Telco Edge Cloud Forum

Meeting 04

10th March 2022

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- **DON'T** enter into agreements that restrict other parties' actions or creates barriers to market entry
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Agenda TEC Forum – 10th March 2022

Topic	Presenter	Time
1. Welcome • Summary of achievements and differential value of TEC	• Juan Carlos Garcia (TEF) • Jason Hoffman (MEX)	10 min
2. Operator Platform and OPAG Update • Evolution of Operator Platform - API exposure harmonisation • Operator Platform - From specification to reality	• Alexander Harmand (TEF) • Shamik Mishra (Capgemini)	30mins
3. Session 1: Value of TEC and TEC Trials **a) Fireside chat on TEC value and benefits** **b) GSMA Foundry TEC Trials** • 5G XR Global MEC PaaS Trial (KDDI,DT, MEX) • Holoverse Trial (TEF, DT, TIM, MEX)	• Jason Hoffman (MEX), Juan Carlos Garcia (TEF) • Hiroshi Sankoh (KDDI) • David Moro (TEF)	30mins 20mins
4. **Session 2: Network Integration and Federation** • Network integration and edge use cases • Platform Federation activities - Multi-platform Hub	• Javier Valle De Soto (Ericsson) • Bridge Alliance, Singtel, MEX & TEF	30mins
5. **Conclusions and Q&A**	• Juan Carlos Garcia (TEF)	10mins

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TEC Achievements & Differential Value

Juan Carlos Garcia (Telefonica) and Jason Hoffman (MobiledgeX)

10th March 2022

TEC Achievements – Industry Leadership

Industry Leadership

- 45 MNOs with Global Telco Edge Cloud footprint
- 11 MNOs with multi-operator, public TEC demonstration
- Global Federation

Commercialization

- Wholesale Applications and Services Group Kick-Off
- 3 Year Roadmap

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TEC Achievements - Positioning

Explain the value and benefits

Show and check the value

Value proposition

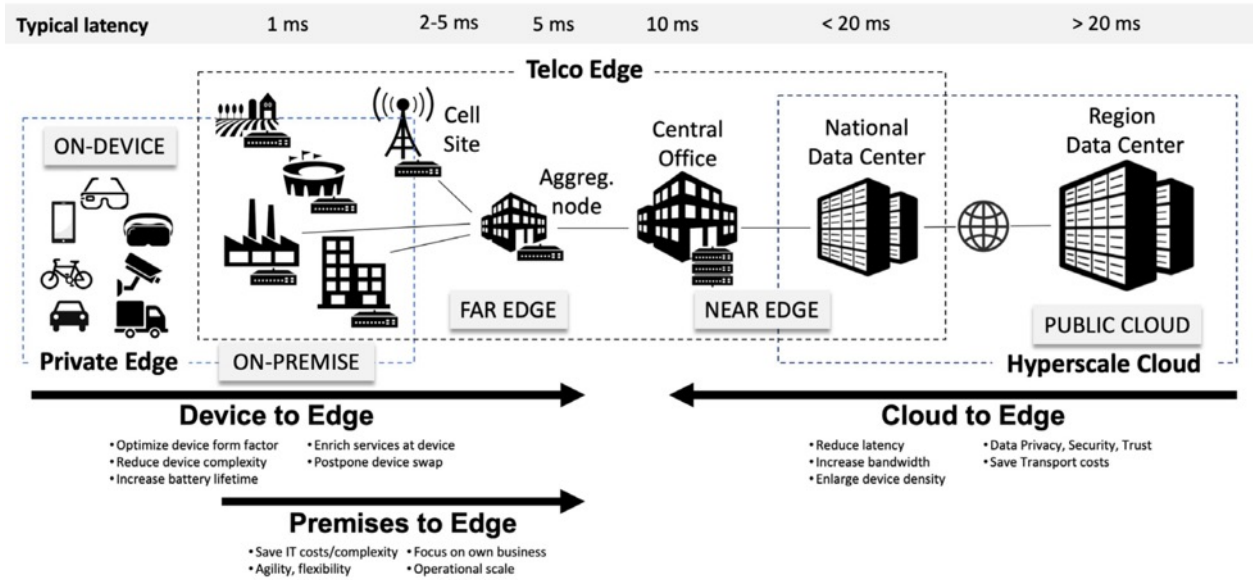
Application categories

Benefits for Stakeholders

+

Use Case Trials

Customer Insights



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TEC Differential Value

- **Core Competency**
  - Low Latency
  - High Bandwidth
- **Value of Telco Edge Cloud**
  - Performance Critical
  - Service Continuity
  - Trust, Highly Secure
  - Network Reliability
- **Edge Native Applications**
  - Network Applications
  - Real-time Data Applications
  - Immersive Applications
  - Vehicle Control Applications

Network

- 4G, 5G, 6G
- Developer consumption experience

Real Time Data

- Pipeline automation
- CV, ML, AI
- Services along the flow

Immersive

- Pervasive
- Multi-Model, Multi-Device
- Personalization
- Interactive
- Local content
- AR/MR
- Metaverse

Autonomous Control

- M2M
- Devices that move or execute independent actions

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Operator Platform API Group

Operator Platform Group

10th March 2022

Agenda

- Operator Platform API Group (OPAG)
- Current main focus areas
- SDOs mapping
- Interfaces definitions
- CAMARA relationship
- Conclusions and next steps

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Operator Platform API Group (OPAG) Introduction

Alexandre Harmand (Telefonica)

10th March 2022

Operator Platform API Group (OPAG)

Scope: Drive the availability of develop-centric APIs realising the interfaces required for an Operators Platform (OP) by landscaping the suitable APIs available from SDOs and collaborating with Linux Foundation's CAMARA project where gaps exist

Timeline: Started in November 2021

Current activity: Weekly calls

Members: 35 in IC2 (18 operators, 17 non-operators)
Companies: 13 operators, 12 non-operators

Alexandre Harmand
Telefonica
OPAG Chair

Jason Hoffman
MobiledgeX
OPAG Deputy Chair

Faisal Zia
GSMA
OPAG Co-ordinator

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OPAG to drive OP development

Why?	In 2021 The GSMA did a great job in defining the Operator Platform concept. That is now understood and endorsed by the industry through the publishing of the OP white paper and PRD. To foster the development of the concept a stage 2 and stage 3 definition of the interfaces is required. Furthermore the market identified the need to build a service API layer northbound to OP in order to ease developer/customer adoptions. CAMARA Project has been built and there is a need for OP to interface to it.
How?	OP API group formed in order to build OP interface specification, manage relationship with CAMARA and major SDOs.
What?	Build stage 2 and stage 3 specification **leveraging seed code and work done in TEC trials**. Define as a priority federation and network interfaces as key differentiator for Telco Edge capability. Ensure adoption of SDO work already available, identify gaps and action plan to filled them. Collaborate with CAMARA to ensure that Service API required by OP are developed, ensure mapping between Service and platform APIs for the system to work properly.

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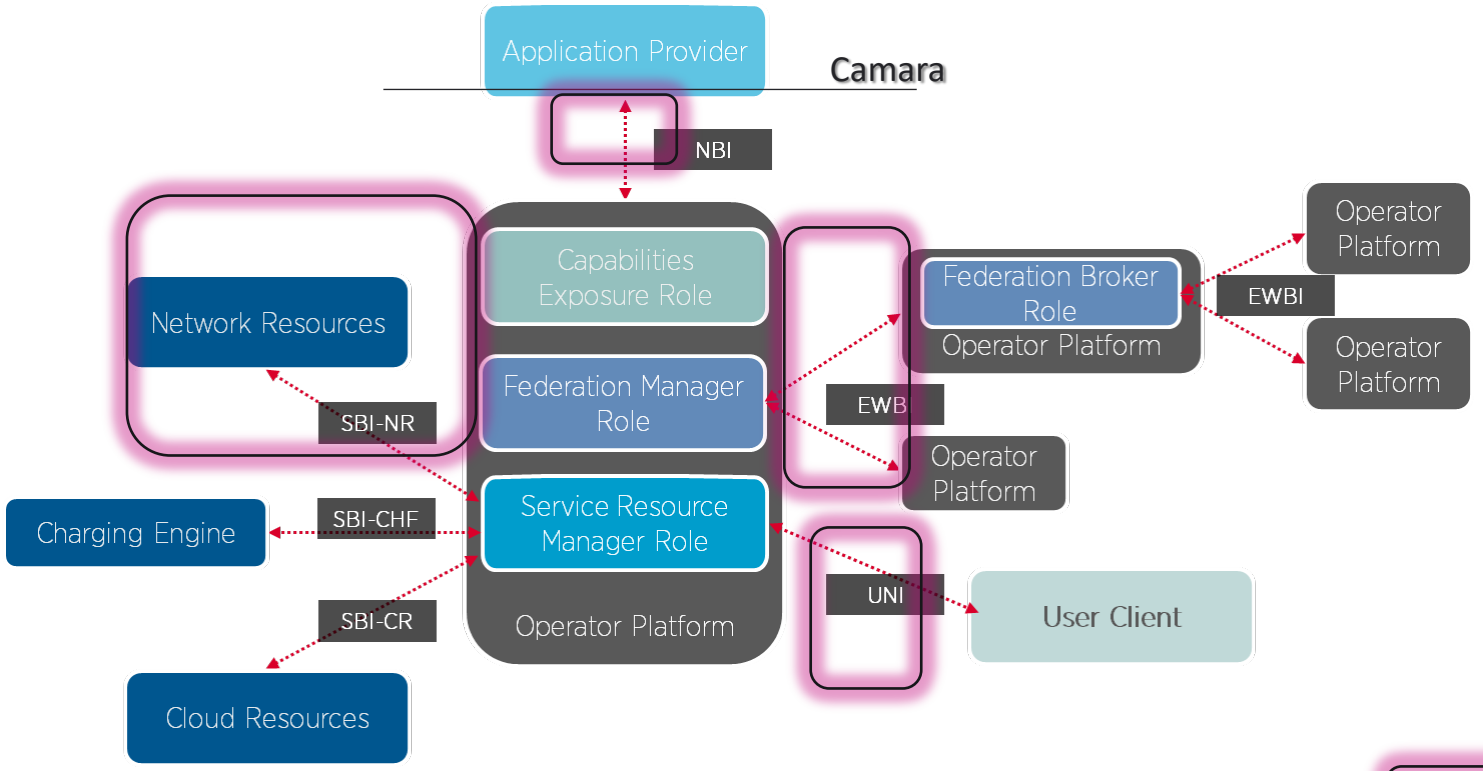
What does OPAG do?

25 Feb 2022

Delivering OP interface definition



Key platform differentials are in federation, network integration and northbound exposure capabilities

Priority in ensuring interface definition for these concepts

Key platform differentials

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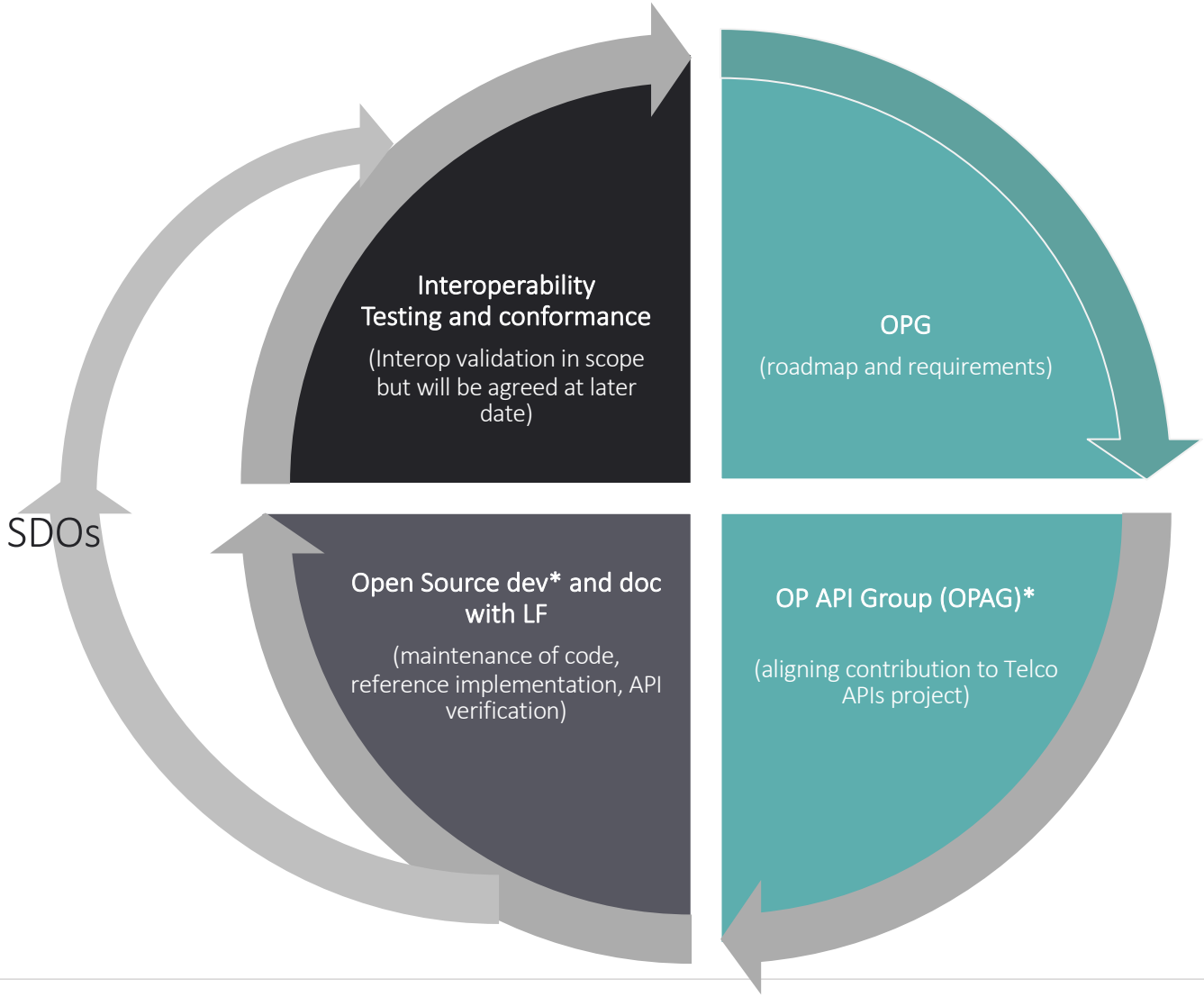
Against a life cycle towards service API development



NOTE: API Subgroup and Linux Foundation (LF) Open Source Development output is to deliver a harmonized set of APIS for interfaces and where appropriate functional blocks, and **NOT** a full platform.

To support standardisation efforts, SDOs will receive two drops:-

1) Requirements after publishing
2) update based on additional requirements and/or documentation on APIs from implementation

Interop testing may cover standards when available.

