

5G-MiEdge Project

Millimeter-wave Edge Cloud as an Enabler for 5G Ecosystem

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Key Capabilities of 5G (IMT2020) relevant for the Project

■ 5G applications selected from ITU-R:

- ✓ Enhanced MBB
- ✓ Ultra-Reliable LLC

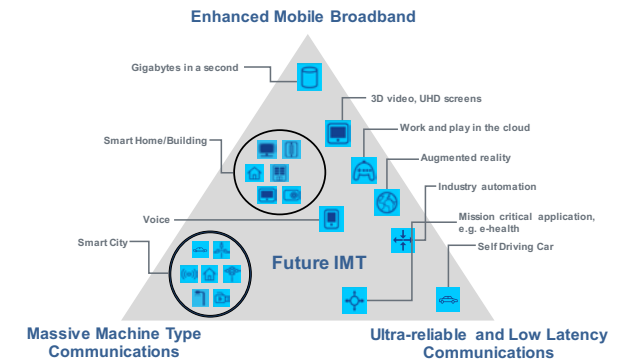
■ Key capabilities

- ✓ >10 Gbps peak user rate
- ✓ >1000x system rate
- ✓ <5 ms latency

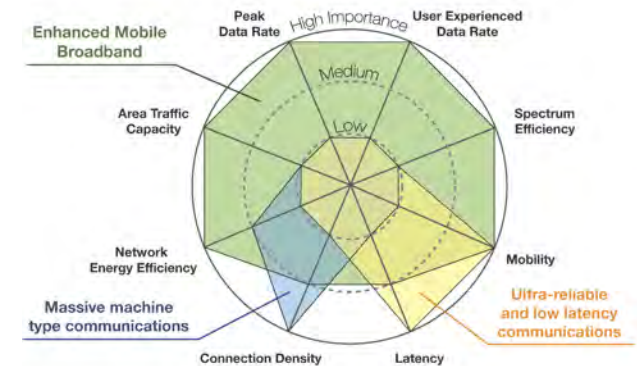
■ Background technological enablers

- ✓ Millimeter-wave (mmWave) + HetNet for eMBB
- ✓ Numerology + edge cloud for uRLLC
- ✓ Multi-connectivity both for eMBB & uRLLC

