The 6G series workshop by
Hexa-X-II

EuCNC & 6G Summit June 3 2024
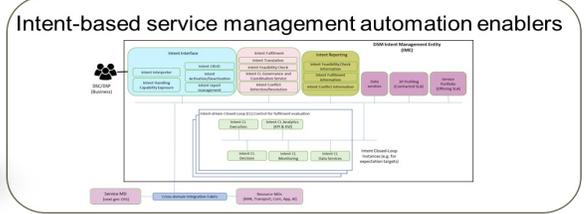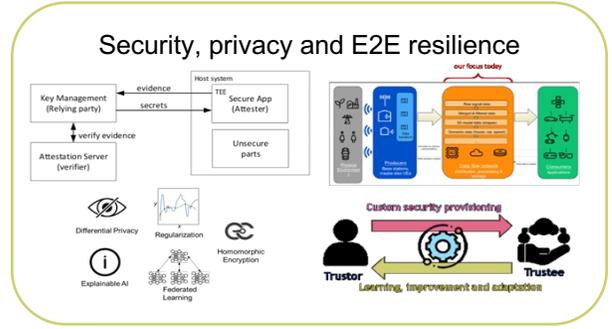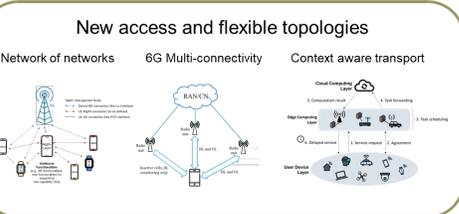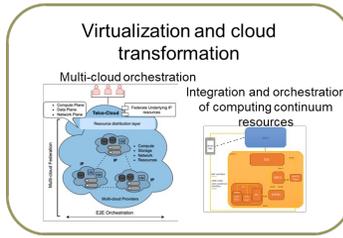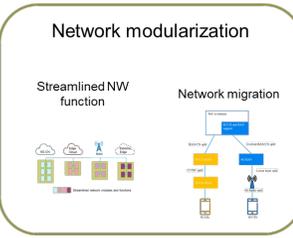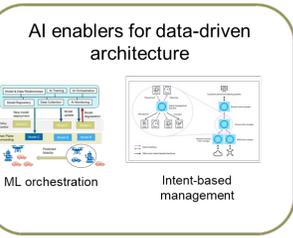
# Hexa-X-II: Overall 6G system design

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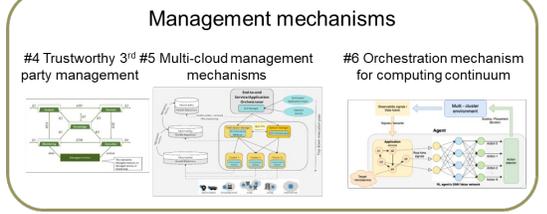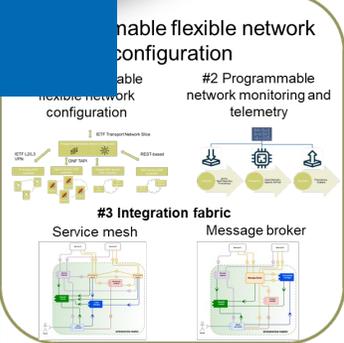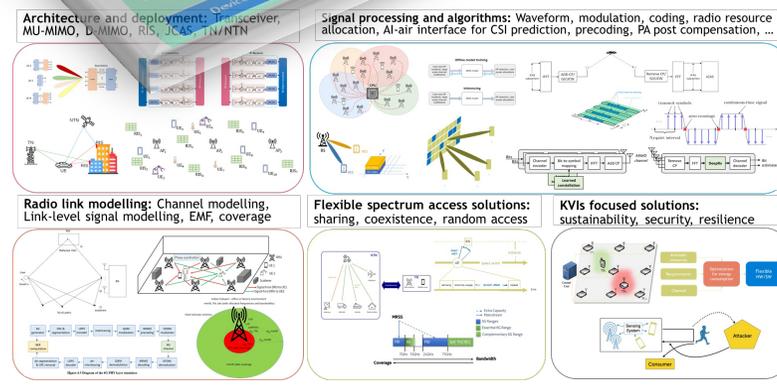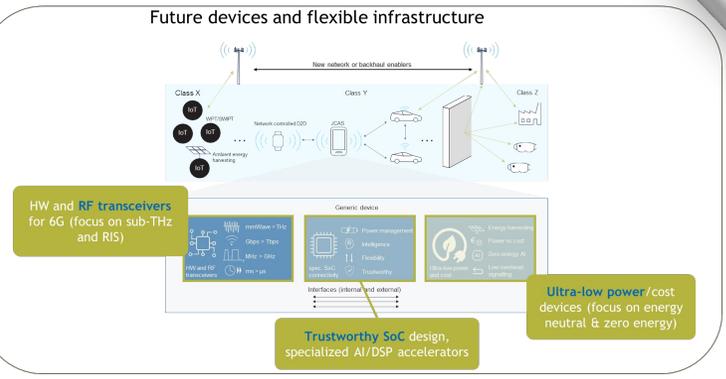
# From 6G enablers to 6G system design?



