



OPEN EDGE COMPUTING INITIATIVE **FALL ONLINE WORKSHOP**

9 AND 10 DECEMBER 2021

- DAY 1 -

INVITEE PROFILE

Cloud Service Providers

AWS
Facebook
Google
Microsoft

Edge Applications

Akka
BMW
EdgeGap
Megh
Niantic
Optare Solutions
Polaris Group

Edge Infrastructure

Atrius Industries
Capgemini
Cirrus360
Edgeinfra Group
Equinix
Vapor IO
VMware

Edge Platforms

Alef Mobile Technology
Canonical
JMA
MobileedgeX
Nodeweaver
NOKIA
Stackpath

Research, Development, Innovation

5G Open Innovation Lab
CableLabs
CMU
ECCE/Fraunhofer
Fachhochschule Dortmund
InterDigital
KTH
STL Partners
University Clinique Duesseldorf

Silicon Technology

ARM
Intel
Seagate

Standardization and Open Source

TIP
ETSI
GSMA
NGMN
OpenStack Foundation
Small Cell Forum

Telecom Operators

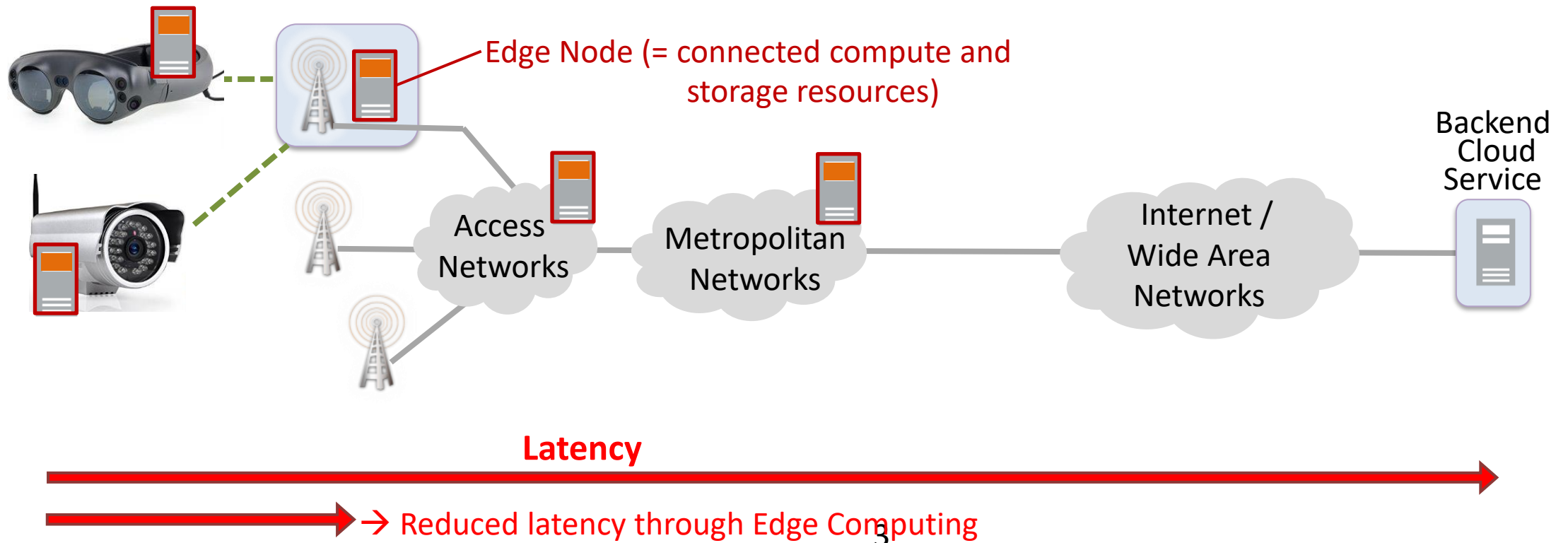
AT&T
Bell Canada
BT
Crown Castle
Deutsche Telekom
Jio
Proximus
Tata Communications
Telefonica
Verizon
Vodafone

WHAT IS EDGE COMPUTING?

➡ Edge Computing: small data centres at the network edge that offer connected compute and storage resources right next to the user

Example Use Cases:

- Augmented reality application connected with head mounted display
- Analyzing large volumes of data right at the edge (Edge Analytics)



CURRENT MARKET SITUATION AND DEVELOPMENT:

➡ EDGE COMPUTING ROLL-OUT AND ADOPTION IS HAPPENING!

Telco Edge Providers

- Telco edge services rolling-out now
- Strong push for new use cases
- Close cooperation with cloud providers
- Push for enterprise 5G + edge
- Plan to launch vertical edge solutions

Edge Use Cases

- Automotive starts to move towards edge
- AR shifts more compute to the edge
- Manufacturing & health picks up edge
- Forecast*: 20 edge use cases will generate USD 200 Bn by 2025

Cloud Edge Providers

- Heavy investment in edge products, services and infrastructure
- Focus on ease of application development
- Strong push for new use cases
- Cooperation with telecom providers

Edge Platforms and Infrastructure

- Good progress with edge management platforms → but still no converged APIs!
- Strong increase in edge infrastructure service offerings
- Forecast*: 1500 network edge data centers by 2025

➡ Edge Computing is becoming a very attractive business area!

OPEN EDGE COMPUTING INITIATIVE: KEY ACTIVITY AREAS

OEC Mission: ...is a collective effort for driving the business opportunities and technologies surrounding edge computing.