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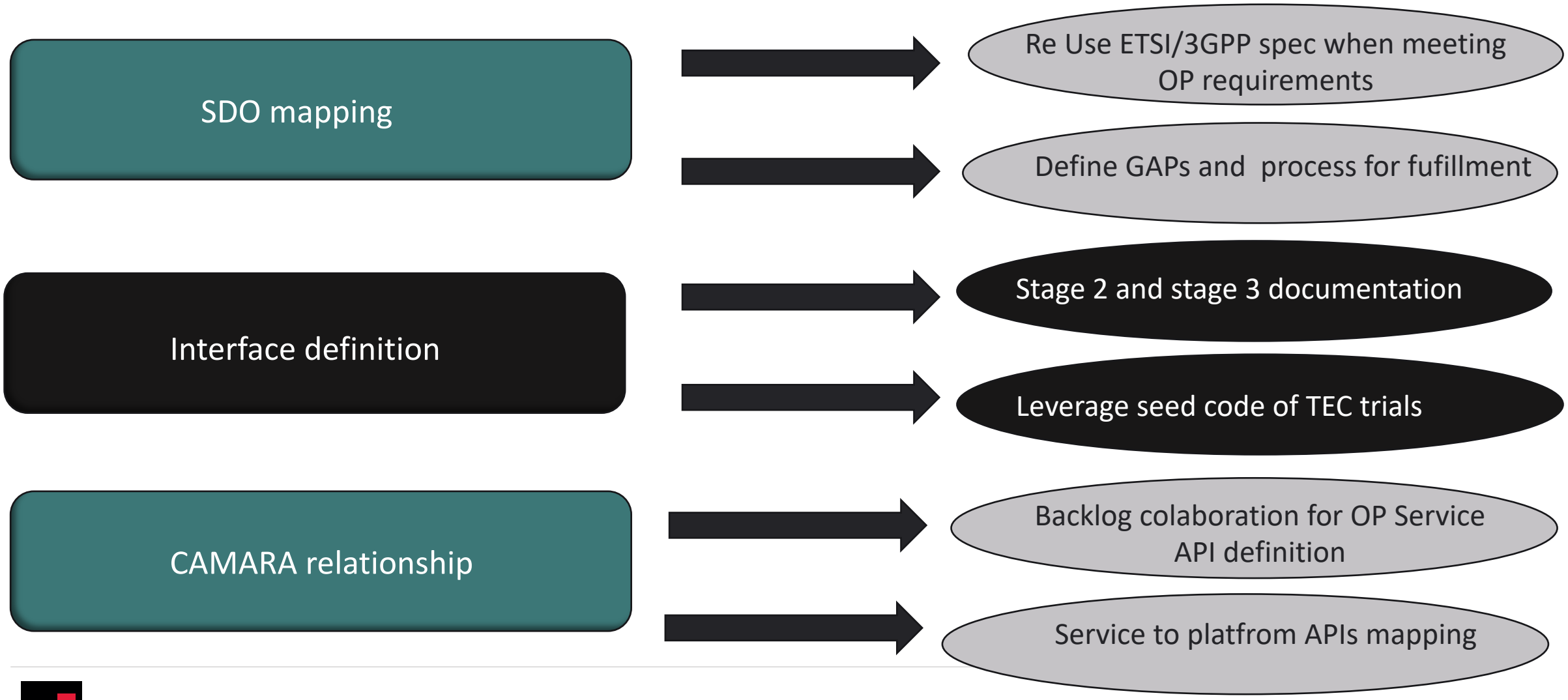
Legend AA.35 ACTIVITY LF ACTIVITY HOST TBC

With three main focus areas



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SDO mapping

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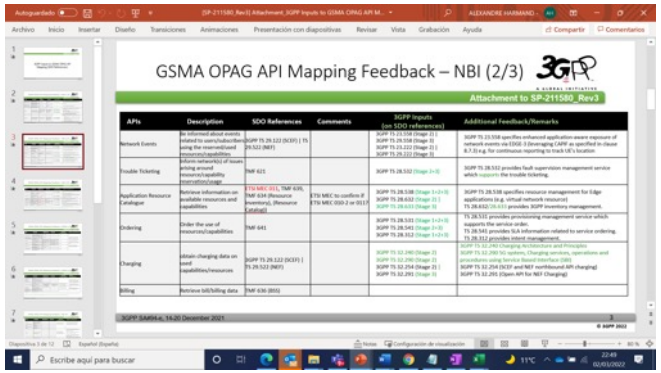
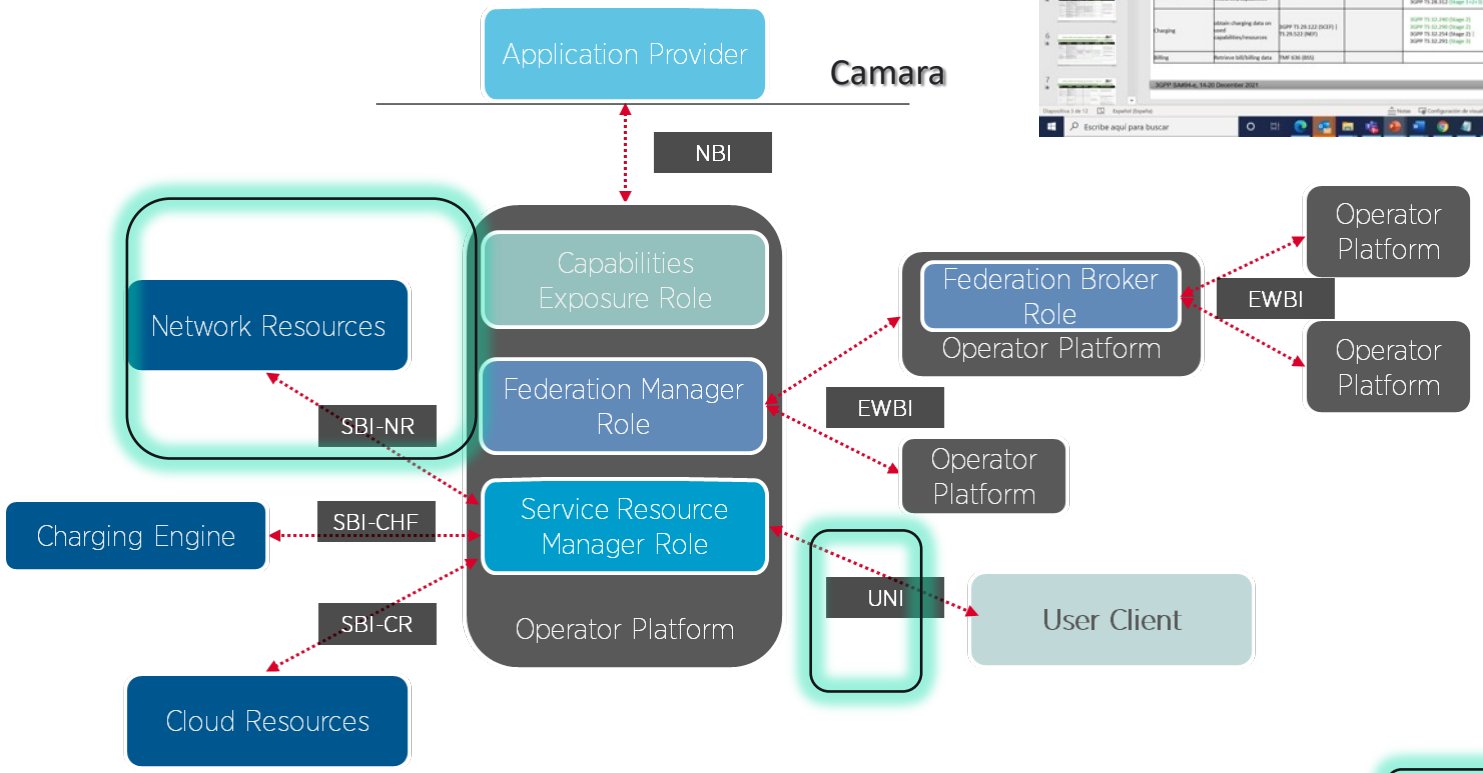
Extensive work already done by ETSI and 3GPP





Good SDO coverage for SBI-NR, UNI

Lack of SDO definition for federation and nortbound capabilities.

SDOs building plan to fulfill GAPs but time for availabiltiy still under definition. **2023-2024?**

Interface with high level of coverage

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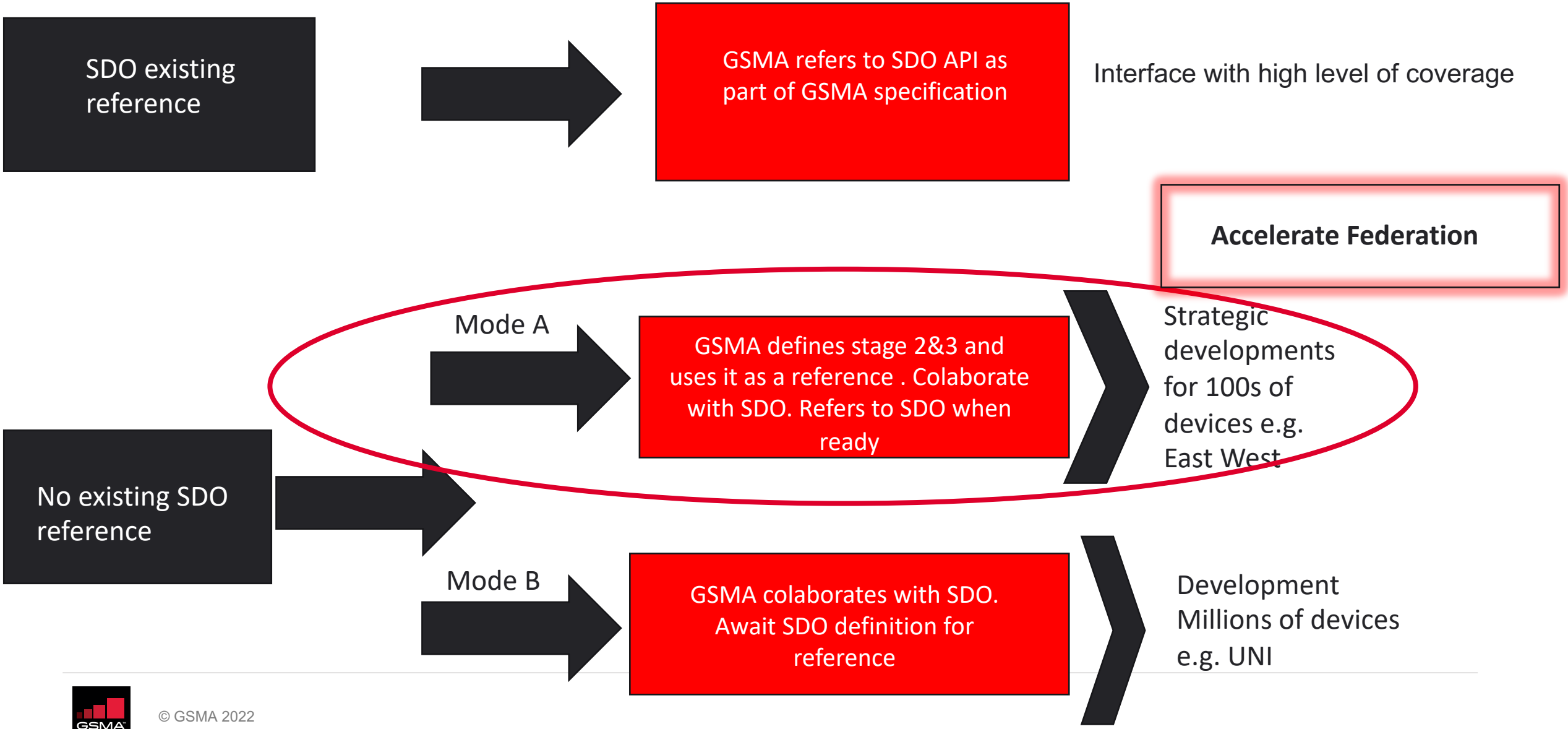
Interconnection and system exposure remain work in progress though in SDOs. There is a need to accelerate



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Interface definition

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Block split for API definition

Block A - Telefonica

- Application Onboarding
- Application Instance Management (Resource Life-Cycle Management)
- East/West Bound Interface Management
- Availability Zone Information Synchronisation Service
- LBO Roaming (Monitoring)
- LBO Roaming (Authentication)
- Edge Node Sharing (resource onboarding & Management)

Federation Definition Support

Low level of SDO coverage
50% of seed code coverage
Key for Edge diferential

Block B - BT

- QoS Management
- Charging
- Billing
- Traffic Influence
- Collecting Network Status / Network Events
- Confirm User Location
- Mobility Triggers
- Mobility Control
- Location Privacy Indicator
- Managing Service availability in LADN
- Application relocation

Network Integration Support

High level of SDO coverage
High impact on CAMARA relationship

Block C - TBC

- Application Resource Catalogue
- Orchestration
- Virtualised Infrastructure Manager
- Container Infrastructure Manager

Orchestration / Cloud Management

Block D - TBC

- Telemetry
- Notifications
- Trouble Ticketing
- Ordering
- User Authentication and Authorisation
- Registration
- Discovery
- Mobility/QoE

Management & Others

Treated as lower priorirty

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With a clear approach

Block A - Telefonica

- Application Onboarding
- Application Instance Management (Resource Life-Cycle Management)
- East/West Bound Interface Management
- Availability Zone Information Synchronisation Service
- LBO Roaming (Monitoring)
- LBO Roaming (Authentication)
- Edge Node Sharing (resource onboarding & Management)

Stage 2 & 3 definition
YAML definition

Used as 1st reference for OP federation

SDO alignment

Block B - BT

- QoS Management
- Charging
- Billing
- Traffic Influence
- Collecting Network Status / Network Events
- Confirm User Location
- Mobility Triggers
- Mobility Control
- Location Privacy Indicator
- Managing Service availability in LADN
- Application relocation

Reference stage 2 & 3 from SDOs

Identify gaps to be taken into account by SDOs

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CAMARA Relationship

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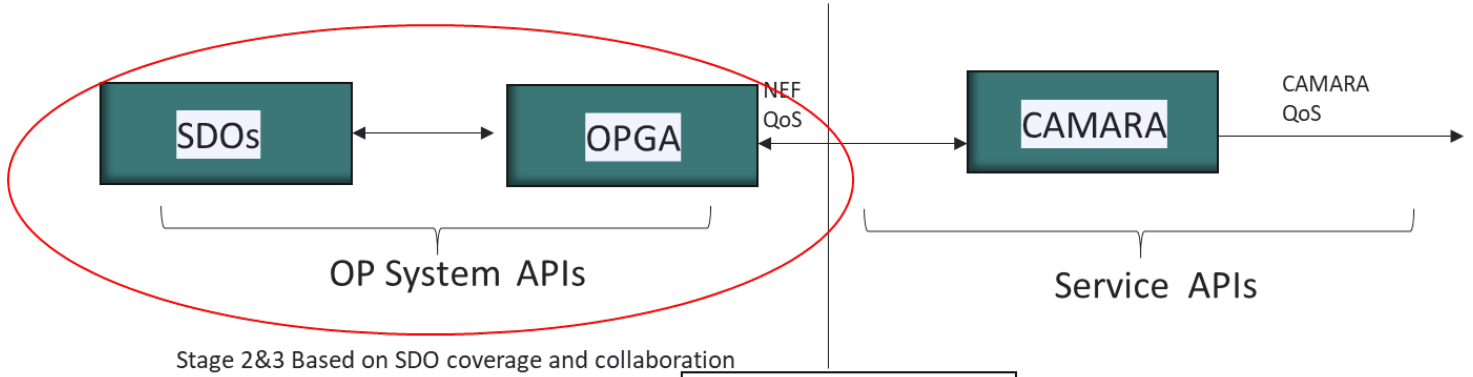
CAMARA relationship awaiting ToR to come to play



Stage 2&3 Based on SDO coverage and collaboration

Stage 2&3 Service APIs

1 OPG A includes Service APIs to be defined in CAMARA Backlog

2 OPG A shares stage 2 & 3 related system API to CAMARA

3 CAMARA defines Service API and Service/system API mapping

OPAG priority for CAMARA backlog

Survey Results

Priority	Topic	Median Priority in survey
1	Application onboarding and image management	1.5
2	Application Instance Management (Resource Life-Cycle Management)	2.5
3	QoS Management	4
4	Telemetry	6.5
5	Traffic Influence	6.5
6	Network Events	7
7	NEW: Confirm User Location	7
8	Notifications	7.5
9	Application Resource Catalogue	7.5
10	Charging	8.5
11	Application relocation	9.5
12	Billing	11.5
13	Trouble Ticketing	11.5
14	Ordering	12.5
15	Managing Service availability in LADN	13

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Top Service API priority for Telco Edge, to be fed and defined with CAMARA

Conclusion and next steps

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Key next steps

Finalise federation and network APIs (Block A&B) stage 2 & 3 definition and referencing- Target April

Kick off CAMARA relationship , ensure OPAG Service APIs needs fufillment and Service API to OPAG system API mapping.

Define approach with SDO to consider OPAG requirements for fullfilling GAPs identified.

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Operator Platform Group

From Specification to Reality

Operator Platform Group

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Operator Platform Group (OPG) Introduction

Structure and scope of the ISIG

Shamik Mishra (Capgemini)

10th March 2022

Operator Platform Group (OPG)

Scope: Develops requirements to offer services to app providers/developers using interoperable network capabilities using a federated platform approach

Timeline: Started in 2020 based on the concept whitepaper from Future Networks

Current activity: Weekly calls to deliver V2.0 in April
Members: 170 in IC2 (94 operators, 76 non-operators)
Companies: 40 Operators & rapporteurs, 35 non-operators + non-members

Sandra Ondrusova
CK Hutchison
OPG Chair

Shamik Mishra
Capgemini
OPG Deputy Chair

Tom van Pelt
GSMA
OPG Co-ordinator

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What does OPG do?

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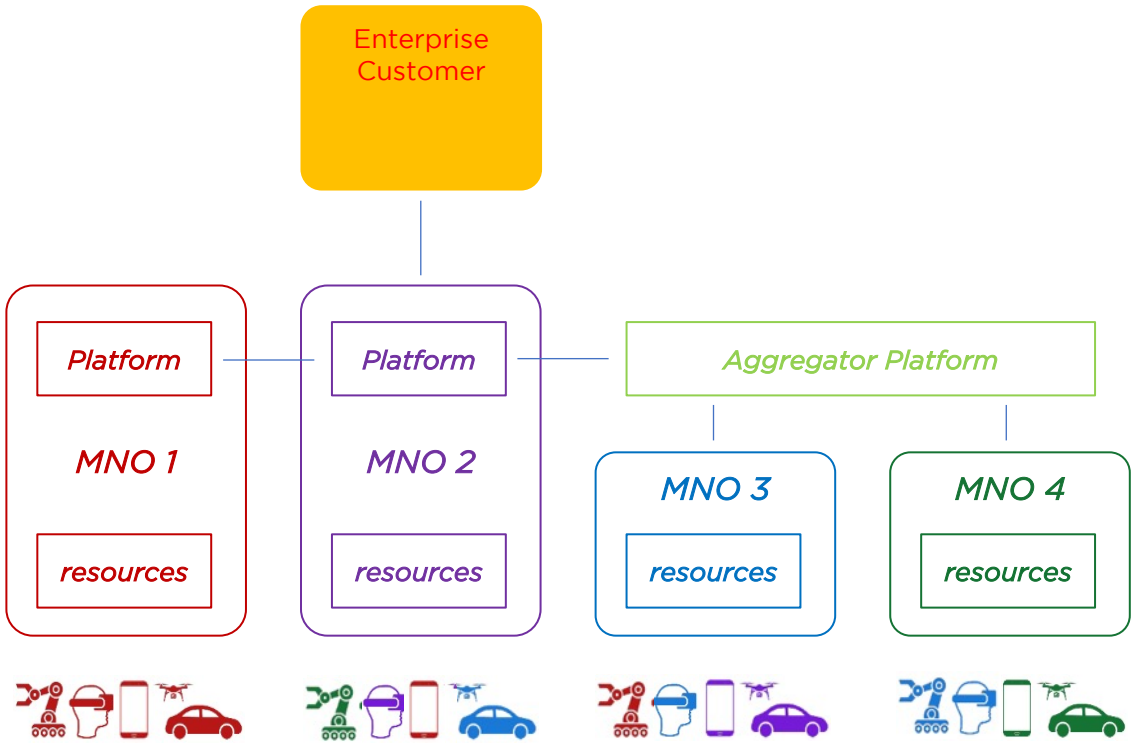
What is the Operator Platform (OP)?



