ETSI / LINUX Foundation – Edge Hackathon Final Pitch-off Competition

"Build your Edge Application with ETSI MEC APIs and LF Edge Akraino Blueprints"

Robert Gazda (InterDigital)
ETSI ISG MEC
– Hackathon Co-Chair

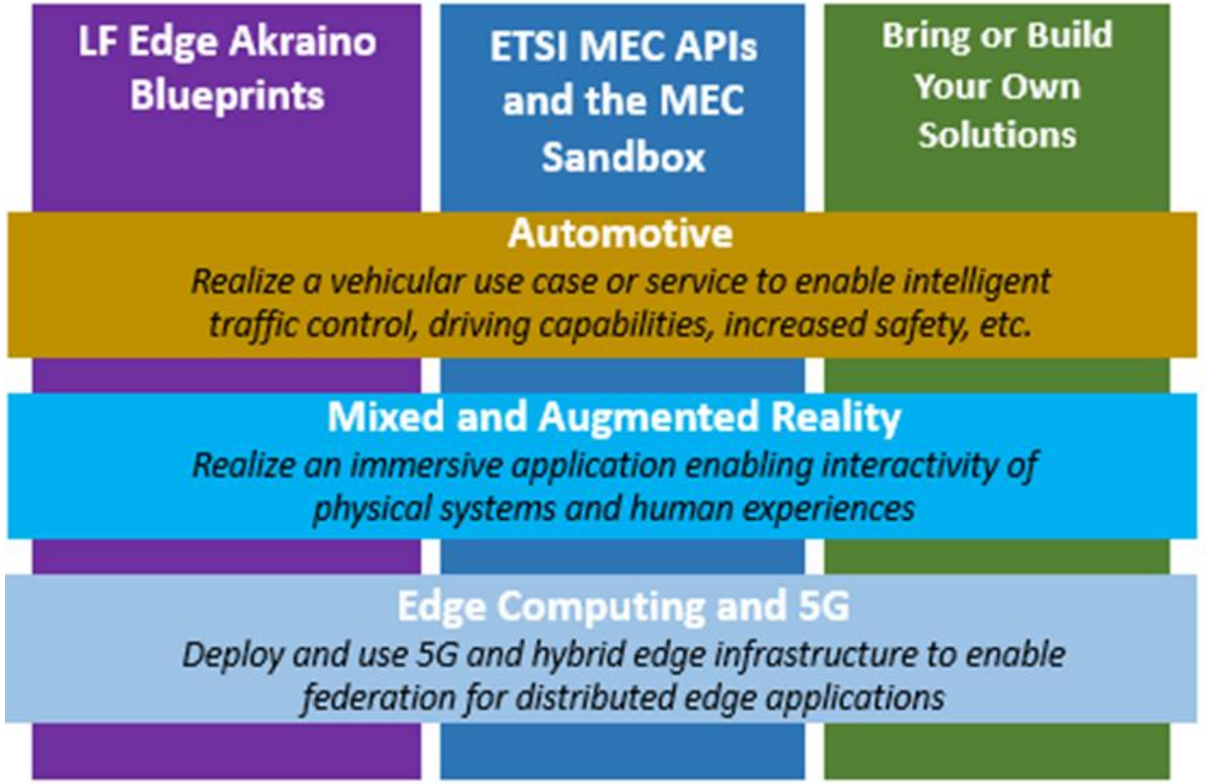
Tina Tsou (ARM, LF Edge Board Chair)
LF Edge Akraino
– Hackathon Co-Chair

Edge Hackathon - 2022

Call for Developers:

Realize an innovative edge application, solution, or use-case utilizing ETSI MEC Service APIs and LF Edge Akraino Blueprints

- Collaboration between ETSI (ISG MEC), the LINUX Foundation (LF Edge), and the 5G Automotive Association (5GAA)
- World-wide Hackathon that included Fifteen Teams competing in three application verticals
- Remote Competition from July 1st to Sept 23rd
- ECW Developer Conference – Onsite Competition
  - Three best teams short-listed
  - Demonstrations in the exhibition area
  - Live "Pitch-off" Competition and Judging
  - Winner will be announced immediately



Now!!

Hackathon Prizes

1st Place: $9,000

2nd Place: $2,500

3rd Place: $1,000

Special Best Automotive Prize: $2,500

Special Thanks

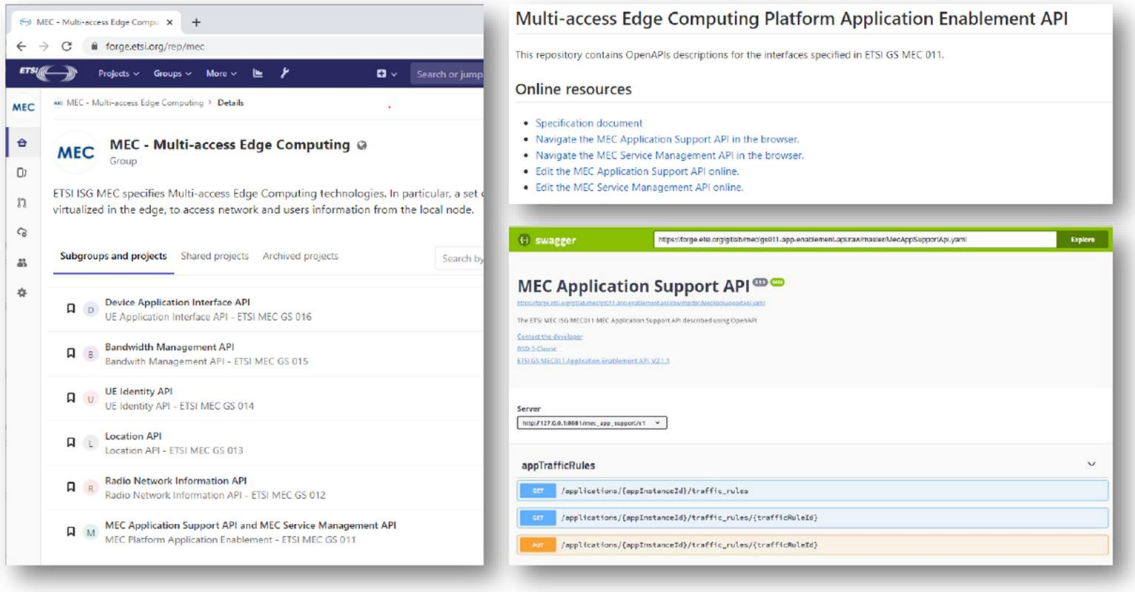
Hackathon Sponsors and Supporters

ETSI MEC Resources

Suggested ETSI MEC Services and APIs:

1) MEC011 - MEC Platform Application & Service Enablement (Mp1)
2) MEC012 - Radio Network Information Service (RNIS)
3) MEC013 - Location Service
4) MEC021 - Application Mobility Service (AMS)
5) MEC028 - WLAN Access Information Service (WAIS)
6) MEC030 – V2X Information Service (VIS)

Developers encouraged to use other APIs of their choosing

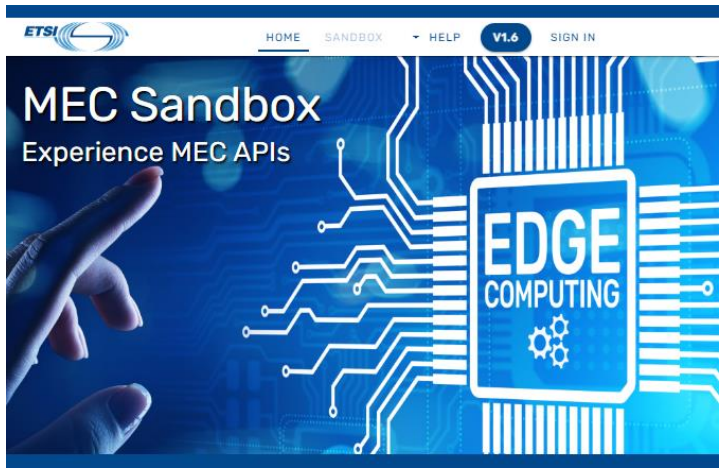


ETSI Forge - forge.etsi.org/rep/mec:

- OpenAPI representations for the all the MEC Service APIs; implementation ready

ETSI MEC Sandbox - try-mec.etsi.org:

- Experimentation Environment for MEC Service APIs



LF Edge - Akraino Blueprints

Automotive	1. MEC-based Stable Topology Prediction for Vehicular Networks
Mixed and Augmented Reality	2. Virtual Classroom (Integrated Edge Cloud Type 4)
Edge Computing and 5G	3. Integrated Cloud Native NFV/App Stack 4. Public Cloud Edge Interface (PCEI) 5. Enterprise Applications on Lightweight 5G Telco Edge (EALTE)

Developers encouraged to use other Blueprints of their choosing

Additional Resources

Equinix offered teams access to their Metal Platform - metal.equinix.com

- Deploy powerful, dedicated bare metal across 18 global metros in minutes, using battle tested APIs, infra-as-code and your favorite DevOps tools.
- Ride the same private internet that digital leaders use: faster, cheaper, more secure and connected to everyone/everywhere

Intel offered teams access and technical support for their Smart Edge Open Toolkit:

- smart-edge-open-overview
- Cloud-native tools that are optimized for an edge platform, addressing edge resource constraints, performance, and security

Hackathon “Pitch-off”

- Each Team will have 7 minutes to pitch their Hackathon Solutions
- After each pitch, there will be a short Q&A with Hackathon Jury members
- Final judging will take place immediately
- *Winner announcement!!*

Hackathon Judging Panel

Mukaddim Pathan
- DISH Network

Jyoti Sharma
- 5GAA Board Member (Verizon)

Jane Shen
- ETSI MEC Leadership Team (Mavenir)

Tina Tsou
- Hackathon Co-chair
- LF Edge Governing Board Chair (ARM)

Bob Gazda
- Hackathon Co-chair
- InterDigital

Hackathon Pitch-off Teams

Pedraforca

SmartMEC – Virtualized Mobile & Edge Infra scaling

Presenter: Michail Dalgitsis (Vicomtech)

K.I.T.T. - Knowledge In The Traffic

Connected Car – 5G, MEC, and AI

Presenters: Santi Rodríguez & Fernando Lamela

DOMINO

MEC Service Federation for Location aware IoT with DevOps MEC Infra Orchestration

Presenters: Oleg Berzin (Equinix) & Vivekanandan Muthukrishnan (Aarna Networks)

ETSI/LINUX Foundation Edge Hackathon 2022

"Build your Edge Application or Solution with ETSI MEC APIs and LF Edge Akraino Blueprints"

TEAM: Pedraforca

Team members: Michail Dalgitsis (mdalgitsis@vicomtech.org), Rasoul Nikbakht (rnikbakht@cttc.es), Sarang Kahvazadeh (skahvazadeh@cttc.es), Sergio Barrachina-Muñoz (sbarrachina@cttc.es)

Project: Virtualized mobile and edge infrastructures with OpenAPI integrations

11-12 of October 2022, Santa Clara, California

Agenda

- Team presentation and use-cases
- Use-case 1: Cloud-native 5G network
- Use-case 2: Microservice scaling with K8s OpenAPI and MEC sandbox
- Use-case 3: Edge network slicing integrated with MEC RNI API
- Conclusions & lessons learned

Team presentation and use-cases

Figure 1: Members of Pedraforca team

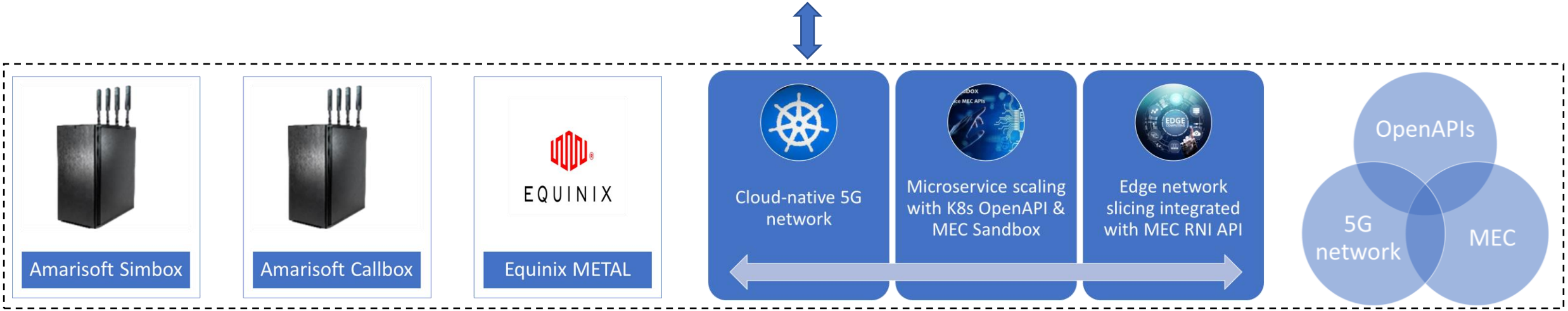


Figure 2: Workspace & resources

Figure 3: Hackfest use-cases

Figure 4: Main system components

Cloud-native 5G network

- A Kubernetes cluster deployed by Kubespray in an automated way.
- Open5Gs core, Prometheus, and a video on demand(VoD) application are deployed in the cluster.
- In another VM, UERANSIM as Radio Access Network (RAN) is deployed.
- Open5Gs core in Kubernetes is connected to UERANSIM (RAN)
- A UE from UERANSIM is streaming the VoD app

