Where the Edges Meet, Infra Forms, Apps Land and Work Flows

How DevOps driven optimally deployed infrastructure and software will make cloud native 5G a reality

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Co-chair Akraino TSC

Akraino Technical Event Fall 2022

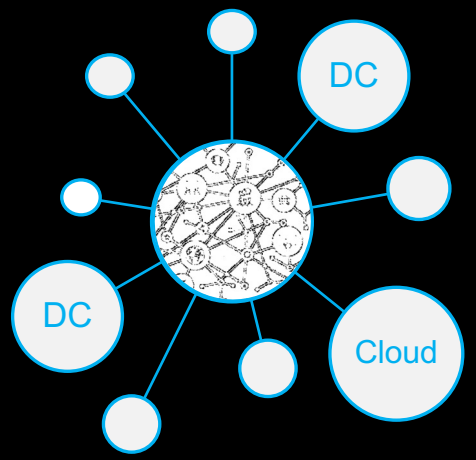
Outline

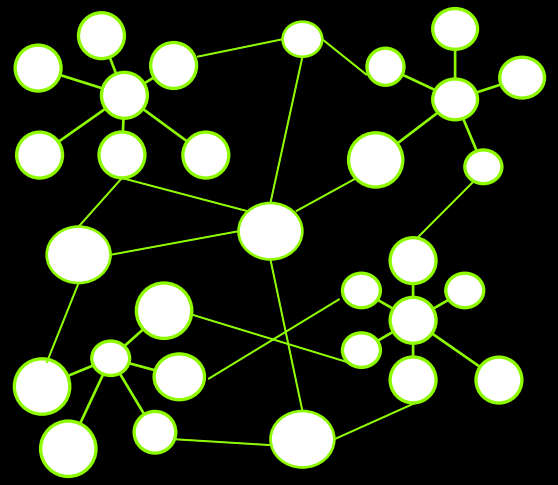
- 5G and Edge
- DevOps Multi-domain Infra Orchestration
  - Public Cloud Edge Interface
  - MEC Federation use case
- Who Is Equinix?

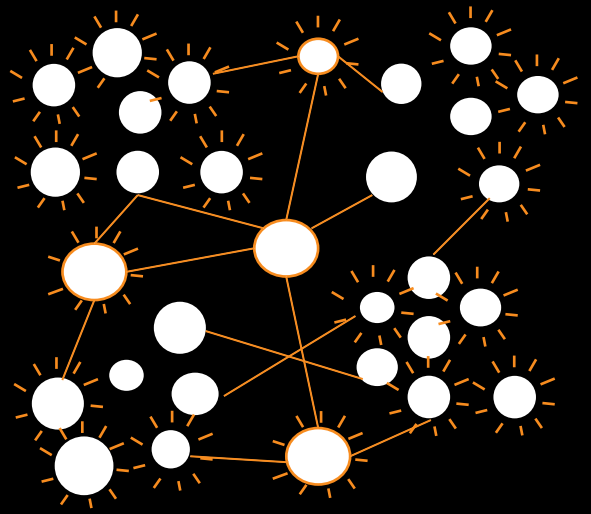
5G and Edge

New applications drive expansion to the edge and densification of networks

Legacy	Existing	Forming
Centralized	Distributed	Edge







User to App Distance	~ 10^3 km ~ 10^0 sec	~ 10^2 km ~ 10^{-1} sec	~ 10^1 km ~ 10^{-2} sec

Ubiquitous Edge

present, appearing, or found everywhere

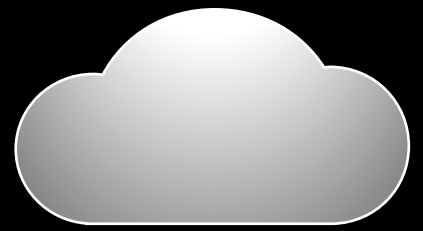
Devices

Fiber Aggregation
Tower Sites
Premise

Traffic Aggregation
Central Office
Edge Data Center
Cloud Edge Zones

Interconnection Hubs / Peering
Mobile Switching Centers
Multi-Tenant Data Centers
Cloud Local Zones

Cloud AZ
Telco Core

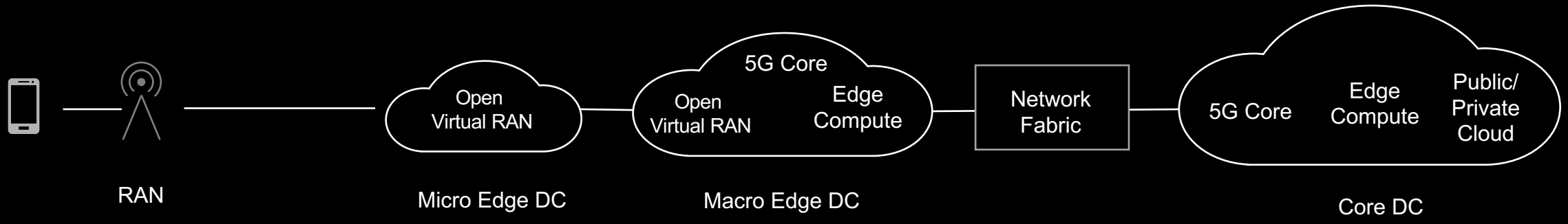


	DEVICE EDGE	FAR EDGE	MICRO EDGE	MACRO EDGE	CORE CLOUD
Latency	0 – 1 ms	1 – 5 ms	5 – 10 ms	10 – 50 ms	50 – 100 ms
Power	0.5 - 1 W	10 – 100 KW	100 – 5000 KW	5000 – 20000 KW	20000+ KW

5G: Major Technological Inflection Point for Digital Infrastructure

New thinking required to optimize an evolving multi-variable function

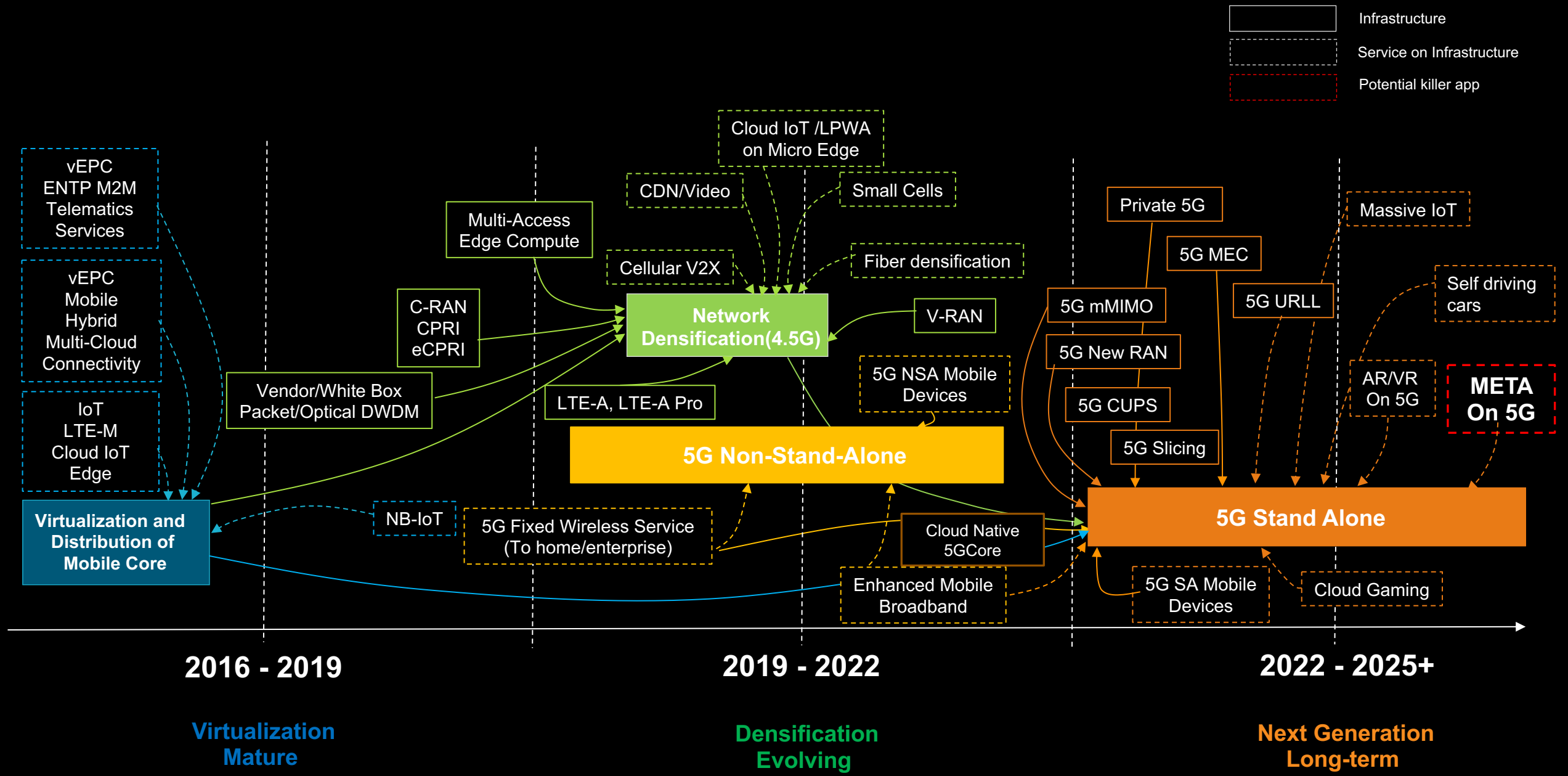
10 Gbps Peak Data Rate | 10 Tbps/km2 Area Traffic capacity | 500 km/h Mobility | 1M devices / km^2 | 5 msec E2E Latency | 99.999% Availability | Energy efficiency | Rapid Service Deployment | Edge and Core Applications



SPECTRUM | FIBER | TRANSPORT | HARDWARE | ECOSYSTEMS

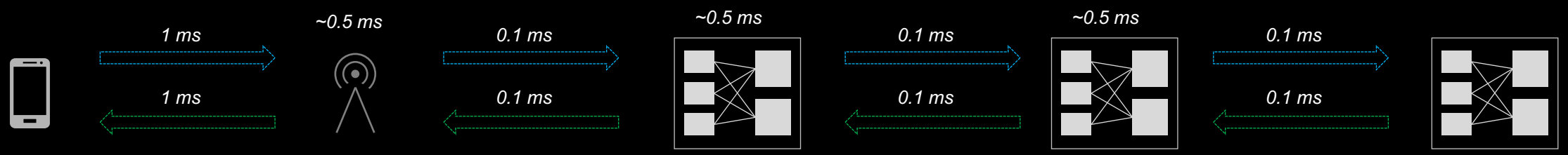
RAN DENSITY | MICRO EDGE DC | MACRO EDGE DC | INTERCONNECTION | APPLICATIONS

Transformation of 4G/5G infrastructure and use cases



Making 5G a Reality: Optimally-Distributed Architecture

Optimally-placed & interconnected infrastructure required to deliver on 5G performance promises