- Operator Platform exposes capabilities in the operator network to 3rd parties
- Initial focus was on Edge Compute
  - Edge is a critical enabler for 5G
- Being extended with other capabilities that would be required in the context of edge
  - e.g. NaaS, Network slicing
- Advantages
  - **FEDERATION**: one party's OP can provide access to capabilities managed by another
  - Interoperability: interfaces are aligned
  - Flexibility: several approaches supported

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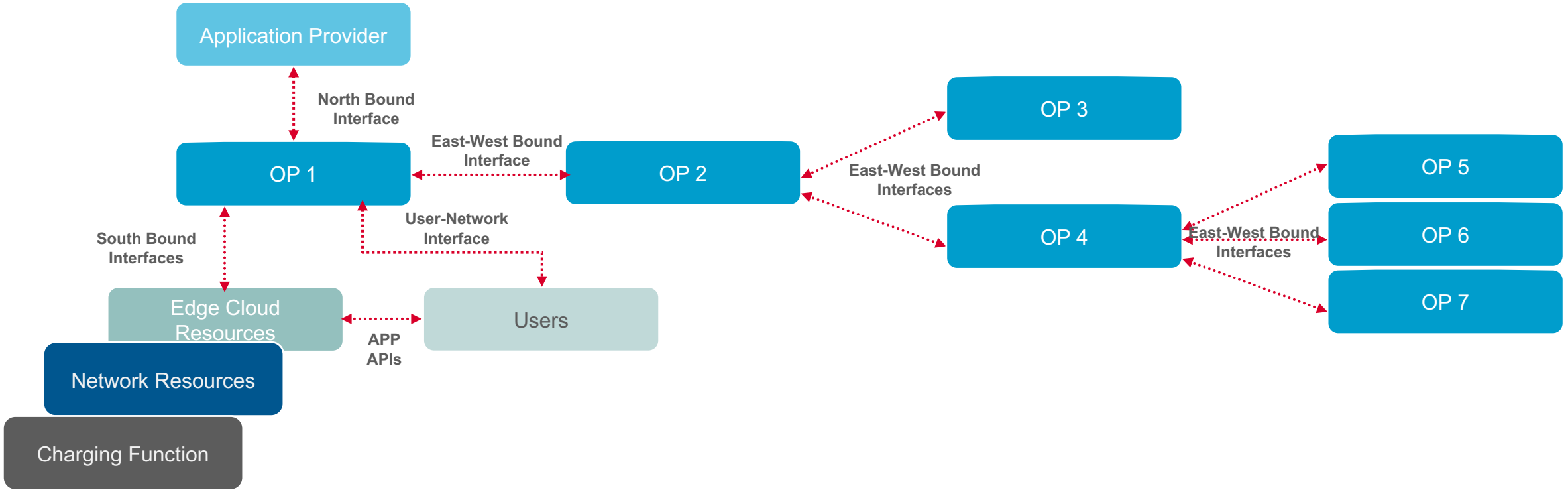
Architectural approach



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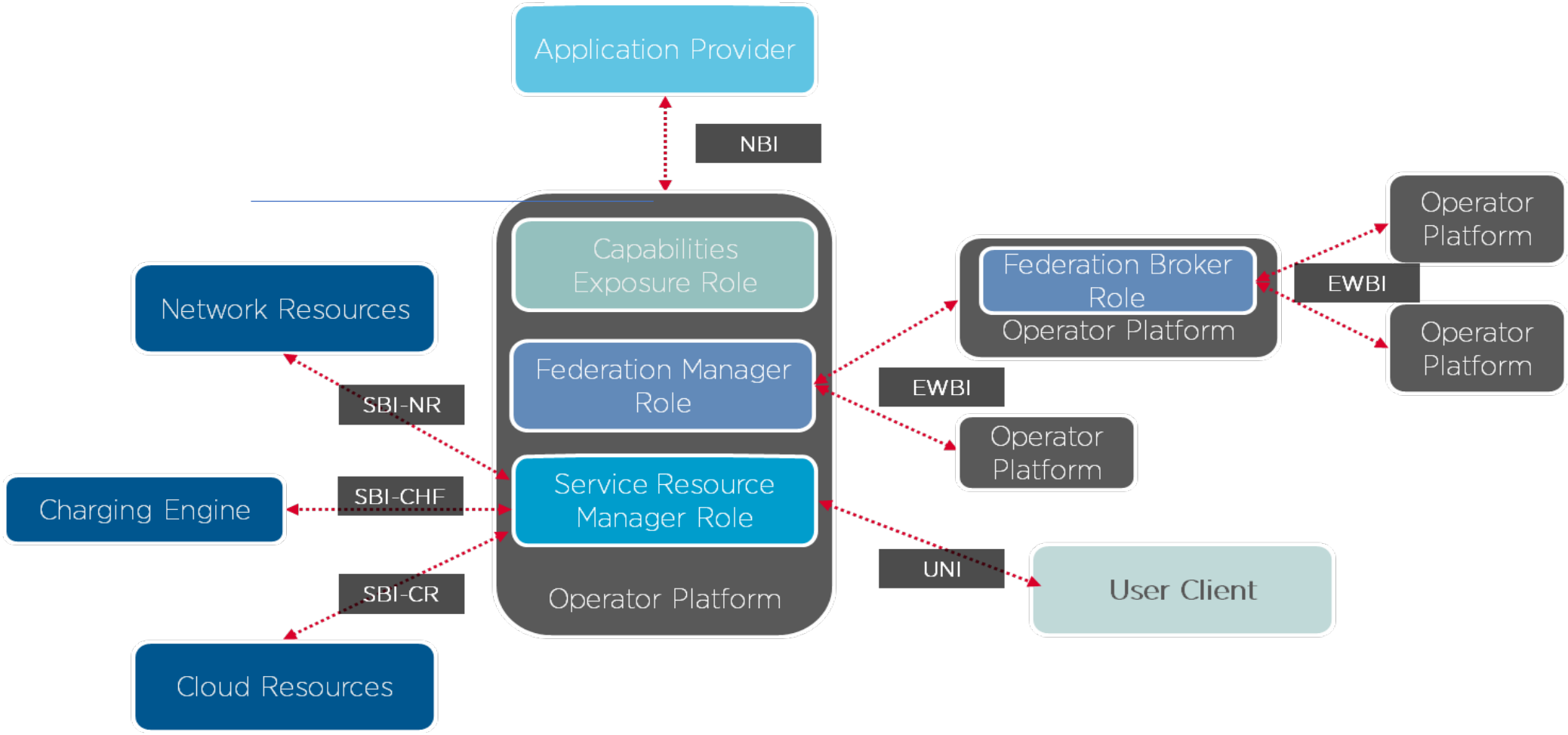
OP Interface Definitions



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Federation

- To be enabled by East-West bound interface
- Should enable:
  - Offering resources/capabilities in other networks to application providers
    - Needs exchange of resource catalogues
  - Lifecycle management and monitoring of resources/capabilities in other networks provided to application providers
  - Access to edge resources and network capabilities in visited networks (i.e. roaming)
  - Sharing of edge resources to/from other networks
  - Low latency interaction between edge resources in different networks

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OPG Work and Published Documents

- Phase 2 delivered the first drop of requirements
- Phase 3 builds and enhances requirements and focuses on API development and contribution to Linux Foundation: Project Camara

Phase 1

Phase 2

Phase 3

Operator Platform Concept Whitepaper, Jan 2020

TEC: Edge Service Description and Commercial Principles Oct 2020

OPTEC Proposal Whitepaper v1 Oct 2020

OP Tech Requirements PRD Jun 21

OP Tech Requirements PRD Apr 22

API development
(collaboration with Linux Foundation)

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OPG Phase 3 – Key Topics

- 16 topics proposed for Phase3
- Challenging timelines - 5 topics prioritised

Seamless service continuity (Capgemini)

Exposure of operator network capabilities beyond edge (MobiledgeX)

Detailed requirements on the Capability Exposure Role (Intel)

Session connectivity models (Ericsson)

Handling of non-SIM devices (GS Labs)

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Support for commercial models

- OP required to be able to track
  - Subscribed capacity and effective usage of compute
  - Subscribed capacity and effective usage of storage
  - Subscribed capacity and effective usage of network resources
  - Subscribed and effective accelerator capacity
  - API usage
- OP required to identify the parties involved in a charging transactions
  - OP(s), Operator(s), Application Provider, Edge application, Availability Zone

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OP and Roaming

- OP exposes Edge Compute and other latency sensitive capabilities
- Conflicts with roaming using home routing to access resources in the home network
- Most use cases relying on OP will need Local Breakout and support in the visited network
- Current assumption: support only needed if visited network is part of federation with the home network
- Some OP applications need/prefer seamless handover between networks
  - E.g. edge-supported self-driving car crossing border
  - OPG starting to look into OP requirements enabling this

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Value of OP for edge computing and other capabilities

The OP makes them a true interoperable operator service

Single entry point to subscribers serviced by all federated OPs

Similar to business voice call do not require connection to each MNO to reach user base

i.e. extends geographic and user base that is offered by MNO/OP provider

Requires alignment in service offered, e.g. similar compute profiles offered

Service in roaming and while mobile

- Similar to voice calls reaching subscribers wherever they are and while on the move
- Edge requires use of nearby compute resources that follow user when moving
  - Ideally with smooth handover between networks cross-border
- Requires the integration with the (packet) core network provided by the OP

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Value of OP for edge computing and other capabilities

The OP makes them a true interoperable operator service

Can link capabilities of different operators

- Similar to voice calls between subscribers on different operators
- Edge applications serving subscribers on different networks may have to interact
  - e.g. gaming against each other or automotive applications cooperating to improve accuracy

Disconnects service offering from capabilities

- Similar to voice call service relying on multiple network capabilities
- Developers may need an offering combining different capabilities
  - e.g. Edge with NaaS and/or slicing
- OP providing access to all capabilities allows to break silos and merge capabilities into a single offering

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Q&A

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Session 1: Value of TEC and GSMA Foundry Trials

- TEC Benefits with Enterprise Testimonials
  - Edge Value & Achievements Whitepaper
  - Customer Insights
  - 2022 TEC Trial Workshop
- TEC Trials
  - Virtual Human Guide (5G XR PaaS)
    - Participants: Sturfee, Mawari, KDDI, Deutsche Telekom, MobiledgeX
    - Presenter: Hiroshi Sankoh, KDDI
  - Holographic Video Conferencing
    - Participants: Double Me, TIM, Telefonica, Deutsche Telekom, Orange France, MobiledgeX
    - Presenter: Name, Telefonica

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Session 1: Value of TEC

- Telco Edge Cloud Benefits with Enterprise Testimonials
  - Introduction (Juan Carlos)
    - Description of Telco Edge Cloud
    - How is Telco Edge Cloud Different?
    - TEC Footprint
  - Value of Telco Edge Cloud (Jason)
    - Platform for Edge Native Applications
    - TEC Trials
  - Benefits for Stakeholders – TEC Impact (Juan Carlos)
    - Customers
    - Developers
    - MNOs
  - Roadmap – Vision for the Future (Jason)
    - From Lab to Commercialization
  - Conclusion (Juan Carlos)
    - 2022 TEC Trial Workshop Preview

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Telco Edge Cloud concept

GLOBAL PLATFORM

TEC is a global platform solution to expose, manage and market edge compute and network resources and capabilities across different operators and national boundaries, leveraging existing and future telco assets.

DIGITAL ONE-STOP-SHOP

A platform solution that packages and offers MNO's unique edge compute and network capabilities for customers to deliver, and end-users to consume, commercial edge services across different networks seamlessly

OPEN AND STANDARD

It combines open cloud technology and telco standards, taking the best of both worlds: the flexibility, agility and scalability of the cloud with the reliability, security, interoperability and portability from the Telco world.

UNIQUE FOR MOBILITY

Due to its optimal integration with the network, it provides a unique solution for mobility and roaming management, especially relevant for moving devices (handsets, vehicles, trucks, drones, etc).

MULTICLOUD, FEDERATED

It federates MNO's edge and network resources enabling a global footprint and giving TEC customers access via a unified easy-to-use interface to leverage single sign-on, global distribution, and a consistent and fast go-to-market.

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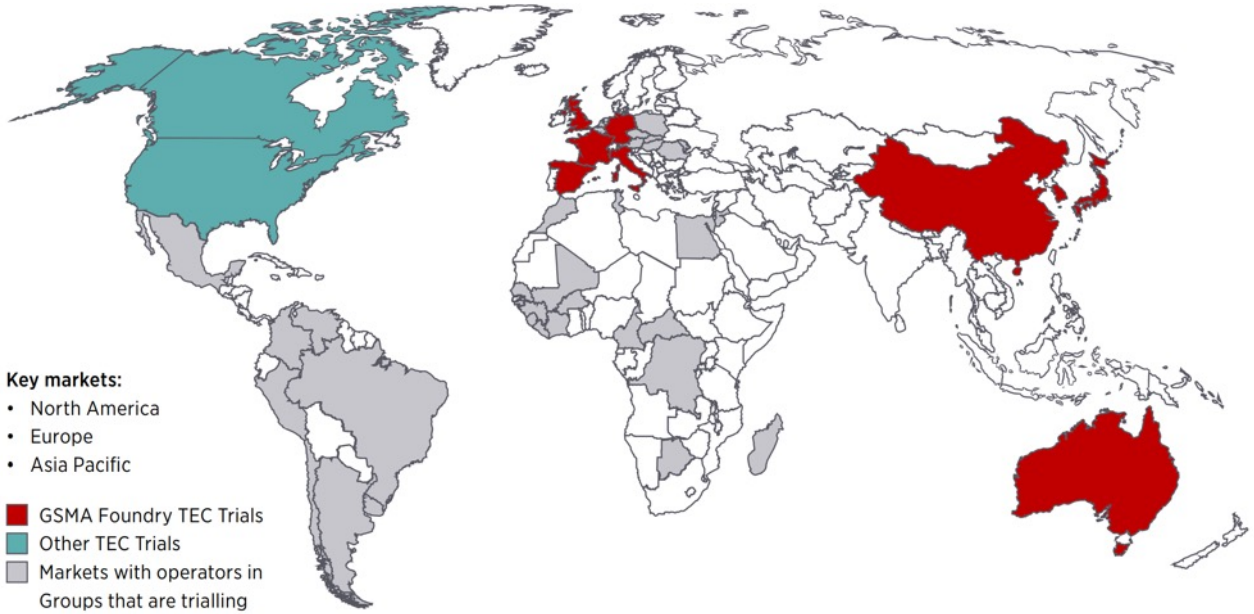
Industry Leadership

After 2 years, OPG and TEC at the GSMA has got to create one of the largest telco communities:

- 45 operators and
- more than 30 Technology partners

participating in OPG and/or TEC Forum, representing a good part of the markets worldwide

The Telco community is active in trialling the Operator Platform-based concepts with multi-operator trials involving 11 operators mainly in Europe, Asia-Pacific and North America.
Operators have shown at least twice the feasibility of the federation of heterogeneous Edge Computing platforms to create the global TEC Network we envisage.