Systemization towards 6G involves studying technical components and assessing how they contribute to performance and impact
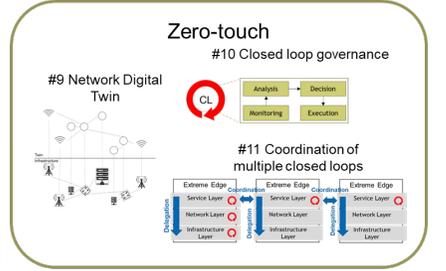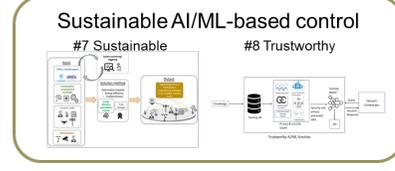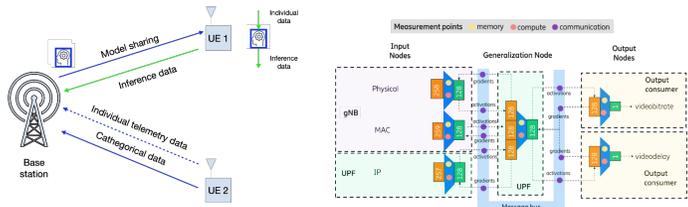
# Architectural enablers

## AI enablers for data-driven architecture

### Data and model sharing

### Split learning setting

## Network modularization

### Modularization granularity

Increased modularization granularity

Lower Flexibility
Higher Performance

Higher Flexibility
Lower Performance

### Modular network functions for cell-free MIMO

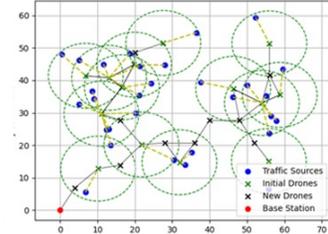## New access and flexible topologies

### Flexible topology with optimal drone placement

### Multi-connectivity
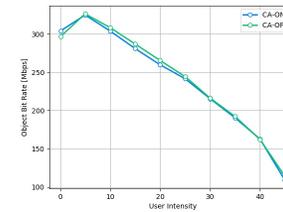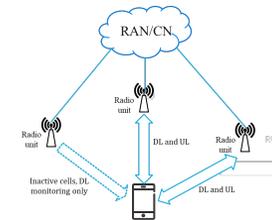
### Context aware management
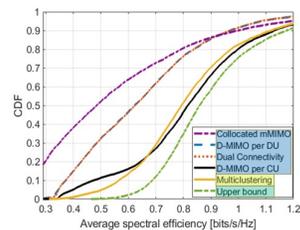
## Virtualization and cloud transformation

Orchestration in the compute continuum
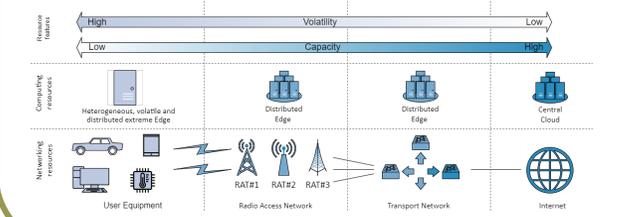
## Networks beyond communications

### JCAS
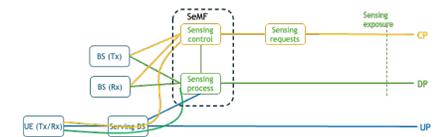
### Dynamic device offloading
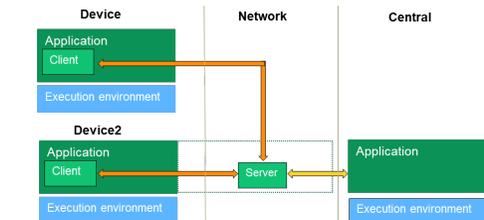
# Radio interface and protocol enablers