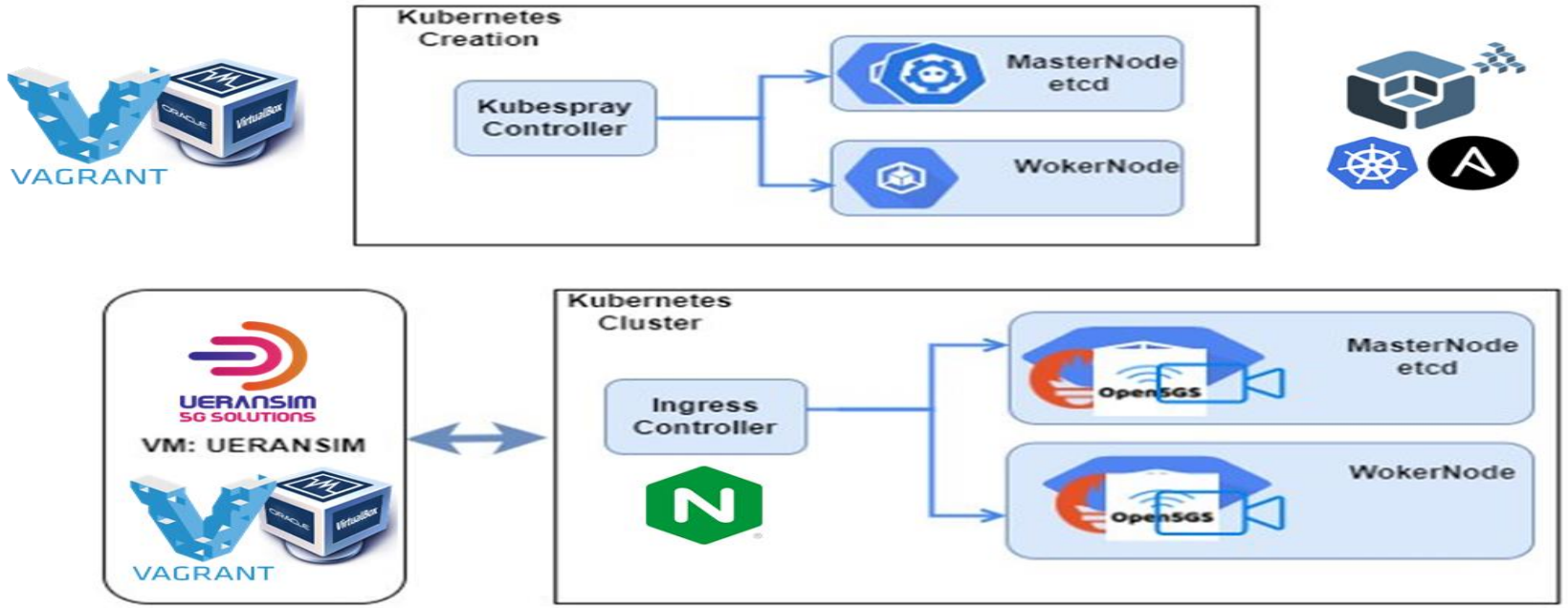


Figure 5: Cloud-native 5G network system model

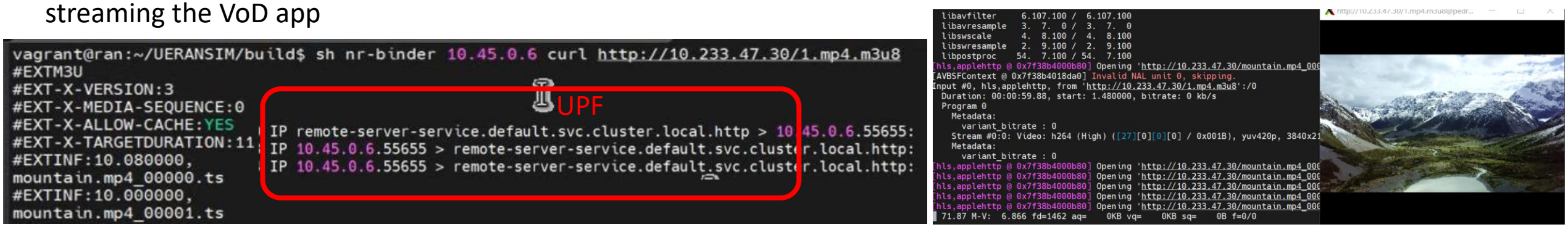


Figure 6: UE video streaming, curl & UPF logs (left), ffplay video (right)

Microservice scaling with K8s OpenAPI & MEC Sandbox

Pedraforca

Open5GMEC – Virtualized Mobile & Edge Infra with APIs

Centre Tecnològic de Telecomunicacions de Catalunya

vicomtech MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

- **Scenario & system model:**
  - MEC sandbox is running with 4G-5G-Wifi-macro scenario
  - Assume all the users in one Zone3 of the MEC sandbox are using the VoD streaming application
- **MEC Location API:**
  - Using MEC Location API, we retrieve the number of users in the given zone (zone3)
- **Decision engine:**
  - Samples user numbers per second in the given zone
  - Looks at the moving average of the last 5 samples
  - Triggers a custom-made K8s OpenAPI to scale pods based on a predefined threshold
  - Runs as a pod in the K8s cluster
  - Exports Prometheus metrics
- **K8s OpenAPI server:**
  - A custom-made OpenAPI on the top of the K8s python client is used
  - Deployed as a pod in the K8s cluster
  - K8s OpenAPI client sends a scaling request to K8s OpenAPI server
- **Grafana:**
  - Runs in the k8s cluster
  - Visualize Prometheus scrapped metrics

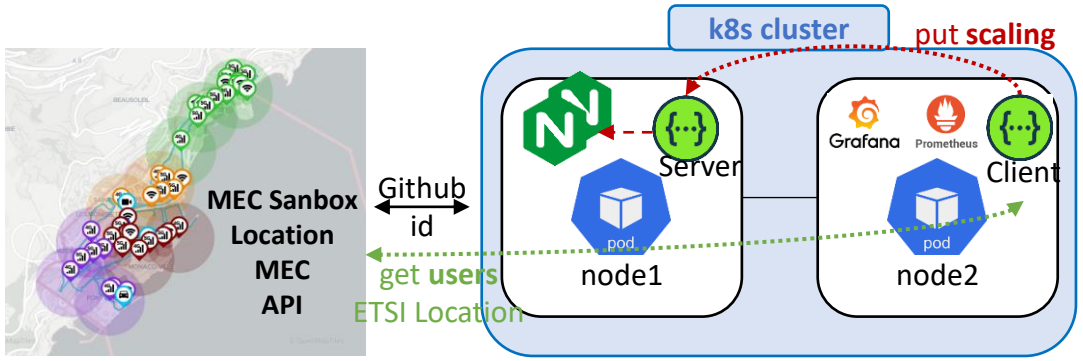


Figure 7: Microservice scaling with K8s OpenAPI & MEC Sandbox system model

Figure 8: K8s OpenAPI server UI

Figure 9: Grafana visualization tool

Edge network slicing integrated with MEC RNI API

- **Infrastructure:**
  - gNB: Amarisoft Callbox , UE: Amarisoft Simbox UE emulator.
  - EDGE: VM acting as an edge server or MEC host (K8s node)
  - CLOUD: VM acting as cloud server (K8s node)
- **Multi-domain deployment of an open source 5G core:**
  - 5GC is realized through the Open5GS network functions (NFs)
  - CP at the cloud node, whereas the DP (UPF) at the edge node
  - Amarisoft configuration file connects gNB with the Open5GS AMF
- **E2E Network slicing**
  - (Default) Best-effort slice: sst 1, 5QI 9, no edge capabilities
  - High priority slice: a custom slice with sst 4, 5QI 6 with edge capabilities
- **Microservices:**
  - VoD application
  - RNI MEC API
  - Broker (Backend/Business logic of MEC API)