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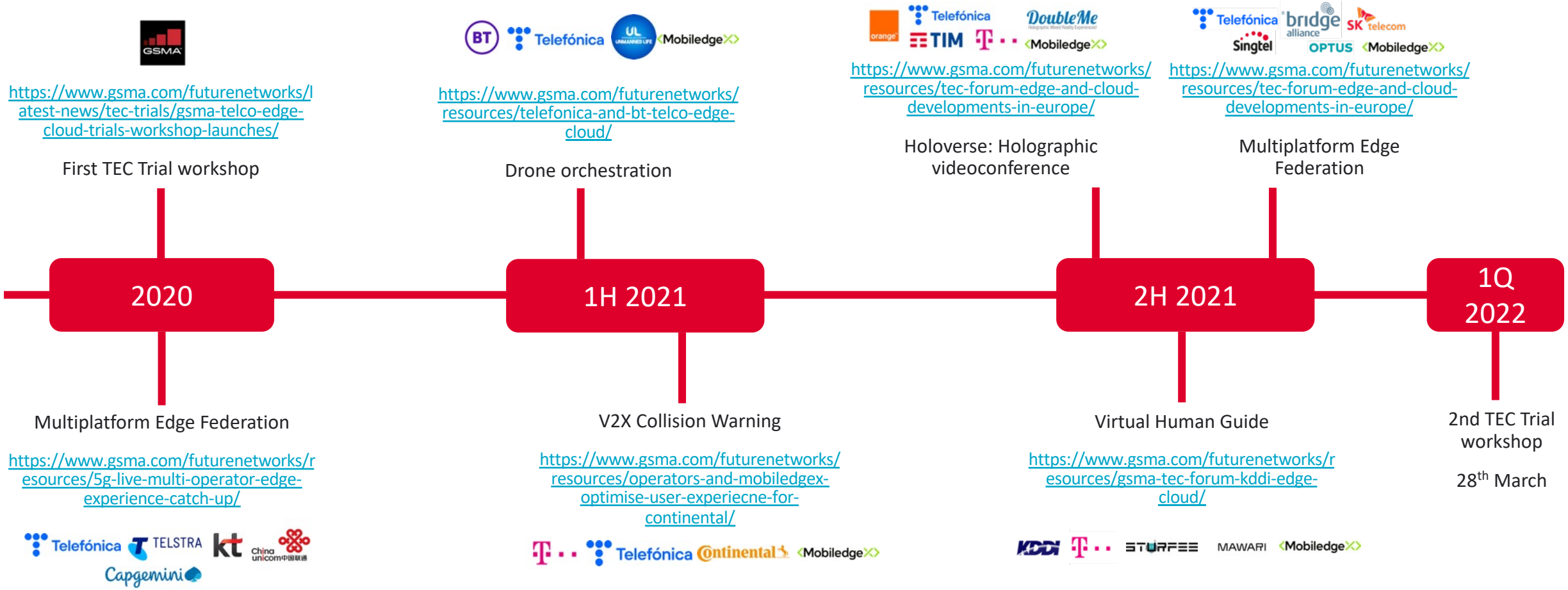
TEC Trials Foundry project



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Several Edge Native Application Categories were trialed

Network

- 4G, 5G, 6G
- Developer consumptionexperience

Real Time Data

- Pipeline automation
- CV, ML, AI
- Services along the flow

Immersive

- Pervasive
- Multi-Model, Multi-Device
- Personalization
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Autonomous Control

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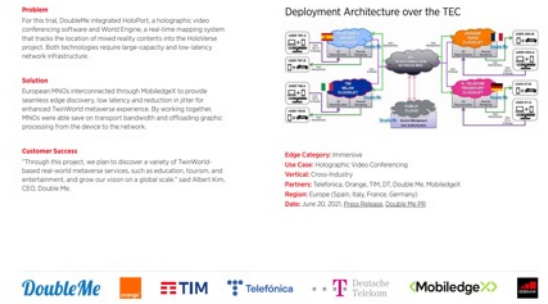
- Devices that move or execute independent actions

Sturfee & Mawari: Virtual Human Guide

STURFEE MAWARI KDDI Deutsche Telekom MobiledgeX

DoubleMe: Holographic Video Conferencing



DoubleMe TIM Telefónica Deutsche Telekom MobiledgeX

Unmanned Life: Drone Orchestration

UNMANNED LIFE Deutsche Telekom BT MobiledgeX

Continental: V2X Collision Warning

Continental Deutsche Telekom Telefónica MobiledgeX

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…and also, the Federation of Edge Compute platforms

MultiOperator MEC Federation Experience

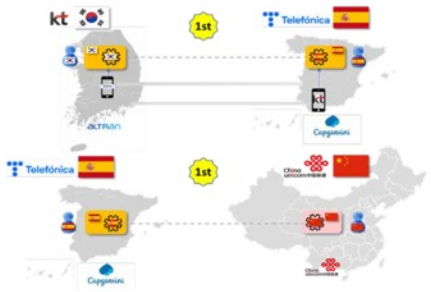
Problem

MEC roaming mechanism allows mobile users visiting abroad to leverage nearby MEC infrastructure for optimal MEC experience beyond their home networks. Without this mechanism, mobile users abroad will have to resort to MEC infrastructure located back in home country, significantly undermining the low-latency feature at the expense of user experience.

Solution

Telefónica, KT Corporation and China Unicom collaborated to verify 5G Multi-access edge computing (MEC) technology for global roaming infrastructure and federation among different edge platforms. This scenario was successfully tested between KT and Telefonica. The platforms used have been based on Altran technology and China Unicom in house technology.

This groundwork for enterprises and private developers to be able to make inroads into domestic and global markets with a single service development that satisfies common standards.



Edge Category: Network
Use Case:
Vertical: Telecommunications
Partners: Telefonica, Telstra, KT, China Unicom, Capgemini
Region: Europe, Asia
Date: March 4, 2020, Telefonica PR

Capgemini · China Unicom · kt · Telefónica · TELSTRA · GSMA

Multi-Platform Edge Federation

Opportunity

Bridge Alliance, MobiledgeX, Singtel and Telefonica achieved interconnection between two heterogenous multi-access edge computing (MEC) platforms. Allowing customers, developers, and partners to discover, and order cross-regional edge resources and deploy applications through a unified interface, ensuring a uniform application deployment experience across different networks and markets in these regions.

Solution

Hub-to-hub interconnection between the Bridge Alliance Federated Edge Hub (FEH) and MobiledgeX Edge-Cloud platform allows edge applications to be deployed across different edge platforms and regions served by each hub. Singtel's MEC is connected to FEH while Telefonica's MEC is enabled by MobiledgeX's Edge-Cloud platform.

Customer Success

Telefonica's user (edge application provider) was able to deploy and run a containerised edge application on Singtel MEC through the hub-to-hub interconnection and vice versa.

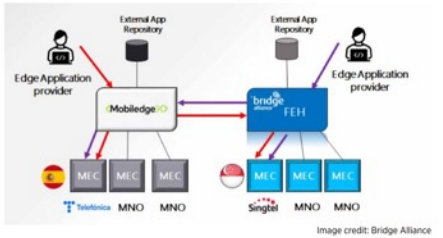


Image credit: Bridge Alliance

Edge Category: Network
Use Case: Multi-Operator Platform Interconnect
Vertical: Telecommunications
Partners: Telefonica, Singtel, Bridge Alliance, Singtel, MobiledgeX
Region: Europe, Asia
Date: Feb 25, 2022, Press Release

bridge alliance · MobiledgeX · Singtel · Telefónica · GSMA

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Other Trials from TEC Members

Video Search

Problem

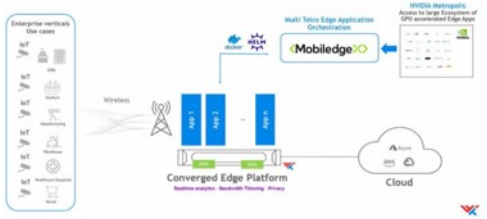
Live video streams and archived video files process massive amounts of data to deliver real-time notifications using AI-engines. In order to accomplish this at the edge, compute processing with physical GPUs handle the mathematical algorithms that filter videos based on the AI engine being utilized.

Solution

Instead of deploying compute clusters at each site to support thousands of cameras, the Converged Edge Platform can be centrally located to run the MobiledgeX cloudlet and AICUDA application, which lowers the cost to the consumer using bandwidth thinning along with meeting the lower latency requirements for operating at the edge.

With MobiledgeX, Vaidio™ can off-load compute intensive activities to the telco edge cloud. MNOs are perfectly suited for real-time video analytics applications as the delay between computing the video streams and presenting the alerts to the user is minimized. There is also a growing demand to integrate Vaidio™ AI-powered analytics in mobile edge devices like body worn cameras and drones. With extreme high bandwidths, low latency and assured high speed mobile connectivity MNOs worldwide can deliver what Vaidio™ customers are looking for.

Enabling Telco Edge Applications



Edge Category: Read-Time Data
Use Case: Video Search
Vertical: All
Partners: AICUDA, MobiledgeX, WWT, NVIDIA
Region: US, Germany
Date: Oct 28, 2021, WWT Spotlight, Aicuda Partner Page

AICUDA NVIDIA World Wide Technology MobiledgeX

Network As a Service (NaaS) for bandwidth control
Singtel has run a field trial around surveillance drones. These drones send SD (standard definition) video to a central control centre. When a human operator at the central control centre observes a specific event or anomaly in the video sent by one of the drones, he may need a more detailed view with a higher resolution. With one click, the operator requests the drone to send HD (high definition) video to the control centre to immediately see in greater detail the thing he wishes to inspect.

From a network connectivity point of view, all drones, during regular operation, are sending video in standard definition resolution to optimise the mobile data bandwidth usage. However, the drone application allows the user to switch to high-definition resolution in real-time via a NaaS (Network-as-a-Service) API, which enables to change device connectivity characteristics such as data bandwidth, as in this case, or the Quality of Service (QoS) literally on the fly.

Real-time data edge applications for Factories
In China, mobile network operators have conducted telco edge trials across verticals, including manufacturing, multimedia and mobile health. Some of the use cases are described in the quarterly report to Networld Europe[1]. Among them, the Haier Smart Factory use case shows how a Telco Edge Cloud, together with 5G, can bring much value to the enterprises' edge applications, including machine vision, defect inspection and intelligent security.

The 5G deterministic network and edge computing technology have provided guaranteed low latency and service assurance fulfilling the high requirements of the manufacturing applications, and network slicing technology provided the required data security. By deploying 5G+MEC+AI solutions, the product quality is improved by 28%, and production efficiency is improved by 40%.

5G User Plane Function

Problem

Since the introduction of mobile packet data in 3G, all data traffic, irrespective of source, destination, and requesting application, has been tunneled back to a limited number of fixed (packet gateway) anchor points inside the mobile networks. This is increasingly inefficient, non-performant, and prone to bottlenecks.

Solution

DT, Mavinir and MobiledgeX demonstrated and validated the reference design for deploying cloud-native 5G User Plane Function (UPF) to support Multi-Access Edge Computing (MEC) applications, tailored to each use case need for proximity and performance. The reference design is fully cloud-native, abstracted away from underlying cloud architecture, infrastructure vendor and operating owner.

Scenario: Video Application Traffic

A video application is initiated on a 5G phone in Location A. This request is sent to a 5G core that selects UPF placement in Location A. Tunneling between the two is established. The video request is then passed to the local edge content delivery network for delivery. An identical request is made in Location B. Traffic is then established to Location B and local fulfillment occurs. The MNO dynamically controls traffic including secure placement, lifecycle management and traffic routing of the UPF and video application at the telco edge.

Deutsche Telekom

"We are excited to partner with Mavenir and MobiledgeX to demonstrate dynamic cloud-native deployment of 5G Core UPF for users where it is needed. The UPF can run inside the operator's owned network, inside a private 4G/5G network, inside the roaming network, or in the public cloud. The ability to dynamically and seamlessly orchestrate traffic across our own footprint and the footprint of others opens up the possibility for new connectivity solutions for customers," says Alex Choi, SVP Strategy & Technology Innovation, Deutsche Telekom.

Edge Category: Network
Use Case: 5G User Plane Function
Vertical: Telecommunications
Partners: DT, MobiledgeX, Mavenir
Region: Germany, USA
Date: June 22, 2021, Mavenir PR

Deutsche Telekom MAVENIR MobiledgeX

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Benefits for the different stakeholders

ENTERPRISES

- Device augmentation, offloading
- Network Intelligence
- Network Control
- End-to-end Security and Privacy
- Flexibility

DEVELOPERS

- Partnering & Ecosystem
- End-user's reach
- Seamless experience across providers

END USERS

- Less reliance on hardware
- New, more intelligent services even on current devices
- Security, fraud prevention and Privacy
- Consistent Service experience while moving and roaming, even across borders

OPERATORS

- Global scale
- Control over traffic loads
- Improve network infrastructure scale
- Innovation and product evolution
- Open and Standard Edge Cloud

Work started with the GSMA WAS Group (Wholesale Agreements and Solutions), responsible for the commercial aspects of interoperability (Interworking & Roaming) between Industry players, providing consistent and reliable services to consumers, to start defining the framework for agreements around Edge and NaaS

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Customer Insights

ENTERPRISE CUSTOMERS

Haier

"The value of the Telco Edge Cloud includes realising the centralised management of traditionally distributed deployed control applications, enabling real-time analysis and operations, and keeping sensitive data in the local site. The overall network performance is important for the business, and among them, latency and bandwidth may have higher requirements".

ABB

"The convergence of OT/IT/NT provides the chance to access and process data fast and in high volumes, enabling the improvement of the manufacturing processes in real-time at the factory. 5G (NT) provides fast access to high volumes of data, and Edge (IT) provides the capability to process high volumes close to the source."

SAP

"The value of the edge is to be close to the factory to ensure, depending on the use case, data sovereignty, low-latency and low jitter that can be crucial or a nice to have. APIs to control the network are mostly needed on-site for the private network."

APPLICATION DEVELOPERS

PROXY42

"Low latency and jitter are crucial for interactive AR and gaming. In addition, network information to support the gaming use case, such as connectivity and location, is very helpful for optimisation and fraud prevention."

Tencent

"Using edge compute for live streaming, cloud gaming and industrial site application areas, the key benefit is to reduce network latency and cost, where edge compute shows significant improvement. Latency, jitter and guaranteed bandwidth are essential to their business".

Genymobile

"Essentially, a completely virtualised phone can use fewer mobile resources (memory, CPU, battery). Security is improved as data does not need to reside on the mobile device but rather in a secure cloud/edge environment. Our prioritisation of network APIs that provide information and control over network quality and performance are (1) network load, (2) number of devices connected, (3) network congestion/packet loss and (4) connection/bitrate."

MNOs & SERVICE PROVIDERS

broadpeak

"Moving CDN capacity to the edge makes it easier to limit congestion, which is expected to significantly increase with the migration of legacy broadcast technologies towards streaming. There is no sophisticated processing at the edge with basic CDN functions, but the integration with the mobile network (e.g., using RAN APIs) and the addition of AI/ML engines in the cache server to enhance the streaming efficiency are changing the game."

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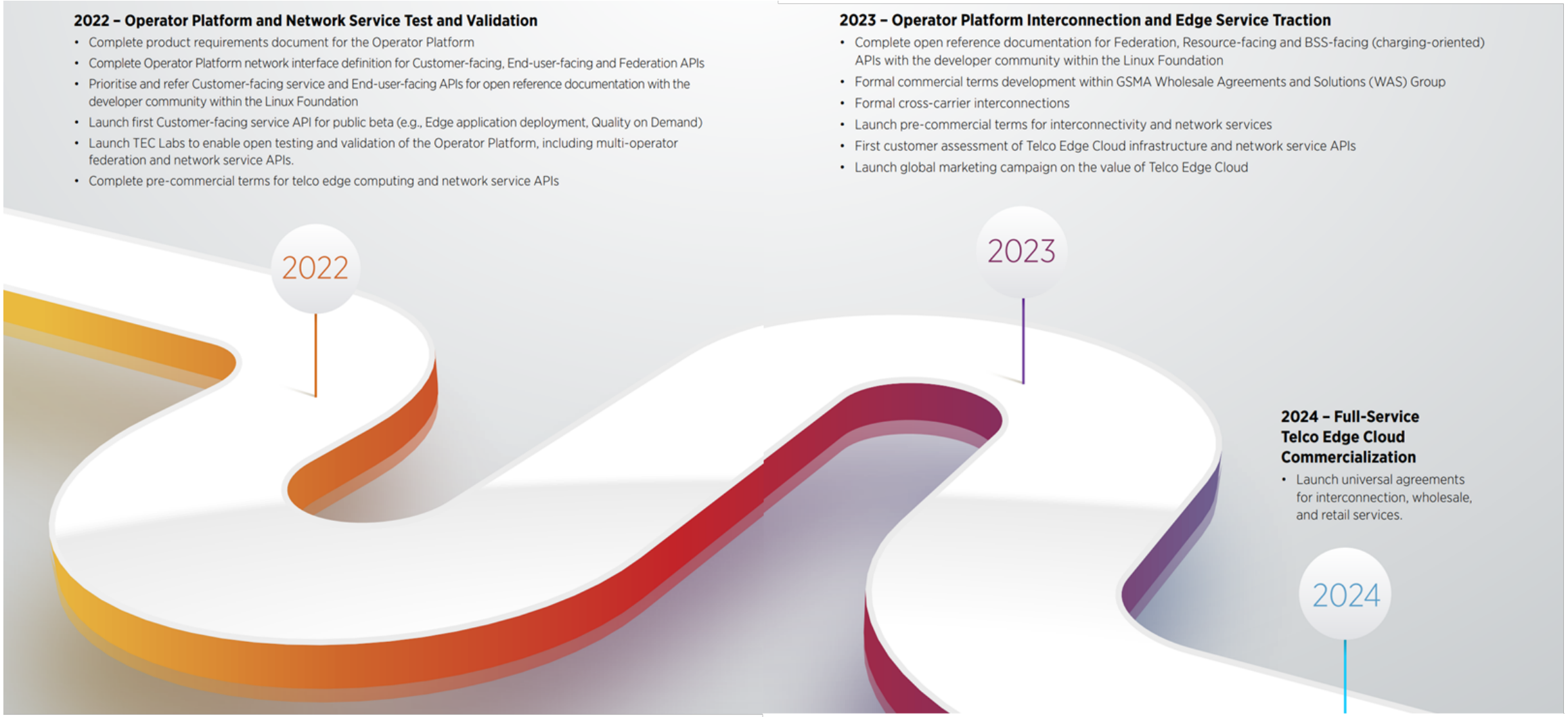
Our Roadmap



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Agenda TEC Forum – 10th March 2022

Topic	Presenter	Time
1. Welcome • Summary of achievements and differential value of TEC	• Juan Carlos Garcia (TEF) • Jason Hoffman (MEX)	10 min
2. Operator Platform and OPAG Update • Evolution of Operator Platform - API exposure harmonisation • Operator Platform - From specification to reality	• Alexander Harmand (TEF) • Shamik Mishra (Capgemini)	30mins
3. Session 1: Value of TEC and TEC Trials **a) Fireside chat on TEC value and benefits** **b) GSMA Foundry TEC Trials** • 5G XR Global MEC PaaS Trial (KDDI,DT, MEX) • Holoverse Trial (TEF, DT, TIM, MEX)	• Jason Hoffman (MEX), Juan Carlos Garcia (TEF) • Hiroshi Sankoh (KDDI) • David Moro (TEF)	30mins 20mins
4. **Session 2: Network Integration and Federation** • Network integration and edge use cases • Platform Federation activities - Multi-platform Hub	• Javier Valle De Soto (Ericsson) • Bridge Alliance, Singtel, MEX & TEF	30mins
5. **Conclusions and Q&A**	• Juan Carlos Garcia (TEF)	10mins

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5G XR Global MEC PaaS

GSMA TEC Trial with Deutsche Telekom, MobiledgeX, Sturfee, Mawari

Hiroshi SANKOH, KDDI

10th March 2022

Speaker Introduction

Hiroshi SANKOH, PhD

Assistant Manager

5G XR Services Planning & Development Dept

KDDI Corporation

Hiroshi Sankoh has been in charge of R&D and Planning of XR related projects such as Visual Positioning Service (VPS) and Volumetric 3D Video. He leads technical developments and PoCs of immersive XR experiences utilizing the advantages of ultra low-latency of 5G and Edge Computing (MEC).