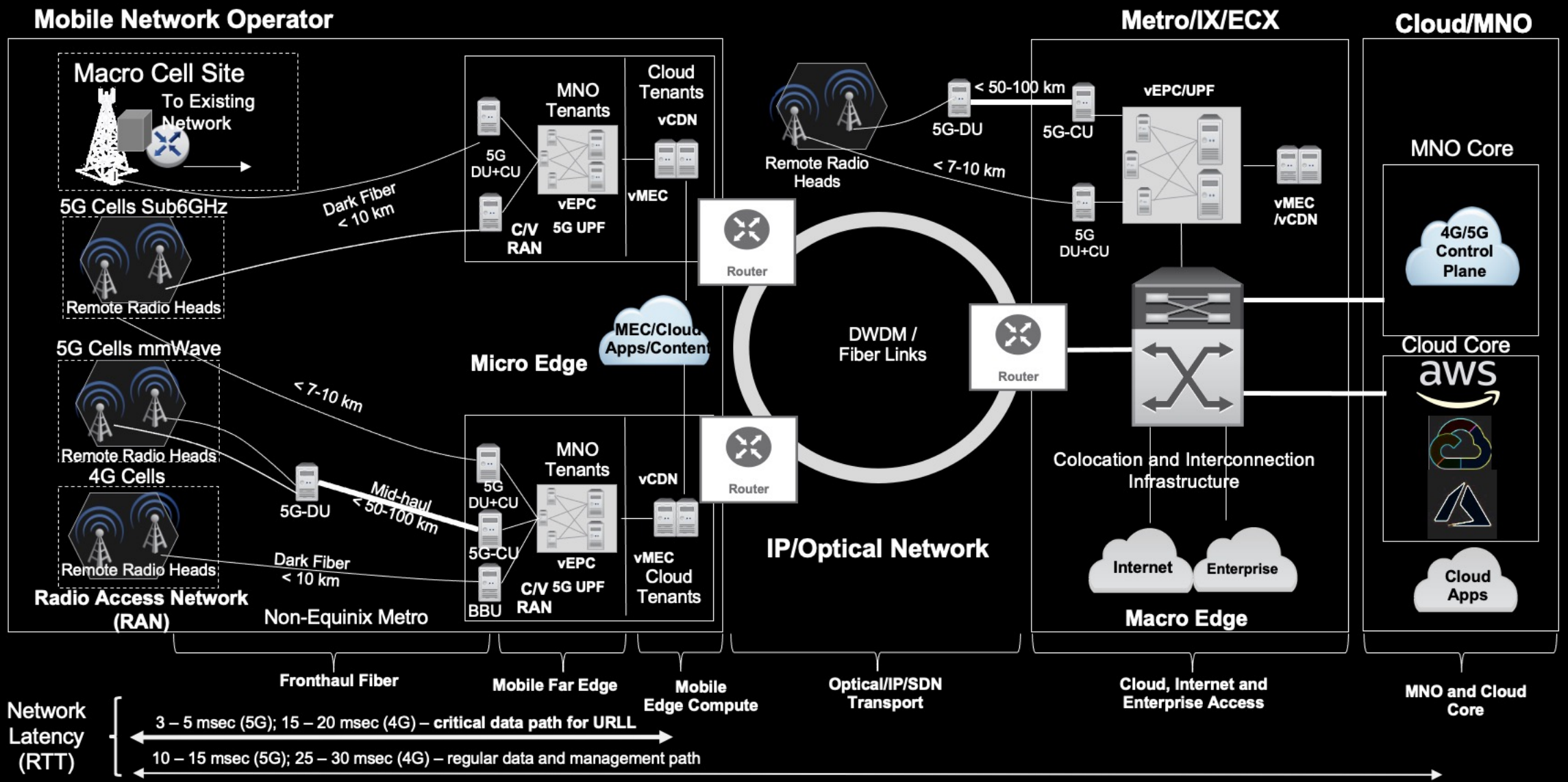
~2.5 ms latency | ~0.7 ms latency | ~0.7 ms latency | ~0.2 ms latency | 0.9 ms remaining

Distance spectrum dependent (0.1-5 km) | Distance ~10 km | Distance ~10 km | Distance ~10 km

Example: Desired End-to-End Latency of 5 ms

Latencies and distances are estimates

Ubiquitous Metro Edge Architecture



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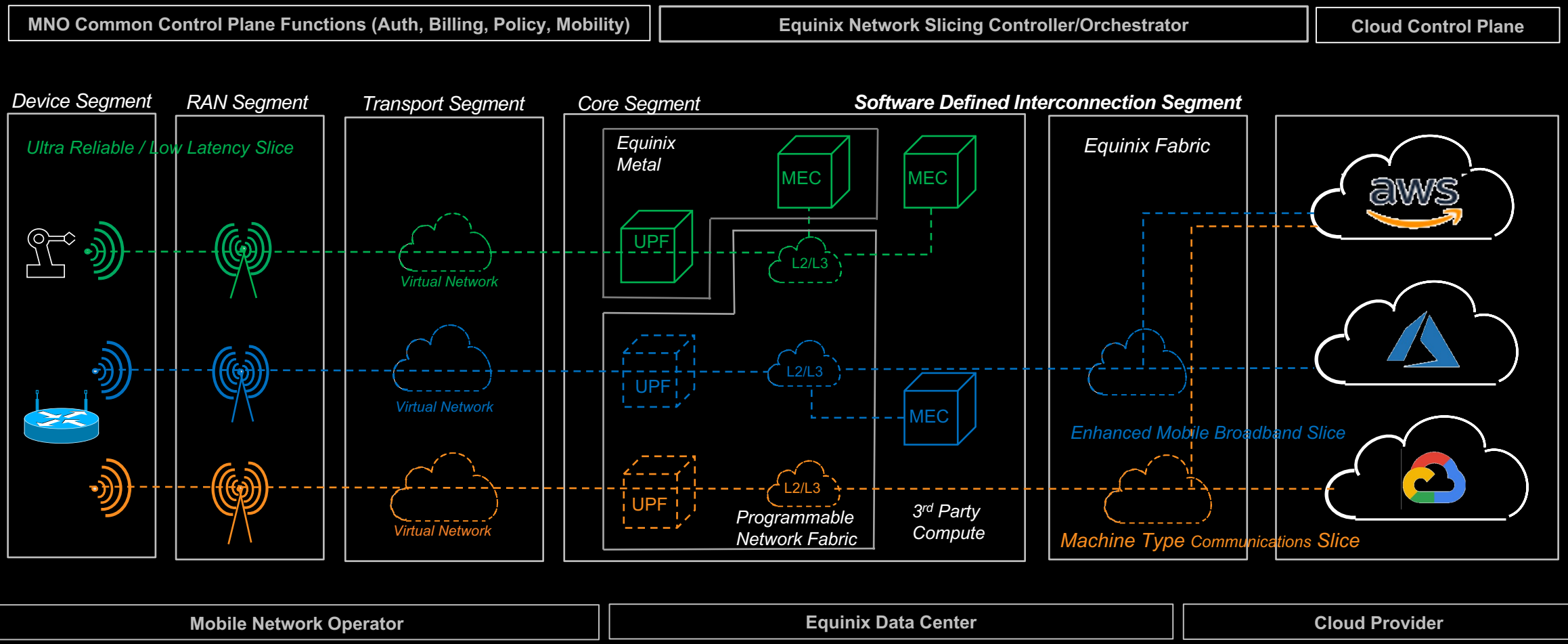
Power	0.5 - 1 W	10 – 100 KW	100 – 5000 KW	5000 – 20000 KW	20000+ KW