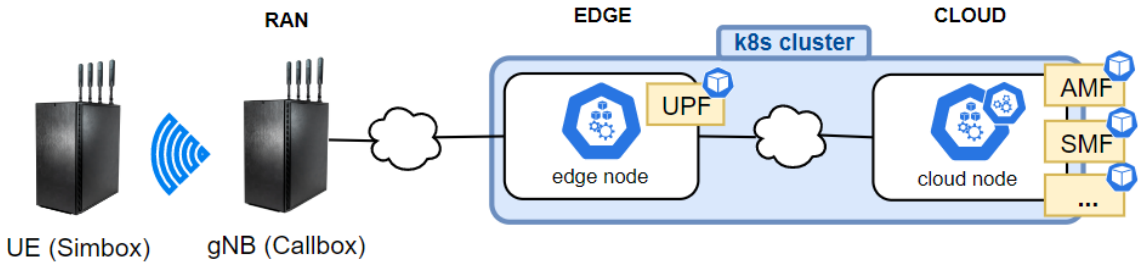


Figure 10: Infrastructure and Open5GS cloud-native deployment

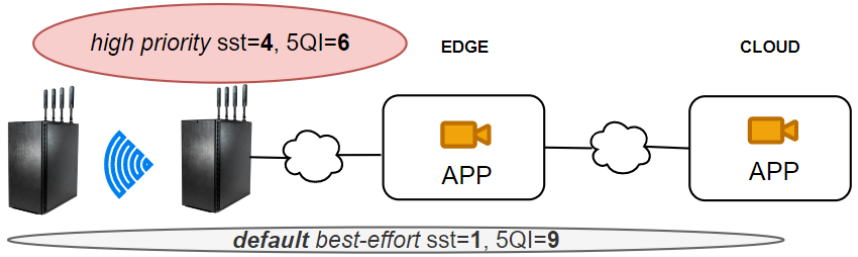


Figure 11: Slice system model

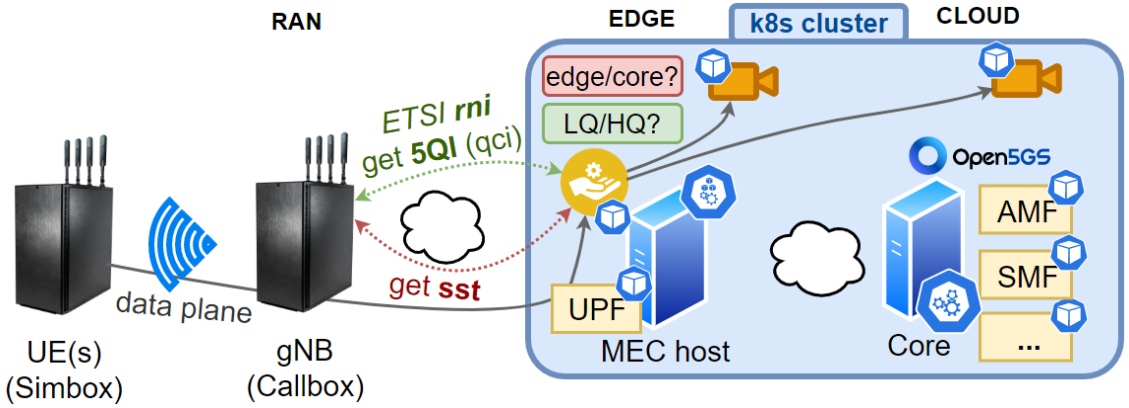


Figure 12: All components of the proof-of-concept

Conclusions, lessons learned & future steps

- Telco virtualization and automation decreases the deployment time
- Cloud-native practises adds a complexity in terms of service networking
- OpenAPI´s client/server role-model integrates seamlessly with 5G and MEC
- Baremetal hardware commercial solutions co-exist with open-source software-defined networks and services
- MEC-OSM integration through the K8s OpenAPI *(future steps)*
- Apply machine learning techniques in the client role-model of the APIs *(future steps)*
- Implement even more realistic scenarios with Cloud/Equinix-Edge-gNB nodes *(future steps)*

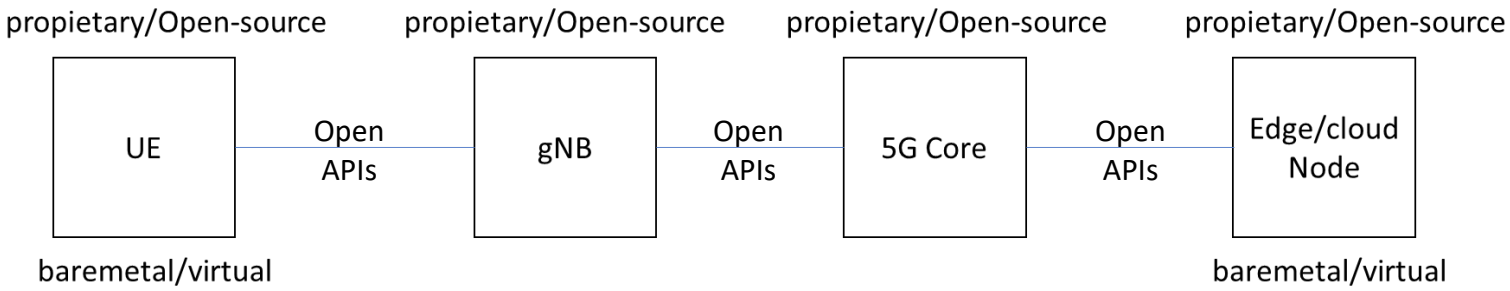


Figure 13: Overall system architecture of Pedraforca solutions

Pedraforca

Open5GMEC – Virtualized Mobile & Edge Infra with APIs

cttc

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vicomtech

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THANK YOU

ETSI

LF EDGE

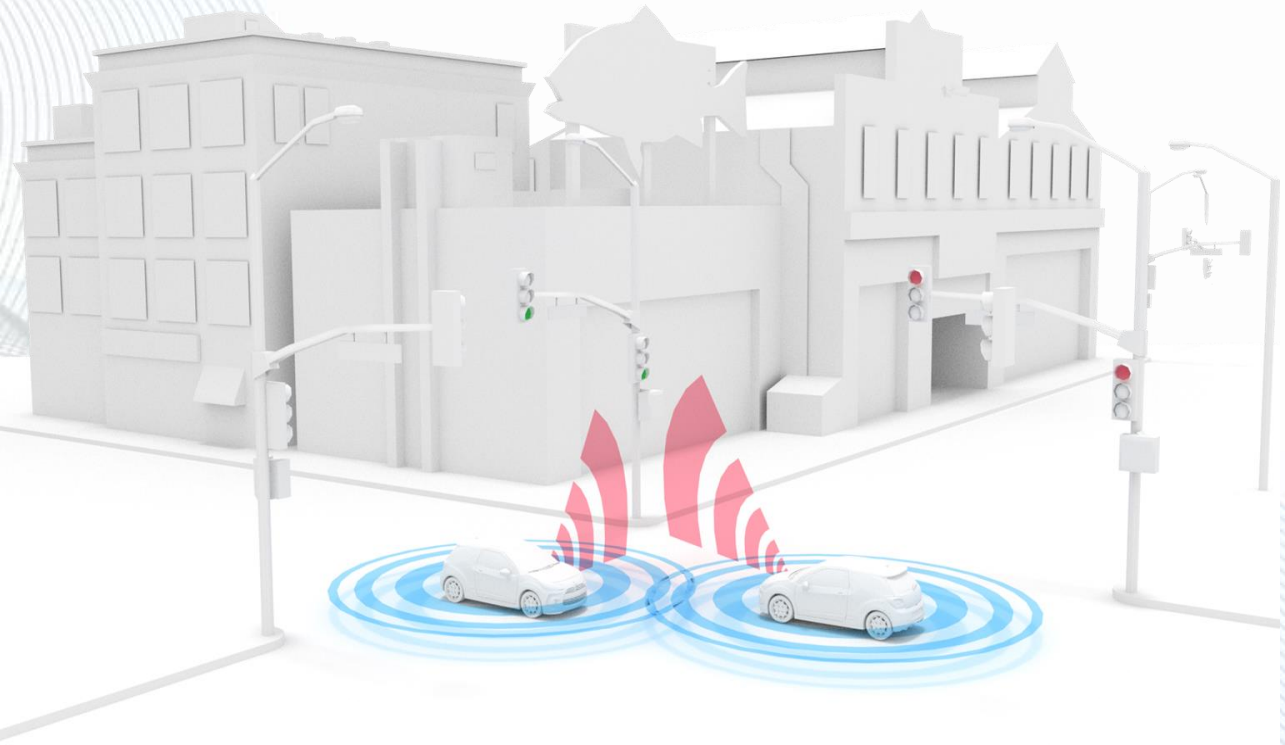
EDGE COMPUTING WORLD

K.I.T.T. – knowledge in the traffic

ETSI MEC Hackathon 2022

K.I.T.T. - Concept

A connected vehicle that with the support of 5G, MEC and artificial intelligence technologies can capture information from the surrounding environment and feed a smart platform with this information to be able to maintain, predict and adopt several actions for the good of people and provide access to digitalization scenarios and opportunities.



The information retrieved by the car and sent to the platform is collected by three different ways, cameras, in-car sensors and information sources.

In regions/areas where the city information sources are isolated (low power, signal quality, bad coverage due maintenance, weather conditions), the car can act like a link between the information source and the smart city platform, uploading that information in the next available coverage area crossed by the car in its route.