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Agenda

1. 5G Deployment and Telco Edge Computing
2. KDDI XR Strategy
3. TEC Trial Progress Update

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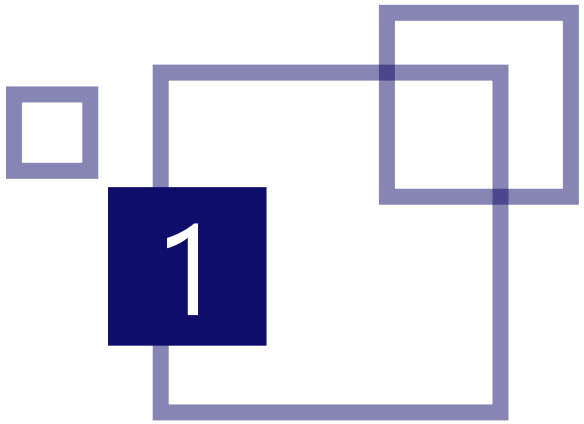
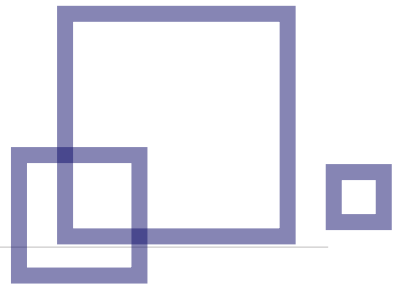


5G Deployment and Telco Edge Computing



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5G
1. High Speed
2. Massive Device Connectivity
3. Ultra Low Latency
3. Ultra Low Latency
Unprecedented user experience by ultra low latency

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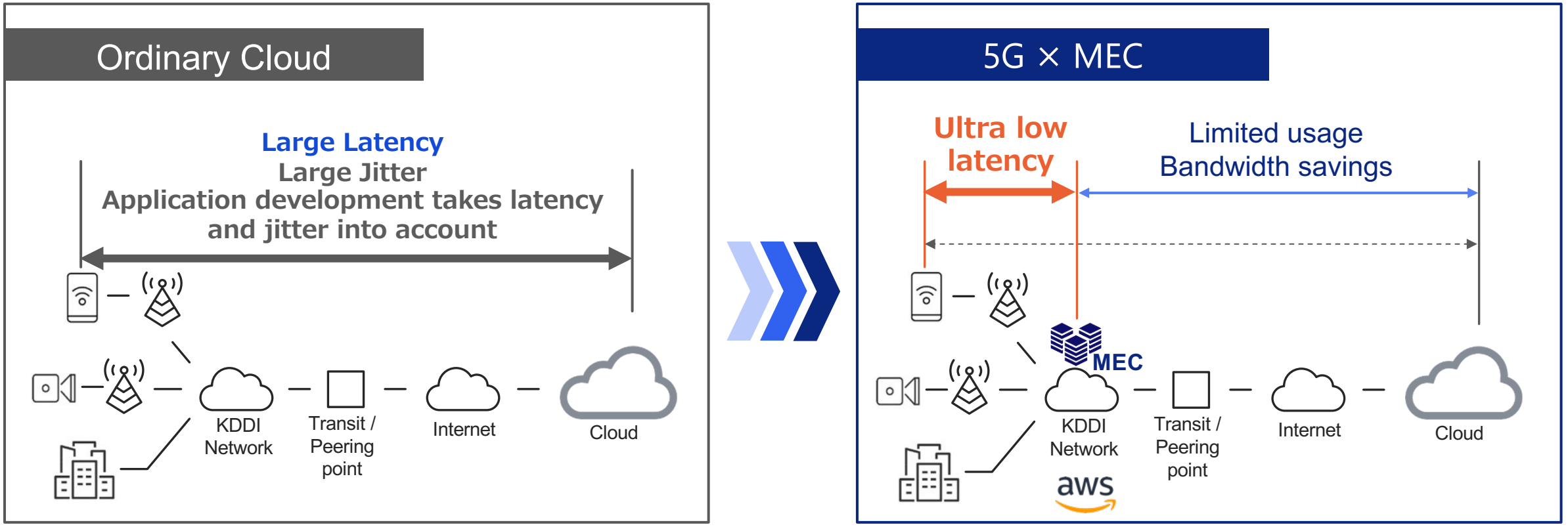
The value of edge computing



Ultra low latency is available with the combination of 5G and MEC.
Unprecedented user experience available to end users.

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2

KDDI XR Strategy

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“Society 5.0” world – where data circulating between Cyber space and Physical space

Cyber space

Data analytics · Learning · Prediction

Society 5.0

Data (collection)

Feedback

Physical space

Real world · Life · New business

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Toward “Fusion of Virtual and Real worlds” as after-COVID is approaching

Virtual

Collection of virtual data & Feedback in real-time

VPS technology for spatial recognition
5G MEC for Cloud Rendering

Visualization of Data

Physical

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3

TEC Trial Overview

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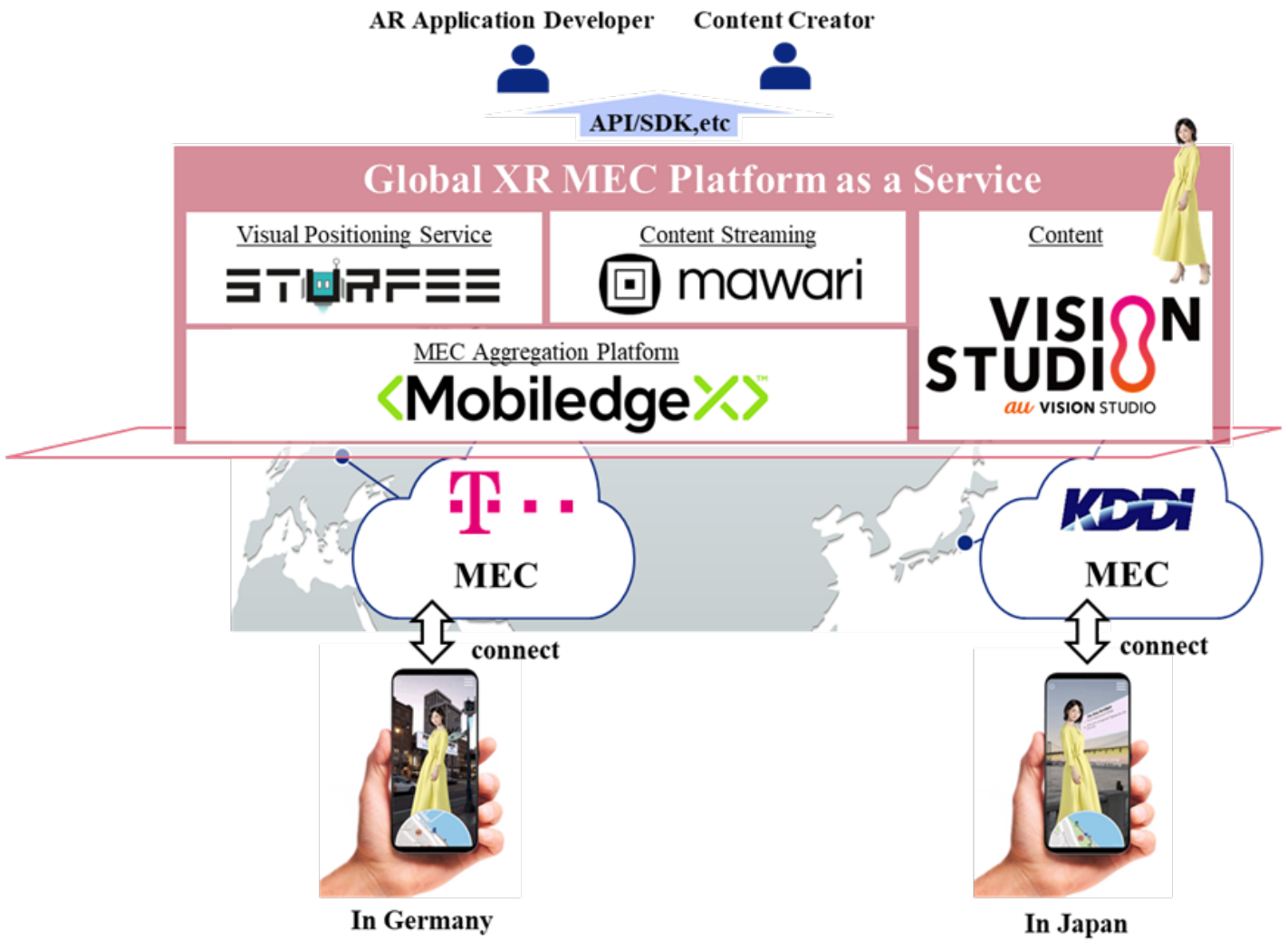
XR MEC PaaS Trial with DT, MeX, Sturfee, Mawari



Concept:
Easy and consistent way of developing XR applications and deploying to global Multiple Operator MECs

Teaming up:

- **Operator MECs – DT in Germany** and **KDDI in Japan**
- **Platform – MobiledgeX**
- **Application – Sturfee** and **Mawari**

Launched in June 2021, as part of GSMA TEC Trials initiative

- Press-released on 29 June 2021

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Acceleration of global edge-enabled XR application development

- PaaS providing XR core techs (VPS and XR-streaming) as API/SDK

  -> Developers can locate their immersive XR content on various global regions!

  – VPS: satellite-imagery based high-precision localization system of Sturfee

  – XR-streaming: New delivery framework for an interactive 3D Content of Mawari

KDDI's au VISION STUDIO created a super photo-realistic 3DCG character "coh" which looks like real humans

-> Rendering requires huge computing resources and cloud based processing on top of 5G edge NW is essential to realize ultra-low latency interactive UXs.

MobiledgeX Edge-Cloud platform provides unified access to 5G edge networks jointly provided by KDDI and Deutsche Telekom

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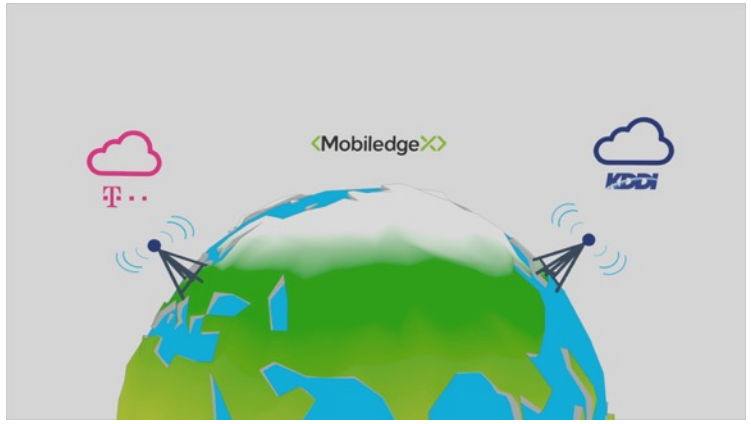
TEC Trial Results

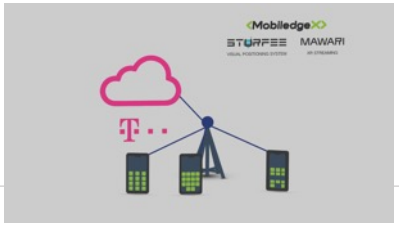
- Global PaaS for edge-enabled XR techs successfully completed!
  1. Sturfee/Mawari could easily deploy their unified backend services on top of a common platform (MobiledgeX) across KDDI's and Deutsche Telekom's 5G edge resources

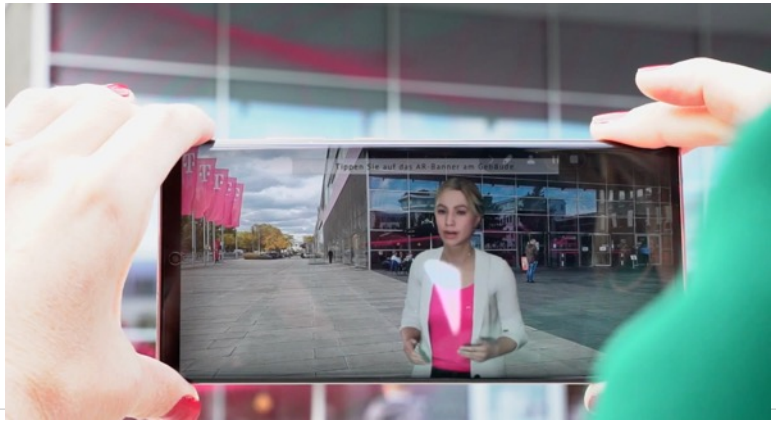
  -> Dynamic/Optimized deployment with just one API call to multiple MNO's edge networks

  2. The demo app delivers multiplayer experience featuring hyper-realistic, personalized digital assistants that lead app users on a guided tour of Bonn, Germany or Tokyo, Japan.

  -> Various immersive XR content can be overlaid atop the user's real world view via VPS







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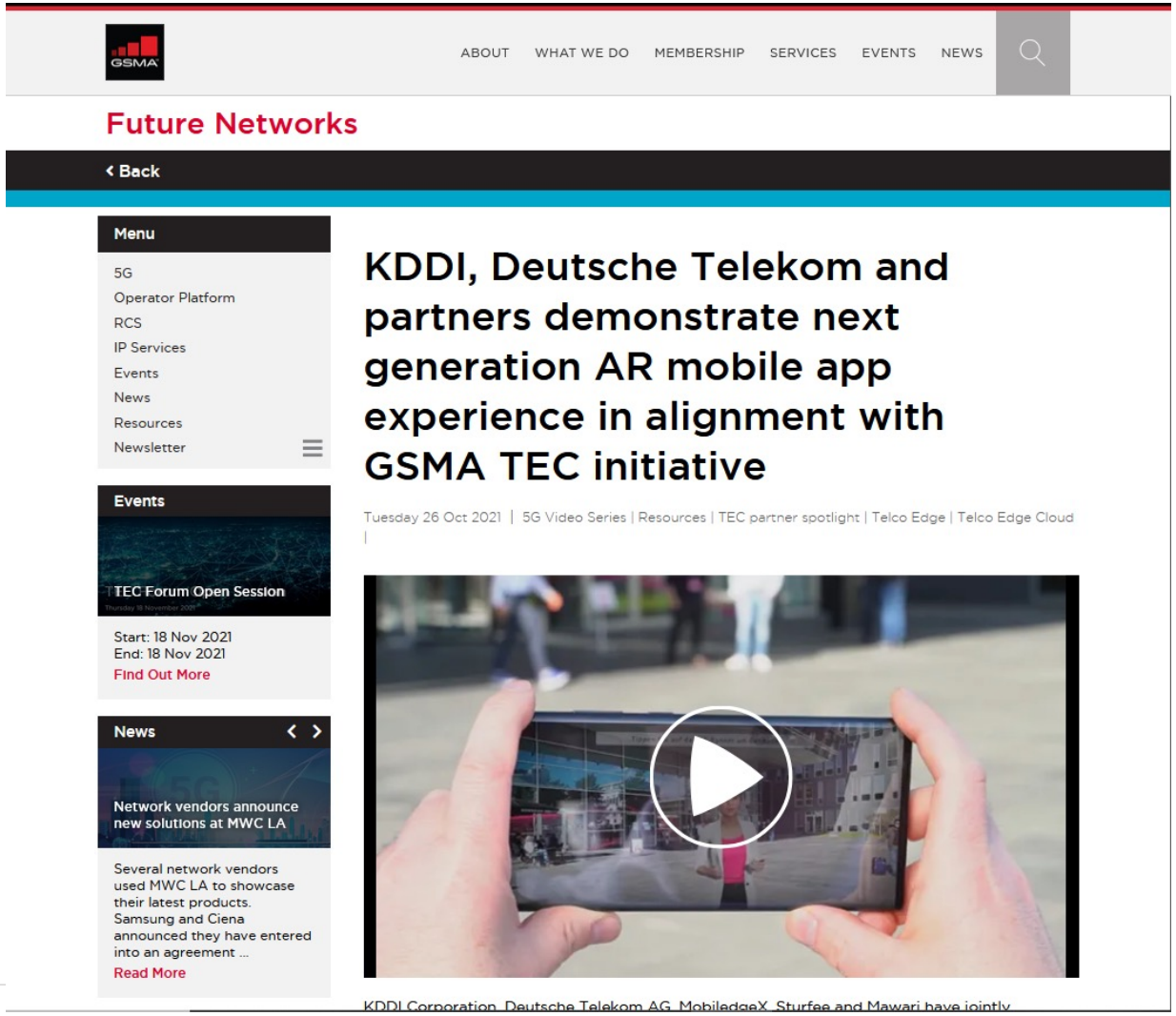
News Release

https://www.gsma.com/futurenetworks/resources/kddi-deutsche-telekom-and-partners-demonstrate-next-generation-ar-mobile-app-experience-in-alignment-with-gsma-tec-initiative/

https://www.globenewswire.com/news-release/2021/10/26/2320942/0/en/KDDI-Deutsche-Telekom-MobiledgeX-Sturfee-and-Mawari-to-Demonstrate-Bloom-City-Next-Generation-AR-Mobile-App-Experience-in-Alignment-with-GSMA-Foundry-Telco-Edge-Cloud-TEC-Trials-In.html



