Blueprint Proposal: Public Cloud Edge Interface Family
(Type 2: Federated Multi-Access Edge Cloud Platform)

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The purpose of Public Cloud Edge Interface (PCEI) Blueprint family is to specify a set of open APIs for enabling Multi-Domain Interworking 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.
Typical PCEI 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.

- **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.

- **Local Break-Out (LBO)** – Examples: video traffic offload, low latency services, roaming optimization.
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.

A simulated mobile access environment is used to mimic a real time device access condition changes.

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.
Use Case Scenario

Multi-Access, Multi-Operator Network

1. Service Discovery Flow
2. Game Service Flow
3. Session Migration Flow
4. Game Service Flow

Cloud Game Service Key Enablers
- Service Discovery Service
- Service Catalog
- Multi-mesh
- Service Migration Service
- Federated Edge Cloud Scheduler
- Cluster Registry
- AutoScaling
- Deployment Service

Edge (MEC A)
Edge (MEC B)
Edge (Wifi EC C)
Edge (Wifi EC D)

Multi-Access GW Service
Federated Edge Service
Game Edge Service

Device

Location X

From location X to Y

Location Y

Game App

Game Service Flow

Service Discovery Flow

Session Migration Flow
KubeEdge provides the logical MEC station abstraction by using K8S labels to group edge nodes into logical MEC stations. 

Operator deploys cloud gaming workload to the specified MEC station/s in accordance to the MEC application placement policies.

UE retrieves the optimal location-aware endpoint address of the edge node (using cloud core side Service Discovery service interface).

UE establishes session to the retrieved edge cloud telco UPF service (provides support for multi-access protocols).

UE connects to the cloud gaming service instance on the edge node.

Cloud Core side application migration service subscribes to UE location tracking events or resource rebalancing scenario.

Upon UE mobility or resource rebalancing scenario, application migration service uses Cloud core side Service Discovery service interface to retrieve the address of new appropriate location-aware edge node.

Cloud Core side application migration service initiates UE application state migration process between edge nodes.

Edge-to-Edge state migration (using east-west multi-mesh networking).

UE connects to new edge telco UPF service.

Redirect UE connection to the new cloud gaming service instance on the new edge node.
Disparate Multi-Access Protocols Migration Challenges

- Challenges due to **Intra** & **Inter** Operator Roaming
  - WIFI ↔ WIFI transition
  - 5G ↔ 5G transition
  - WIFI ↔ 5G transition
KubeEdge Project 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://kubeedge.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
Multi-Operators Deployment Topologies

Soft Multitenancy using one K8S cluster (Current KubeEdge)

Hard Multitenancy using multiple autonomous K8S clusters (Federated KubeEdge)

Cluster Registry
Uber Scheduler
Placement Policies

Cloud

Edge

Scheduler
Controller
API Server
etcd

KubeFed

Cloud

Edge

Scheduler
Controller
API Server
etcd

KubeFed

Kubelet
Pod
Pod
Node

Scheduler
Controller
API Server
etcd

Kubelet
Pod
Pod
Node

Kubelet
Pod
Pod
Node

Kubelet
Pod
Pod
Node
Thank You!