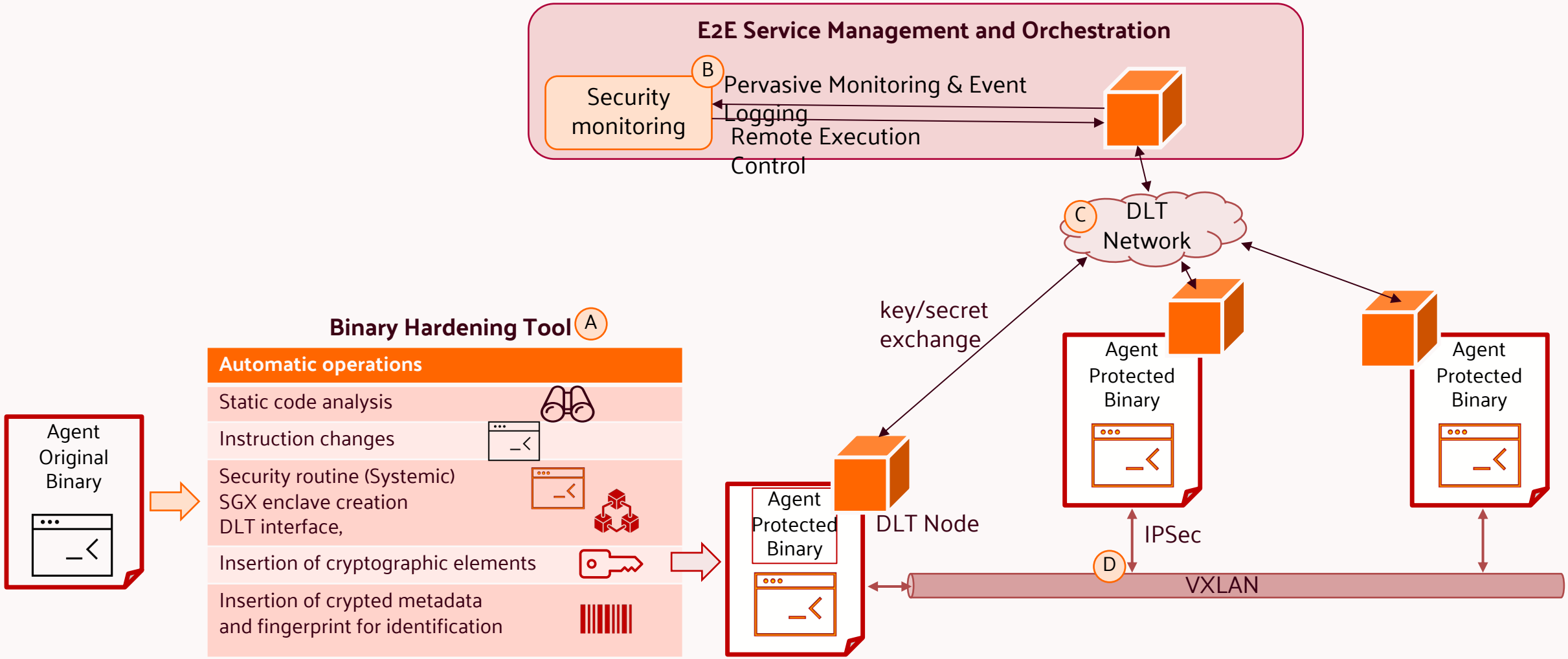
- Telemetry processor
  - collecting and processing/aggregating local telemetry data





D6G: “Pervasive monitoring and distributed intelligence for 6G near real time operation". EUCNC Poster
D6G: “Autonomous flow routing for near real time quality of service assurance”. IEEE TNSM [subm.]

EARLY RESULTS: SECURING INTELLIGENCE



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THANKS!