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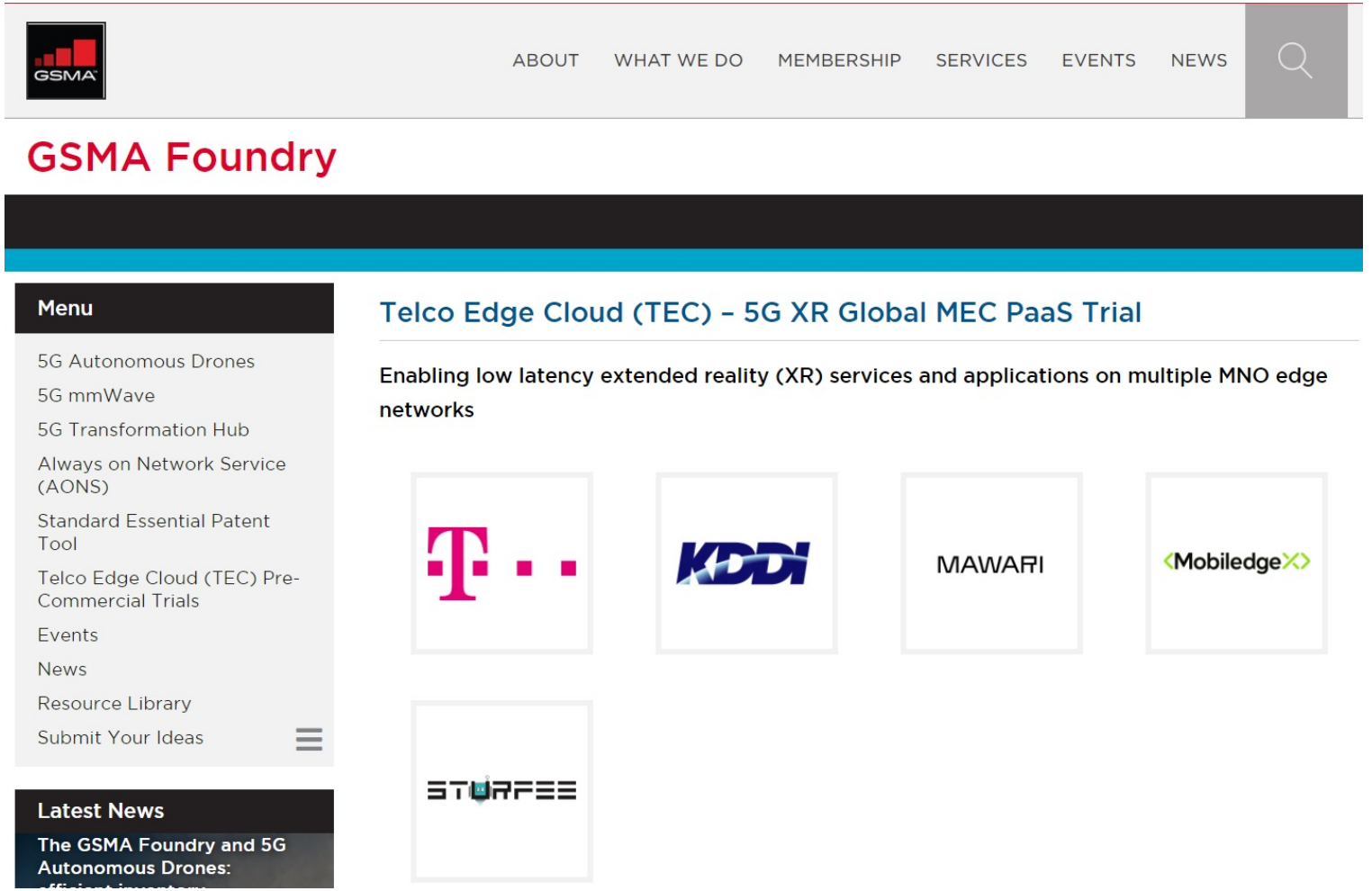
TEC Trial Web Page / Demo Video

https://www.gsma.com/foundry/telco-edge-cloud-tec-pre-commercial-trial/

https://youtu.be/NoaqlsZoW2o



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Updates after the trial / Future Plans

- Make the APIs/SDKs available for XR developers' use via "KDDI Open API"
- Collaboration with additional MNOs and expand coverage in the world
- Develop and deploy innovative applications / use cases using the XR MEC PaaS

-> Accelerate the fusion of Virtual/Real worlds with 5G and MEC

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Holoverse GATE Service Trial

TEC Forum Open Session

David Moro (Telefonica)

10th March 2022

About

- **Background**: Video calling exploded during Covid, enabling us all to WFH, be educated and stay in touch with friends & family. AR / VR takes to the next level, to be “virtually there” in the same environment, to socialise, work, collaborate, interact, share, in a way that video doesn’t allow
- **The scope**: a Multi-operator trial to demonstrate the benefit of the Telco Edge Cloud (TEC) with a service that can be understood as public utility in current socio-economic context: **holographic communications & virtual shared world**
- **The Partners:**
  - DT, TIM and Telefonica providing the network and edge infrastructure.
  - MobiledgeX as telco edge platform provider
  - DoubleMe providing “TwinWorld” the holographic and virtual world application to be deployed on TEC

Telefónica

DoubleMe
Holographic Mixed Reality Experiences!

TIM

MobiledgeX

- **The objective:**
  - Improve end user experience on holographic communications by bringing the relevant application components closer to the end-user (relying on the better latency and jitter, saving transport bandwidth and offloading graphic processing from the device to the network)
  - Demonstrate key MNO features in the telco edge: primarily roaming and interconnection, as well as the multi-MNO aggregation (federation) & smart Edge Discovery
- **What we are doing:**
  - Adapt the application design to work in a distributed environment where users from different MNOs need to communicate altogether
  - Enable local break out roaming at network layer to enable Edge Service Availability in Visited Networks
  - Expose specialized hardware resource in the TEC cloudlets (GPU – graphical processing units)

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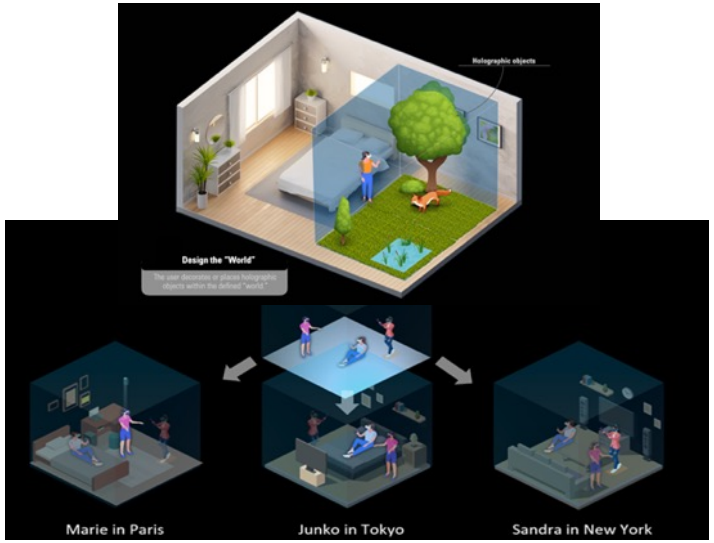
About the application

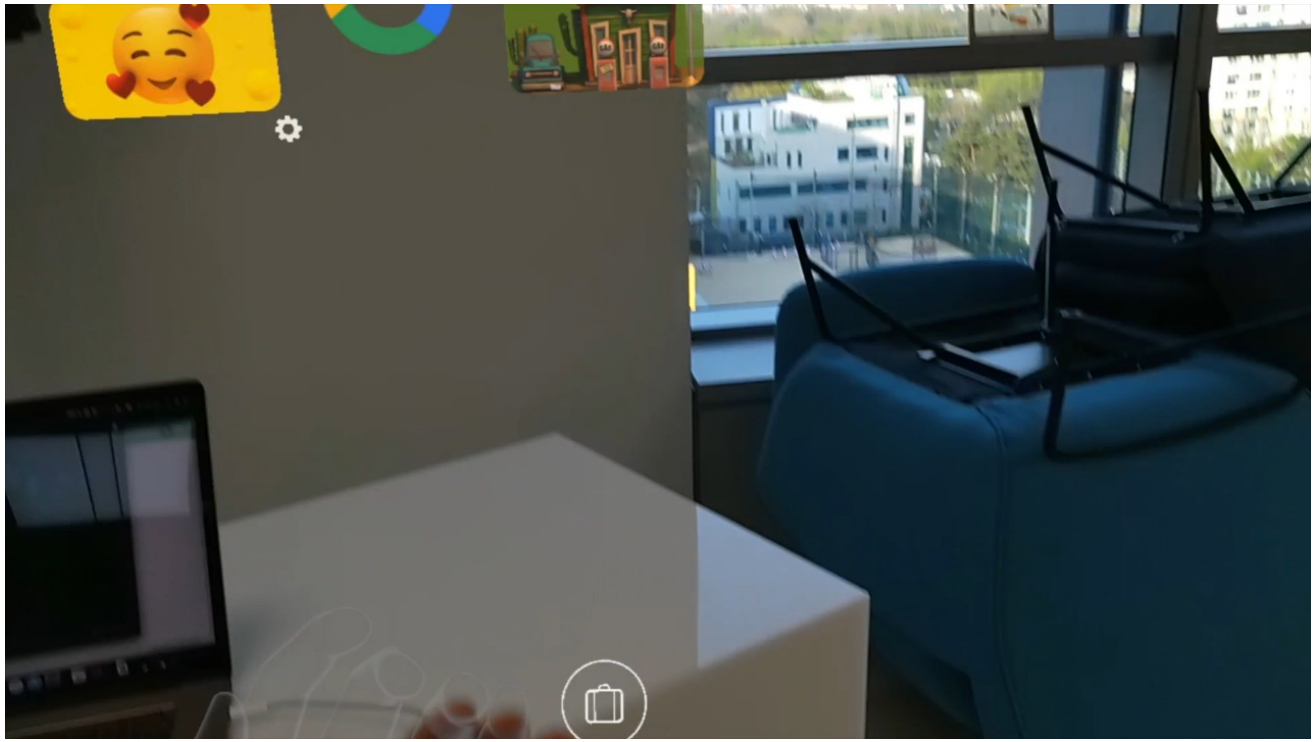
DoubleMe´s TwinWorld application & Holoport

- An AR Metaverse: Users can create shared virtual spaces in AR that can decorate with virtual objects and where to collaborate and communicate with other users joining from any country or MNO



- Users can be present in their virtual space as 3D avatars as well as as realistic holograms thanks to the Holoport Service integrated in TwinWorld

- The Holoverse Service trial focuses on bringing the Holoport Service component to the Telco Edge Cloud



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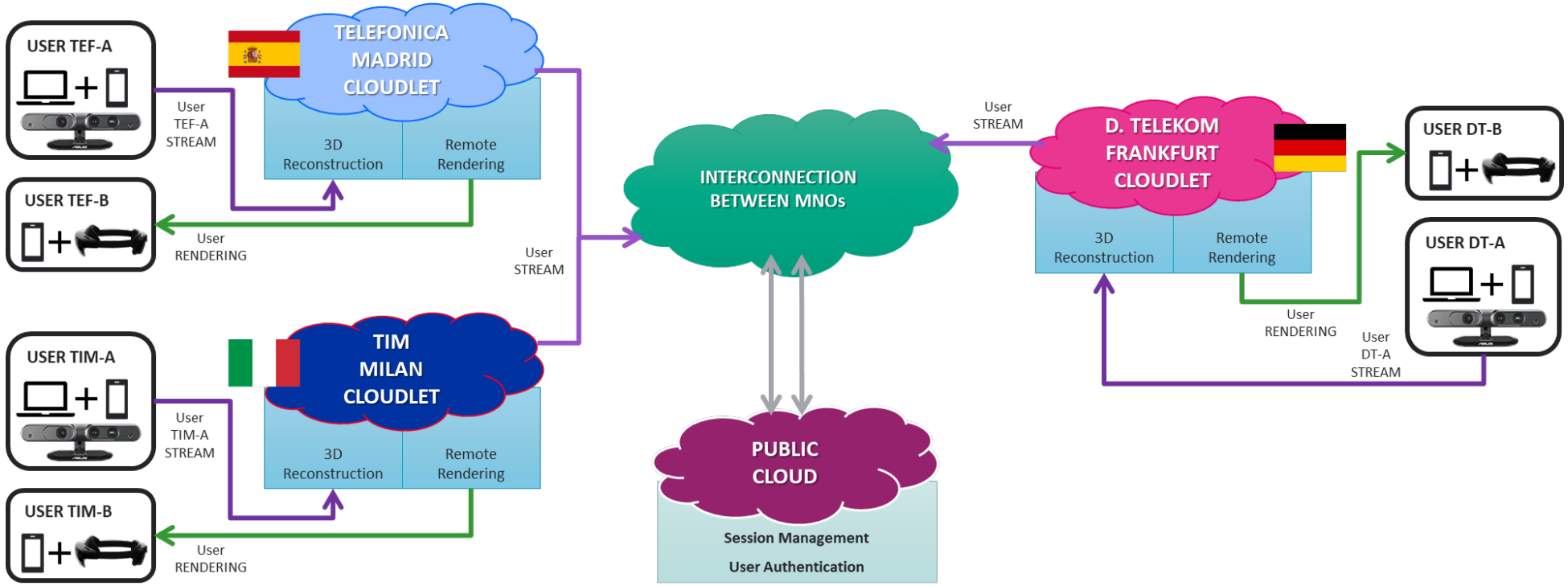
Deployment architecture of Holoport over the TEC



- The **hologram Reconstructor component and 3D rendering** component is to be deployed in the **TEC cloudlets** of each MNO. These components requires GPUs in the cloudlet
- The session and user manager is kept centralized deployed at the **public cloud**
- On the end user side, the holograms and avatars are captured using **one** depth camera at the “caller”/ producer side, and the visualization of the virtual world and holograms at the “callee”/consumer side requires a mixed reality glasses like Hololens2

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Phases

- We follow an incremental approach in phases.
  - **Phase 1. HOME scenarios:** focuses on adapting the application load into the TEC and enabling communication among users in the home network working properly with the GPU resources. This phase also deals with inter-MNO communication
  - **Phase 2. ROAMING scenarios** deals with implementing Network LBO with different options, validating Edge Roaming at TEC platform level and testing service for the trial scope, thus enabling the service to work in home and roaming scenarios
  - **Phase 3. IMPROVEMENTS:** focuses on improvements on the multi-MNO interconnection and improvements with QoS with e.g., IPX, improvements in edge roaming, new features in the application, new devices on the end user side and other aspects that might be decided during the first two phases

- **Expected Timeline.**
  - The project started in May
  - We expect major milestones delivered for Phase 1 and Phase 2 by December 2021.
  - Phase 3 contains several optional items, with some of them yet to be planned according to priority.

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Status

- **Phase 1:**
  - Holoport app deployed in DT and TEF and tested, & under rollout in TIM cloudlet
  - Inter-MNO communication using basic configuration tested
  - Development for advanced inter-MNO (inter-cloudlet connection) developed by DoubleMe
- **Phase 2:**
  - Several options for implementing Network LBO decided of which the basic ones are implemented:
    - option 1. simple MME configuration (vCountry Spain - ALL)
    - Option 2. HSS-controlled LBO (vCountry Italy- TEF-TIM)
    - Option 4. remote home PGW/UPF using Carrier multihomed platform in visited country (country Spain- DT-TEF)
  - Basic edge roaming tested with MobiledgeX
- **Phase 3:**
  - Dynamic cloudlet selection implemented using MEX API

Major milestones

- **Phase 1:**
  - First basic holographic call between two Operators
- **Phase 2:**
  - Basic Edge roaming validated with LBO

Major Progress since last TECForum

- TIM GPU infrastructure ready in the cloudlet. App under deployment.
- TIM´s LBO Option 2 for Edge roaming tested.
- DT´s LBO Option 4 implemented – pending start of testing phase.
- MEX API for dynamic cloudlet selection implemented at Holoport Session control server and Broadcaster app (testing pending).