Network Slicing for Interconnection of Core and Edge – Multi-MEC, Multi-Cloud

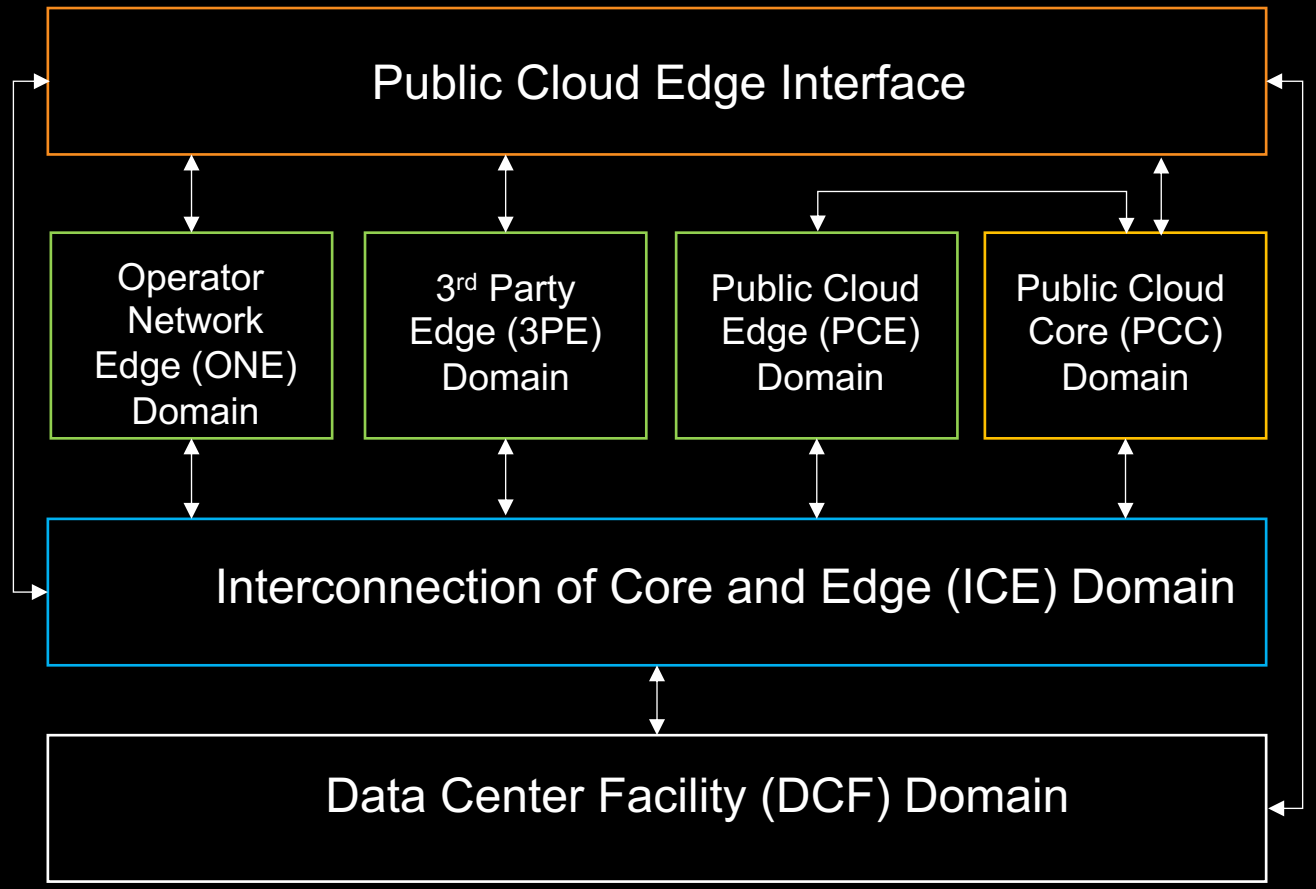
The Slicing Must Go On



DevOps Multi-domain INfra Orchestration

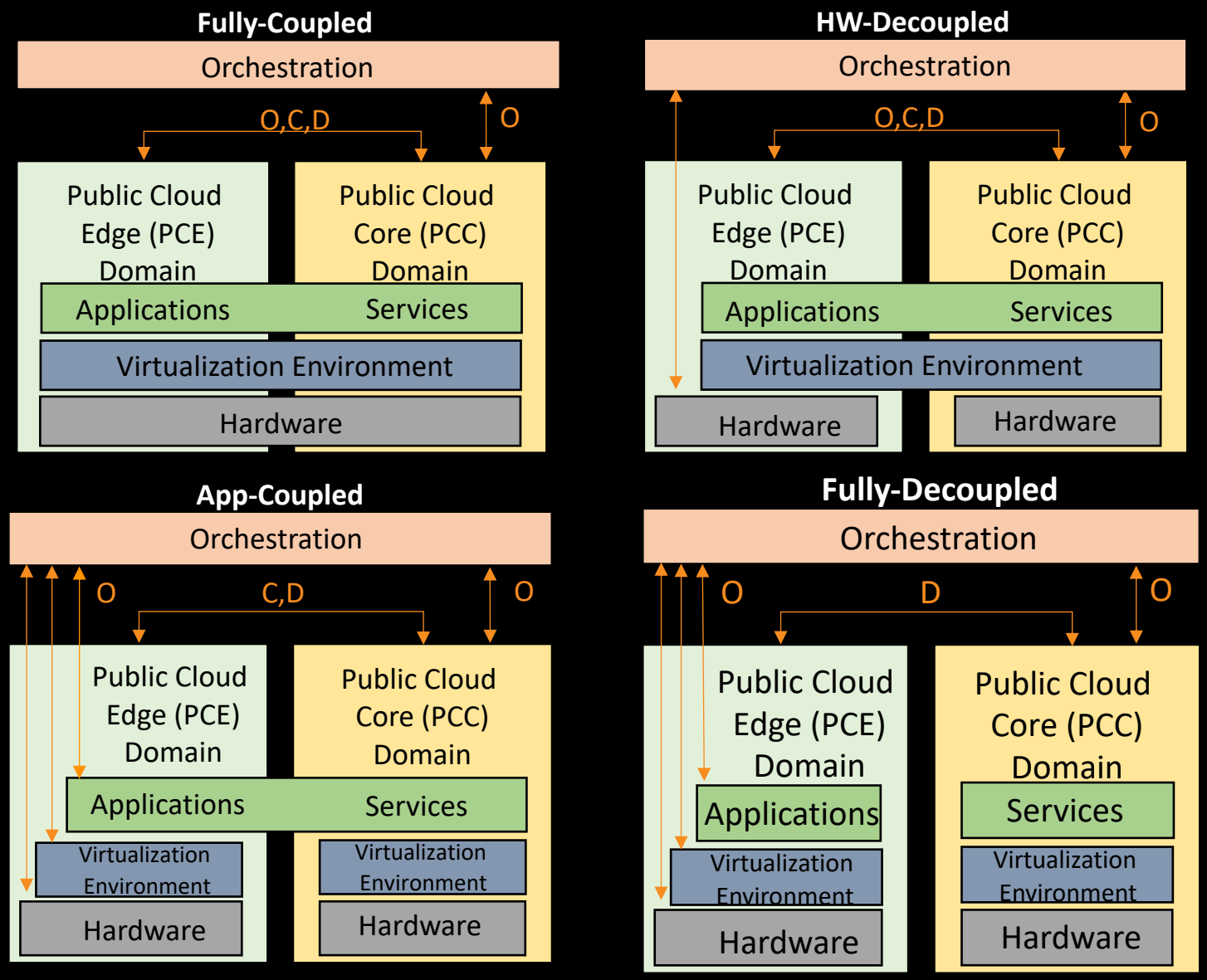
Akraino Public Cloud Edge Interface (PCEI) Blueprint

Overview



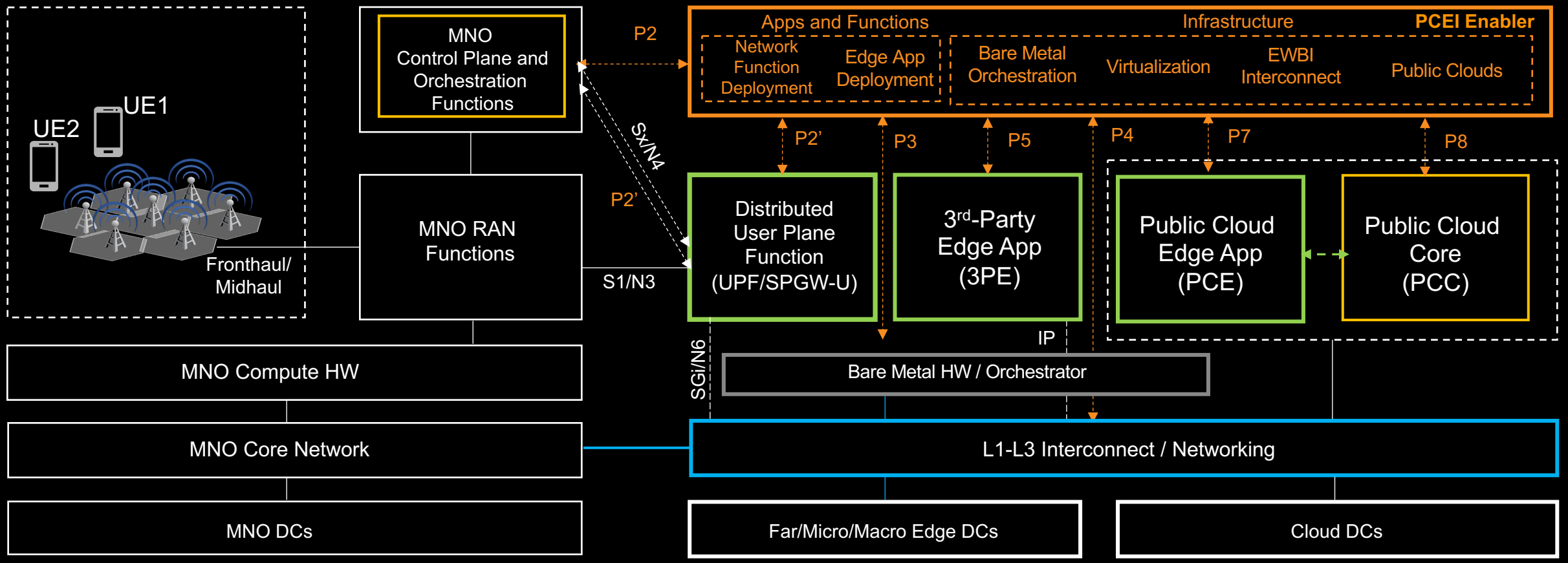
The purpose of Public Cloud Edge Interface (PCEI) Blueprint is to develop a **set of open APIs**, **orchestration functionalities** and **edge capabilities** for enabling Multi-Domain Interworking across the Operator Network Edge, the Public Cloud Core and Edge, the 3rd-Party Edge as well as the underlying infrastructure such as Data Centers, Compute Hardware and Networks.

Public Cloud Driven Edge Computing: PCC-PCE Interactions

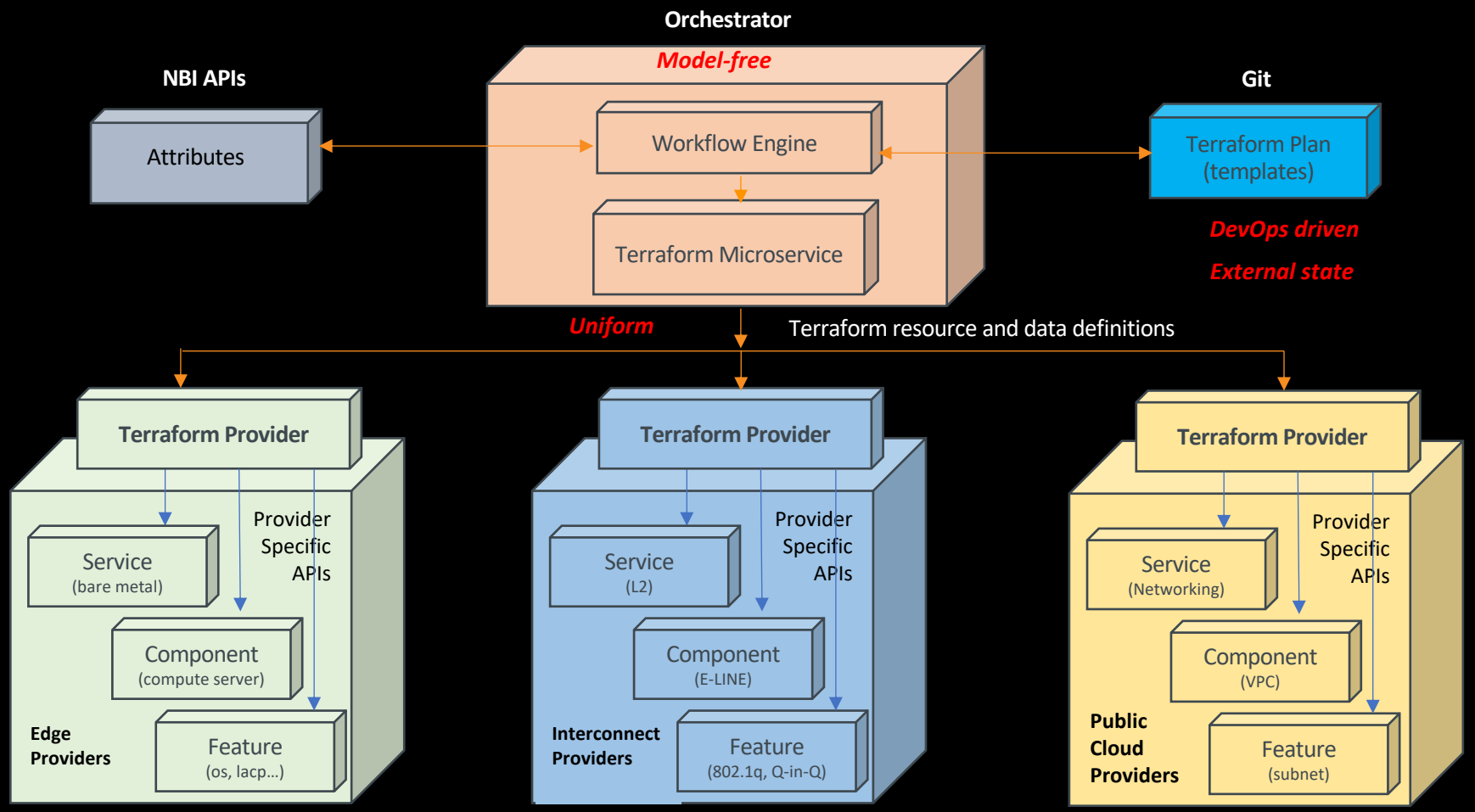


- **Orchestration (O):** Automation and sequencing of deployment and/or provisioning steps. Orchestration may take place between the PCC service and PCE components and/or between an Orchestrator such as the PCEI Enabler and PCC or PCE.
- **Control (C):** Control Plane messaging and/or management interactions between the PCC service and PCE components.
- **Data (D):** Data Plane messaging/traffic between the PCC service and the PCE application.