## Control plane

**Flatter RRC**
- Avoiding hierarchy levels
- ASN.1 shall not enforce nor prohibit procedures

**Modular RRC**



## User plane

**UP for Beyond Communication**
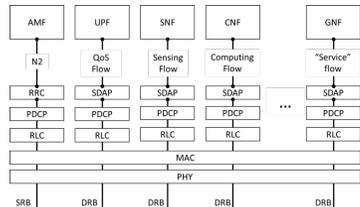


**Two-stacks UP**
High/low bitrate stack



## Separation of IDLE/CONNECTED SSB



Reduce signalling overhead

Different types of connected mode mobility
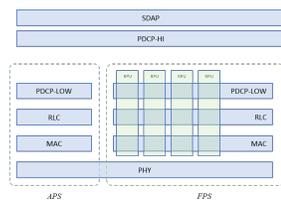
## Application-NW interaction for service differentiation



## Mobility improvements

**Data-driven mobility**
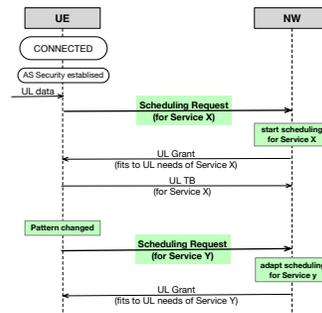


**Computational aware mobility**



Move

It is unknown to UE If C#1 or C#2 satisfy Computation requirements.
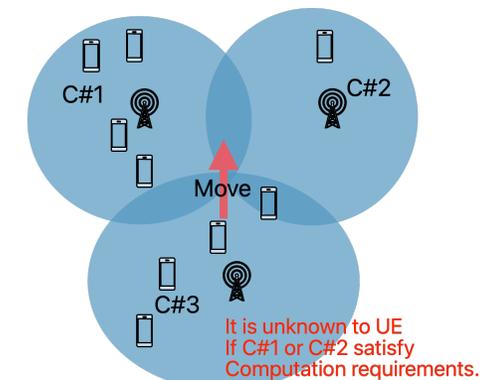
# Management & orchestration enablers
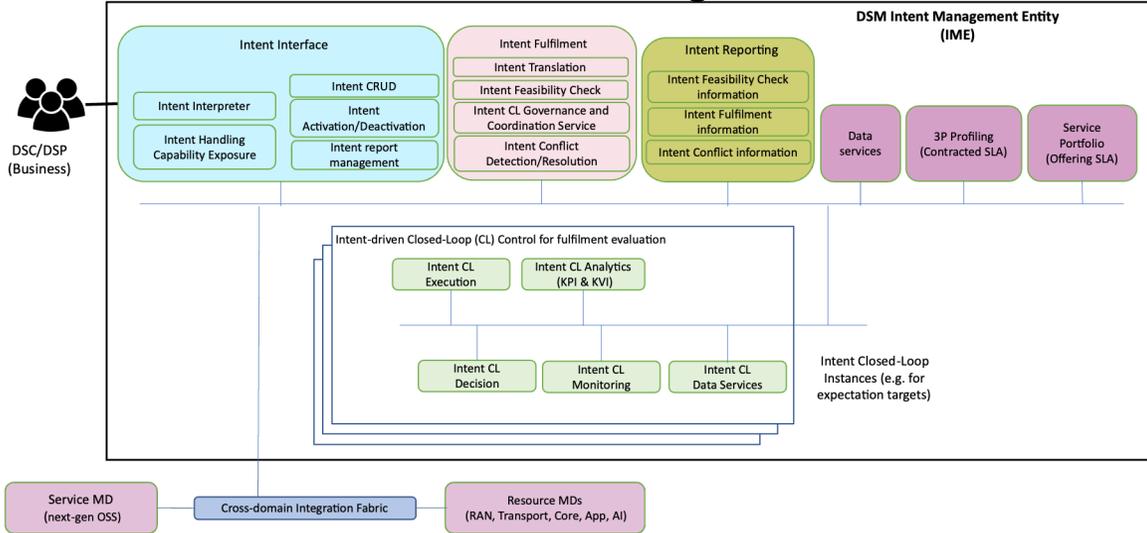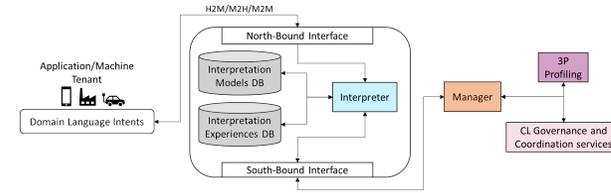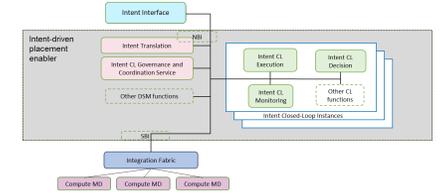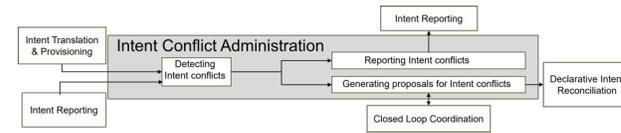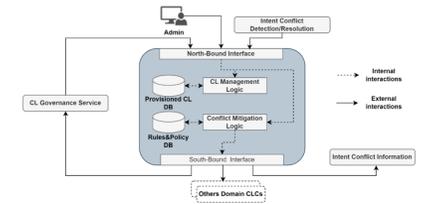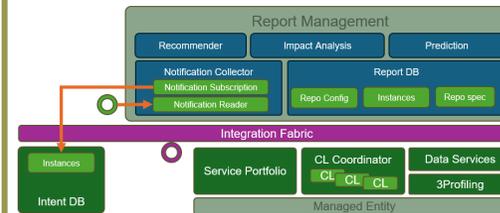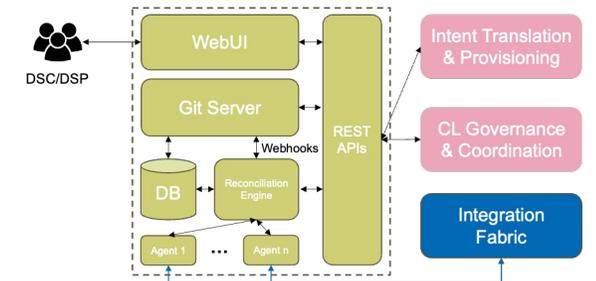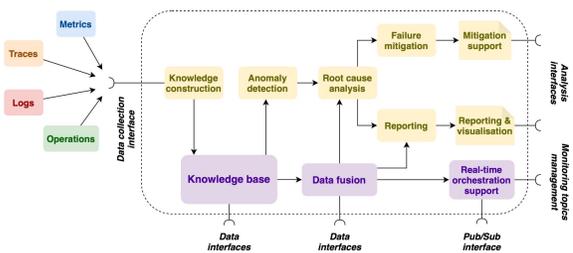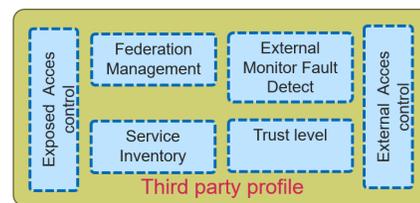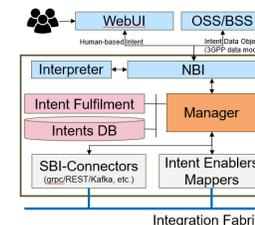
# Security privacy and resilience enablers