3 Key application areas of 5G



8 Key Capabilities (KPIs) of 5G



@ Recommendation of ITU-R M.2083-0, Sep. 2015

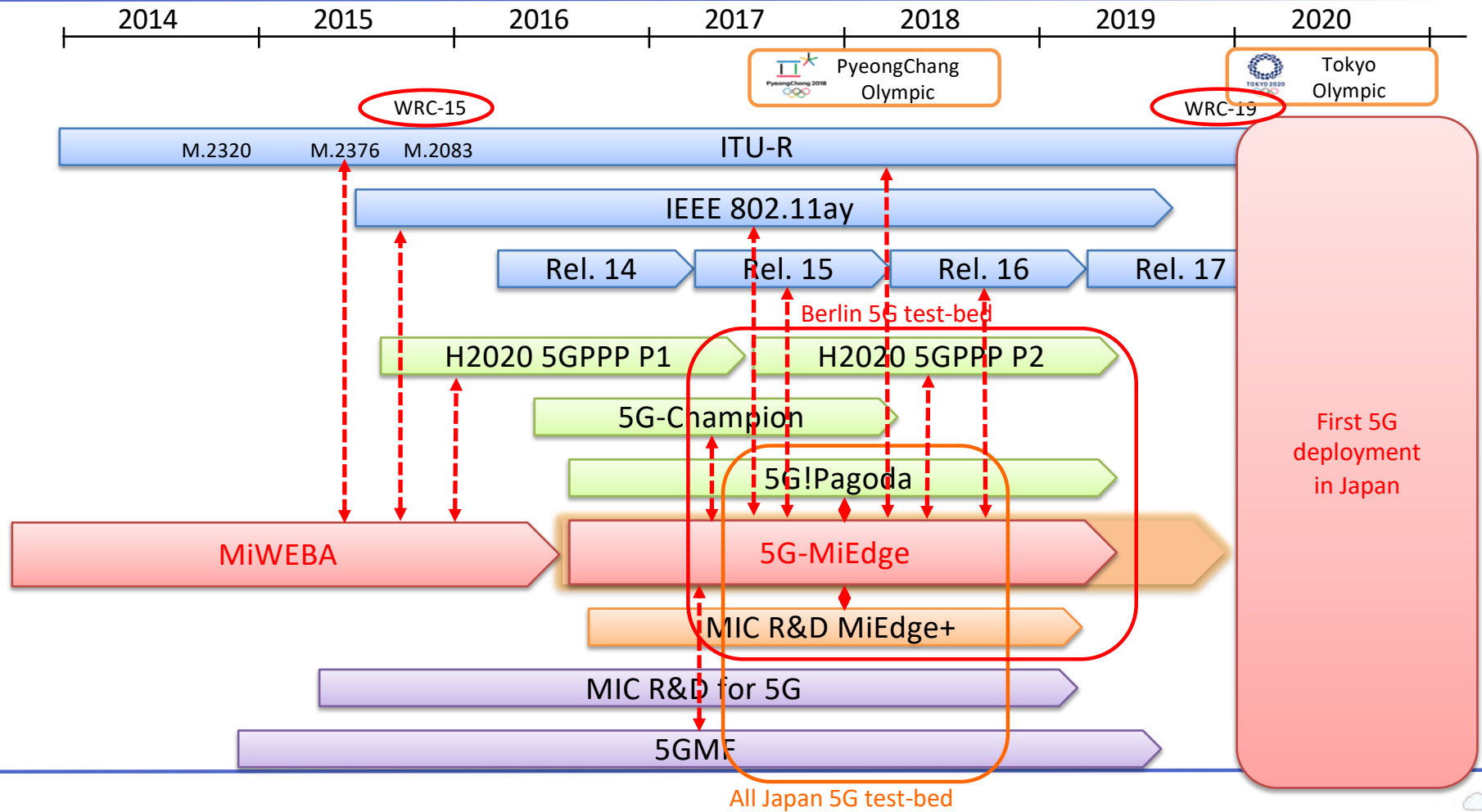
5G MiEdge Project

5G-MiEdge: Millimeter-wave Edge Cloud as an Enabler for 5G Ecosystem

Objectives

- To **combine mmWave access and Mobile Edge Cloud (MEC)** to realize ultra high speed & low latency communications even with limited backhaul
- To **develop a new cellular network control plane (liquid RAN C-plane)** in order to enable a proactive resource allocation for the mmWave edge clouds
- To develop mechanism (new ecosystem) to **realize user/application centric orchestration** of deployed mmWave edge clouds (RAN virtualization)
- To **contribute to the standardization of mmWave access and liquid RAN C-plane** in both 3GPP and IEEE
- To **demonstrate a joint test-bed of 5G-MiEdge project** in the cities of Berlin and 2020 Tokyo Olympic game areas

5G-MiEdge and the Road to 5G



5G-MiEdge Use Cases

Omotenashi Service

- Download in-flight entertainment or VR city info
- **>6 Gbps at waiting area**



Moving hotspot

- Download entertainment and upload massive SNS
- **>80Gbps in train and >2.6Gbps in bus**



2020 Tokyo Olympic

- Immersive AR/VR, public video surveillance for security
- **>500Gbps in stands and <5ms latency**



Outdoor dynamic crowd

- Download VR city info and upload massive SNS
- 6Gbps in 1600m² -> **15Tbps in 4km²**