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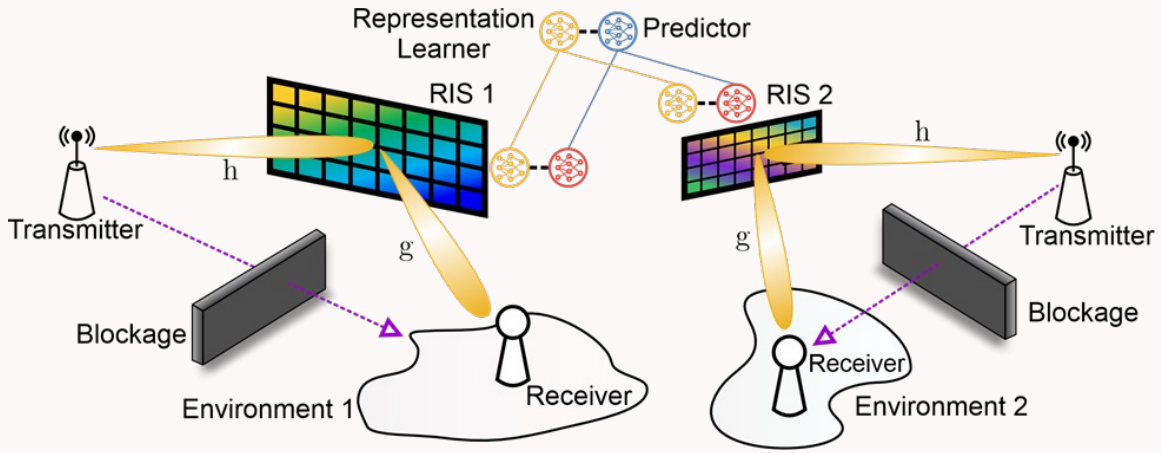
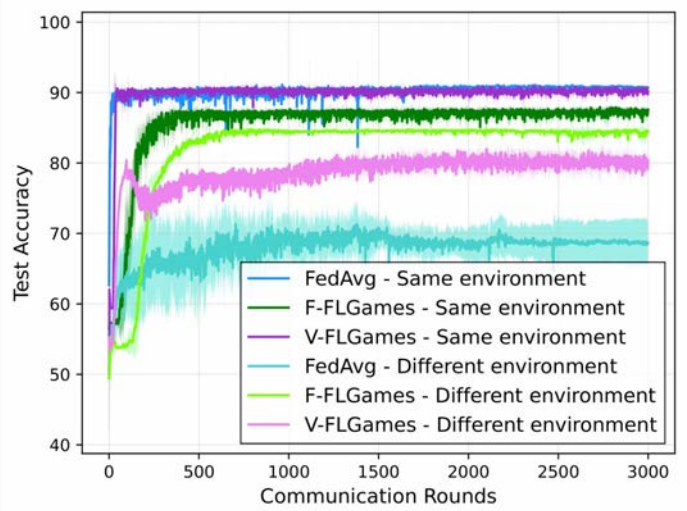
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission. Neither the European Union nor the granting authority can be held responsible for them.

EARLY RESULTS: EDGE INTELLIGENCE

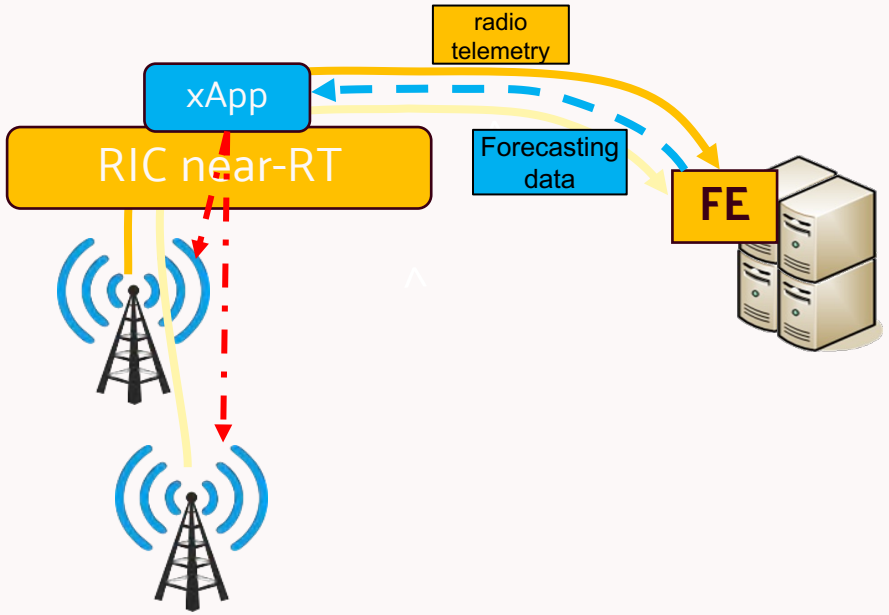


- **Setting:** Fed. AI for RIS over Heterogeneous Env.
- **Goal:** Downlink rate maximization through RIS phase tuning
- **Method:** Distributed Invariant Risk Minimization (IRM) aka FL Games
- **Intelligence:** Causal inference via representation learning



- Solution method is **robust** against **heterogeneous** environments
  - e.g., different user distributions, RIS architecture
- Solution method is **privacy preserving**, i.e., raw data need not be shared
  - inherited from federated setting
- Solution method is **distributed**
- **Sample efficiency** → enables effective use of EDGE resources, e.g., storage

EARLY RESULTS: EDGE INTELLIGENCE



- Forecasting element (FE) running at the edge
- **Goal**: assisted slice control relying on forecasting metrics, allowing margin in time to implement near-real time operations
- **Input features**:
  - Collection of UE telemetry data from the radio segment (i.e., widebandCQI) as a xApp
- Each slice is allocated with a specific forecasting job, running a forecasting model
- **Output**: FE generates a forecasted version of the UE indicators
- The forecasted metrics can be used to perform the slice adaptation, with the resource block group (RBG) enforcement, with margin in time

INTELLIGENCE CONTINUUM

- The SMO oversees non-real-time tasks, including service provisioning, inter-segment (RAN, transport, core) coordination etc.
- MAS is a set of individual agents that share knowledge and communicate with each other to solve a problem that is beyond the scope of a single agent.
  - Decision-making is performed by every individual agent with up to sub-second granularity based on its own observed data, as well as on the data and models received from other agents in the same layer.