

Blueprint Proposal: Public Cloud Edge Interface Family

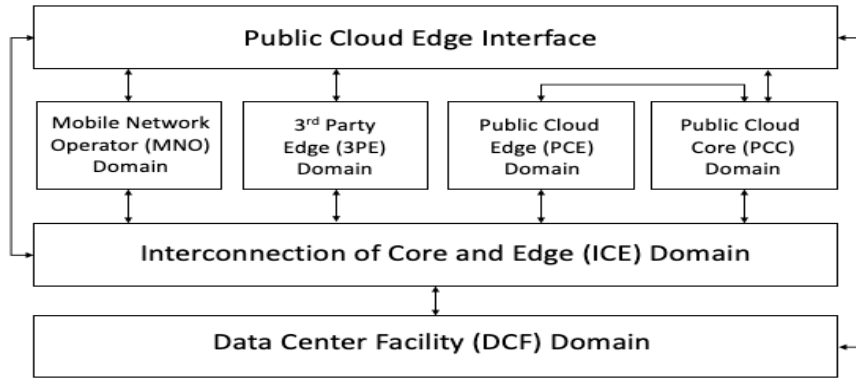
(Type 2: Federated Multi-Access Edge Cloud Platform)

KubeEdge MEC Team (Futurewei, China Unicom, China Mobile, Huawei...)

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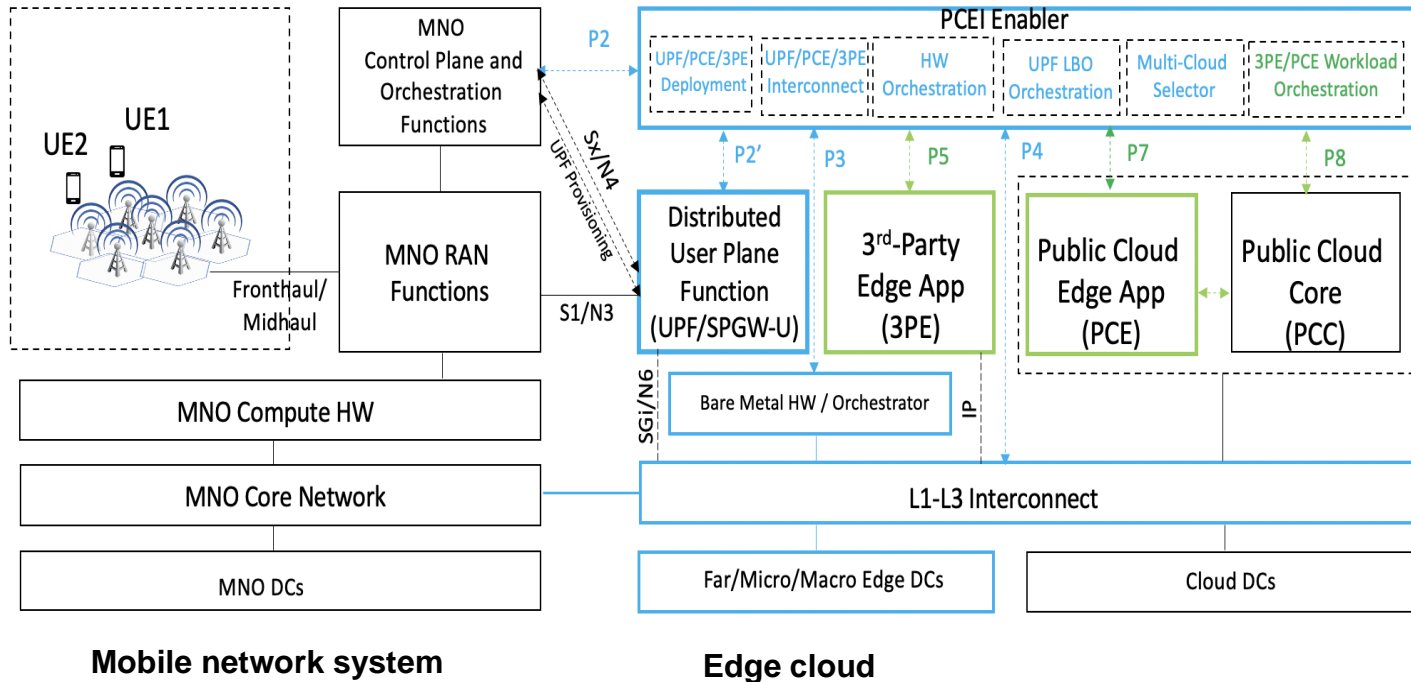
PCEI Overview