- **Drive Cross-Operator Edge Alignment**
→ Agree and establish a edge technology that enables a globally uniform mechanism to use edge services (Edge Interconnect, Telco vs Cloud Edge, Edge Platform APIs etc.)
- **Drive Edge Adoption**
→ Develop attractive edge applications and drive engagement with edge application developers
- **Tackle Key Technology Challenges**
→ Deliver prototype solutions for key technical edge challenges (Edge Orchestration, Hand-off etc.). Release solutions as open-source
- **Engagement and Alignment**
→ Cooperation with other edge related activities and initiatives (ETSI MEC, NGMN, GSMA, Linux Foundation Edge, OpenStack etc.)
- **Living Edge Lab**
→ Provide and utilize an E2E testbed for edge applications with a broad set of latest edge technologies



For further information

Twitter: @openedgecomput1, Web: www.openedgecomputing.org

OPEN EDGE COMPUTING INITIATIVE - CURRENT PARTNERS (AS OF DECEMBER 2021)

Industry Partners

- Arm
- AWS
- CableLabs
- Crown Castle
- Deutsche Telekom
- Facebook Connectivity
- Intel
- InterDigital
- Microsoft
- MobilEdgeX
- Seagate
- Verizon
- VMware
- Vodafone



OEC FALL ONLINE WORKSHOP 2021 – OVERVIEW TARGETS



General Workshop Target

- Update on Edge Computing
- Voice of the customer – Look at attractive edge applications
- OEC partner edge activities – Share insight / success stories
- Look at the latest edge research from CMU
- Connecting edge enthusiasts globally
- (OEC workstreams – Review existing / initiate new workstreams)

Special focus this workshop:

- Update on the opportunities and requirements of selected edge applications (AR, virtual desktop, drones etc.)
- Bring together the Telco Edge and the Cloud Edge
- Look at latest development in edge management platforms and edge infrastructures
- Identify inhibitors for edge adoption & suggest solutions
→ separate Miro board to gather input from all workshop participants

AGENDA DAY 1

DAY 1 - 9 December 2021

EST

11:15 Web-Conference Set-up and Test with all Participants

11:30 **Introduction**

Welcome and Introductions (Satya & Rolf)
Workshop Overview (Rolf)

11:50 **Edge Applications and Services**

Edge Compute & Spark AR
Pranav Saxena, Meta Reality Labs
DaaS and the Edge
Mahadevan Iyer and Julio Correa, VMware

Networking Break

13:00 **Cloud Edge and Telco Edge**

Cloudification of the Telecom Networks

Sunay Tripathi, Google

Telco Edge - Current Status and Roadmap

Cristina Santana Casillas, Telefonica

AWS Edge Solutions and Case Studies

Kai Mao, AWS

Verizon Edge Products and Roadmap

Richard Lamb, Verizon

14:20 **Summary Workshop Session Day 1**

Summary Day 1 and Outlook Day 2 (Satya & Rolf)

14:30 **End of Workshop Day 1**

AGENDA DAY 2

DAY 2 - 10 December 2021

EST

- 11:15 Web-Conference Set-up and Test with all Participants
- 11:30 **Welcome**
Overview Workshop Day 2 (Satya & Rolf)
- 11:35 **Update on Edge Work at OEC & CMU**
OEC - Progress and Outlook (Jim & Rolf)
- 11:50 **Cloud Edge and Telco Edge (cont.)**
Video Analytics at the Edge, the Ideal Technology
for the 5G Cloud
Ganesh Ananthanarayanan, Microsoft
- 12:10 **Edge Platforms and Infrastructure**
E2CO Edge Management Platform
Shamik Mishra, Capgemini
Edge and Equinix
Marco Zacchello, Equinix
Edge Gaming with Anbox Cloud
Maciej Mazur, Canonical

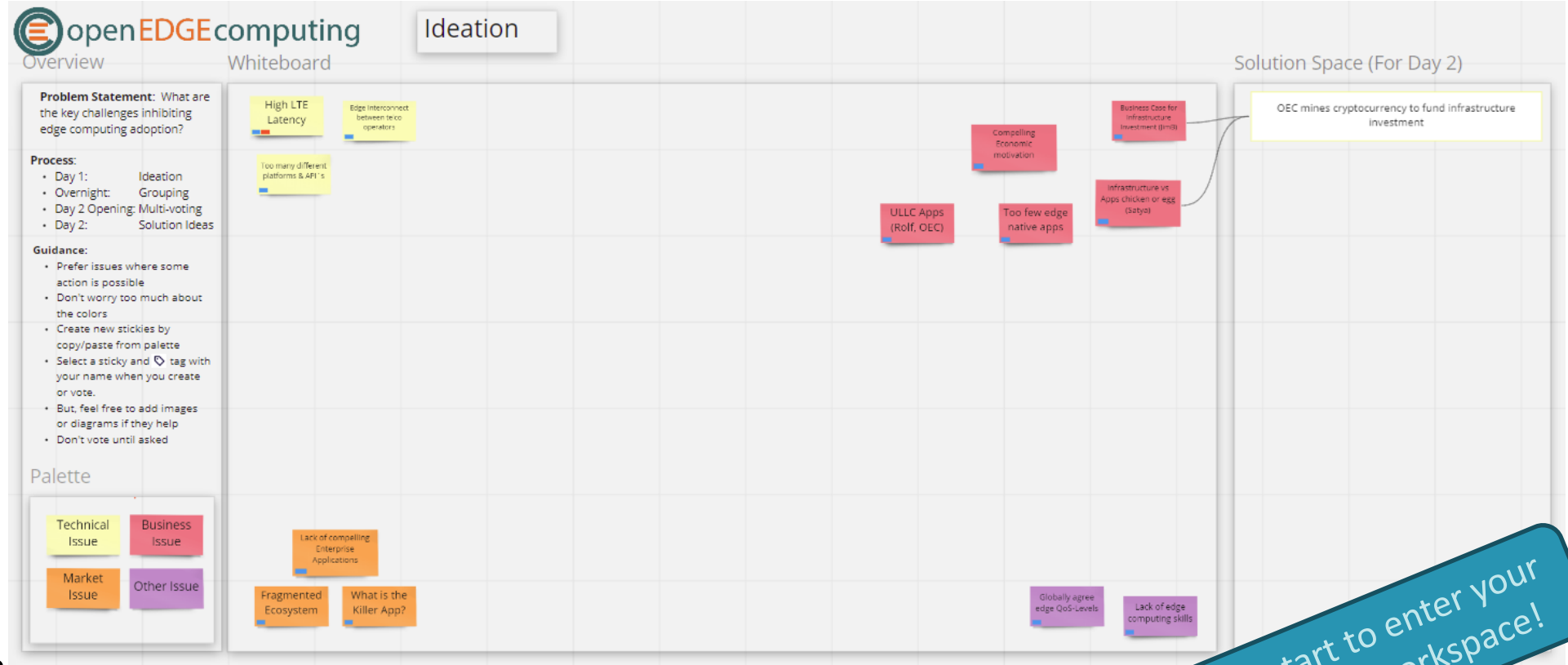
Networking Break

- 13:25 **Edge Communities and Solutions**
Akraino Update
Oleg Berzin and Tina Tsou, LF Edge
Linux Foundation
ETSI MEC Update
Dario Sabella, ETSI MEC
Follow Mec - the surveillance drone mec application
Santiago Rodríguez, Optare Solutions
- 14:10 **Workshop Summary**
Global Edge Challenges & Solutions
Summary of Workshop and Action Items (Satya & Rolf)
- 14:30 **End of Workshop**

WORKSHOP WORKSPACE (MIRO BOARD) PARALLEL TO SESSIONS

Problem Statement: What are the key challenges inhibiting edge computing adoption?