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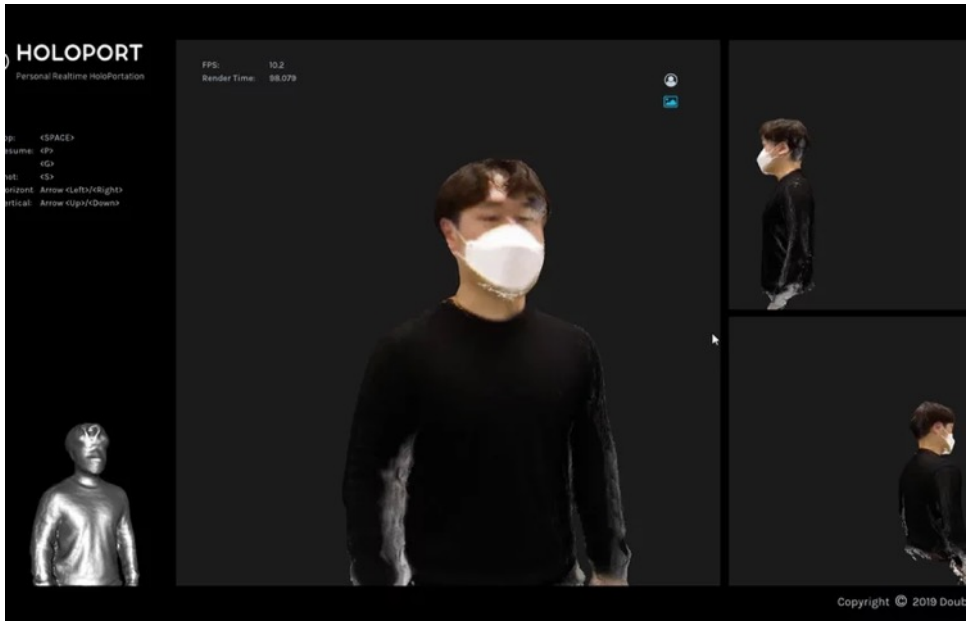
Next steps

- **Next in Holoverse trial:**
  - Include the third MNO, and progress with Inter-MNO testing with 3 MNOs
  - Testing Holoport app in all roaming scenarios (including option 4 for LBO)
  - Test the app in different combinations of home and roaming scenarios across the three operators
  - Hologram quality improvement and quality testing with improved calibration of RGBD cameras



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Conclusions so far and Next steps

- **Learnings – so far**
  - For Edge services, at network layer a **local break out mechanism** must be implemented, to provide access to the local edge cloudlet
    - This mechanism should allow simple enabling for edge services (vs other non-edge services) (APN based?) and the technical solution must allow future scale in aspects such as integration with home network control plane systems, etc.
    - Dynamic cloudlet location mechanisms in place must be prepared for roaming scenarios
  - When adapting applications from public cloud to the edge**, developers must consider the hyper distributed architecture** that will come with it. This basically means that instances from the app running in different locations/cloudlets may need to inter-communicate across the edge and therefore a routing intelligence would be necessary
  - GPUs will be a key resource in the edge to offload computing processing from devices
  - It is key to start looking and compression methods (codecs?) for reducing bandwidth at interconnection points for volumetric video and holographic comms

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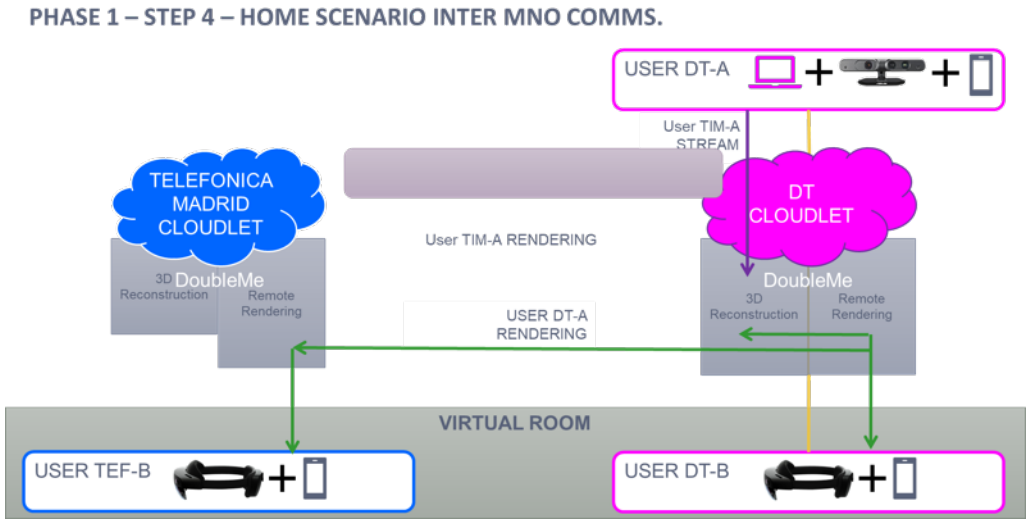
Back up

Milestones explained–Phase 1: Inter-MNO holographic communication

- **End user experience**:
  - A user from Telefonica “Carol” in Madrid logs into TwinWorld and open the Holoport service, being able to bring an AR hologram from a Telefonica user “Cindy” and an AR hologram DT user “Daniel” in the same virtual room and physical space
- **Technical Architecture**:
  - In the Edge, the user must be served by the closest cloudlet. This brings a hyper distributed architecture where different instances spread across MNOs and network topologies must be able to inter-communicate
  - The holoport 3D reconstructor is the fundamental piece that needs to be closest to the broadcasting user. in the basic scenario the renderer is local to the reconstructor
  - In the advanced scenario the renderer is local to the served user (Carol) and connects to the remote reconstructor if needed. This logic was developed by DoubleMe during the trial, to enable a multi-connection between the 3D reconstructor 'Holoport-Engine' and 'Remote-Renderer’

Carol´s view on Hololens:



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Milestones explained: Phase 2- Basic Edge roaming with LBO

- **End user experience:**
  - Alice and Bob are users from DT roaming in Spain. Carol is a Telefonica user in Spain as well. Alice SimCard is configured for regular home routed roaming and Bob has been configured to use local breakout in Telefonica network
  - When connecting to the apps in the TEC, Alice is directed to a cloudlet in Germany and Bob is connected to the closest local cloudlet in Spain. Carol is connected to the closest local cloudlet in Spain, unaltered

Carol, TEF user at home

Alice, DT user roaming in Spain (Home Routed)

Bob, DT user roaming in Spain (LBO)

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Agenda TEC Forum – 10th March 2022

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4. **Session 2: Network Integration and Federation** • Network integration and edge use cases • Platform Federation activities - Multi-platform Hub	• Javier Valle De Soto (Ericsson) • Bridge Alliance, Singtel, MEX & TEF	30mins
5. **Conclusions and Q&A**	• Juan Carlos Garcia (TEF)	10mins

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Session 2: Network Integration and Federation (30 min)

TEC Trial Presentations (15min each)

- Network Integration and Edge Use Cases (Javier Valle De Soto, Ericsson)
- Platform Federation Activities, Multi-Platform Hub (Bridge Alliance, Singtel, MEX and TEF)

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Network Integration and EDGE Use Cases

Javier Valle (Ericsson)

10th March 2022

Network interaction needs for EDGE Use Cases

- Most EDGE use cases will require close interworking with MNOs to provide the right service at the right time, short term known needs:
  - UE location
  - UE identity
  - Notifications (i.e. UE mobility, change roaming status…)
  - Edge Mobility (Traffic Influence)
  - QoS Modification
  - Dynamic Network Slice Selection
  - Change Chargeable Party
  - …

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EDGE Use case examples with AF/TEC/Network integration

Remote management of connected drones

– Drone uses standard network to reach destination
– Only once arrived at target drone has new requirements:
  – Better video quality by means of higher QoS settings
  – Better response time by means of another network slice with lower latency and selected EDGE APP location
– Once the inspection is over, the drone can return and QoS is reset to normal

Network Integration: Event monitoring (position) + OAuth + AS Session with required QoS + Application driven dynamic network slice selection

Location based sponsored service experience optimization for Events

- The Event Application monitors the location of the customers
- When the customer reach the Event (Stadium, Concert…) the App requests better QoS and network slice/EDGE server depending on their location and valid Event ticket
- Event APP sponsors improved QoS and slice/EDGE usage
- When the customer leaves the Event QoS and Slice are reset to normal

Network Integration: Event monitoring (position) + AF influence traffic routing + Application driven dynamic network slice selection + change chargeable party

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MEC-5G Network Integration PoC

Objective:

Demonstrate effective integration AF-MEC-5GSA Network to enable improved QoS on demand for MEC Applications

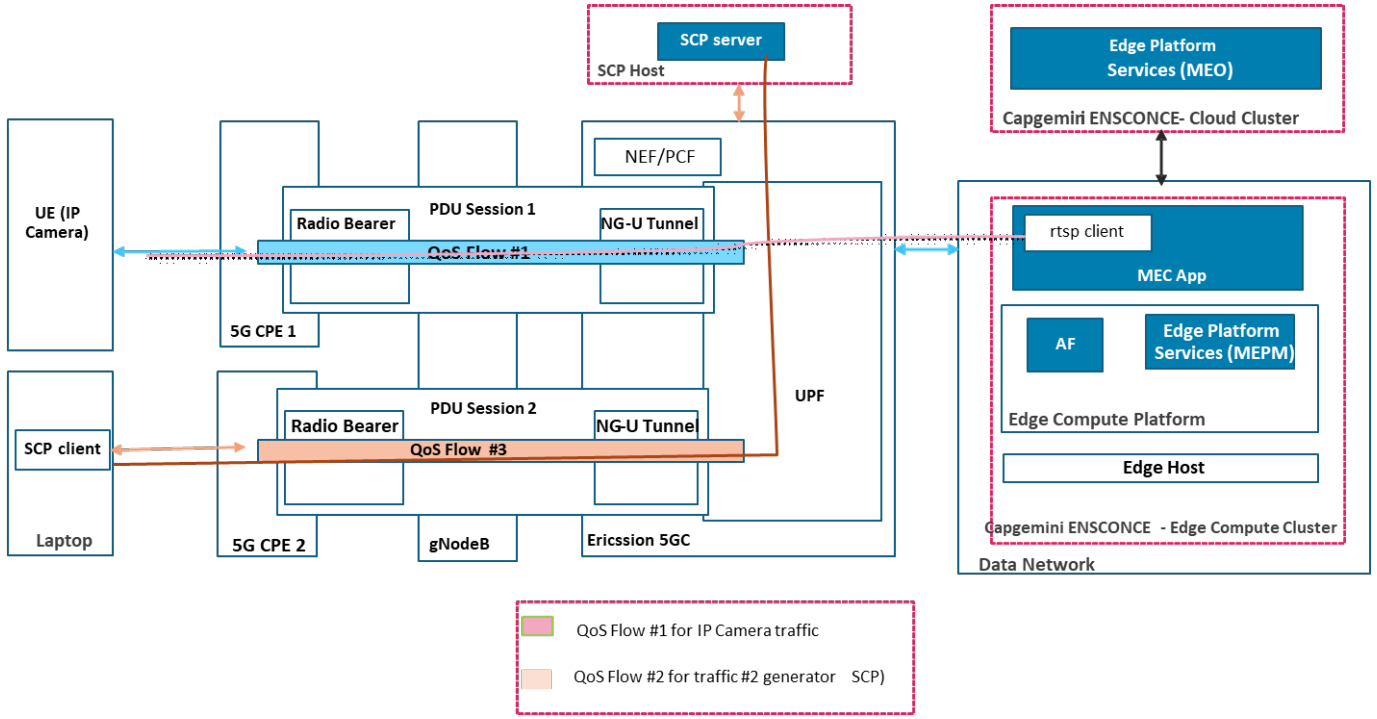
Lab located in 5Tonic environment

PoC setup:

- Capgemini ENSCONCE MEC Platform
- Ericsson NR and 5GCore including NEF for exposure and integration
- 2 ASKEY 5GSA CPEs
- IP Camera and Laptop (to congest Radio link)
- DeepSight Application Function

Use Case:

- An application provider should be able to request specific QoS for session between Edge App and UE traffic.
- As MEC platform it should be able to map the applications requested QoS to network level QoS and dynamically interact with the 5GC via NEF to request the network QoS for edge applications



MEC-5G Network Integration PoC results

- Uplink(UL) bandwith which will be shared by the two CPE with two different flows
  1. QFI #1 – Video Traffic generated by IP camera via 5G CPE #1
  2. QFI #2 – SCP file upload traffic generated by SCP client on Laptop via 5G CPE #2

- APP required QoS is defined during the onboarding in the EDGE according to OPG defined processes.
- The tests will include dynamically requesting the change in QoS for QFI #1 when the session quality deteriorates for CPE #1 due to load generated by CPE #2 in the uplink direction
- Test will include dynamically applying 5QI 2(GBR) and having default 5QI as 9(non-GBR) for QFI #1 via invoking NEF ASSessionWithQoS API

Test KPIs	Without iperf (QFI_9, gNodeB - 21mbps uplink)	With iperf (load - UDP, QFI_9, gNodeB - 21mbps uplink)	With iperf (load - UDP, QFI_2 using NEF API, gNodeB - 21mbps uplink)	Deleted subscription with QFI 2 using NEF API; connection downgraded to QFI_9
subsession	video/H264	video/H264	video/H264	video/H264
num_packets_received	85340	54100	85712	53901
num_packets_lost	1	30690	1	30879
elapsed_measurement_time	60.517152	60.000071	60.000038	60.000061
kBytes_received_total	120962.794	76664.742	121450.318	76394.666
measurement_sampling_interval_ms	1000	1000	1000	1000
kbits_per_second_min	8478.42272	5086.164283	5839.851903	1173.932159
kbits_per_second_ave	15990.54681	10221.9535	**16193.36548**	10185.94511
kbits_per_second_max	53351.69388	26835.18306	43499.08515	19583.44209
packet_loss_percentage_min	0	0	0	0
packet_loss_percentage_ave	0.001172	36.195306	0.001167	36.422505
packet_loss_percentage_max	0.079936	72.780159	0.079554	69.069279
inter_packet_gap_ms_min	0.005	0.005	0.005	0.005
inter_packet_gap_ms_ave	0.707892	1.10823	0.699493	1.112214
inter_packet_gap_ms_max	747.467	764.3	791.458	890.04

Bandwidth improvement on applying 5QI as 2 via NEF (GBR)

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Next Steps

- Continue expanding Network APIs towards full NaaS concept to enable new 5G use cases
- Work on needed integration with the network to maximize usage of 5G slicing

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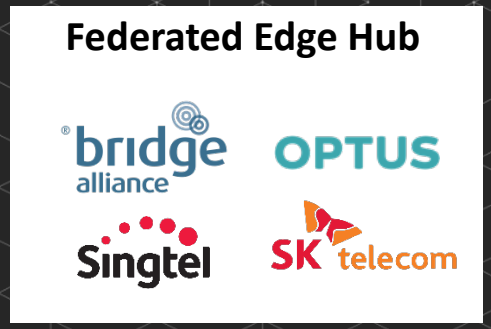

Bridge Alliance Federated Edge Hub ⇔ MobiledgeX Interconnection

Bridge Alliance (Pai Achuth)

MobiledgeX (Michael Lochead)

Singtel (Louis Lai)

Telefonica (Cristina Santana Casillas)

10th March 2022

Recap: Objectives of FEH⇔ MEX trial

- To demonstrate **TEC hub to hub interconnection** with an MNO customer able to deploy edge app in its own MEC and at the MEC owned by a federated MNO
- To implement the **East-West (EW) interfaces** for the TEC hub-to-hub interconnection aligning with OPG requirements
- GSMA Operator Platform (OP) defines a hub role for abstracting the complexity of MNO interconnections and avoid for a connections mesh. In this trial, **Bridge Alliance Federated Edge Hub (FEH)** and **MobiledgeX (MEX)** are the 2 hubs

TEC Hub to Hub Interconnection enables cross-region edge compute services for enterprises, developers and partners

GSMA TEC TRIAL FOUNDRY PROJECT

bridge alliance · MobiledgeX · OPTUS · Singtel · SK telecom · Telefónica

Edge compute service

GSMA | Telco Edge Cloud Trials - Future Networks

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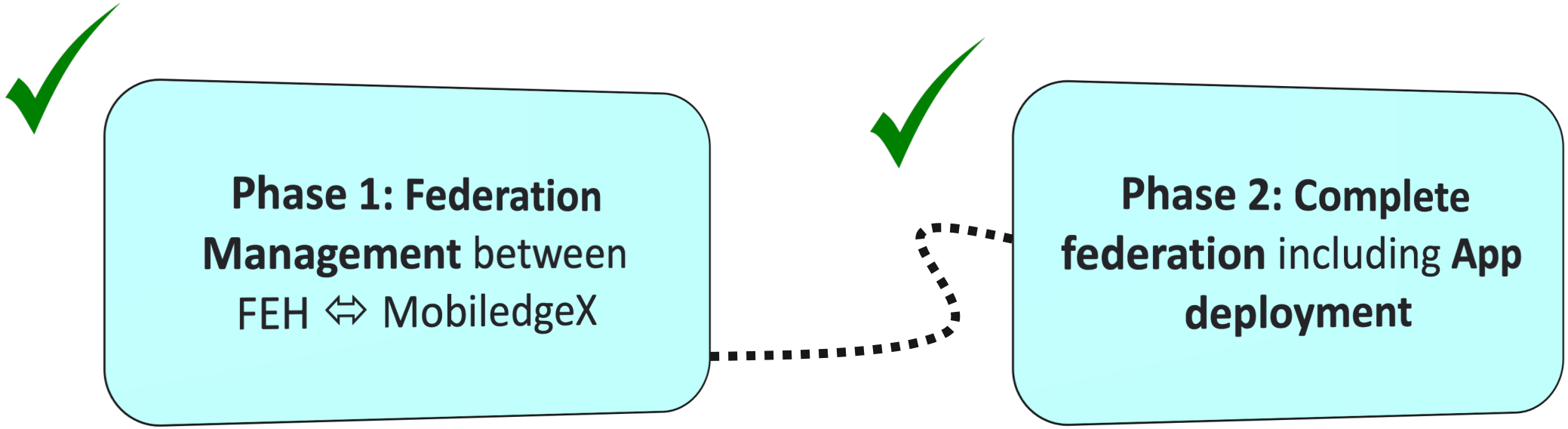
Implemented the TEC Hub-to-Hub interconnection involving 2 heterogenous MEC platforms