The purpose of Public Cloud Edge Interface (PCEI) Blueprint family is to specify a set of open APIs for enabling Multi-Domain Inter-working across functional domains that provide Edge capabilities/applications and require close cooperation between the Mobile Edge, the Public Cloud Core and Edge, the 3rd-Party Edge functions as well as the underlying infrastructure such as Data Centers, Compute hardware and Networks.

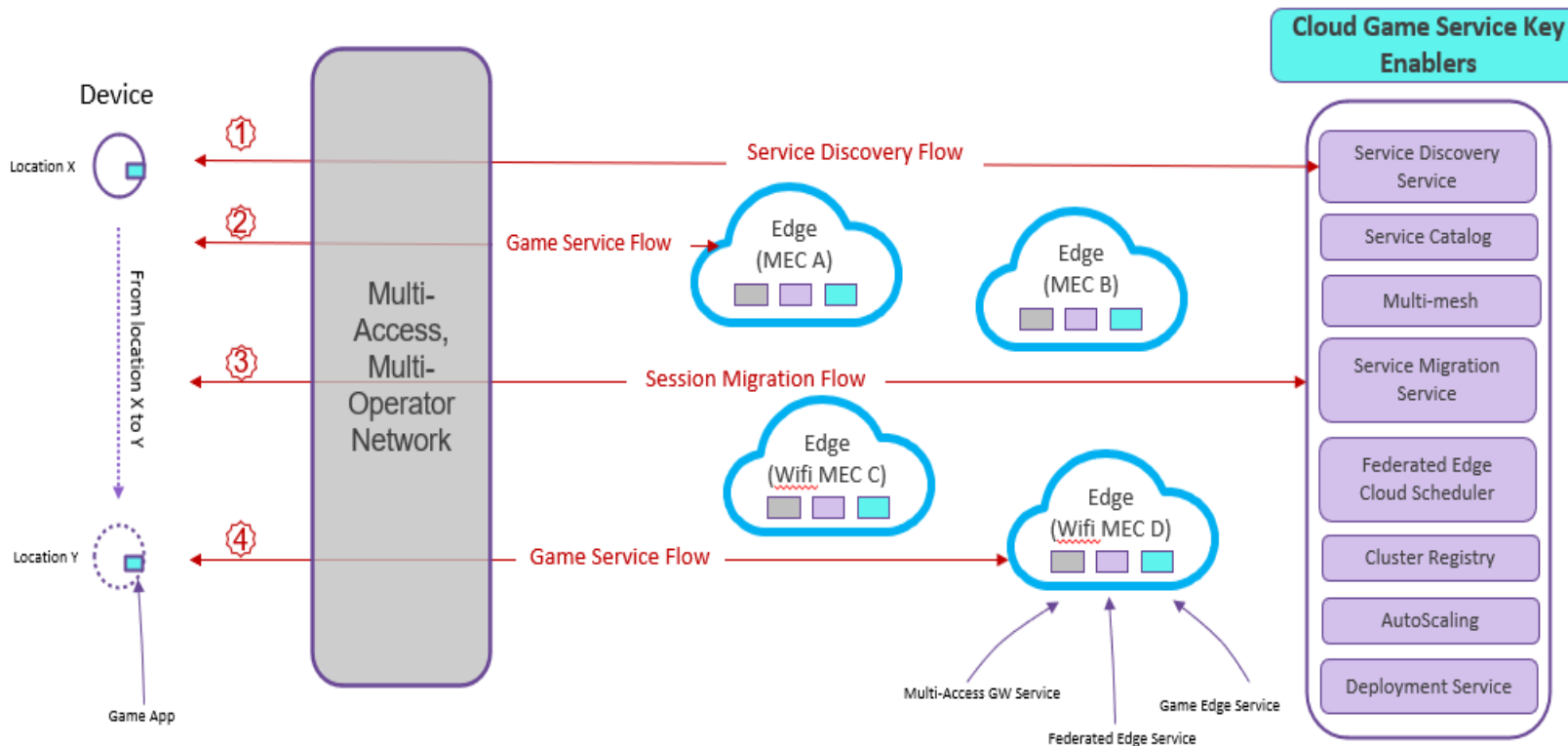
Use Cases

- > **Distributed Online/Cloud Gaming.**
- > Traffic Steering/UPF Distribution/Shunting capability -- distributing User Plane Functions in the appropriate Data Center Facilities on qualified compute hardware for routing the traffic to desired applications and network/processing functions/applications.
- > Local Break-Out (LBO) – Examples: video traffic offload, low latency services, roaming optimization.
- > Location Services -- location of a specific UE, or identification of UEs within a geographical area, facilitation of server-side application workload distribution based on UE and infrastructure resource location.
- > QoS acceleration/extension – provide low latency, high throughput for Edge applications. Example: provide continuity for QoS provisioned for subscribers in the MNO domain, across the interconnection/networking domain for end-to-end QoS functionality.
- > Network Slicing provisioning and management - providing continuity for network slices instantiated in the MNO domain, across the Public Cloud Core/Edge as well as the 3rd-Party Edge domains, offering dedicated resources specifically tailored for application and functional needs (e.g. security) needs.
- > Mobile Hybrid/Multi-Cloud Access - provide multi-MNO, multi-Cloud, multi-MEC access for mobile devices (including IoT) and Edge services/applications
- > Enterprise Wireless WAN access - provide high-speed Fixed Wireless Access to enterprises with the ability to interconnect to Public Cloud and 3rd-Party Edge Functions, including the Network Functions such as SD-WAN.