## Interfaces for SPR control
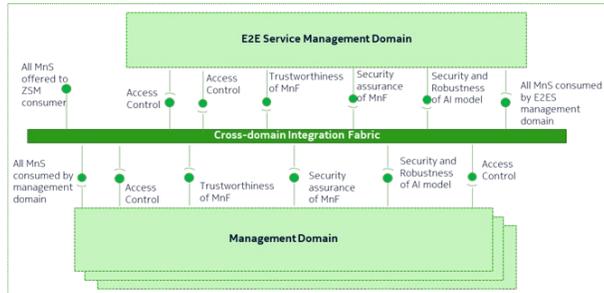


- Use a general loosely coupled model, compatible with the OAM integration fabric
- Use ETSI ZSM014 as foundation for these interfaces

## Attestation capabilities
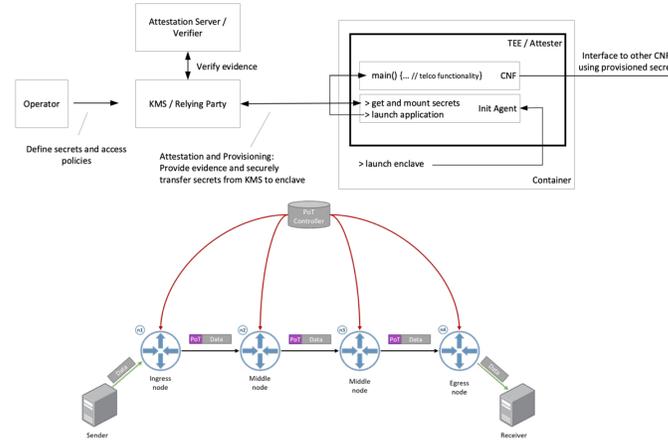


- Confidential Computing
- Topology Attestation

## AI/ML features
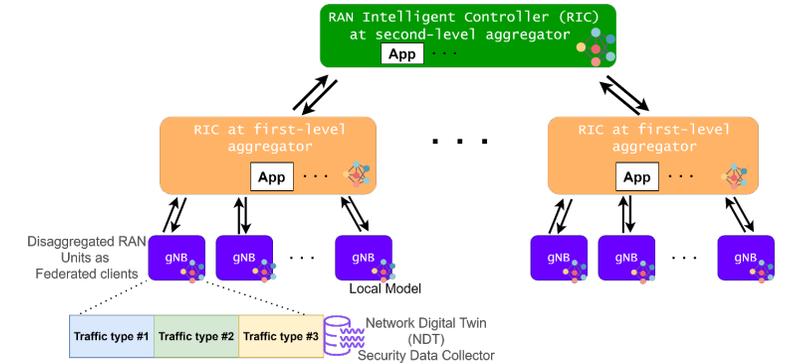


Anomaly detection in disaggregated environments
Secure and privacy-enhanced machine learning

## Trust fabric
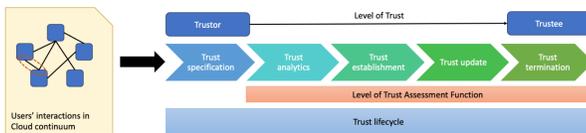


- Crypto transition
- Evolved LoTAF

## Physical layer security

- Context awareness
- DT- and ML-enabled anomaly detection
- Threat model for JCAS
- Physical layer deception
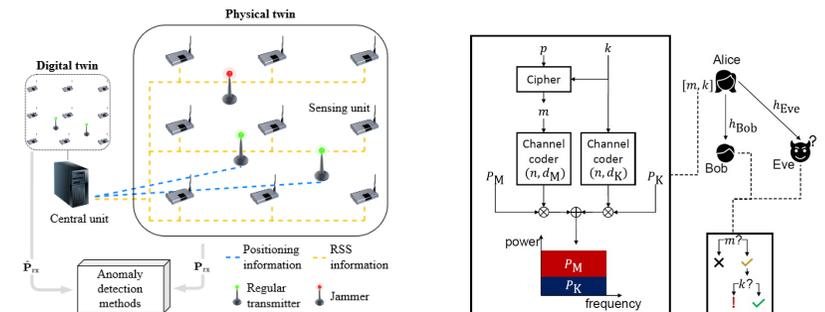
# Enabler selection process