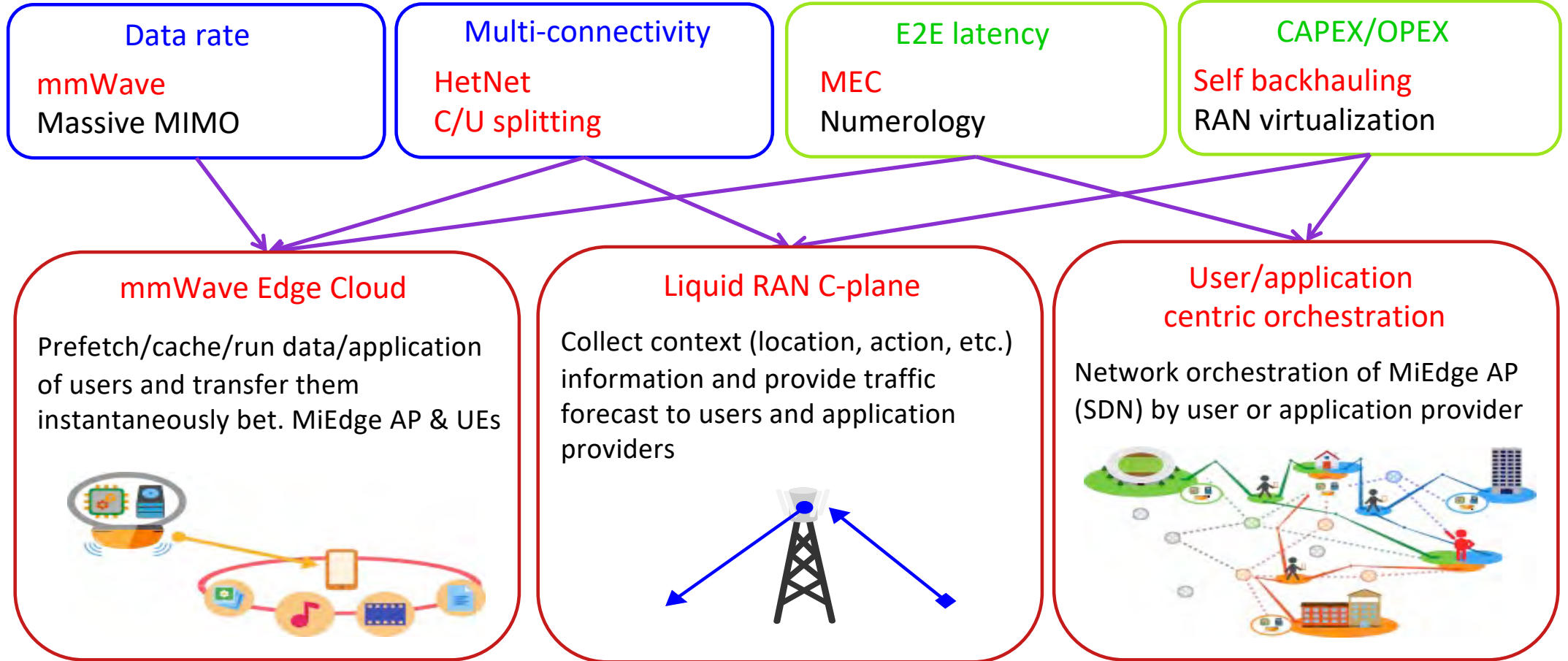
Automated driving

- Exchange sensor information for safety driving
- **>1Gbps data rate and <10ms latency per link**