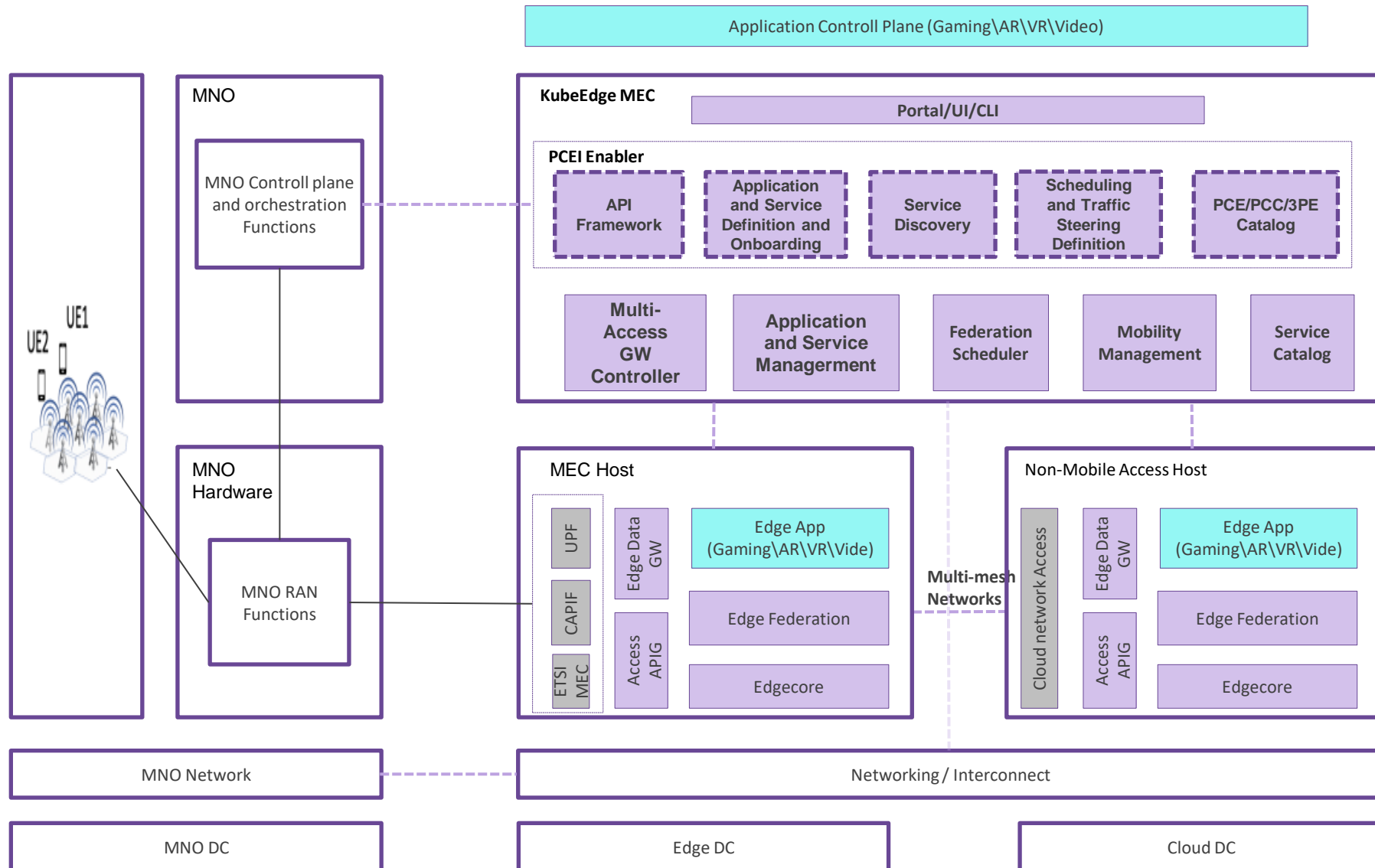
Proposed Blueprint Introduction

Use Case Scenario

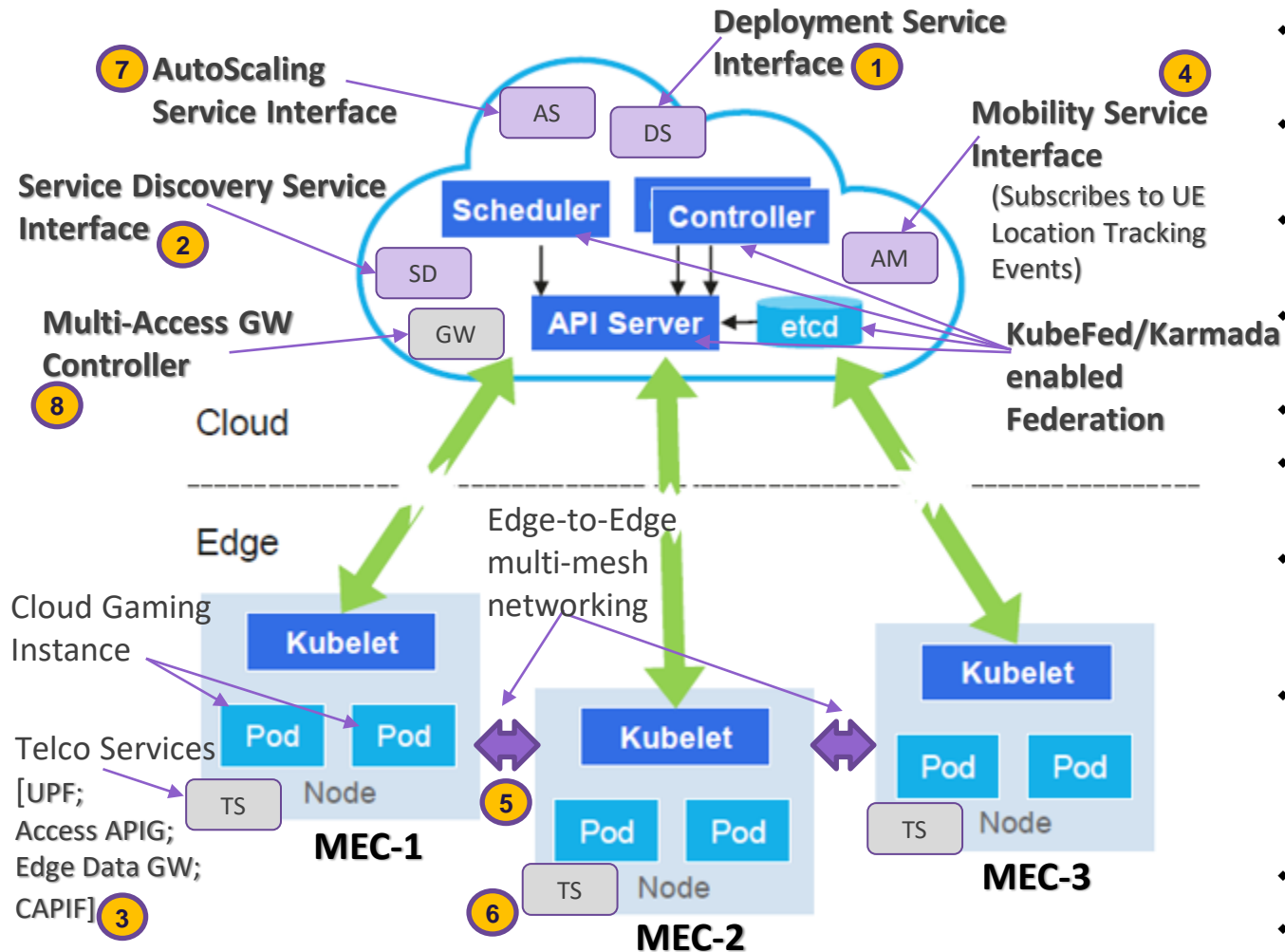


- ❖ Type II of PCEI family focuses on solution with a mobile game deployed across multiple heterogeneous edge nodes using various network access modes including mobile and Wifi.
- ❖ The key component is a federated multi-access edge cloud platform – it features several key components.
- ❖ The platform sits between applications and underlying heterogeneous edge infrastructure and also abstracts the multi-access interface and exposes application developer friendly APIs.
- ❖ This blueprint leverages upstream project KubeEdge as baseline platform – this includes the enhanced KubeFed compatible federation function.