High-Level PCEI Architecture

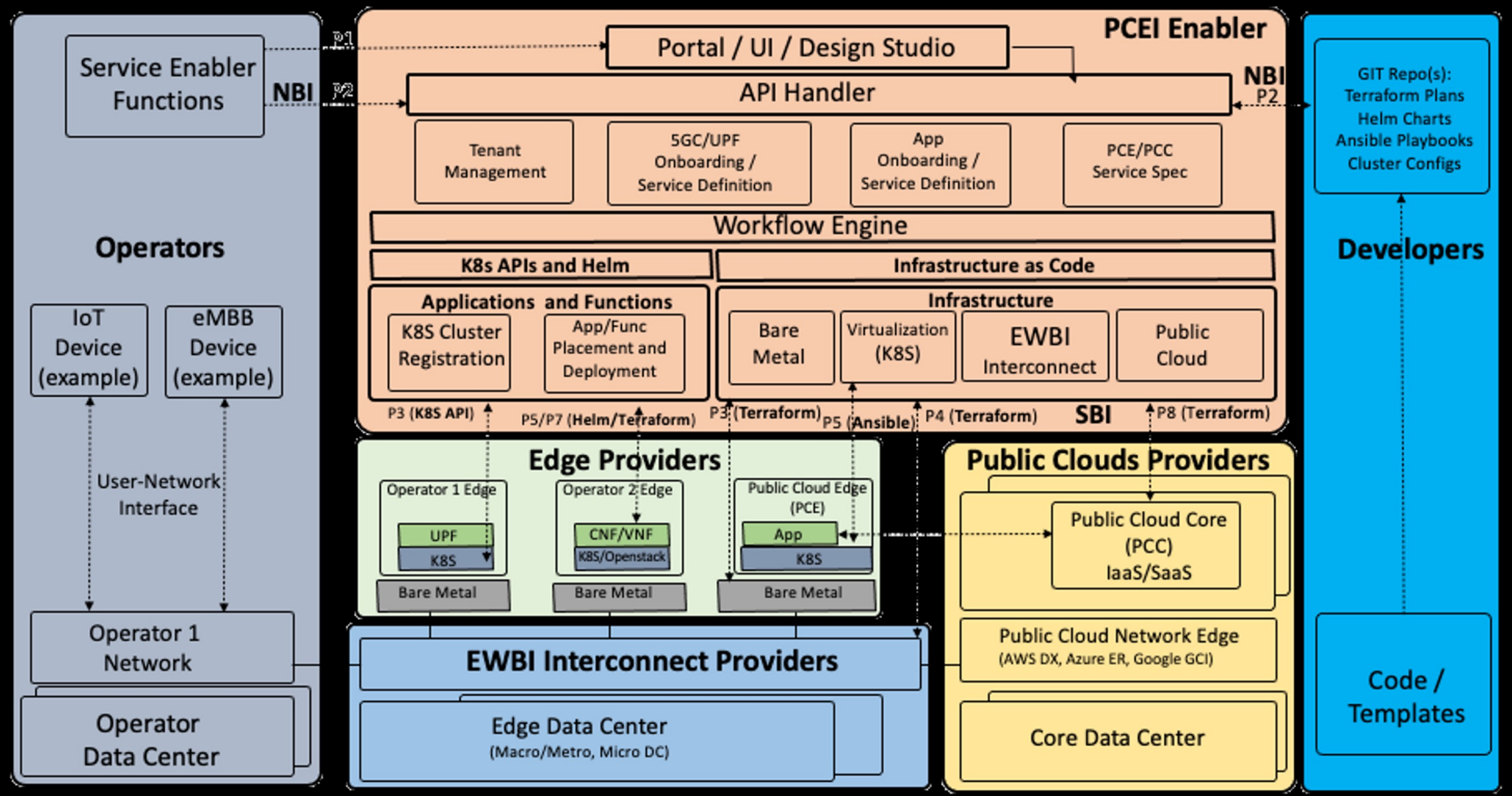


Orchestration with Infra-as-Code



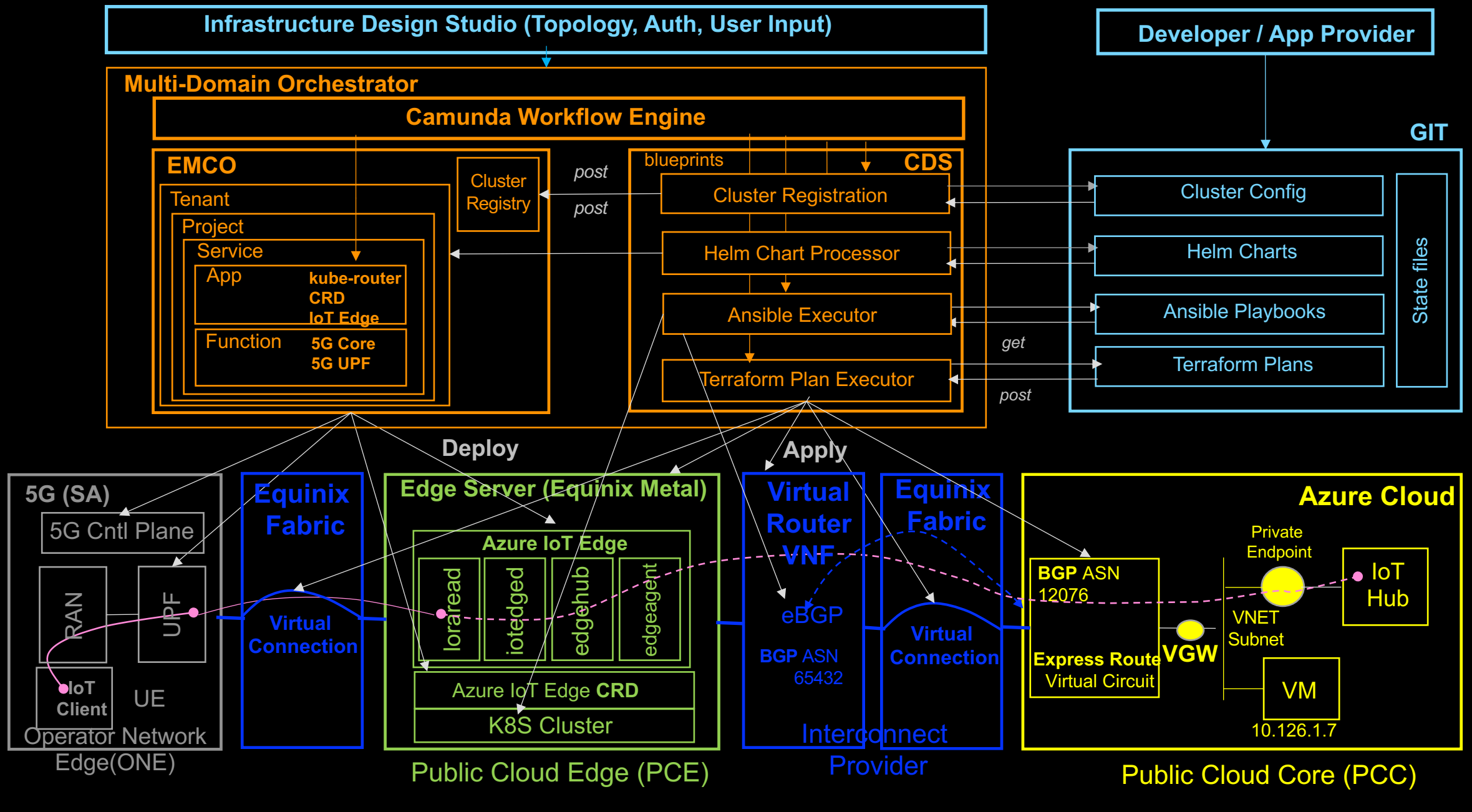
- **Uniform** - use of the same infrastructure orchestration methods across public clouds, edge clouds and interconnection domains.
- **Model-free** – the orchestrator does not need to understand the details of the individual infrastructure domains (i.e., implement their models). It only needs to know where to retrieve the Terraform plans for the domain in question and execute the plans using the specified provider.
- **External state** – the state of infrastructure resources created by the orchestrator is stored outside of the orchestrator itself, making it stateless with respect to the infrastructure
- **DevOps driven** – the Terraform plans can be developed and evolved using DvOps tools and processes.

PCEI Release 7 Overview



- NBI APIs
  - GIT Integration
  - Dynamic Edge Cluster Registration
  - Dynamic App Helm Chart Onboarding
  - Automatic creation of Service Instance in EMCO and deployment of Apps
  - Automatic Terraform Plan Execution
- Workflow Engine
  - Camunda
- Integrated Terraform Plan Executor
  - Azure (PCC)
  - AWS (PCC)
  - Equinix Fabric (Interconnect)
  - Equinix Metal (Bare Metal Cloud)
  - Openstack (3PE)
- Equinix Fabric Interconnect
- Multi-Public Cloud Core (PCC) Orchestration
- Kubernetes Edge
- Openstack Edge
- Cloud Native 5GC and UPF Deployment

DevOps Multi-domain Infra Orchestration: PCEI demo



MEC Federation with PCEI?

(Solution submitted for the ETSI – LF Edge Hackathon 2022)

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

ETSI – LF Edge Hackathon 2022

Team DOMINO solution submission
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oberzin@equinix.com
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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

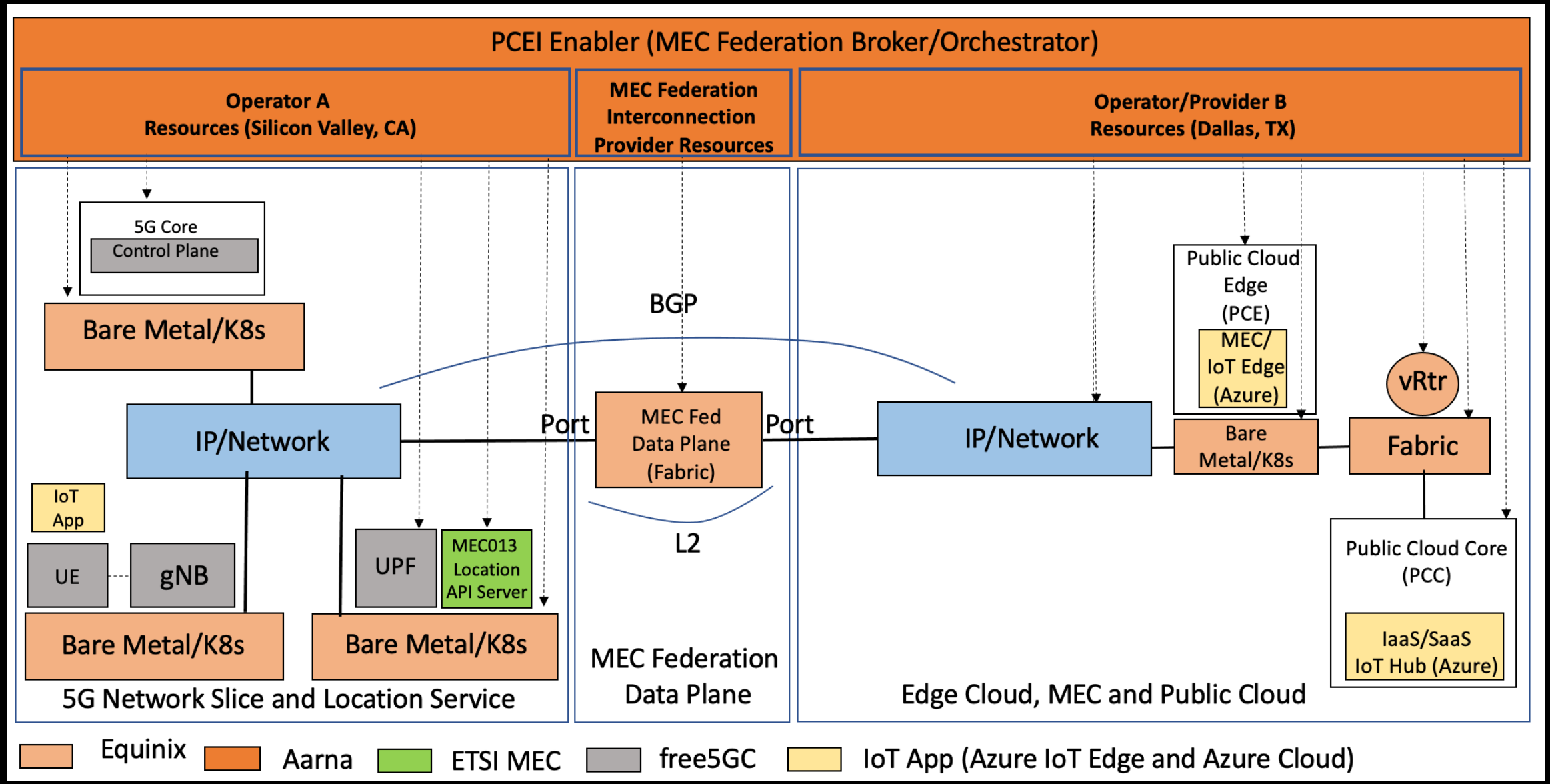
Deployment and operation of end-to-end cloud native IoT application making use of 5G access and distributed both across geographic locations and across hybrid MEC (edge cloud) and Public Cloud (SaaS) infrastructure

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.