→ Site: https://miro.com/app/board/uXjVOdloIUA=/?invite_link_id=991993552793



Process:

- Day 1: Ideation
- Overnight: Grouping of ideas
- Day 2: Multi-voting (before break) and Solition Ideas (after break)

Please start to enter your views in the workspace!

SESSION: EDGE APPLICATIONS AND SERVICES

EDGE COMPUTE & SPARK AR

PRANAV SAXENA, META REALITY LABS

DAAS AND THE EDGE

MAHADEVAN IYER AND JULIO CORREA, VMWARE

SESSION: CLOUD EDGE AND TELCO EDGE

CLOUDIFICATION OF THE TELECOM NETWORKS

SUNAY TRIPATHI, GOOGLE

TELCO EDGE - CURRENT STATUS AND ROADMAP

CRISTINA SANTANA CASILLAS, TELEFONICA

AWS EDGE SOLUTIONS AND CASE STUDIES

KAI MAO, AWS

VERIZON EDGE PRODUCTS AND ROADMAP

RICHARD LAMB, VERIZON

WORKSHOP SUMMARY – DAY 1

Session: “Edge Applications and Services”

- AR & Edge: Insight into latest AR developments & Meta
- Desktop as a Service: Excellent insight into the world of DaaS

Session: “Cloud Edge and Telco Edge”

- Telco Edge products and services
- Cloud edge products and services



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OEC AND LIVING EDGE LAB UPDATES (SINCE MAY 2021)

1 OEC

- **New Member:**
 - Lockheed Martin
- **Workstreams:**
 - Meta
 - Edge Orchestration
 - Opensource Networks
 - AR/VR at the Edge
 - VMware
 - EdgeVDI
 - On-going work with InterDigital, ARM, Cablelabs, Seagate

2 Edge Apps and Infrastructure

- **Papers:** ACM/IEEE SEC Edge Emulation
- **Project:** Living Edge Lab CBRS Network
- **Project:** Latency Segmentation
- **Project:** Student Projects
- **Platform:** Magma LTE Core
- **Opensource:** PyEdgeSim

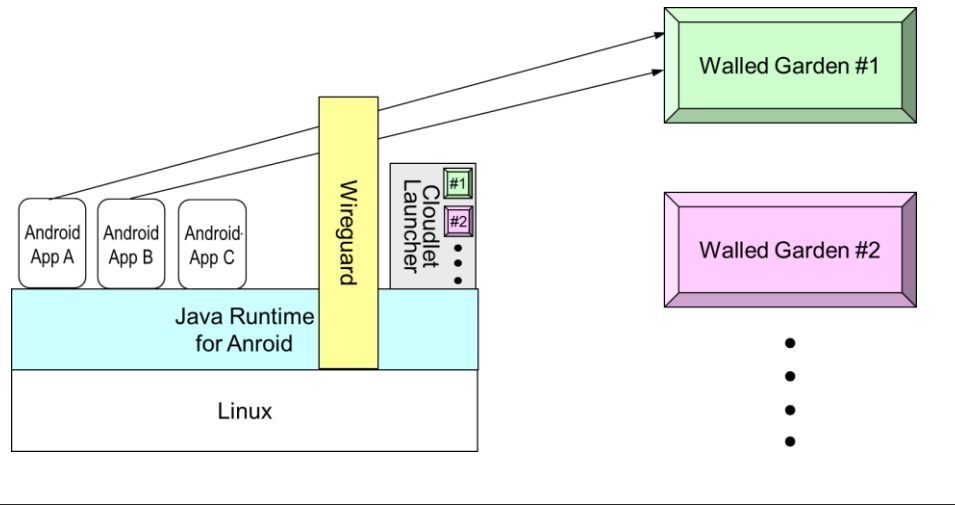
3 2022 Directions

- Continued interest in interconnect work
- Latency optimization
- 5G Migration
- *Other existing platforms:*
 - ARM/Ampere Server
 - AWS Snowball Edge
 - Azure Stack
 - MobileEdgeX
 - Verizon
 - Canonical MaaS

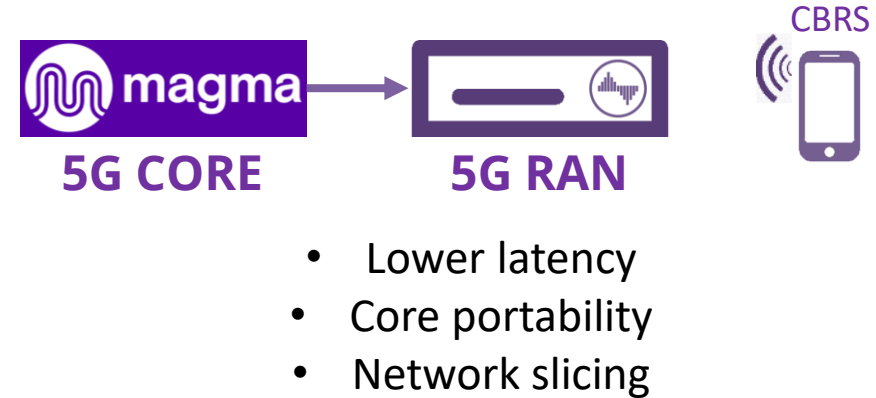
The OEC and the Living Edge Lab Continue to Drive Edge Adoption and Innovation