PCEI KubeEdge – Functional Diagram



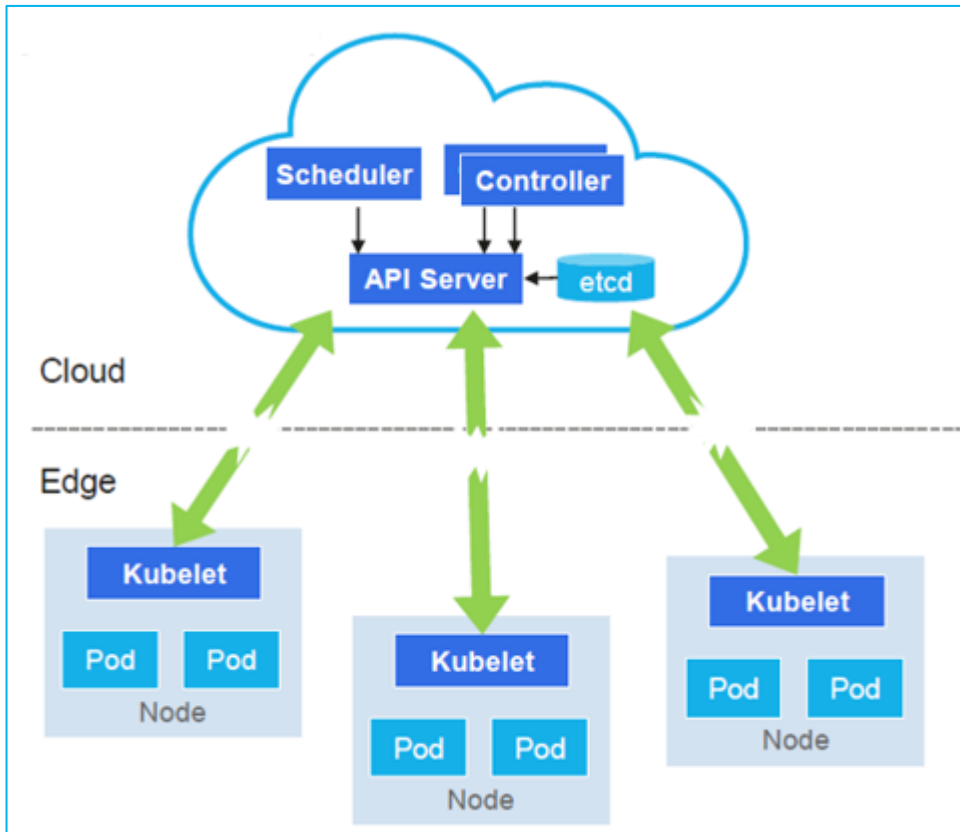
Cloud Gaming Detail Flow using KubeEdge



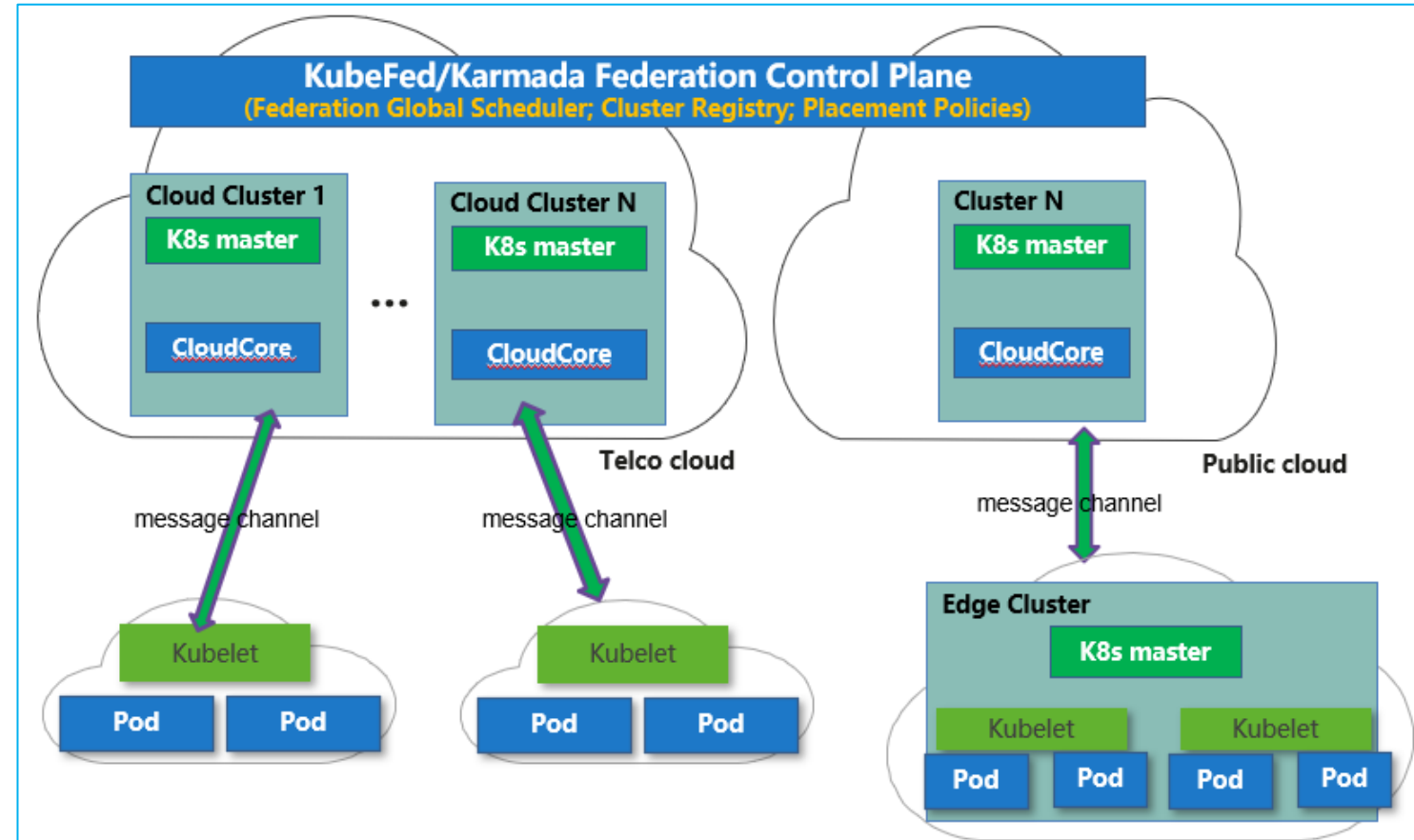
- ❖ KubeEdge provides the logical MEC station abstraction by using K8S labels to group edge nodes into logical MEC stations. ①
- ❖ Operator deploys cloud gaming workload to the specified MEC station/s in accordance to the MEC application placement policies. ①
- ❖ UE retrieves the optimal location-aware endpoint address of the edge node (using **cloud core side Service Discovery service interface**). ②
- ❖ UE establishes session to the retrieved edge cloud telco UPF service (provides support for multi-access protocols). ③
- ❖ UE connects to the cloud gaming service instance on the edge node.
- ❖ **Cloud Core side mobility service** subscribes to UE location tracking events or resource rebalancing scenario. ④
- ❖ Upon UE mobility or resource rebalancing scenario, **mobility service uses Cloud core side Service Discovery service interface** to retrieve the address of new appropriate location-aware edge node. ②
- ❖ **Cloud Core side mobility service** initiates UE application state migration process between edge nodes.
 - ❖ **Edge-to-Edge** state migration (using east-west multi-mesh networking). ⑤
- ❖ UE connects to new edge telco UPF service. ⑥
- ❖ Redirect UE connection to the new cloud gaming service instance on the new edge node.