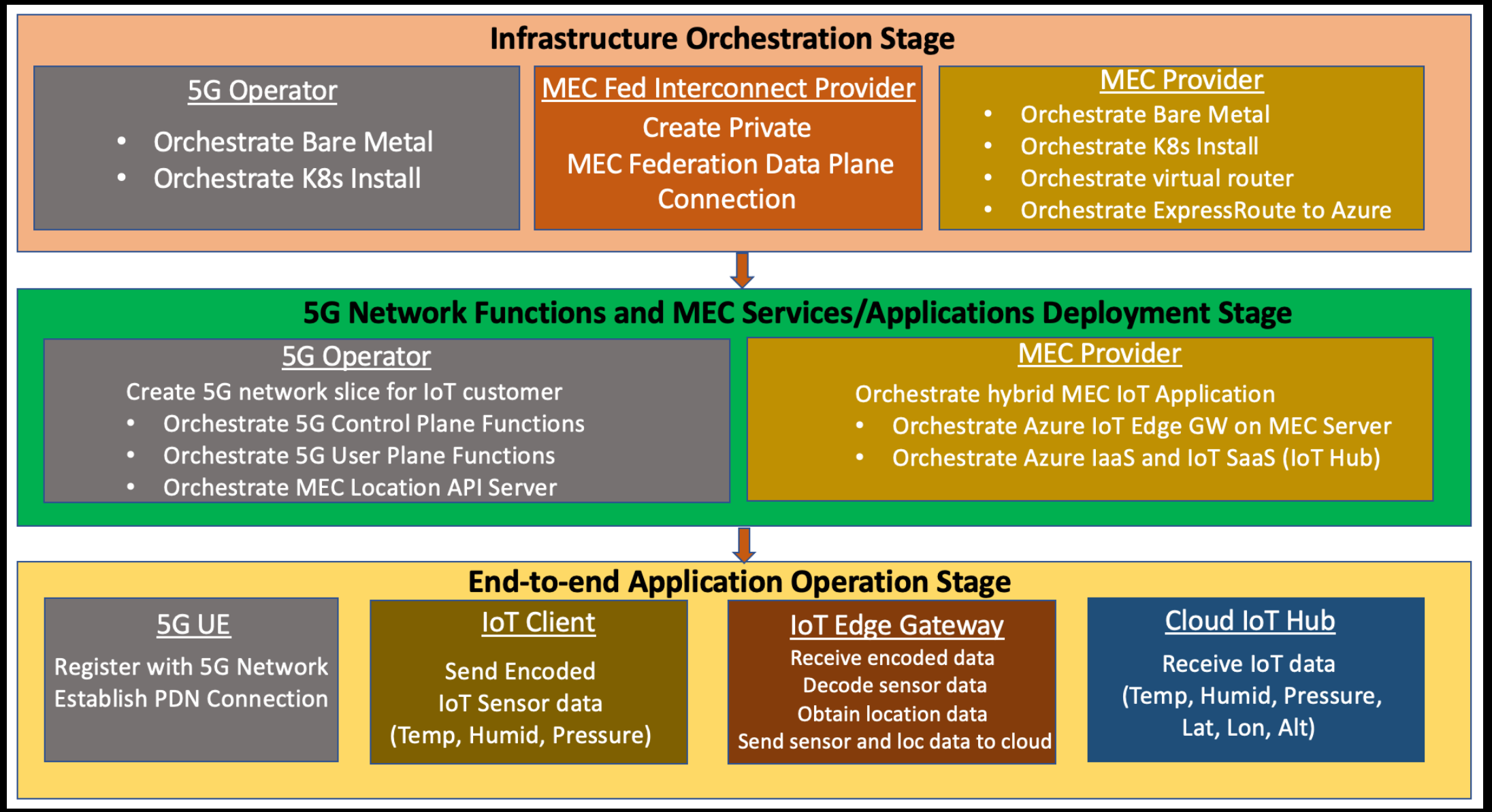
Summary of contributions and innovations

- 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
- Implementation of integrated Ansible Infrastructure Configuration and Installation module into the orchestrator
- Cloud native 5G Control Plane and Distributed UPF deployment design and the correspondent Helm Charts
- Use of production services (by Equinix) such as bare metal cloud, virtual network functions, public cloud access and a global interconnection fabric as dynamically orchestratable infrastructure components for the realization of the MEC Federation use case
- Implementation of a reference IoT client
- Implementation of a custom software module for Azure IoT Edge that enables its integration with ETSI MEC Location API service
- An end-to-end demonstration of the infrastructure orchestration, 5G control plane and user plane functions deployment, ETSI MEC Location API service deployment and the location aware, distributed IoT application operation

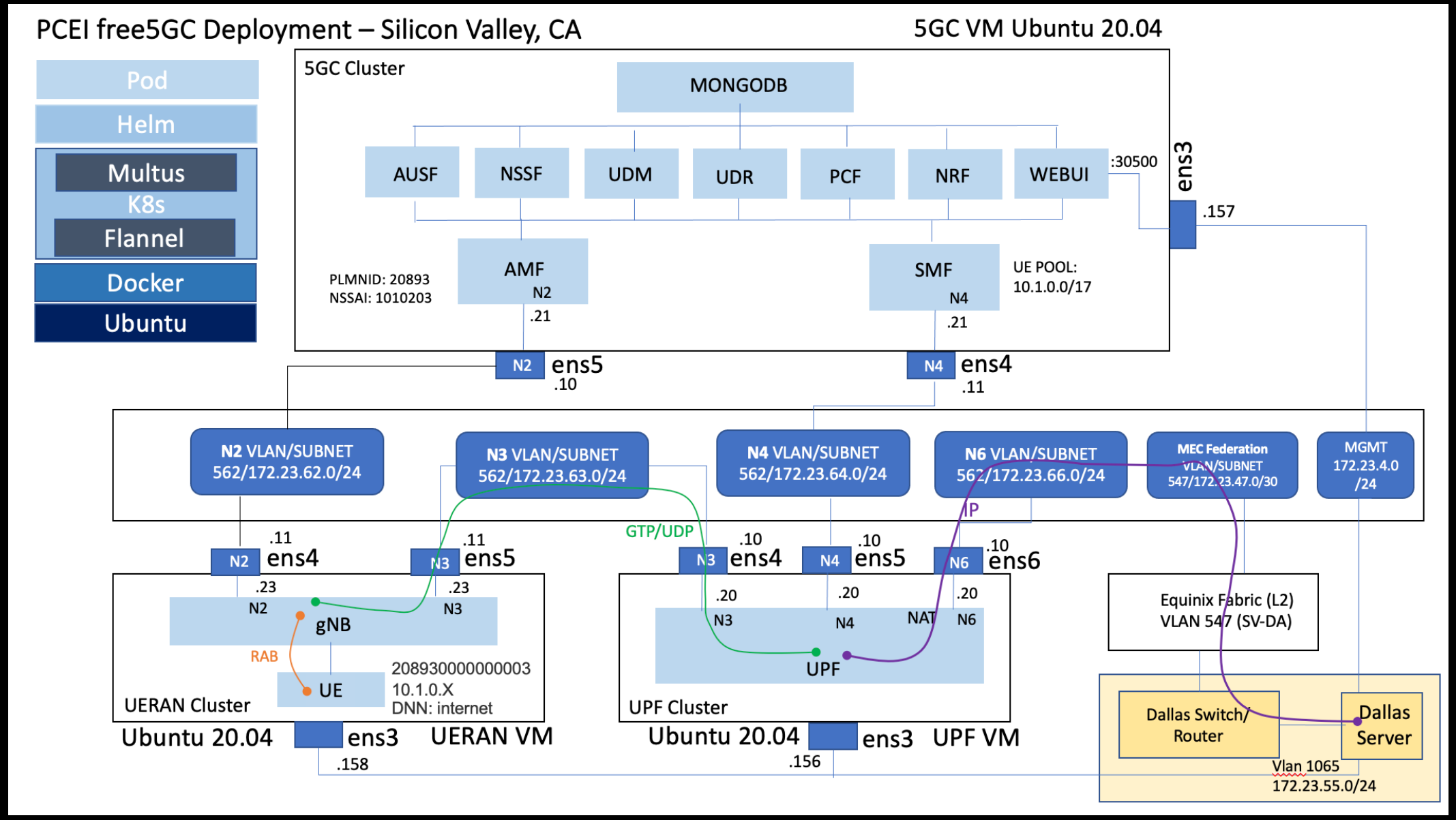
Use Case Description



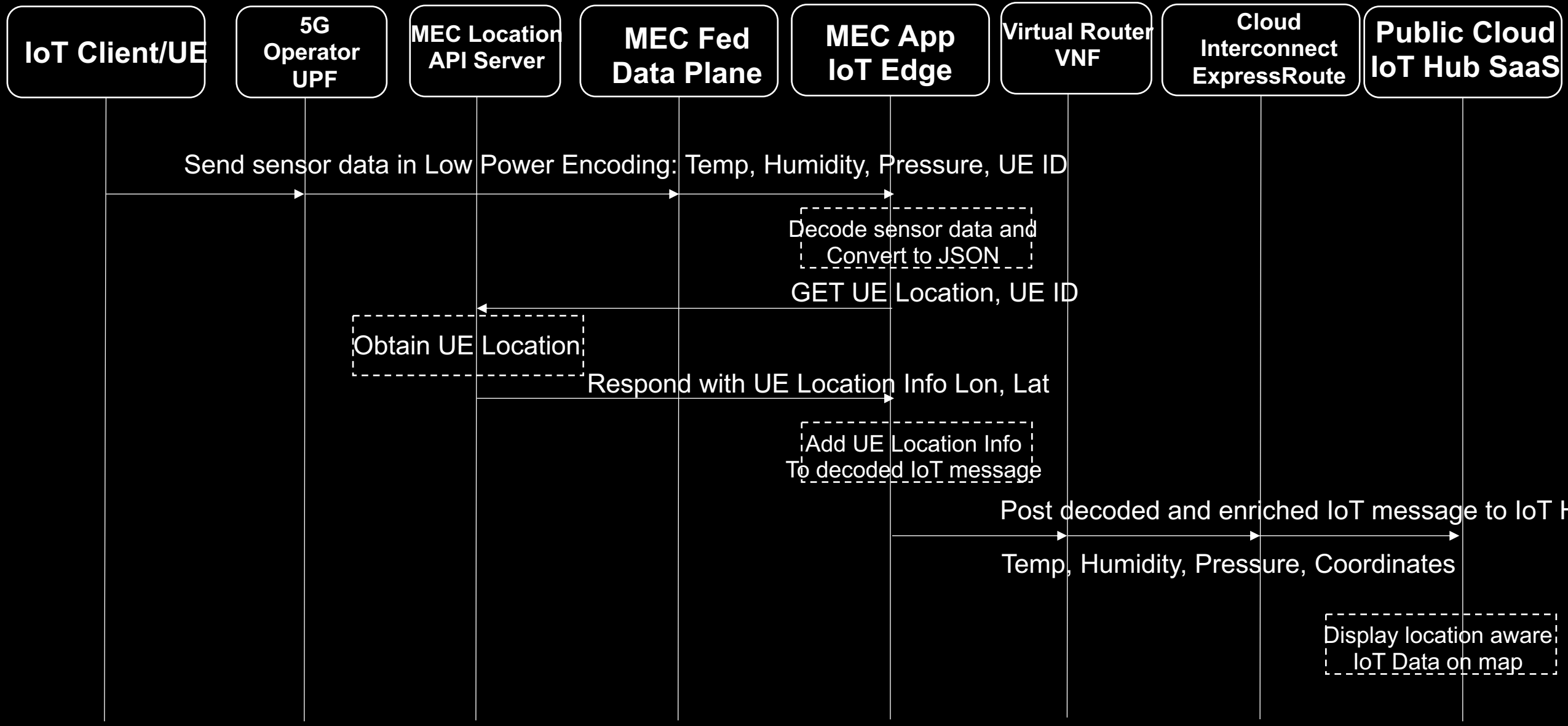
What does the use case do?