## Selection method
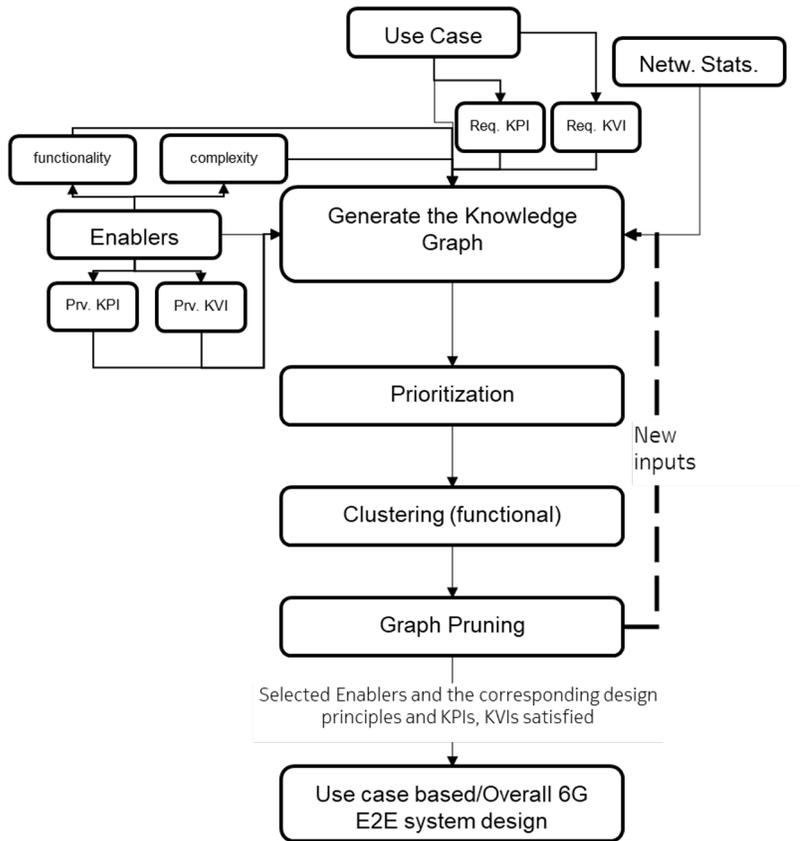
## Knowledge graph

# System blueprint refinement

Data plane
Control plane
API/Interface//Intents
Control/Observability

**Multi-stakeholders**

## Application layer

App

App

Service exposure

Nw App    APIs    Aggregation

**Application enablement platform layer**

Service exposure

**Beyond Communications functions**

Localisation Sensing    ...    AI(aaS) functions

SeMF      AIaaSF

6G Core NFs

6G RAN NF

UE

Transport NFs

5G Core NFs

Data networks

**Network functions layer**

Service exposure

## Cloud continuum

Device    Access    X-haul    Compute    Storage

**Infrastructure layer**

### Management & Orchestration

Service exposure

Intent-based management

Closed Loop controls    Multi-platform orchestration

### Security & privacy

### AI framework

### Data framework

**Pervasive functionalities**

# Mapping selected enablers in the 6G E2E system blueprint

Data plane
Control plane
API/Interface//Intents