K.I.T.T. – Scenario

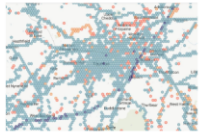
Challenges

5G Deployment
IOT
Remote Areas

High cost

Feasibility

Late Deployment



Unserved Areas

Consequences

Digital Divide

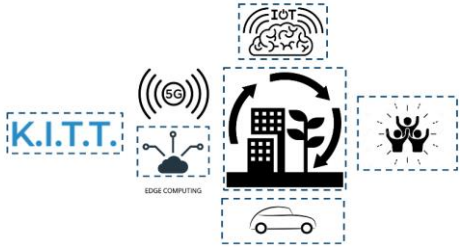
Lack of opportunities

Rural depopulation

Non Susteinable

Prop. Solutions

5G Deployment
Future Vision

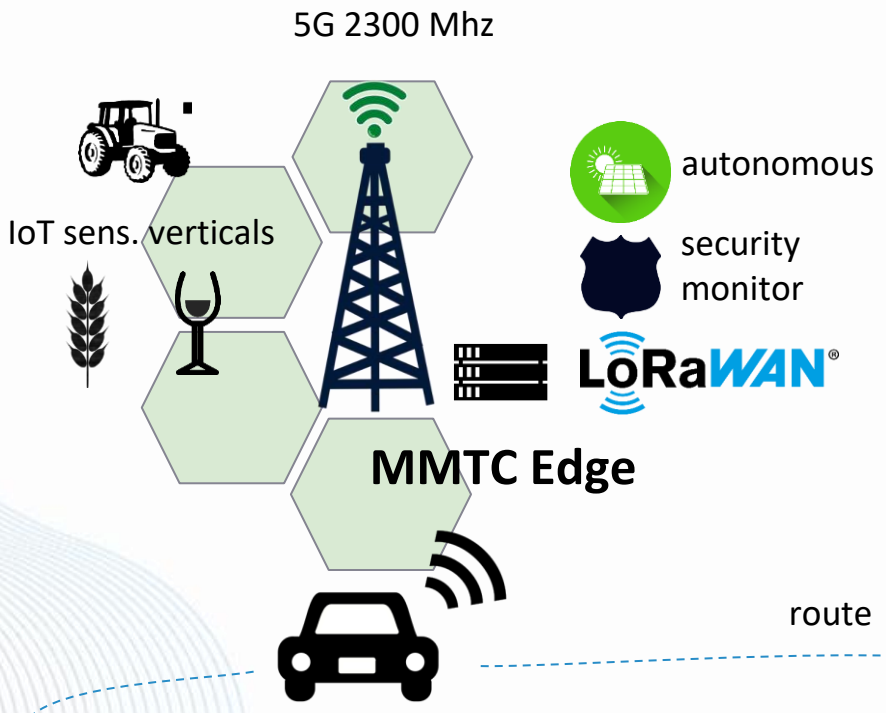


Future

Urban Rural Sinergy

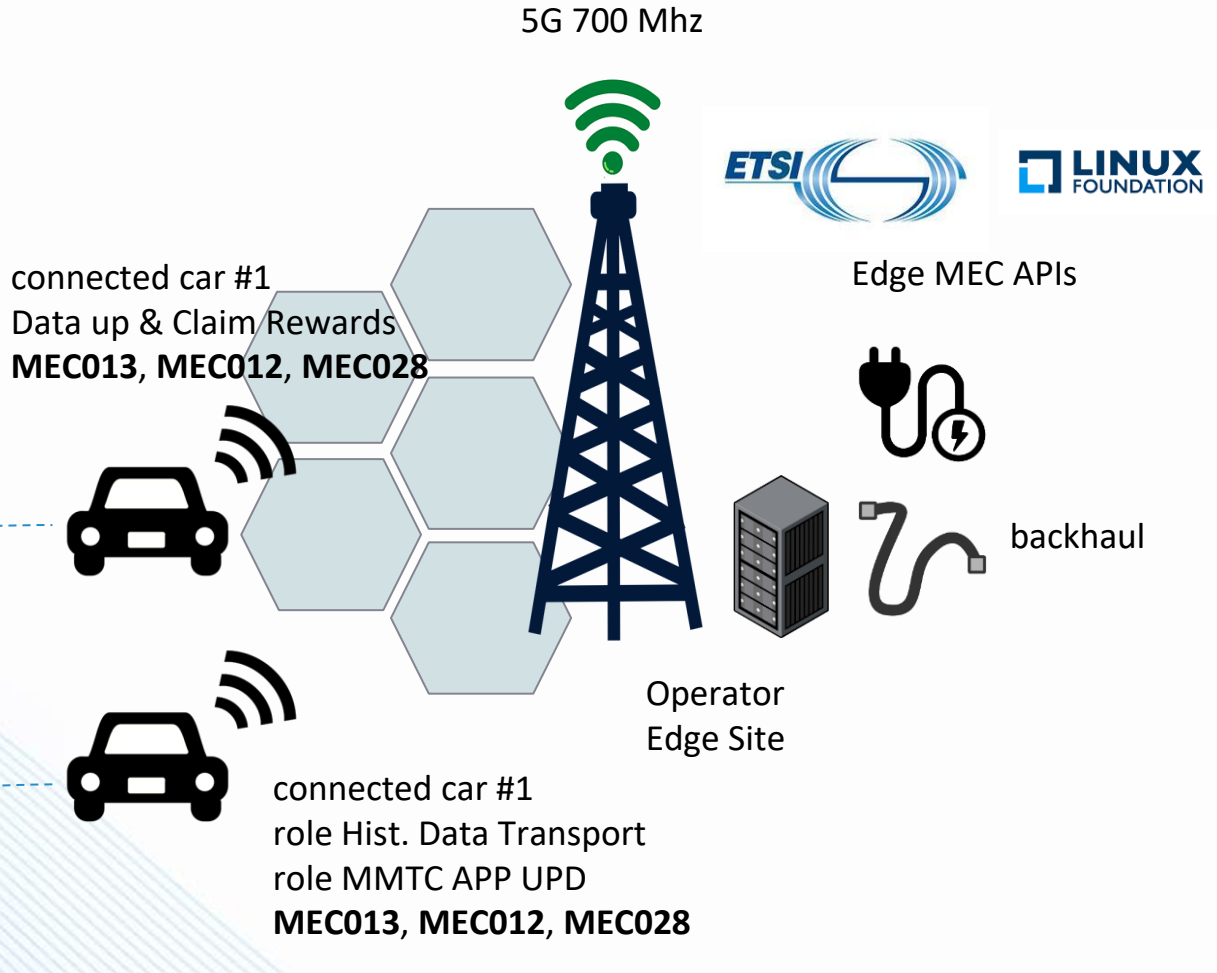
Partnership for success

Green Environment

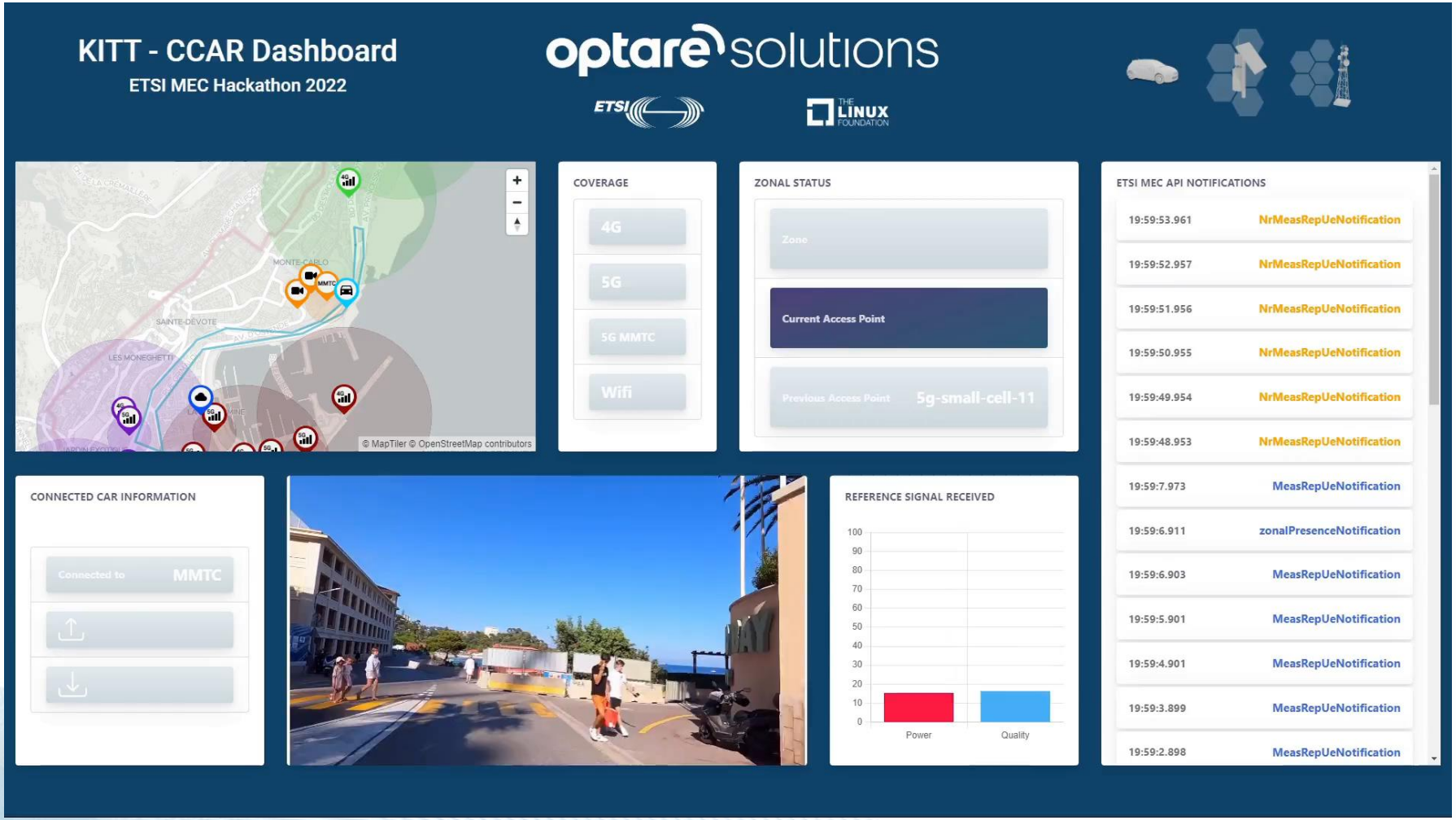


UC1: Historical Data collection from autonomous MMTC Edge

UC2: Service APP Update to autonomous MMTC Edge



K.I.T.T. – PoC Run


KITT - CCAR Dashboard
ETSI MEC Hackathon 2022
optare solutions
ETSI
THE LINUX FOUNDATION
COVERAGE
4G
5G
5G MMTC
Wifi
ZONAL STATUS
Zone
Current Access Point
Previous Access Point
5g-small-cell-11
ETSI MEC API NOTIFICATIONS
19:59:53.961 NrMeasRepUeNotification
19:59:52.957 NrMeasRepUeNotification
19:59:51.956 NrMeasRepUeNotification
19:59:50.955 NrMeasRepUeNotification
19:59:49.954 NrMeasRepUeNotification
19:59:48.953 NrMeasRepUeNotification
19:59:7.973 MeasRepUeNotification
19:59:6.911 zonalPresenceNotification
19:59:6.903 MeasRepUeNotification
19:59:5.901 MeasRepUeNotification
19:59:4.901 MeasRepUeNotification
19:59:3.899 MeasRepUeNotification
19:59:2.898 MeasRepUeNotification
CONNECTED CAR INFORMATION
Connected to
MMTC
REFERENCE SIGNAL RECEIVED