META ↔ LIVING EDGE LAB RESEARCH COLLABORATION

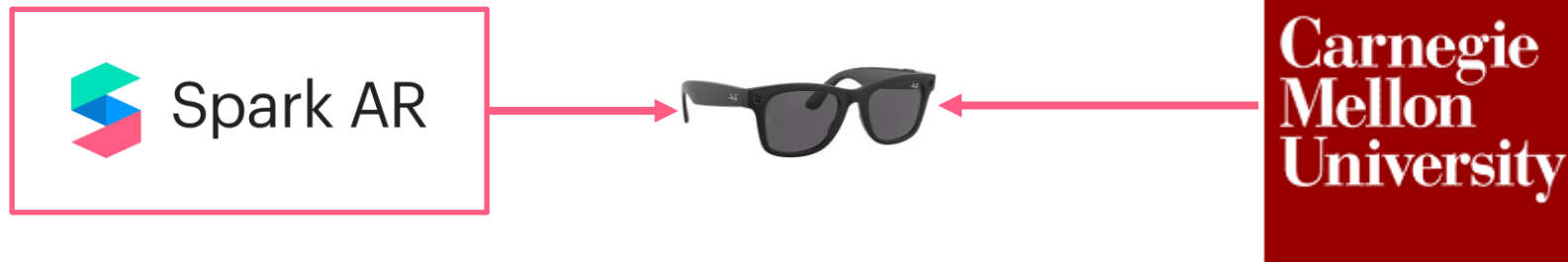
Edge Orchestration



Opensource 5G Networks



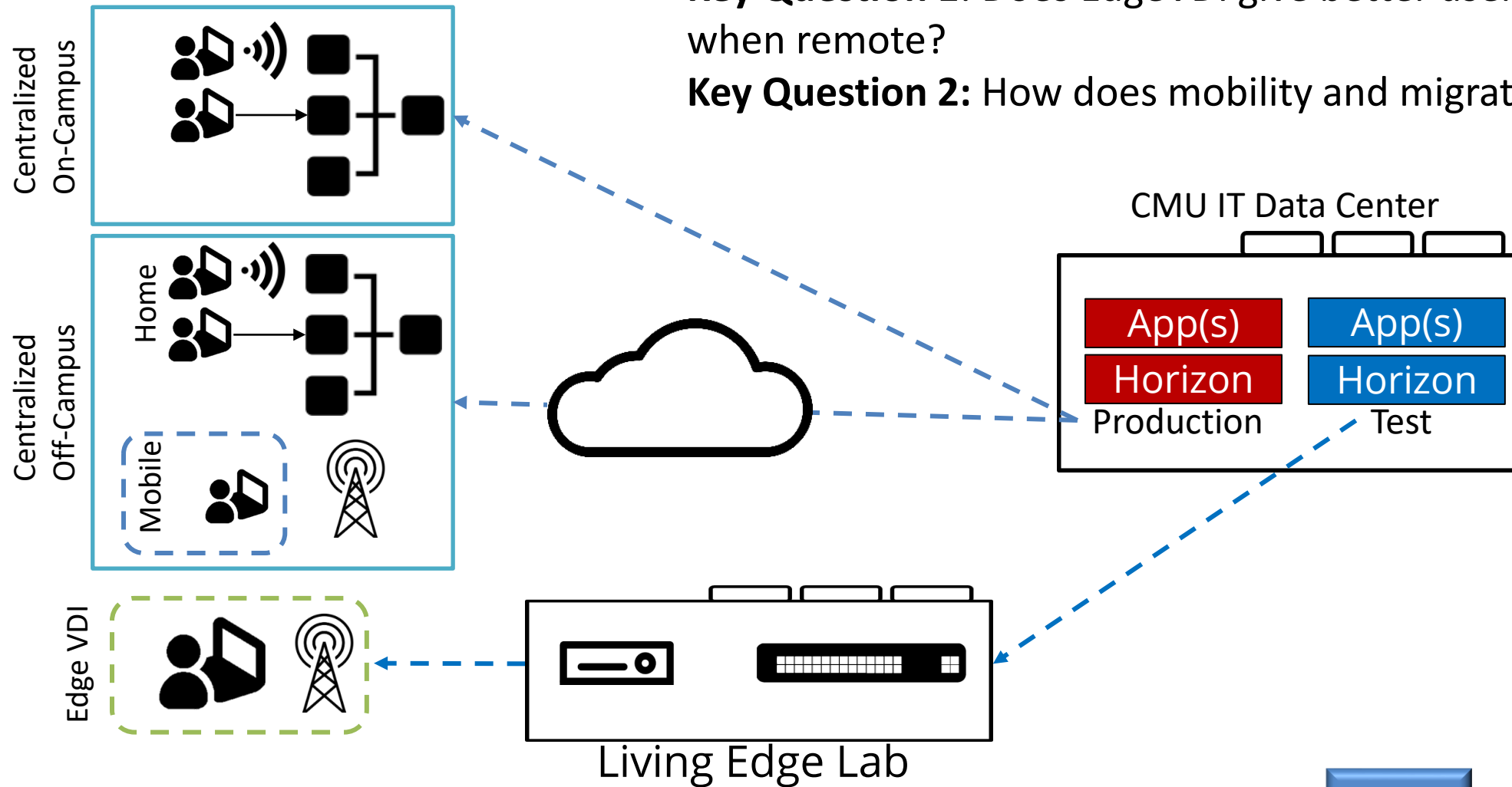
Compelling Edge-Native Augmented Reality Applications