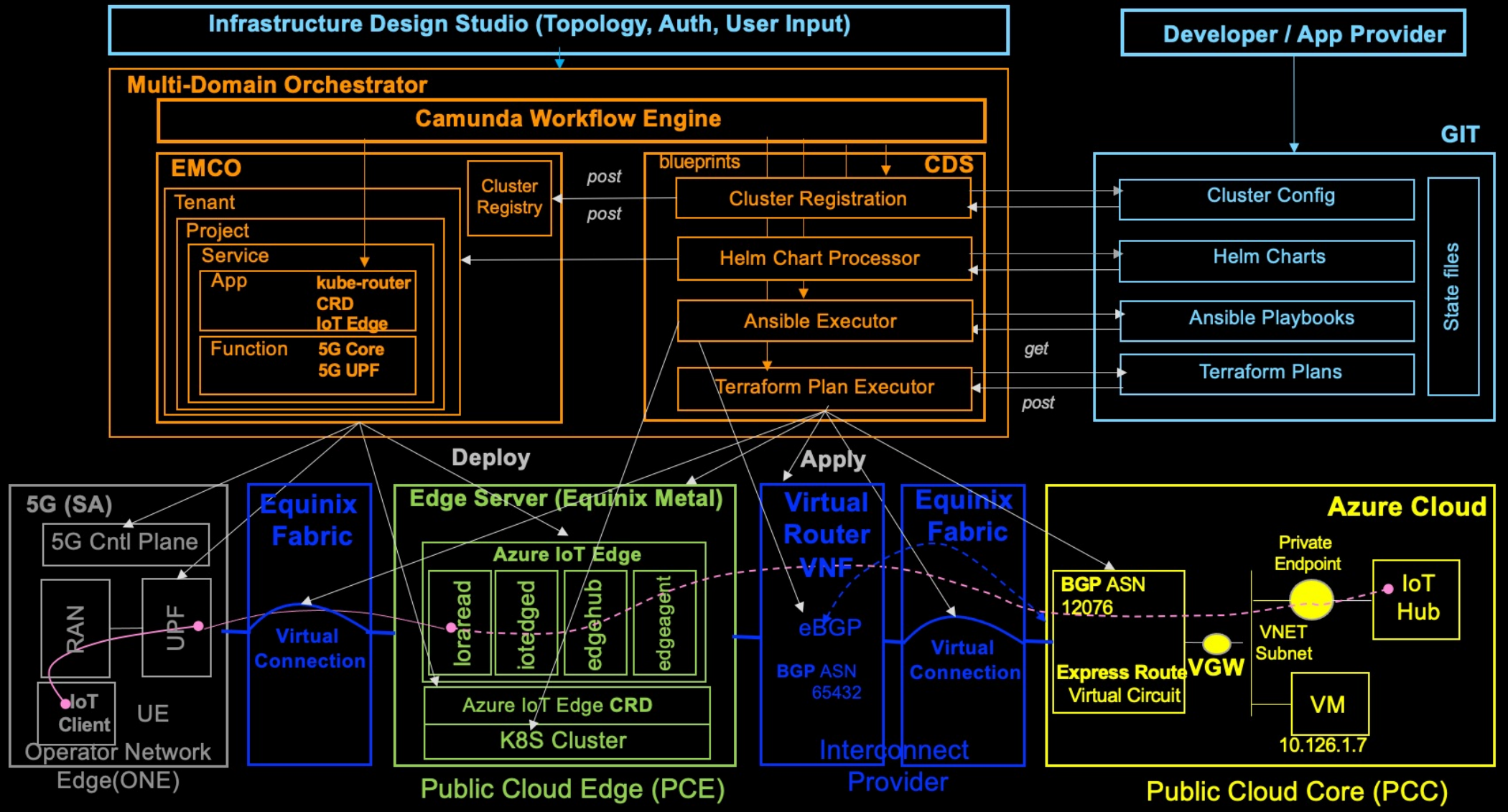
5G cloud native Control and User Plane Functions deployment (with simulated UE/gNB)



MEC Service Federation Call Flow: Location aware Low Power IoT



Architecture of the Orchestrator



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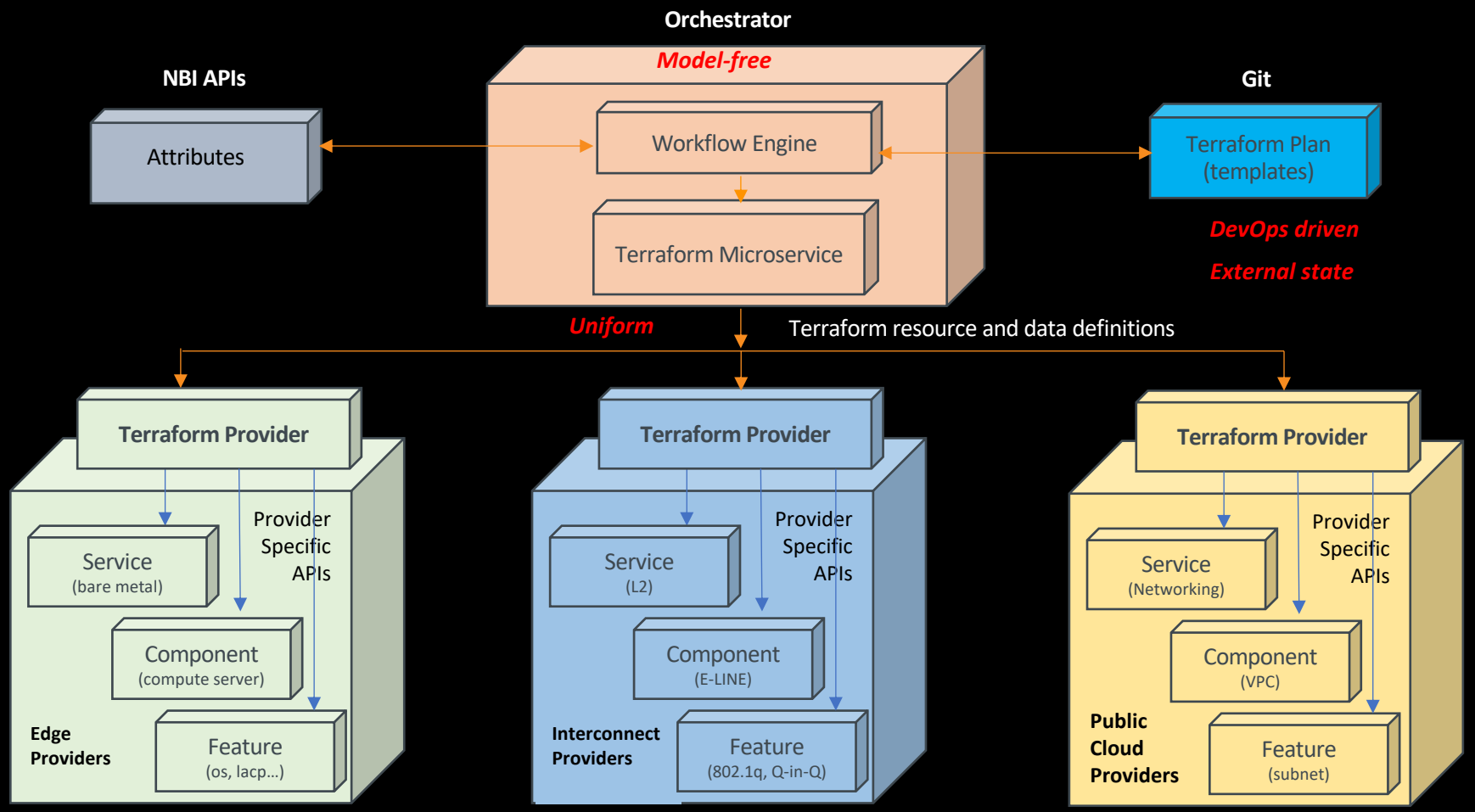

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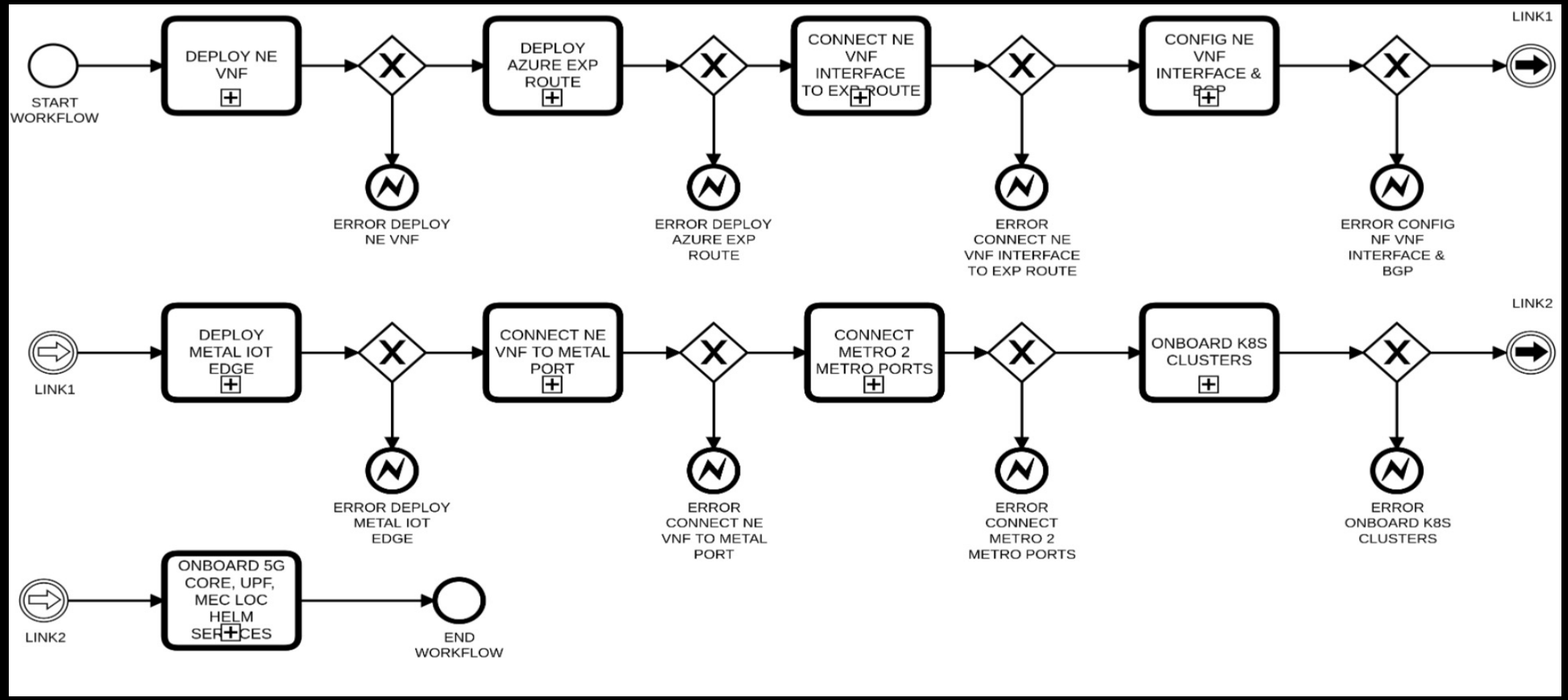
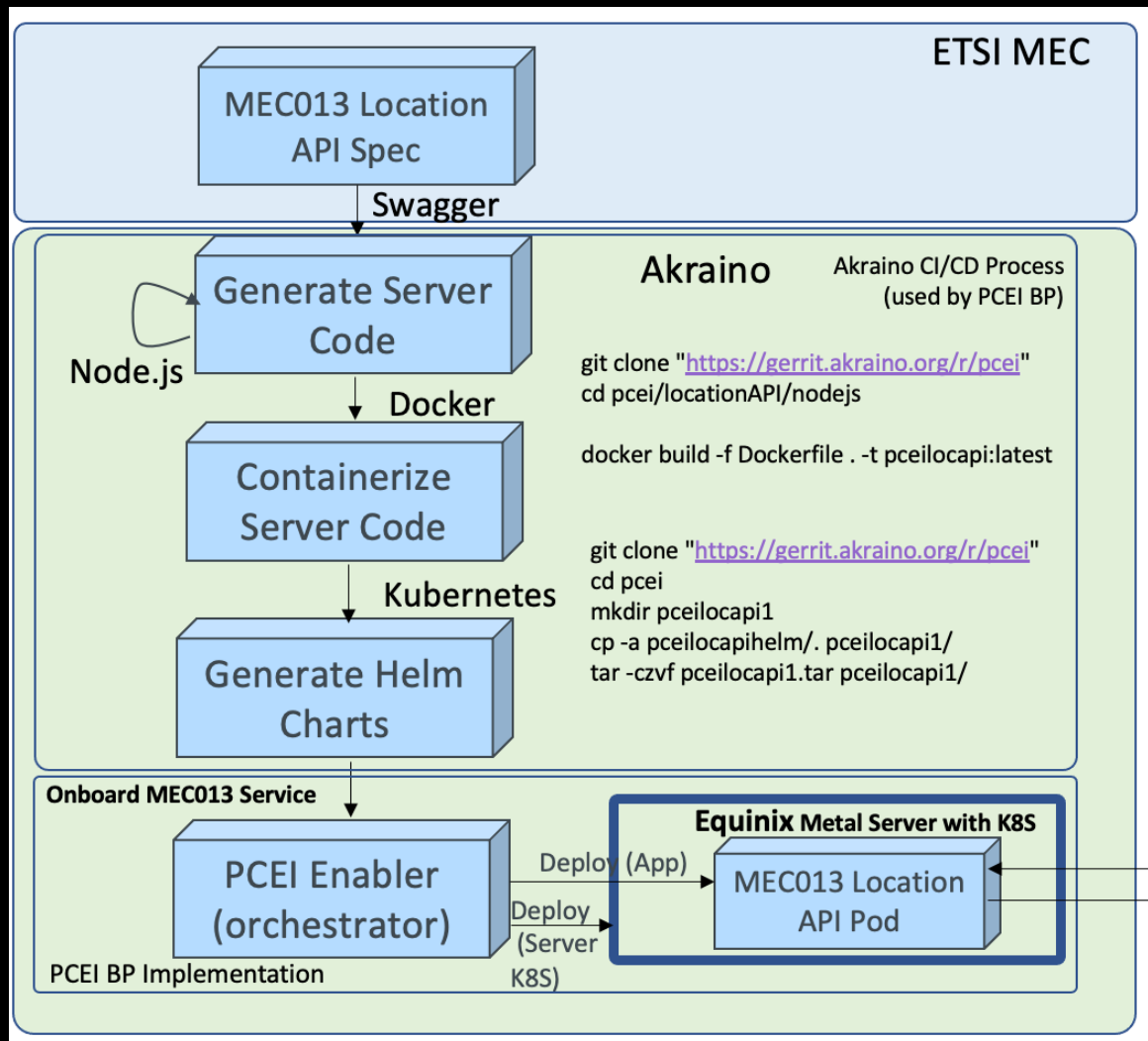
Orchestration Workflow Design