Multi-Operators Deployment Topologies

Soft Multitenancy using one K8S cluster (Current KubeEdge)



Hard Multitenancy using multiple autonomous K8S clusters (Federated KubeEdge)



Key Enabling Cloud Components



- ❖ **Service Discovery:** Retrieves the endpoint address of the edge cloud service instance depending on the UE location, network conditions, signal strength, delay, App QoS requirements etc.
- ❖ **Mobility Management:** Cloud Core side mobility service subscribes to UE location tracking events or resource rebalancing scenario. Upon UE mobility or resource rebalancing scenario, mobility service uses Cloud core side Service Discovery service interface to retrieve the address of new appropriate location-aware edge node. Cloud Core side mobility service subsequently initiates UE application state migration process between edge nodes.
- ❖ **Federation Scheduler:** As a “Global Scheduler”, responsible for application QoS oriented global scheduling in accordance to the placement policies. Essentially, it refers to a decision-making capability that can decide how workloads should be spread across different clusters similar to how a human operator would. It maintains the resource utilization information for all the MEC edge cloud sites.
- ❖ **Multi-Mesh:** Provides support for service mesh capabilities for the edge clouds in support of microservice communication cross cloud and edges.
(<https://github.com/kubeedge/kubeedge/blob/master/docs/proposals/edgemesher-design.md>)

Key Enabling Cloud Components (Cont ...)



- ❖ **Multi-Access Gateway:** Multi access gateway controller manages Edge Data Gateway and Access APIG of edge nodes. Edge data gateway connects with edge gateway (UPF) of 5g network system, and routes traffic to containers on edge nodes. Access APIG connects with the management plane of 5g network system (such as CAPIF), and pulls QoS, RNIS, location and other capabilities into the edge platform.
- ❖ **AutoScaling:** Autoscaler provides capability to automatically scale the number of Pods (workloads) based on observed CPU utilization (or on some other application-provided metrics). Autoscaler also provides vertical Pod autoscaling capability by adjusting a container's "CPU limits" and "memory limits" in accordance to the autoscaling policies.
- ❖ **Service Catalog:** It provides a way to list, provision, and bind with services without needing detailed knowledge about how those services are created or managed.
- ❖ **Cluster Registry:** It tracks a collection of clusters inventory which can store per cluster metadata.

Use Case Details

| Attributes | Description | Information |
|---|---|-------------|
| Type | New | |
| Industry Sector | Cloud, Enterprise, Telco | |
| Business driver | Federated edge cloud imposes challenges in edge service discovery and application migrations in a device/edge/cloud scenario. | |
| Business use cases | | |
| Business Cost - Initial Build Cost Target Objective | | |
| Business Cost – Target Operational Objective | | |
| Security need | KubeEdge supports application-oriented security SPIFFE specifications | |
| Regulations | N/A | |
| Other restrictions | N/A | |
| Additional details | N/A | |

- ❖ Challenges due to **Intra** & **Inter** Operator Roaming
 - ❖ WIFI ↔ WIFI transition
 - ❖ 5G ↔ 5G transition
 - ❖ WIFI ↔ 5G transition