100
90
80
70
60
50
40
30
20
10
0
Power
Quality
© MapTiler © OpenStreetMap contributors

MEC Service Federation for Location-aware IoT with DevOps MEC Infra Orchestration

ETSI – LF Edge Hackathon 2022

Team DOMINO solution submission
Oleg Berzin, Equinix,
oberzin@equinix.com
Vivekanandan Muthukrishnan, Aarna Networks,
vmuthukrishnan@aarnanetworks.com

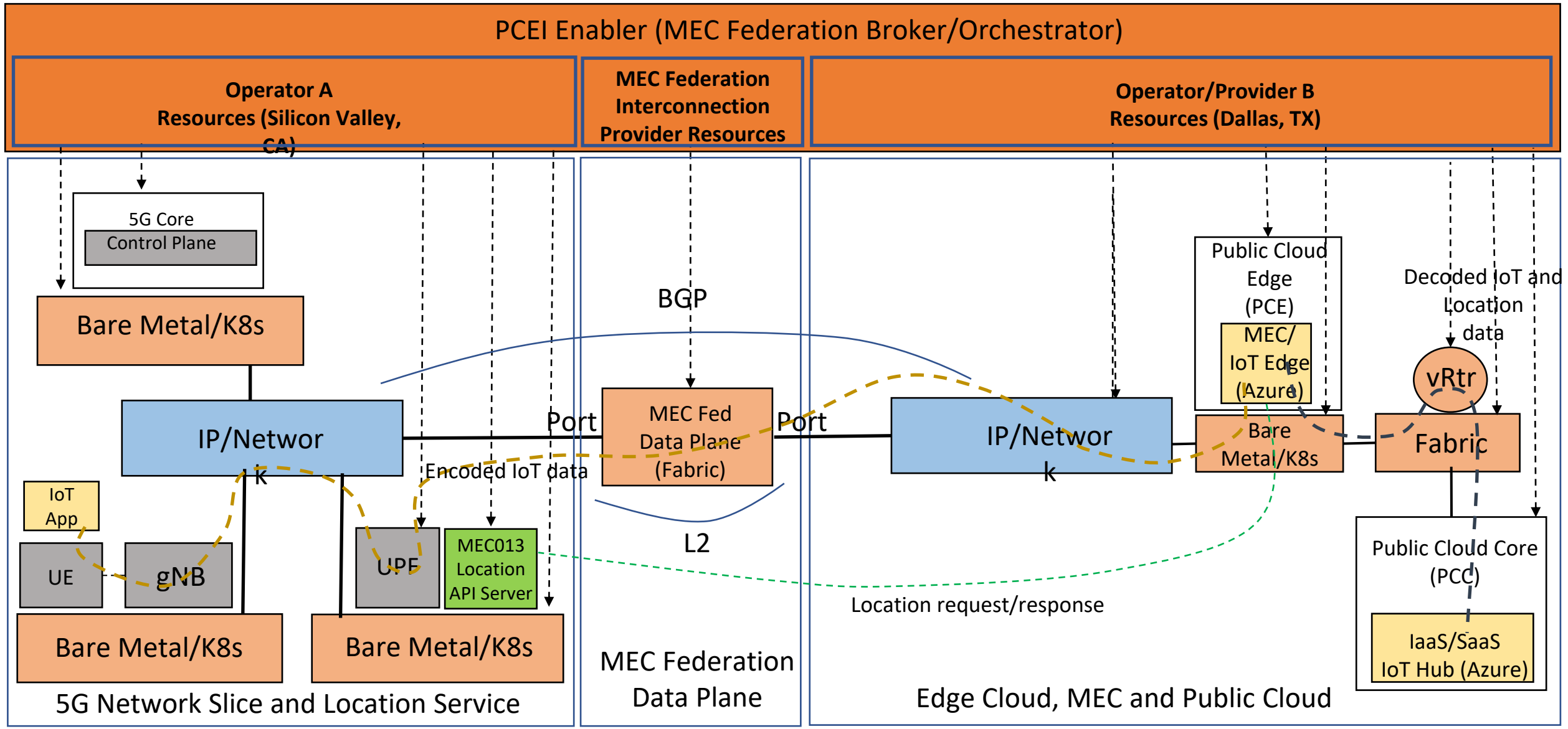
Dev**O**ps **M**EC **IN**fra **O**rchestration

Introduction

In our solution we use Akraino Public Cloud Edge Interface (PCEI) blueprint and MEC Location API service to demonstrate orchestration of federated MEC infrastructure and services, including:

- Bare metal, interconnection, virtual routing for MEC and Public Cloud IaaS/SaaS, across two operators/providers (a 5G operator and a MEC provider)
- 5G Control and User Plane Functions
- Deployment and operation of end-to-end cloud native IoT application making use of 5G access and distributed both across geographic locations and across hybrid MEC (edge cloud) and Public Cloud (SaaS) infrastructure
- By orchestrating, bare metal servers and their software stack, 5G control plane and user plane functions, interconnection between the 5G provider and MEC provider, connectivity to a public cloud as well as the IoT application and the MEC Location API service, we show how it is possible for providers to enable sharing of their services in a MEC Federation environment.