VMWARE EDGEVDI PILOT

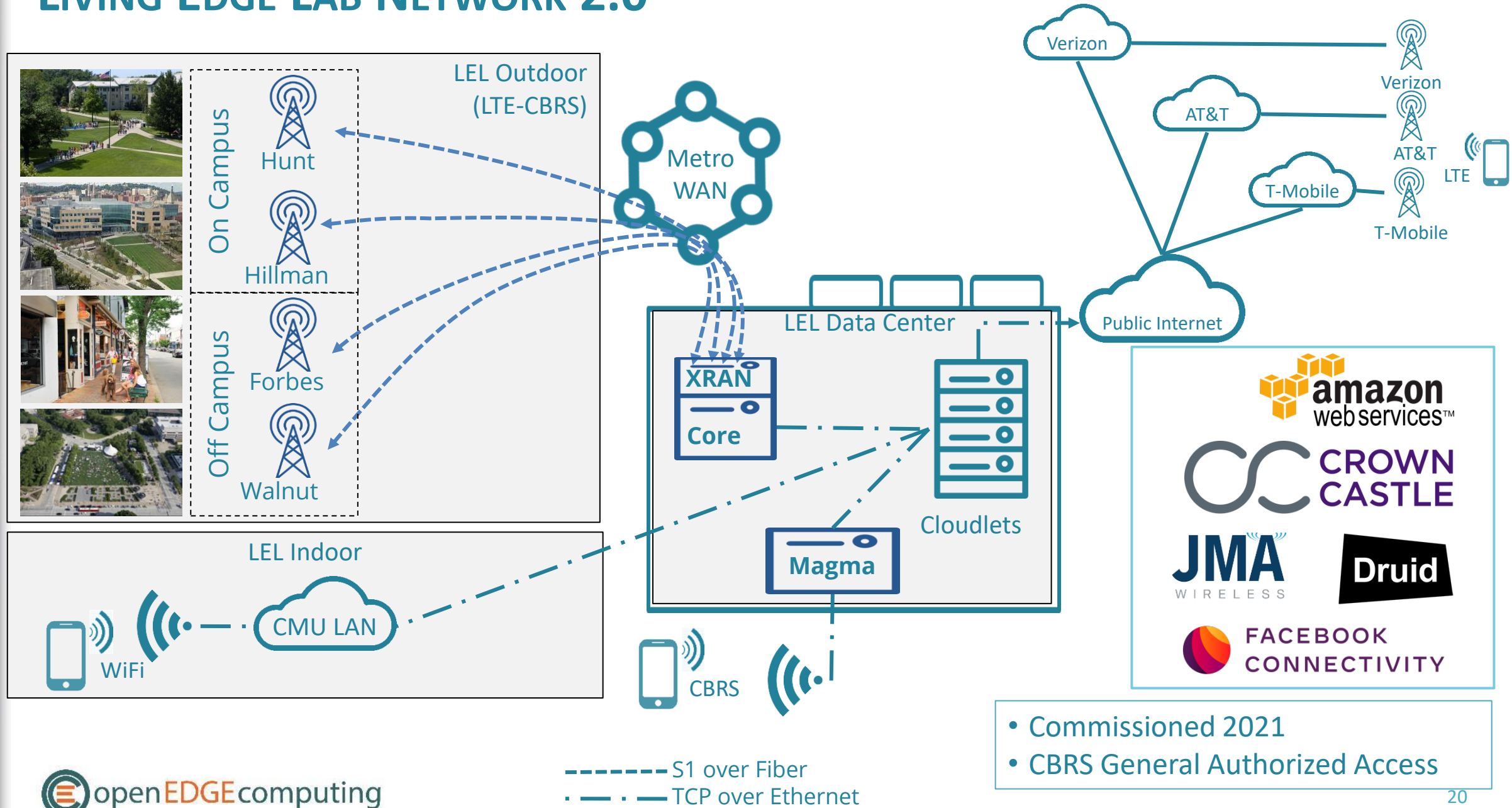
Key Question 1: Does EdgeVDI give better user experience when remote?

Key Question 2: How does mobility and migration impact?



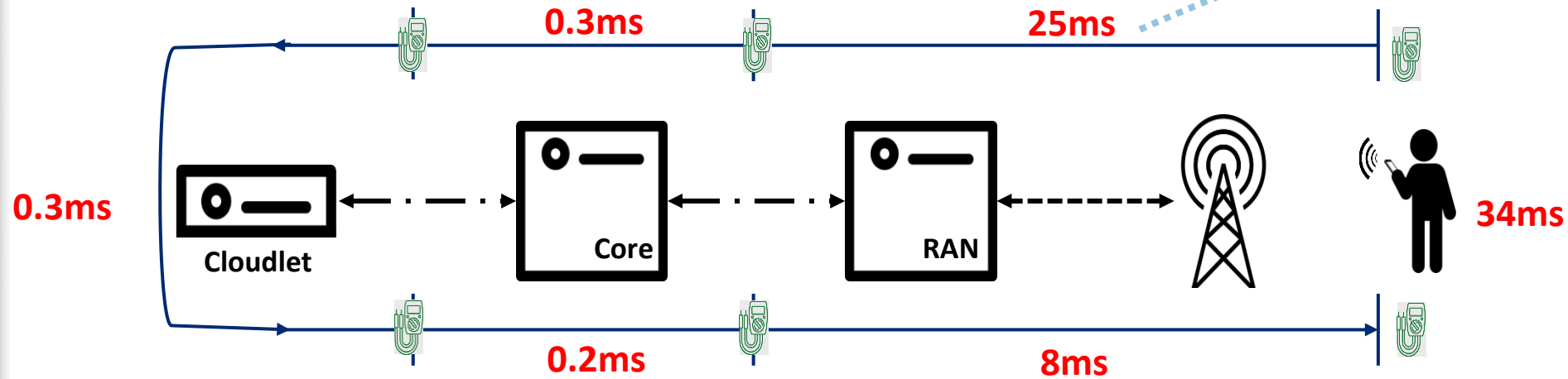
DEMO

LIVING EDGE LAB NETWORK 2.0



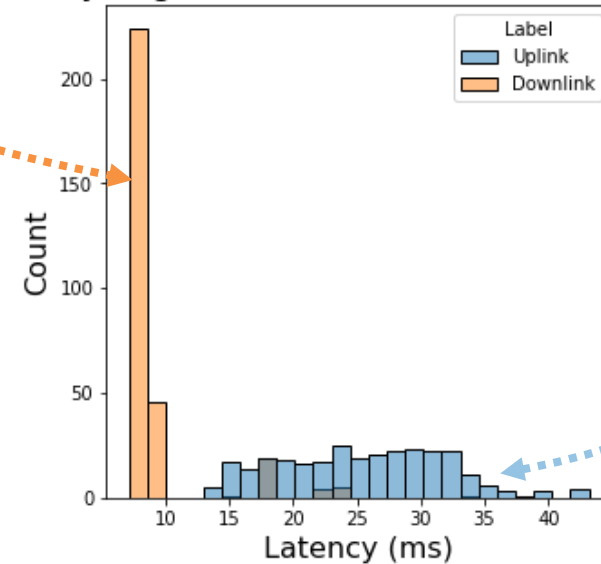
- Commissioned 2021
- CBRS General Authorized Access