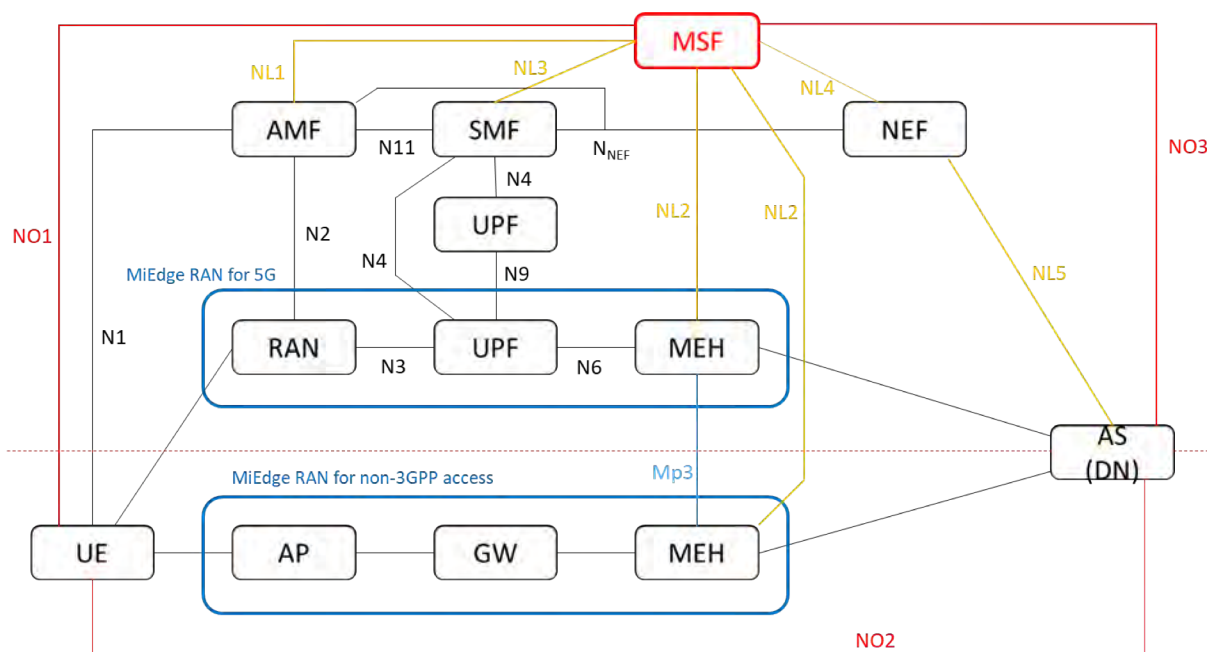
Final PoC

Technology Contributions in 5G-MiEdge



5G-MiEdge System Architecture supporting mmWave & MEC

1. Extension of 5G (3GPP) and ETSI MEC architectures to integrate mmWave & MEC
2. New function (MSF) and related interfaces for service management and orchestration for MEC
3. Interworking between 5G (3GPP) RAN and non-3GPP access for flexible deployment of MiEdge technology