Phase 1 completed in Oct 2021

- Implemented initial set of East-West APIs to enable federation between FEH and MobiledgeX
- Presented at GSMA TEC forum on 18 Nov 2021

Phase 2 by Feb 2022

- Implemented additional East-West APIs for cross-regional app orchestration
- Demonstrated how a **Telefonica** user can deploy an edge application on **Singtel** MEC

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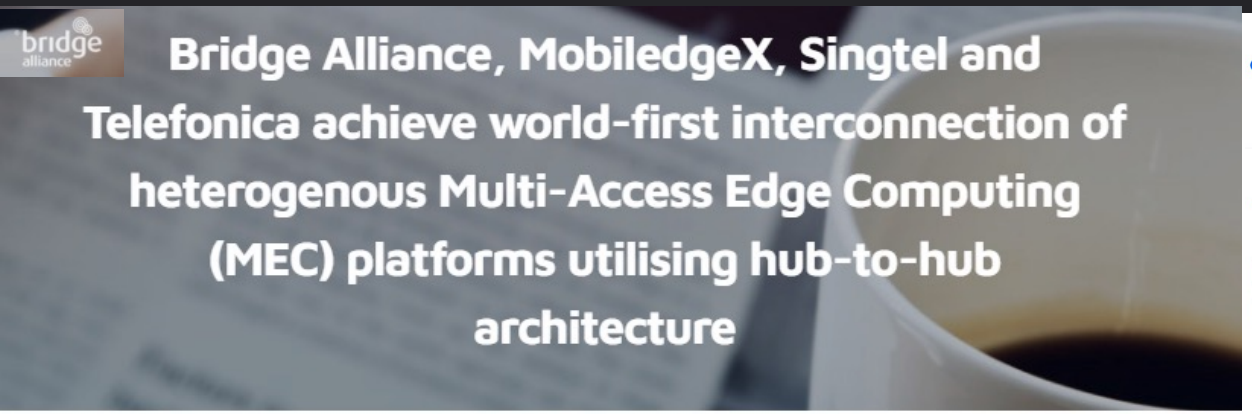
A press release was issued on 25 Mar 2022



25 Feb 2022

- *Simplifies edge infrastructure access and application delivery for enterprise customers and developers seeking to reach users across different markets.*

Telefónica

4,25 EUR +0,08 (+2,00%) ES | EN

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Bridge Alliance, MobiledgeX, Singtel and Telefonica achieve world-first interconnection of heterogenous Multi-Access Edge Computing (MEC) platforms utilising hub-to-hub architecture

MobiledgeX PRODUCT SOLUTIONS

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February 25th, 2022

Bridge Alliance, MobiledgeX, Singtel and Telefonica achieve world-first interconnection of heterogenous MEC platforms utilising hub-to-hub architecture

Press Release

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Bridge Alliance, MobiledgeX, Singtel and Telefonica achieve world-first interconnection of heterogenous Multi-Access Edge Computing (MEC) platforms utilising hub-to-hub architecture

RCRWireless
INTELLIGENCE ON ALL THINGS WIRELESS

Trialing a heterogenous edge with Singtel, Telefonica and Bridge Alliance

Putting its money where its mouth is, MobiledgeX and partners also announced this week the results of a heterogeneous edge connectivity trial. The collaboration is the result of the GSMA Foundry Telco Edge Cloud (TEC) project.

The company worked with Singtel, Bridge Alliance, and Telefonica to connect two geographically disparate MECs. Singtel's MEC deployment uses the Bridge Alliance Federated Edge Hub (FEH), while Telefonica's use MobiledgeX Edge-Cloud.

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Scope of FEH⇔MEX trial

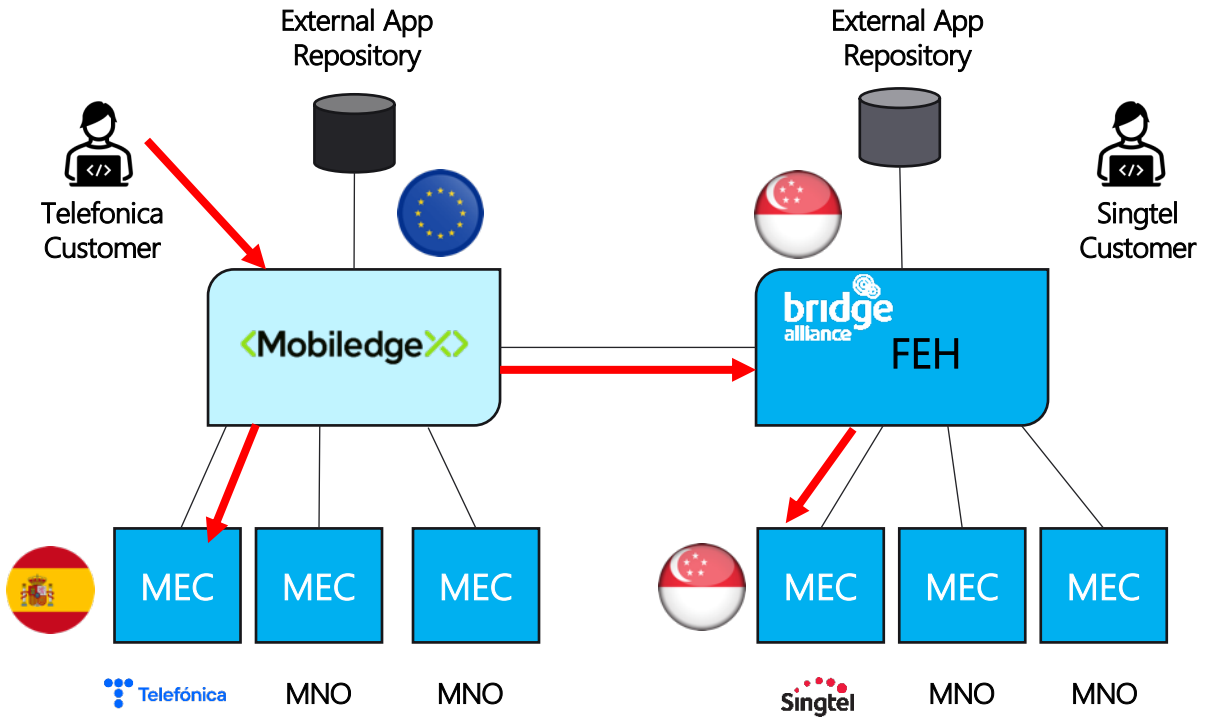
Implementing the TEC Hub-to-Hub interconnection through 2 phases

01 Federation Management

- To perform **federation management** and initiate a federation request between FEH and MEX
- To implement East-West APIs covering **Create federation**, **Register zone** and **Share zone**

02 Complete Federation with App

- **Complete federation** with **App management** by the developer
- To implement additional East-West APIs covering **onboard App** and **provision App**



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Outcome

01 Hub-to-Hub interconnect

Demonstrated TEC of hub-to-hub interconnection covering Federation Management and Application Management

02 Cross-regional App Deployment

Telefonica’s developer deployed a containerized app on a Singtel MEC (Singtel) utilizing hub-to-hub interconnection

03 APIs for interconnect

Implemented the East-West APIs for the TEC hub-to-hub interconnection

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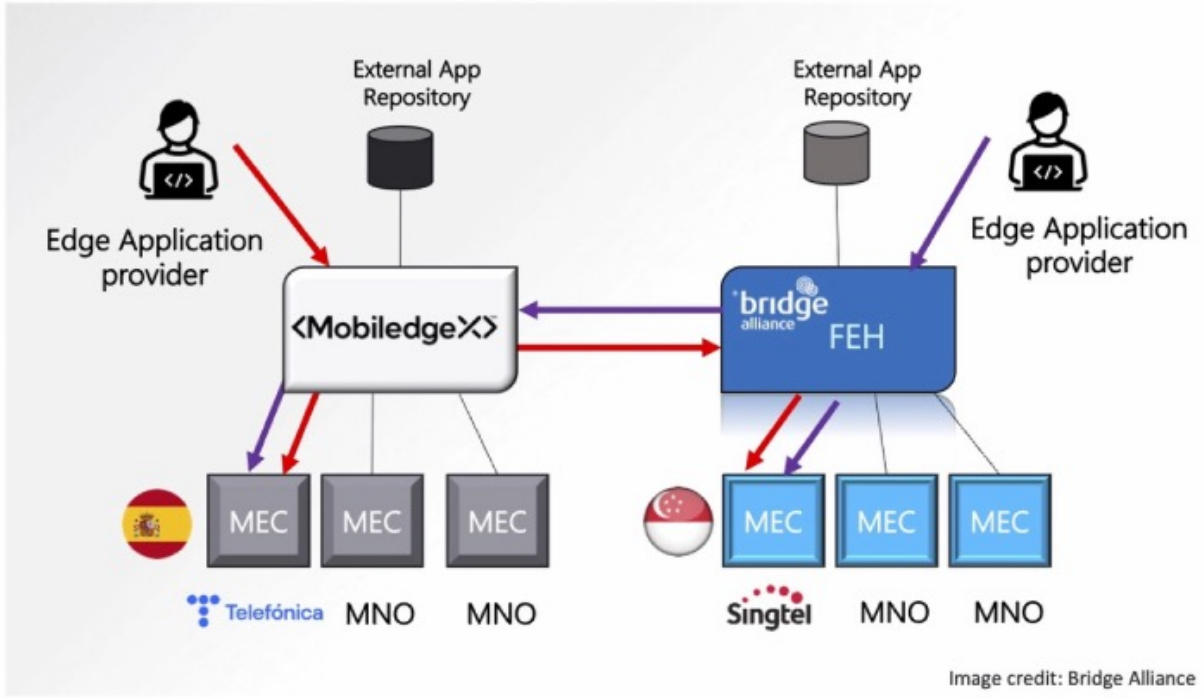
Demonstration video

Enterprises can discover and order cross-regional edge compute resources and deploy applications through a unified interface ensuring uniform application deployment experience



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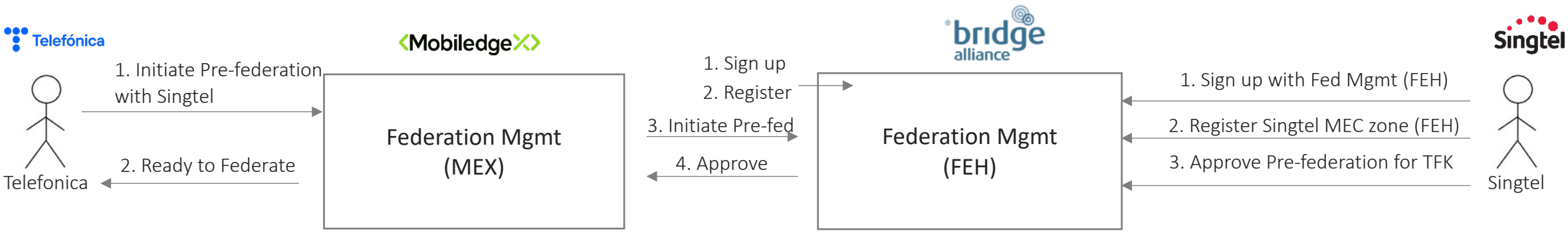
Technical setup for FEH⇔MEX trial

Federation model

1. Establishes an agreement between MNOs to share edge cloud resources
2. Establishes edge cloud resource (e.g. Availability Zone) sharing policy
3. Federation interconnect through FEH⇔MEX uses secure transport (TLS), and verifies each other's identities through mutual authentication (API key-based authentication)
4. Enables EW connectivity between two OPs of MNOs through FEH⇔MEX
5. Federation Management provides the management plane that covers the set of functionalities offered to Application Providers and OPs to control and monitor the resources and applications with the federation under their responsibility



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Reference: GSMA OP Telco Edge proposal

Key learnings and improvements needed (for APIs)

Phase 1 & 2 implemented improvements:

- Added functionality of Registering and Deletion of multiple zones
- Added functionality of returning multiple zonal information
- A pull-based status for Onboarding and Provisioning
- Added API key for authentication purpose
- Used server-side TLS to protect the API end-point (HTTPS)

Further improvements advised:

- Flavor template and API for compute capacity & storage
- Optional Cluster Creation API
- Security and Authentication flows yet to be specified in OPAG
- De-boarding and de-provisioning progress status APIs to be specified
- Further API inconsistencies, typos and fields to be fixed

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Thank You

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Conclusion and Q&A

Juan Carlos Garcia (Chair)

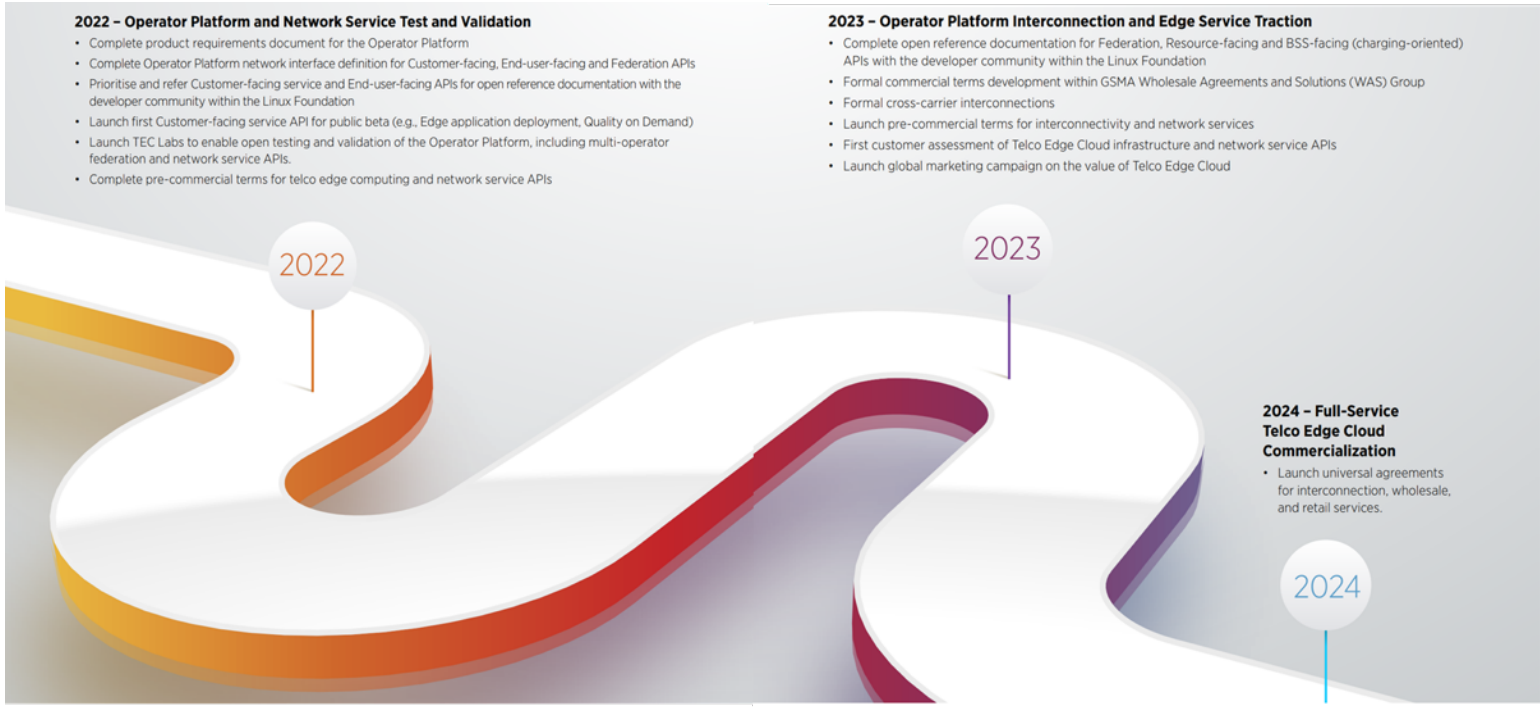
10th March 2022

Conclusions and Q&A (10 Min)

Achievements:
- TEC Trials
- TEC Value assessment
- 4th Forum
- New OPG document
- Standards alignment
- CAMARA launched (28th Feb)

Moving forward (2022):
- 2nd TEC Trial workshop (28th Mar)
- Design and set up TEC Labs (2H 2022)
- Complete requirements for OPG
- Standards Roadmap OPG/ETSI/3GPP
- Make Linux Foundation Project move
- First NaaS API
- Pre-commercial terms for Edge and NaaS (2nd workshop with WAS, 31st Mar)

…and the first targets towards commercial service



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