Use Case Description



What does the use case do?

Infrastructure Orchestration Stage

5G Operator

- Orchestrate Bare Metal
- Orchestrate K8s Install

MEC Fed Interconnect Provider

Create Private
MEC Federation Data Plane
Connection

MEC Provider

- Orchestrate Bare Metal
- Orchestrate K8s Install
- Orchestrate virtual router
- Orchestrate ExpressRoute to Azure

5G Network Functions and MEC Services/Applications Deployment Stage

5G Operator

Create 5G network slice for IoT customer

- Orchestrate 5G Control Plane Functions
- Orchestrate 5G User Plane Functions
- Orchestrate MEC Location API Server

MEC Provider

Orchestrate hybrid MEC IoT Application

- Orchestrate Azure IoT Edge GW on MEC Server
- Orchestrate Azure IaaS and IoT SaaS (IoT Hub)

End-to-end Application Operation Stage

5G UE

Register with 5G Network
Establish PDN Connection

IoT Client

Send Encoded
IoT Sensor data
(Temp, Humid, Pressure)

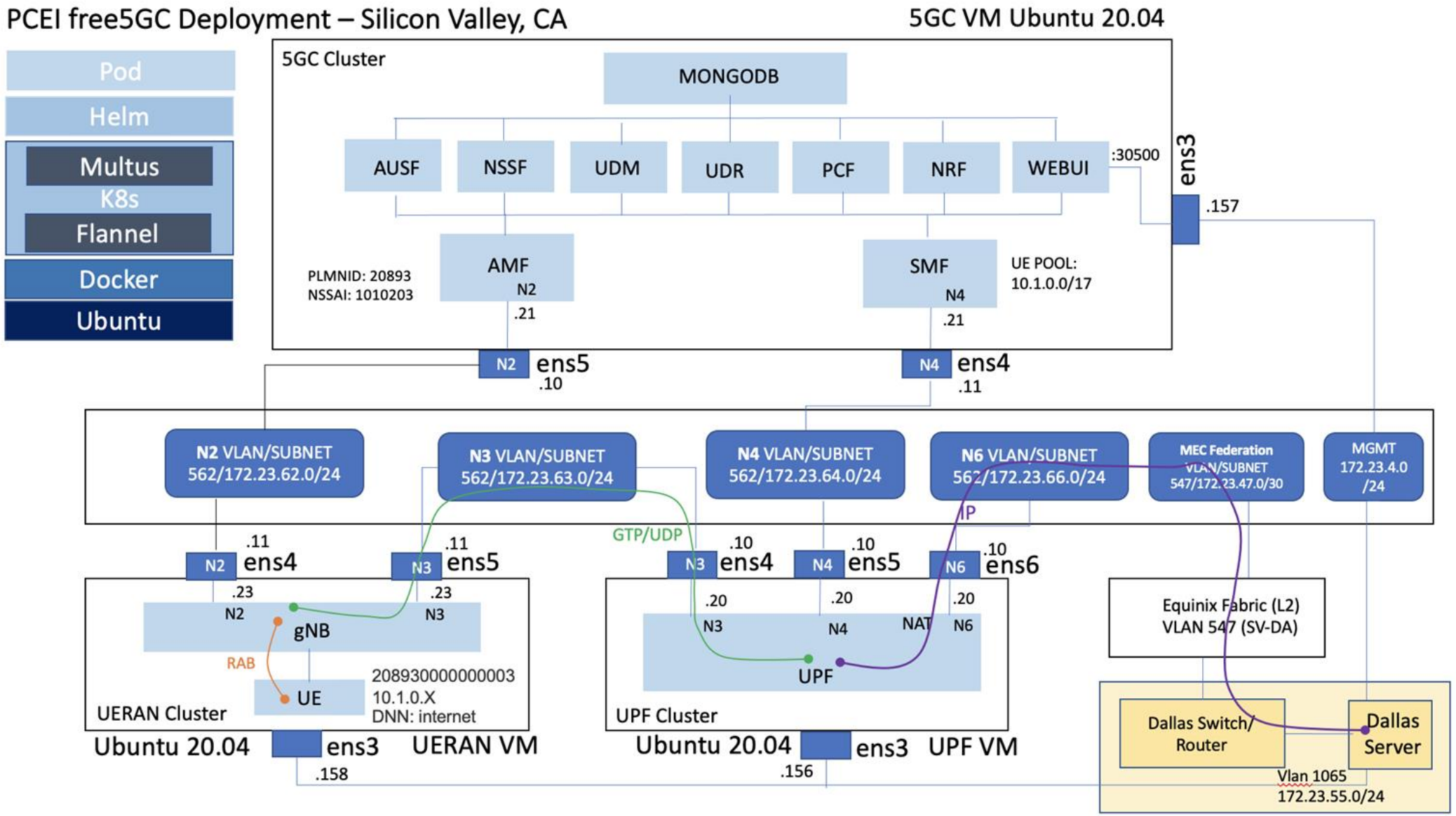
IoT Edge Gateway

Receive encoded data
Decode sensor data
Obtain location data
Send sensor and loc data to cloud