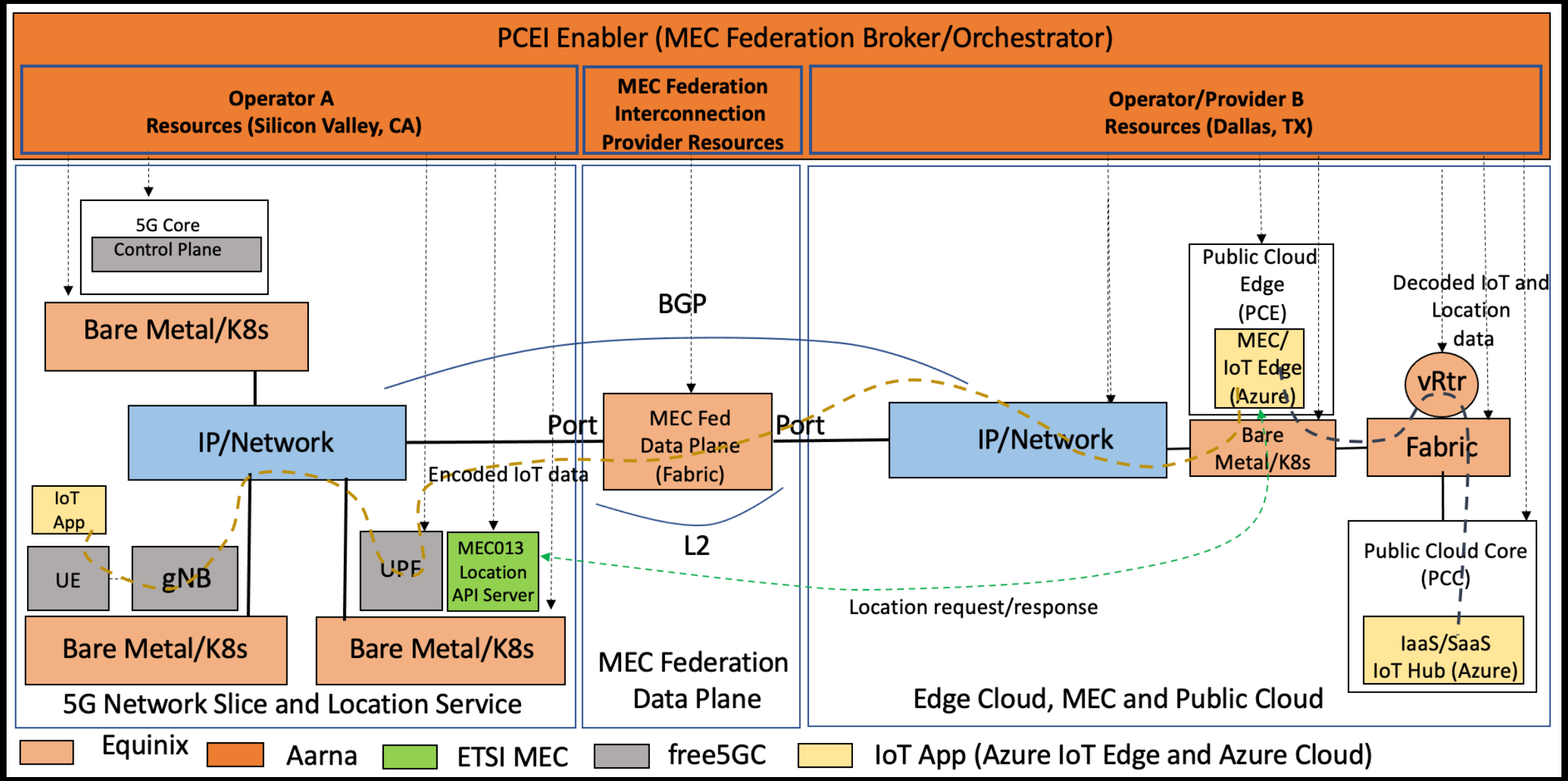


ETSI MEC Location API server implementation



- Use ETSI MEC spec – MEC013 Location API
- Generate and containerize MEC013 Location API server code
- Generate Helm charts for the code to make it deployable on Kubernetes
- Use Akraino PCEI Orchestrator as a MEO/MEPM to:
  - Onboard MEC013 Location API server as a Service/App
  - Deploy Equinix Metal server (MEP/MEC Host)
  - Install Kubernetes on Metal server
  - Onboard Kubernetes cluster to PCEI Orchestrator
  - Deploy MEC013 Location API Service (as MEC App)

End-to-end traffic flow



Thank you

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For more details, please follow the links:

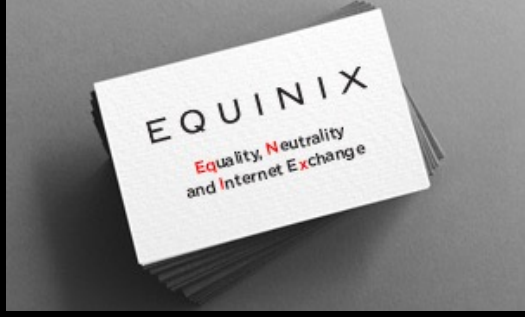
Detailed solution document
Demonstration video
Solution presentation

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

Who Is Equinix?

Who Is Equinix

Equal access, neutrality and interconnection

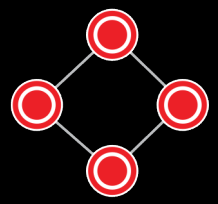


DESTINATION STRENGTH FORTRESS PERSPECTIVE CONNECTION

History of Equinix

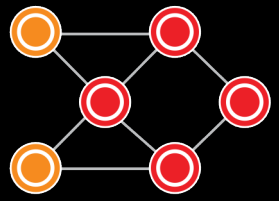
At the center of digital transformation for over 20 years