Control/Observability



**Multi-stakeholders**

**Application layer**

App

App

**Service exposure**

NW-App interaction for QoE/QoS

Nw App

APIs

Aggregation

NW-App interaction for QoE/QoS

**Application enablement platform**

**Service exposure**

Beyond Communications functions

Localisation Sensing

AI(aaS) functions

6G Core NFs

SeMF

...

AIaaSF

NoN

Spectrum sharing

UE

Intel. Rx/(&)Tx

5G R

Modularization & service design

Flexible radio interface & protocols

JCAS /JCAS (radio) prot., sign. & proc

Multi-connectivity

Transport NFs

5G Core NFs

Data networks

**Network functions layer**

**Service exposure**

**Cloud continuum**

Device

6G device classes (RHDRBL, HRLL, EmMTC, EN)

Access

X-haul

Compute

Storage

**Infrastructure layer**

**Management & Orchestration**

**Service exposure**

Intent translation & provision

Intent-based management

ZT automation & coordination
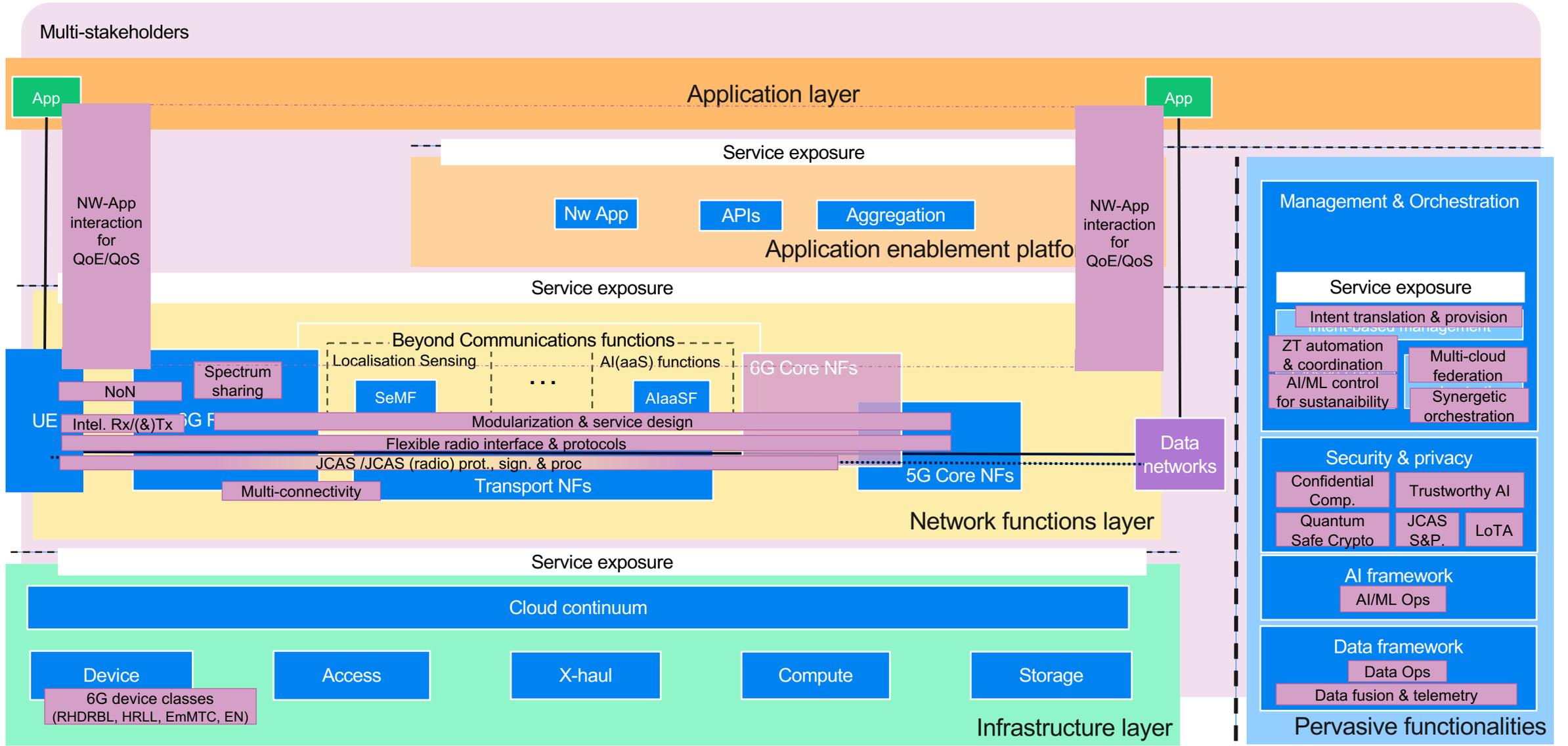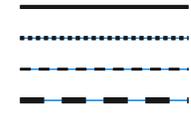
Multi-cloud federation