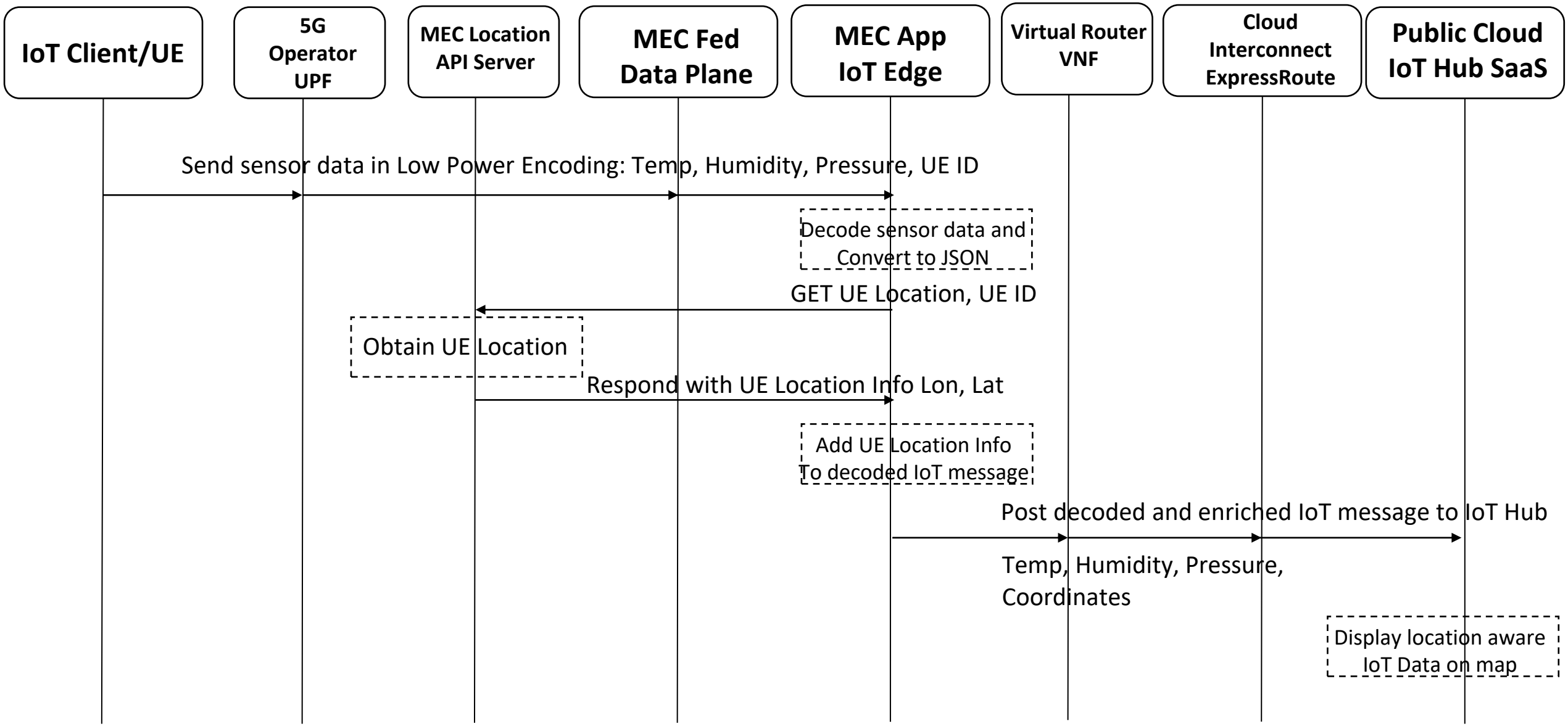
Cloud IoT Hub

Receive IoT data
(Temp, Humid,
Pressure,
Lat, Lon, Alt)

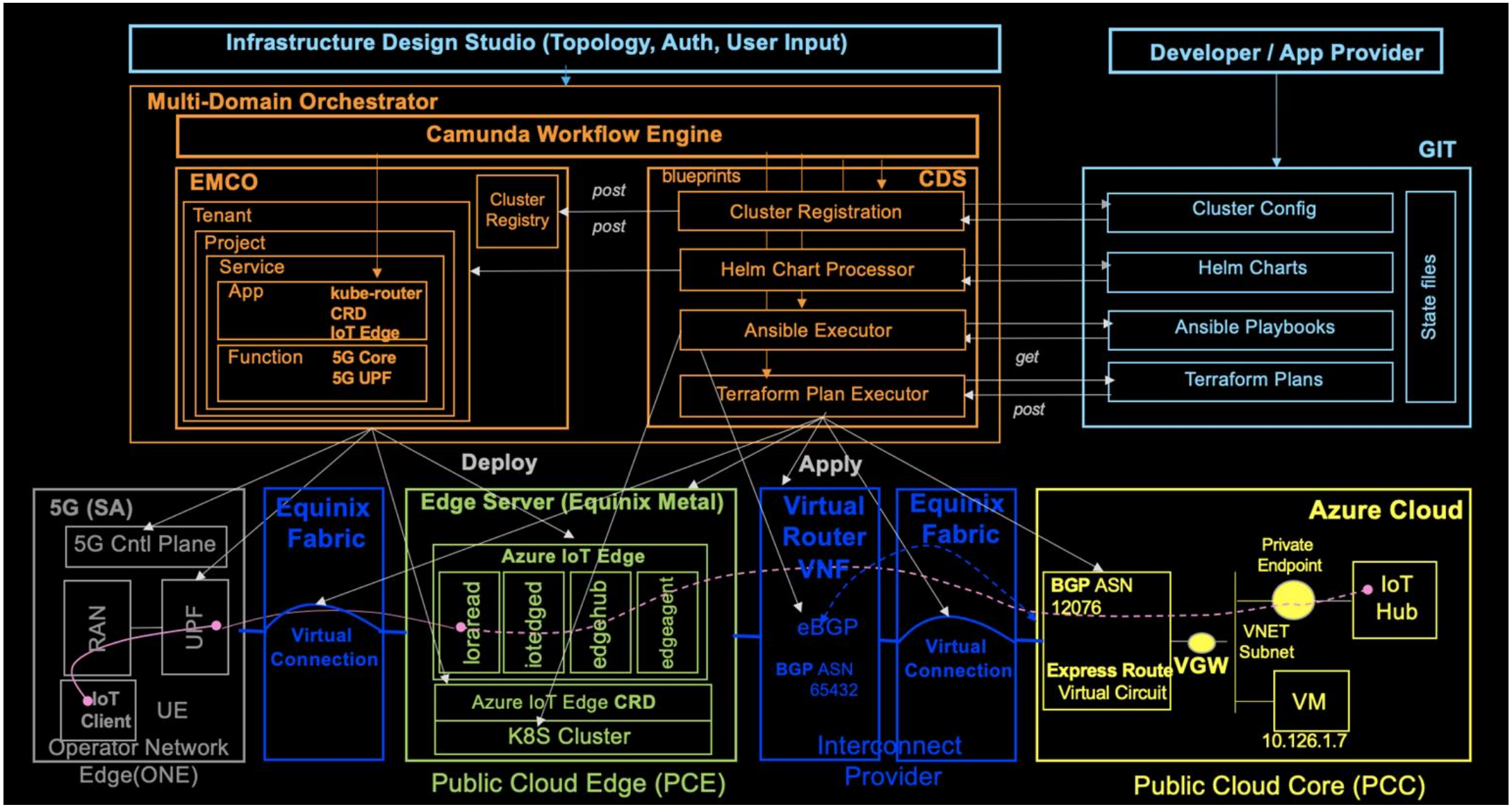
5G cloud native Control and User Plane Functions deployment (with simulated UE/gNB)



MEC Service Federation Call Flow: Location aware Low Power IoT



Architecture of the Orchestrator



Summary of contributions and innovations

- A practical use case showing a realization of ETSI MEC Federation architecture
- An introduction and a functioning demonstration of MEC Federation Data Plane
- Implementation of the GSMA OPG Edge Node sharing scenario using MEC Federation
- Implementation of ETSI MEC Location API Service and its integration with a MEC application
- Implementation of a combined MEC Federation Broker and MEC Orchestrator with unique capabilities for infrastructure orchestration in multiple domains such as public cloud, edge/MEC cloud, network operator, 5G control plane and user plane cloud native function deployment as well as cloud native service and application deployment
- Implementation of integrated Terraform Infrastructure-as-Code module into the orchestrator enabling DevOps infrastructure orchestration

Summary of software contributions

- ***Terraform plans***
https://gitlab.com/akraino-pcei-onap-cds/terraform-plans/-/tree/main/etsi-lfedge-hackathon-2022

- ***Ansible playbooks***
https://gitlab.com/akraino-pcei-onap-cds/ansible-scripts/-/tree/main/etsi-lfedge-hackathon-2022

- ***Helm3 charts***
https://gitlab.com/akraino-pcei-onap-cds/equinix-pcei-poc/-/tree/main/helm3-charts/etsi-lfedge-hackathon-2022

- ***Camunda workflows***
https://gitlab.com/akraino-pcei-onap-cds/camunda-bpmn-samples/-/tree/main/etsi-lfedge-hackathon-workflow

Acknowledgements

The authors would like to acknowledge the following individuals for their critical contributions to the implementation and validation of this project:

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- Premkumar Subramaniyan <premkumar@aarnanetworks.com>
- Sai Lakshmi Cheedella <sailakshmi@aarnanetworks.com>
- Namachi S <namachi@aarnanetworks.com>

Edge Hackathon - 2022

The Winner is……

LF EDGE

ETSI

Congratulations!!!

Thank you!!

EDGE COMPUTING WORLD