Networks



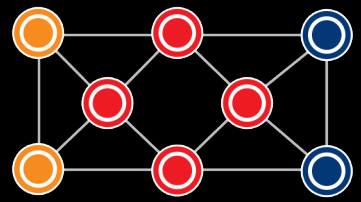
INTERNET

E-commerce and content



WEB

Exchanges

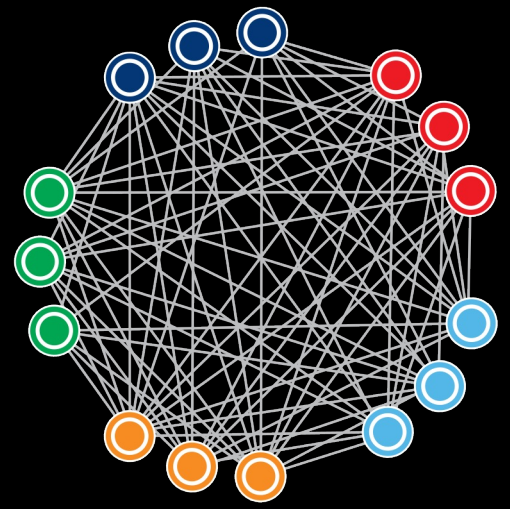


ELECTRONIC TRADING

Clouds

CLOUD

Enterprises



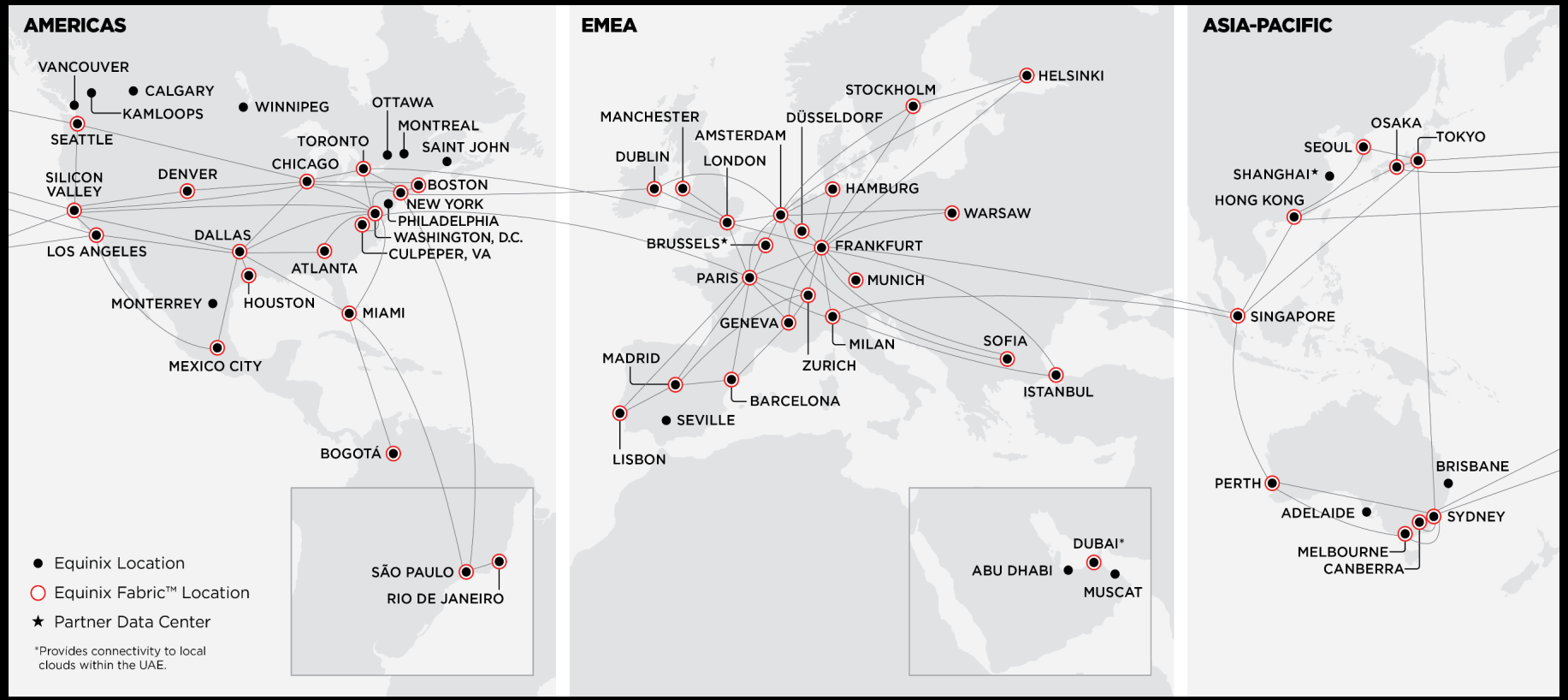
DIGITAL ECOSYSTEMS

Equinix by the Numbers

Global infrastructure and exchange platform for digital business

248+	71	31	6	10,000+	435,000+	99.9999%
Data Centers	Metros	Countries	Continents	Companies	Interconnections	IBX Uptime

IBX: International Business Exchange (DC)



Ecosystems

- 1,800+ Networks
- 650+ Media & Entertainment
- 1,250+ Financial Services
- 2,900+ Cloud & IT
- 3,000+ Enterprises

Edge Services

- Network Edge (NFV)
- Bare Metal (BMaaS)

Interconnection

- Equinix Fabric (SDN-enabled)
- Internet Exchange (12.6+ Tbps)

Strategic Locations

Building Ubiquitous Edge with Platform Equinix

Infra Orchestration

- APIs
- Terraform
- Portals

Edge Services

- Network Edge
- Bare Metal
- Precision Time

Interconnection Services

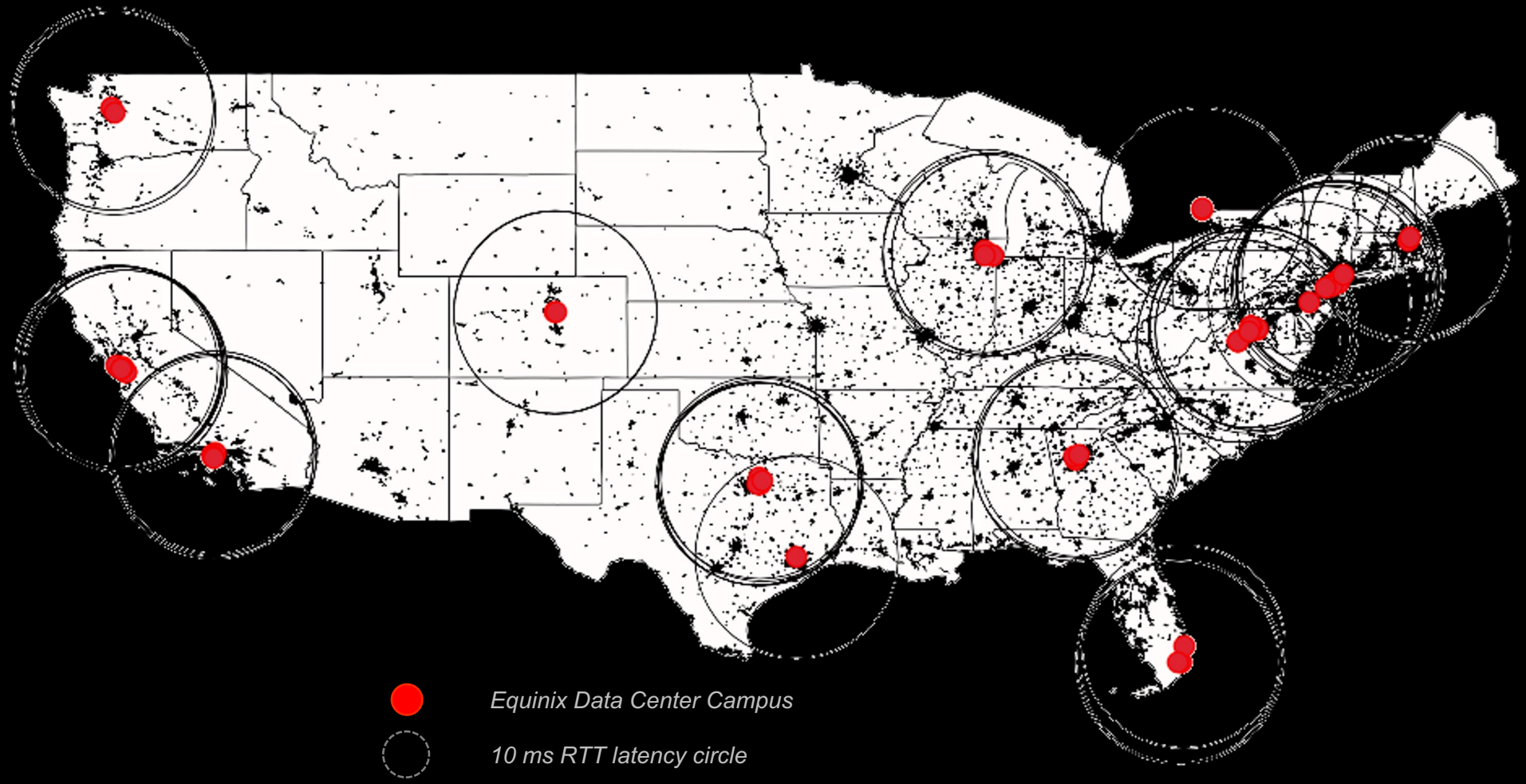
- Cross Connects
- Equinix Internet Exchange™
- Equinix Connect
- Equinix Fabric™

Data Center Services

- Edge Data Centers
- IBX® Data Centers
- xScale™ Data Centers

We Can Start Making 5G Real Now

80% of U.S. urban/metropolitan population is within 10 ms RTT from Equinix data centers



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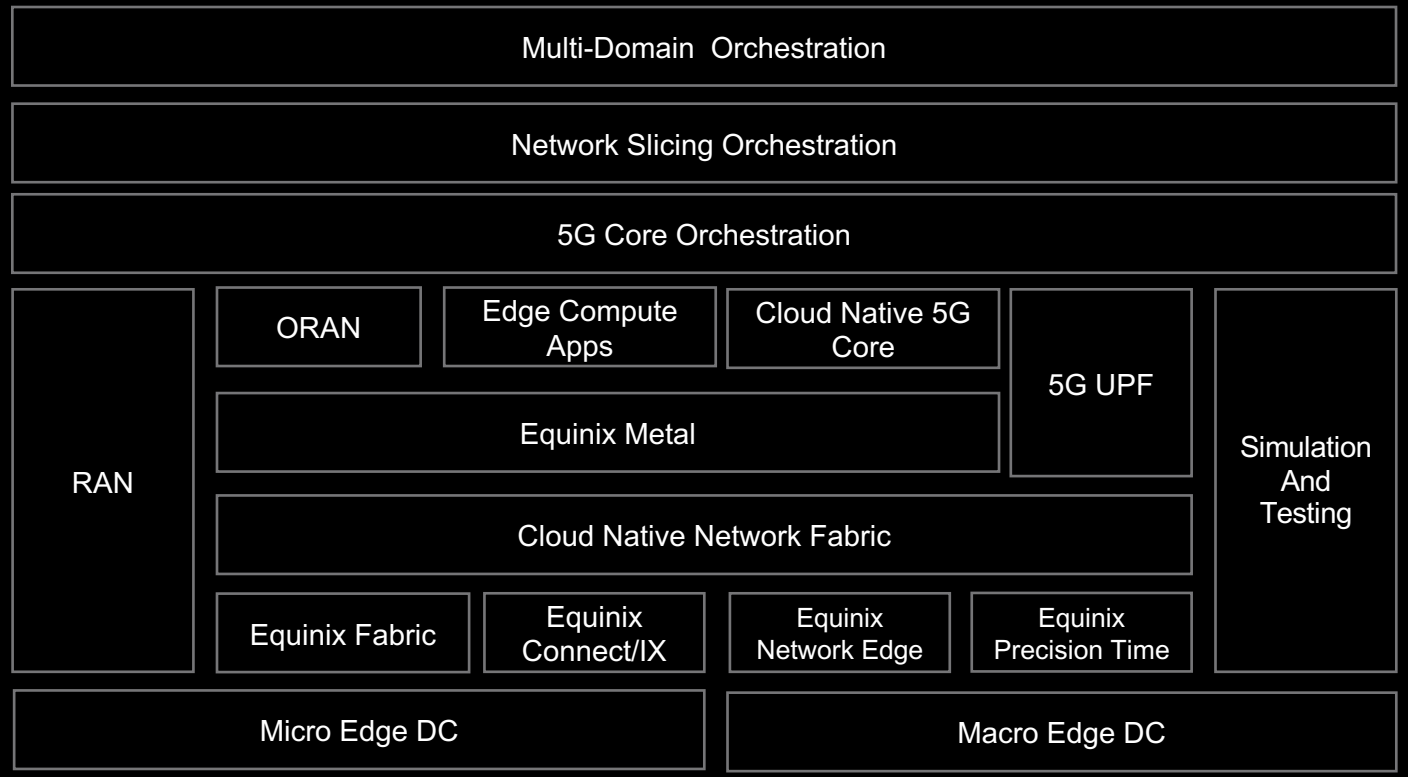
Call for Collaboration (Better Together)

Industry engagements – 5G and edge

- Equinix 5G and Edge Technology Development Center
  - Develop 5G and edge architectures leveraging ecosystems already in place at Equinix
  - Explore hybrid multicloud interconnectivity scenarios between MNOs, public clouds and private infrastructures
  - Develop multiparty business models, partnering strategies and go-to-market motions for 5G and edge market



Call for Collaboration (Better Together)

Industry engagements – open-source & developer community

- LF Edge – The Linux Foundation
  - Premier member (top-level membership)
  - Governing Board member
  - Technical Steering Committee Co-Chair of Akraino project
  - Technical lead for Public Cloud Edge Interface blueprint
- LF Networking – The Linux Foundation
  - Silver member (standard membership)
- CNCF (Cloud Native Computing Foundation) – The Linux Foundation
  - Gold member (2nd-top-level membership)
  - Governing Board member


EQUINIX