LIVING EDGE LAB NETWORK LATENCY SEGMENTATION



- Wireless link through RAN is latency driver
- Uplink is the barrier
- Next:
 - Diagnose uplink issue: – Scheduling? BW asymmetry?
 - Optimization






Latency Segmentation (Device-XRAN Segment)



CMU LIVING EDGE LAB STUDENT PROJECTS FALL 2021

EDGE NATIVE APPLICATIONS AND BEYOND

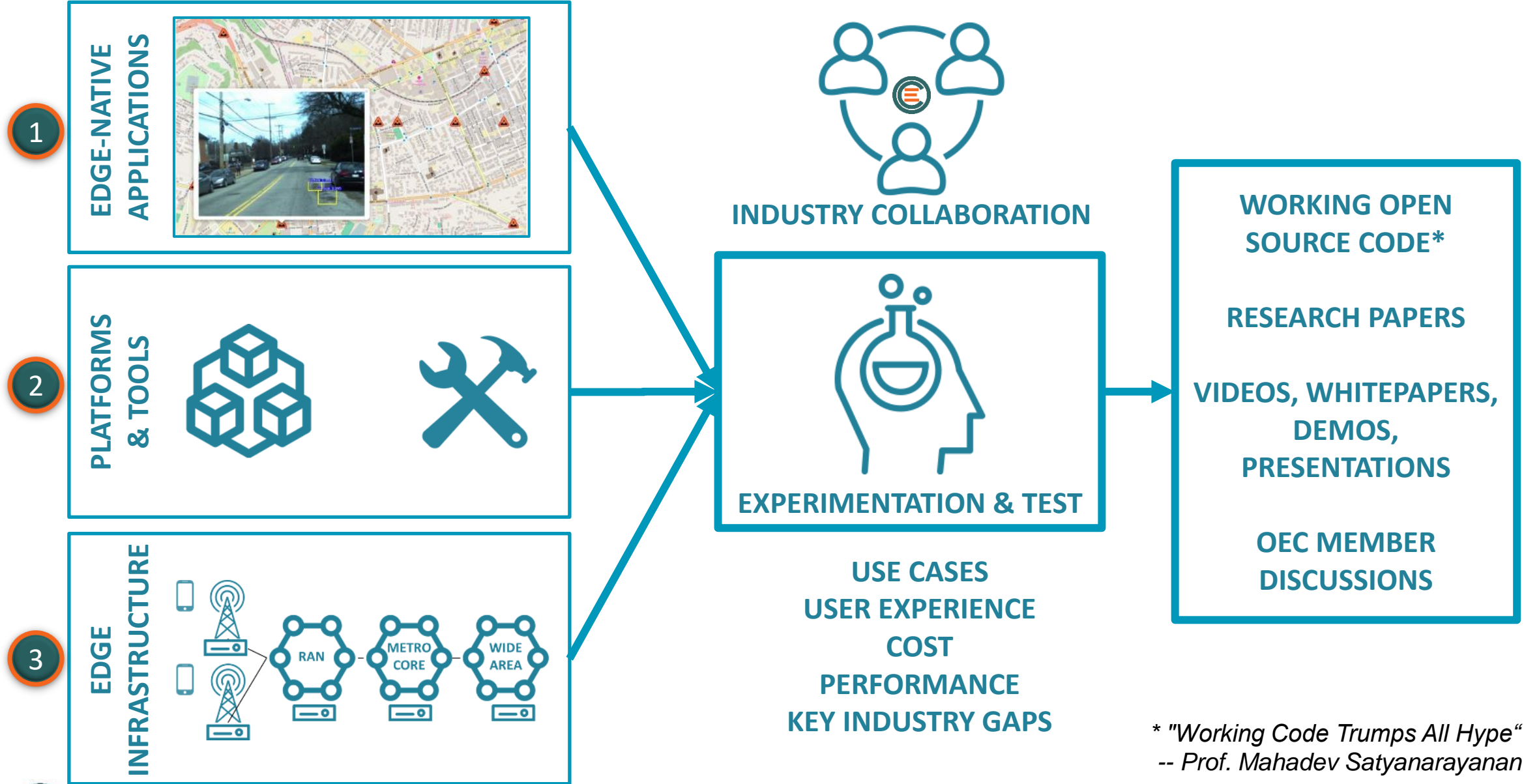
- 10 graduate student projects (Sep-Nov '21)
- Most edge computing focused and several using Living Edge Lab CBRS network

1		2021 Project 1: Edge-based Assembly Assistant Mahadev Satyanarayanan 7:36
2		2021 Project 2: Real-Time Edge-based Vision Assistant Mahadev Satyanarayanan 6:23
3		2021 Project 3: Bringing NeRFs into Augmented Reality Mahadev Satyanarayanan 4:53
4		2021 Project 4: CMU History Through Augmented Reality Mahadev Satyanarayanan 4:29
5		2021 Project 5: Network Latency Segmentation Mahadev Satyanarayanan 10:08
6		2021 Project 6: Privacy-Promoting Fake News Detection Mahadev Satyanarayanan 13:39
7		2021 Project 7: Text Recognition for OpenScout Mahadev Satyanarayanan 10:39
8		2021 Project 8: Edge-based Synthetic Scene Transformations Mahadev Satyanarayanan 7:54
9		2021 Project 9: Vision based Localization on Smartphones Mahadev Satyanarayanan 10:25
10		2021 Project 10: Interactive Virtual Coach for Rehabilitation Mahadev Satyanarayanan 9:59

<https://www.youtube.com/playlist?list=PLKZP6WvztHyvbQqPg4Wj3eB1SpbTAfBSJ>



WHY A LIVING EDGE LAB? – A *PROVING GROUND FOR THE EDGE*



** "Working Code Trumps All Hype"
-- Prof. Mahadev Satyanarayanan*



OPEN EDGE COMPUTING INITIATIVE **FALL ONLINE WORKSHOP**

MAY 2021

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NOKIA

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Altran/CapGemini
STL Partners