AI/ML control for sustanaibility

Synergetic orchestration

**Security & privacy**

Confidential Comp.

Trustworthy AI

Quantum Safe Crypto

JCAS S&P.

LoTA

**AI framework**

AI/ML Ops

**Data framework**

Data Ops

Data fusion & telemetry

**Pervasive functionalities**

# System level evaluations



Warehouse Inventory task

Manufacturing task

AI-assisted E2E lifecycle management of a 6G latency-sensitive service across the compute continuum
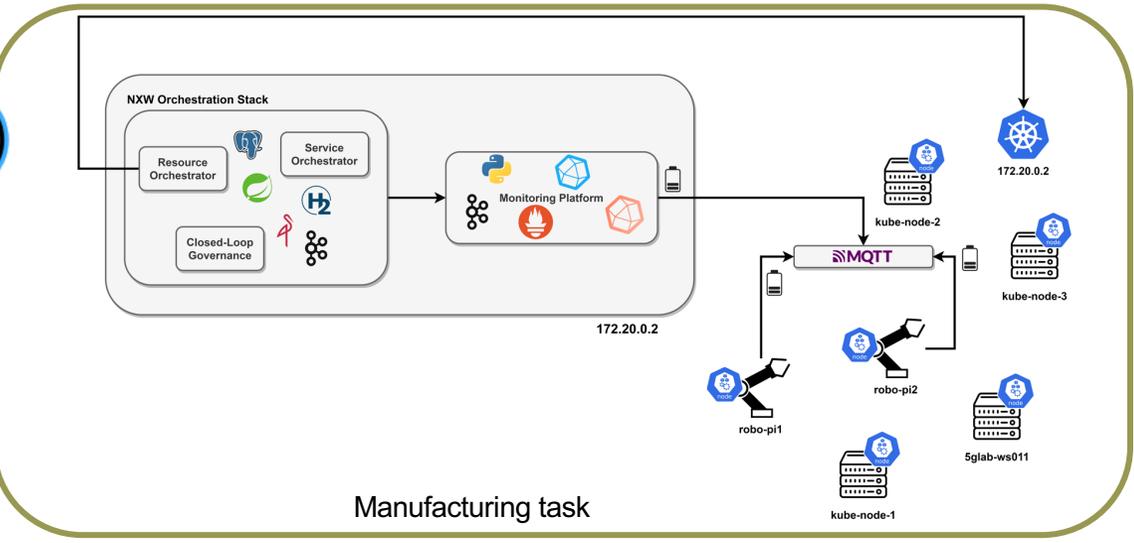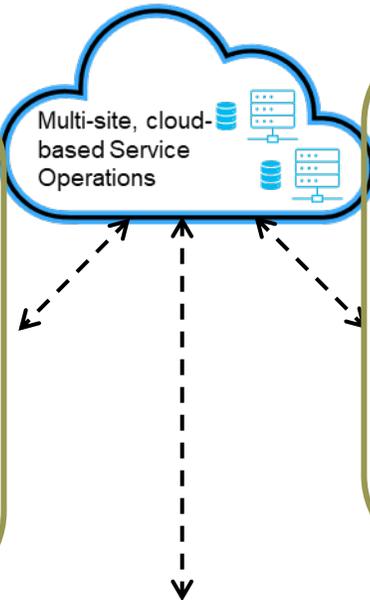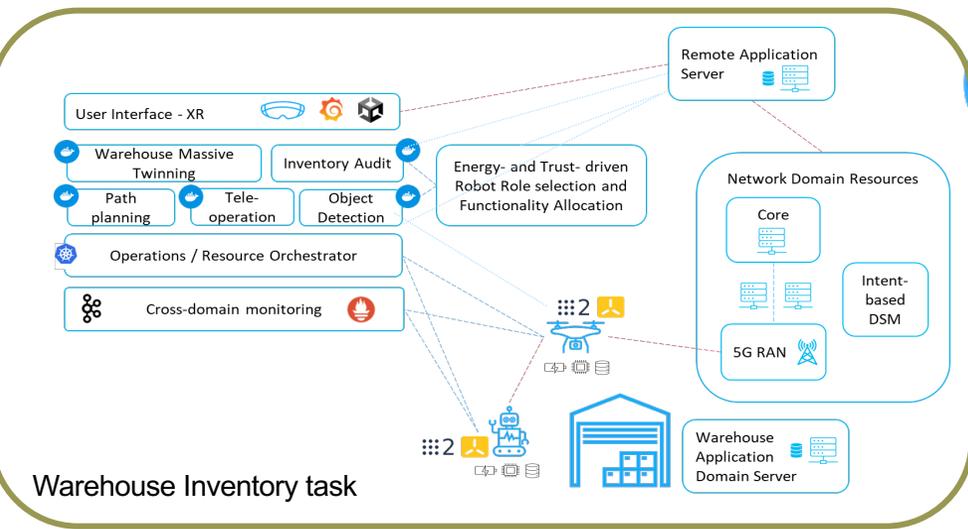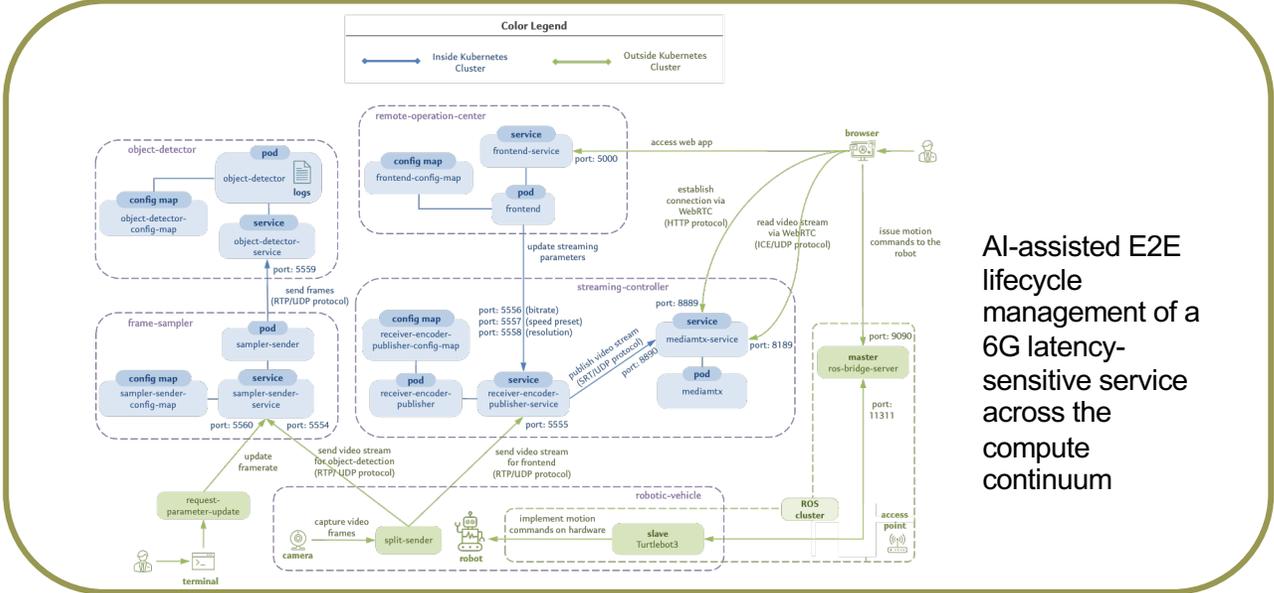
- Energy- and trust- driven management & orchestration
- Flexible topologies

- Training and inference of collaborative distributed machine learning model

Overview of the platforms and tools configuration for the warehouse inventory & manufacturing management designed solution

- Intent Translation and Provisioning
- Synergetic monitoring
- Real-time Zero-touch control loops automation and coordination system,
- Synergetic orchestration mechanisms for the computing continuum

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6GSNS