KubeEdge – a brief overview

- Built upon Kubernetes, 100% compatible with Kubernetes APIs
- Optimized node components and runtimes for edge
- Bidirectional multiplexing message channel
- Metadata persistence at the edge, local autonomy
- Support for extensive edge applications and protocols
- Simplified access and control of edge devices
- Unified management of cloud and edge applications and resources



KubeEdge

<https://kubedge.io>



KubeEdge Architecture

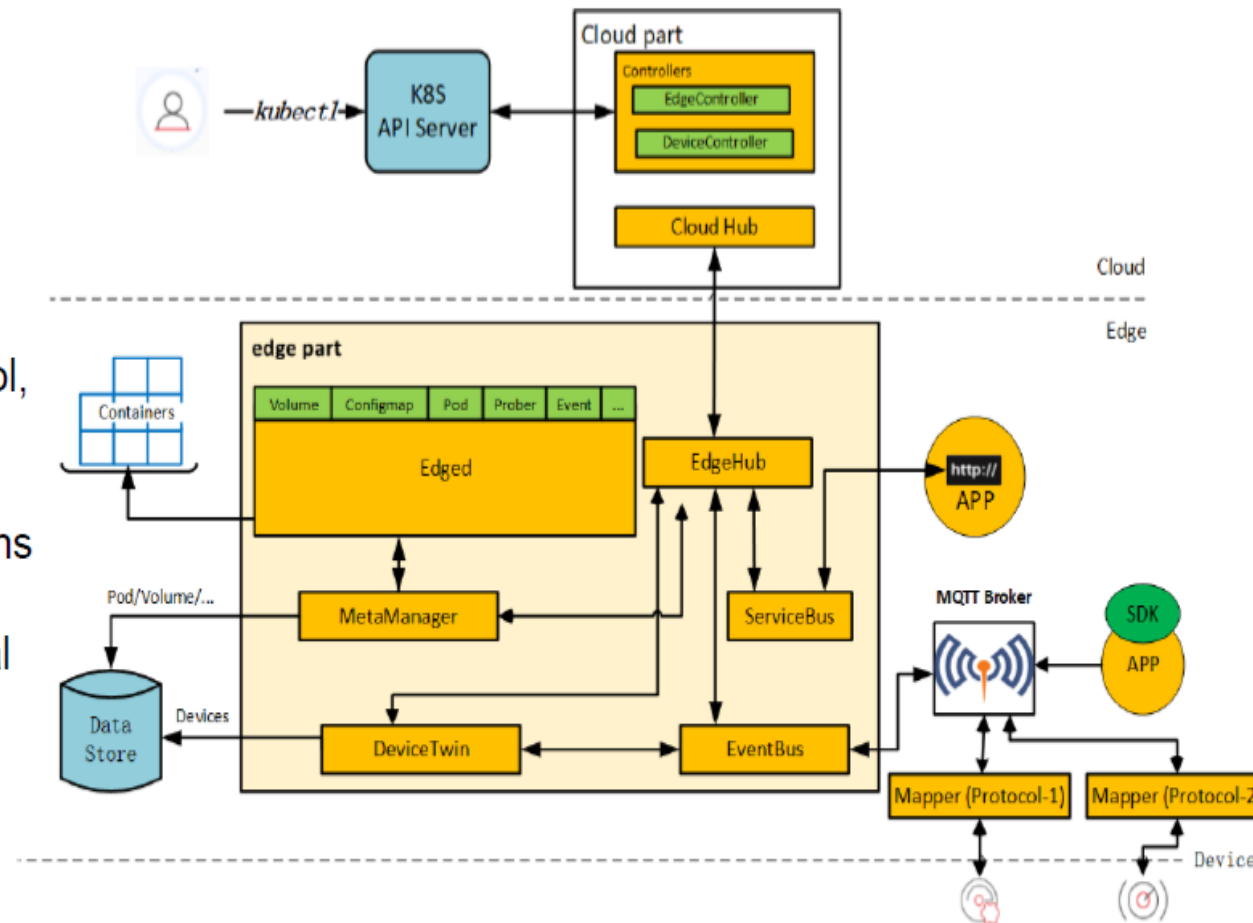
An extensible framework to maximize the compute power at edge

Local persistent metadata management

An Edge-Cloud channel not just for node control, but also for application

Enables node-cloud, node-node communications

Enabler for digital transformation of the physical world



Thank You!