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Unmanned Life

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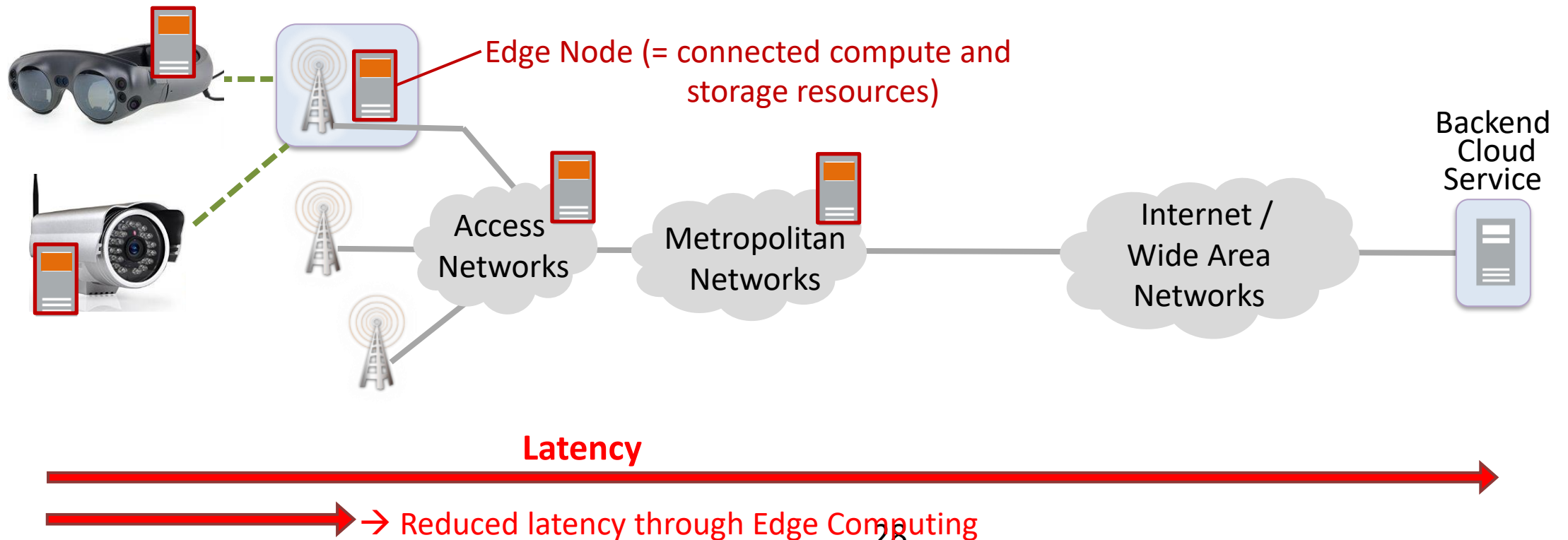
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WHAT IS EDGE COMPUTING?

➡ Edge Computing: small data centres at the network edge that offer connected compute and storage resources right next to the user

Example Use Cases:

- Augmented reality application connected with head mounted display
- Analyzing large volumes of data right at the edge (Edge Analytics)



CURRENT MARKET SITUATION AND DEVELOPMENT:

➡ **EDGE COMPUTING IS DEVELOPING RAPIDLY EVERYWHERE!**

Established Edge Application Areas

- Edge-based AR
- Edge Gaming
- Drone Control
- Automotive Edge

Relatively New Edge Application Areas

- Manufacturing Edge
- Medical Edge
- Home Edge / Building Automation Edge
- Smart City Edge

Edge Technology

- IT & Network Infrastructure
- Accelerators (GPU, FPGA, TPU)
- Security
- Orchestration

Edge Service Offering

- Telecom Operator Edge Services
- Cloud Service Provider Edge Services
- Enterprise Edge Services (IoT, Medical etc.)

➡ **It is still important to drive globally standardized mechanisms to use the edge!**

OPEN EDGE COMPUTING INITIATIVE: KEY ACTIVITY AREAS

OEC Mission: ...is a collective effort for driving the business opportunities and technologies surrounding edge computing.

- **Drive Cross-Operator Edge Alignment**
→ Agree and establish a edge technology that enables a globally uniform mechanism to use edge services (Edge Interconnect, Telco vs Cloud Edge, Edge Federation etc.)
- **Drive Edge Adoption**
→ Develop attractive edge applications and drive engagement with edge application developers
- **Tackle Key Technology Challenges**
→ Deliver prototype solutions for key technical edge challenges (hand-off, edge orchestration etc.). Release solutions as open-source
- **Engagement and Alignment**
→ Cooperation with other edge related activities and initiatives (ETSI MEC, NGMN, GSMA, Linux Foundation Edge, OpenStack etc.)
- **Living Edge Lab**
→ Provide and utilize an E2E testbed for edge applications with a broad set of latest edge technologies



For further information

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OPEN EDGE COMPUTING INITIATIVE - CURRENT PARTNERS

(AS OF MAY 2021)

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- Arm
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- Crown Castle
- Deutsche Telekom
- Facebook Connectivity
- Intel
- InterDigital
- Microsoft
- MobilEdgeX
- Seagate
- Verizon
- VMware
- Vodafone

Academic Partner

- Carnegie Mellon University



FACEBOOK
CONNECTIVITY



SEAGATE

CableLabs®



verizon✓



interdigital™

vmware®



Microsoft



<MobileEdgeX>™

vodafone

OEC SPRING ONLINE WORKSHOP 2020 – OVERVIEW TARGETS

General Workshop Target

- Update on Edge Computing
- Voice of the customer – Look at attractive edge applications
- OEC partner edge activities – Share insight / success stories
- Look at the latest edge research from CMU
- Connecting edge enthusiasts globally
- (OEC workstreams – Review existing / initiate new workstreams)

Special focus this workshop:

- Update on the opportunities and requirements of selected edge applications (edge gaming, manufacturing, drones)
- Bring together the Telco Edge and the Cloud Edge
- Look at latest development in the edge technology space
- Further the dialog and cooperation to make Edge Computing a global success

Networking between Participants

- 1-to-1 Private Chat (at any time)
- 1-to-1 Voice / Video (break and after workshop)
→ tell Jim Blakley via chat whom would like to meet (2 or more participants)
- → Jim will create a breakout room for you and move you there
- You may return to the main meeting by pressing “leave room”

AGENDA DAY 1

DAY 1 - 18 May 2021

EDT

11:15 Web-Conference Set-up and Test with all Participants

11:30 **Introduction**

Welcome and Introductions (Satya & Rolf)
Workshop Overview (Rolf)

11:50 **Edge Applications and Services**

Global Edge-Native Games - Opportunities and Requirements

Foad Shahbazi, Niantic
The BMW Group Edge Platform -
On Demand Functionality for Manufacturing
Dr. Veit Hammerstingl, BMW Group
Edge-Computing and AI for Drones
Kim Clement, Unmanned Life

Networking Break

13:20 **Cloud Edge and Telco Edge**

Edge Cloud Products and Use Cases |
Robin Harwani, AWS
Edge Computing Services @ Vodafone
Marco Dias Silva, Vodafone Group
Cloud-native Abstractions for Network Programmability
Landon Cox, Microsoft Azure

14:20 **Summary Workshop Session Day 1**

Summary Day 1 and Outlook Day 2 (Satya & Rolf)

14:30 **End of Workshop Day 1**

AGENDA DAY 2

DAY 2 - 19 May 2021

EDT

- 11:15 Web-Conference Set-up and Test with all Participants
- 11:30 **Welcome**
Overview Workshop Day 2 (Satya & Rolf)
- 11:35 **Update on Edge Work at OEC & CMU**
OEC - Progress and Outlook (Jim)
V-Light: Edge-Native Mobile Augmented Reality Gaming
Bob Gazda, InterDigital and Tom Eizler, CMU
- 12:10 **Edge Technology**
A Telco Core Designed for the Far Edge – or Crypto Miners?
Brian Barritt, Connectivity @ Facebook
GSMA - Update on the Telco Edge Operator Platform
Shamik Mishra, GSMA and Altran
Edge and 5G Technology
Todd Landry, JMA

Networking Break

- 13:30 **Future of Edge**
Convergence at CableLabs
David Debrecht, CableLabs
ETSI MEC - Edge Sandbox Service
Bob Gazda, Michel Roy, InterDigital
Delivering Value to the Edge – 5G and Beyond
Javan Erfanian, NGMN and Bell Canada
- 14:20 **Workshop Summary**
Summary of Workshop and Action Items (Satya & Rolf)
- 14:30 **End of Workshop**

SESSION: EDGE APPLICATIONS AND SERVICES

GLOBAL EDGE-NATIVE GAMES - OPPORTUNITIES AND REQUIREMENTS

FOAD SHAHBAZI, NIAN TIC

THE BMW GROUP EDGE PLATFORM - ON DEMAND FUNCTIONALITY FOR MANUFACTURING

DR. VEIT HAMMERSTINGL, BMW GROUP

EDGE-COMPUTING AND AI FOR DRONES

KIM CLEMENT, UNMANNED LIFE

SESSION: CLOUD EDGE AND TELCO EDGE

EDGE CLOUD PRODUCTS AND USE CASES

ROBIN HARWANI, AWS

EDGE COMPUTING SERVICES @ VODAFONE

MARCO DIAS SILVA, VODAFONE GROUP

CLOUD-NATIVE ABSTRACTIONS FOR NETWORK PROGRAMMABILITY

LANDON COX, MICROSOFT AZURE

WORKSHOP SUMMARY – DAY 1

Session: “Edge Applications and Services”

- Edge-native Gaming: Insight into business opportunities and requirements
- Excellent insight into the world of edge-based manufacturing
- Edge-based drone applications: opportunities and requirements

Session: “Cloud Edge and Telco Edge”

- Edge activities and use cases at AWS
- Update on latest edge activities at Vodafone
- Network - Edge API concepts from Azure for Operators



AGENDA DAY 2 → TOMORROW

DAY 2 - 19 May 2021

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Please contact: Dr. Rolf Schuster, Director Open Edge Computing Initiative
Rolf.Schuster@openedgecomputing.org, www.openedgecomputing.org, Twitter: [openedgecomput1](https://twitter.com/openedgecomput1)



OPEN EDGE COMPUTING INITIATIVE SPRING ONLINE **WORKSHOP**

18 AND 19 MAY 2021

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SESSION: UPDATE ON EDGE WORK AT OEC & CMU

OEC - PROGRESS AND OUTLOOK

JIM BLAKLEY

V-LIGHT: EDGE-NATIVE MOBILE AUGMENTED REALITY GAMING

BOB GAZDA, INTERDIGITAL AND TOM EIZLER, CMU

SESSION: EDGE TECHNOLOGY

A TELCO CORE DESIGNED FOR THE FAR EDGE — OR CRYPTO MINERS?

BRIAN BARRITT, CONNECTIVITY @ FACEBOOK

GSMA - UPDATE ON THE TELCO EDGE OPERATOR PLATFORM

SHAMIK MISHRA, GSMA AND ALTRAN

EDGE AND 5G TECHNOLOGY

TODD LANDRY, JMA

SESSION: FUTURE OF EDGE

CONVERGENCE AT CABLELABS

DAVID DEBRECHT, CABLELABS

ETSI MEC - EDGE SANDBOX SERVICE

BOB GAZDA, MICHEL ROY, INTERDIGITAL

DELIVERING VALUE TO THE EDGE – 5G AND BEYOND

JAVAN ERFANIAN, NGMN AND BELL CANADA

WORKSHOP SUMMARY – DAY 1 + DAY 2



Day 1

Session: “Edge Applications and Services”

- Edge-native Gaming: Insight into business opportunities and requirements
- Excellent insight into the world of edge-based manufacturing
- Edge-based drone applications: opportunities and requirements

Session: “Cloud Edge and Telco Edge”

- Edge activities and use cases at AWS
- Update on latest edge activities at Vodafone
- Network - Edge API concepts from Azure for Operators

Day 2

Session: “Edge Work at OEC & CMU”

- OEC progress and new workstreams
- InterDigital-CMU work on edge-native gaming

Session: “Edge Technology”

- 5G and Edge solutions at Facebook Connectivity
- Update on GSMA Operator Platform & Overview Ensconce edge platform
- Insight into 5G & Edge Technology at JMA

Session: “Future of Edge”

- Insight into convergence work at CableLabs
- Overview and demo ETSI MEC Sandbox
- Edge Computing and 6G vision from NGMN



Please contact: Dr. Rolf Schuster, Director Open Edge Computing Initiative
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