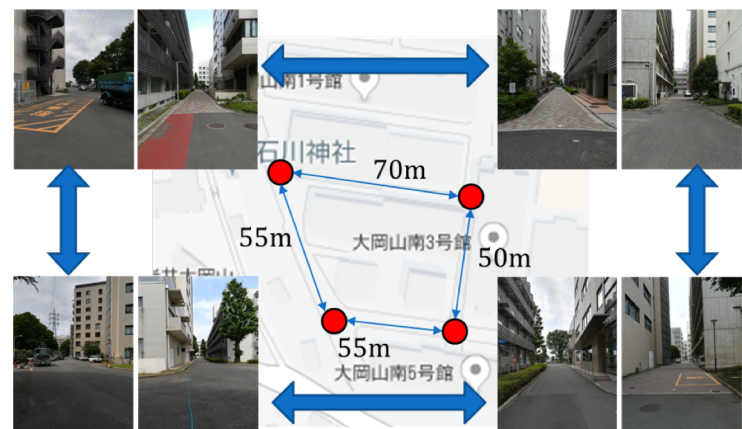
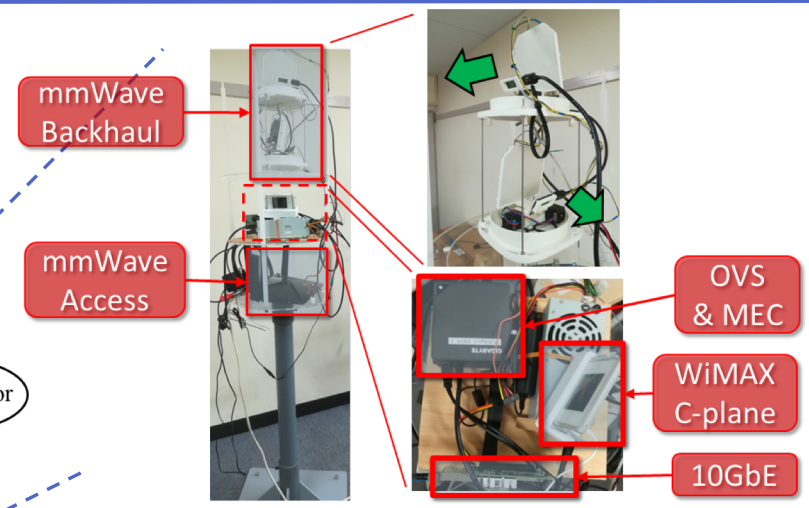
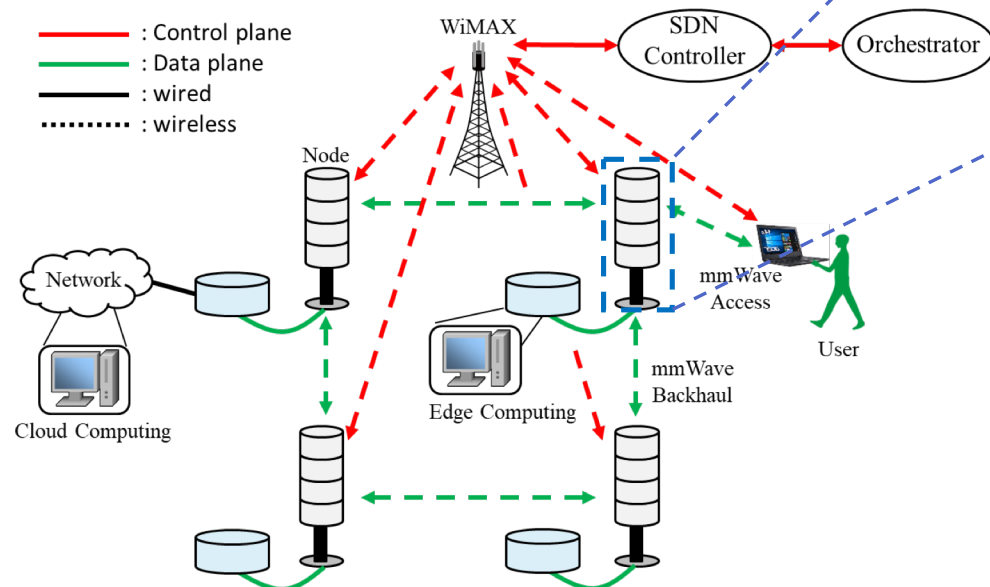


Functions	Roles
AS (Application Server)	Providing MEC applications
AMF (Access and Mobility management Function)	Registration management, Connection management, Reachability management, Mobility management, Access authentication, Access authorization, Security context management
SMF (Session Management Function)	Session management, UE IP address management, Selection and control of UPF, Control and coordination of charging data collection at UPF
UPF (User Plane Function)	Anchor point for Intra-/Inter-RAT mobility, External PDU session point of interconnect to Data Network, Packet routing & forwarding, Traffic usage reporting, QoS handling for user plane
NEF (Network Exposure Function)	Exposition of services and capabilities to 3 rd party, e.g. Application Function, Edge Computing, Mobility Pattern, Communication Pattern
MEH (MEC Host)	Hosting services/contents, Activating/adding/deleting/transferring/resuming services/contents
MSF (MEC Service Function)	MEC service management, MEC capability exposition (via NEF) to Application Server (Service), MEC (MEH) registration for UE, UE location based MEC management and orchestration (long term and short term)

PoC for Outdoor Dynamic Crowd

● 5G-MiEdge architecture enables;

1. Integrated access and backhaul over mmWave
2. Location based data/application prefetching for MEC
3. >2Gbps and <1ms experienced data rate and latency

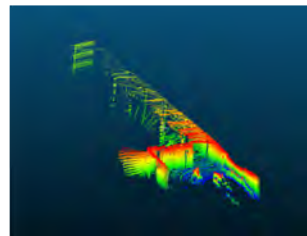
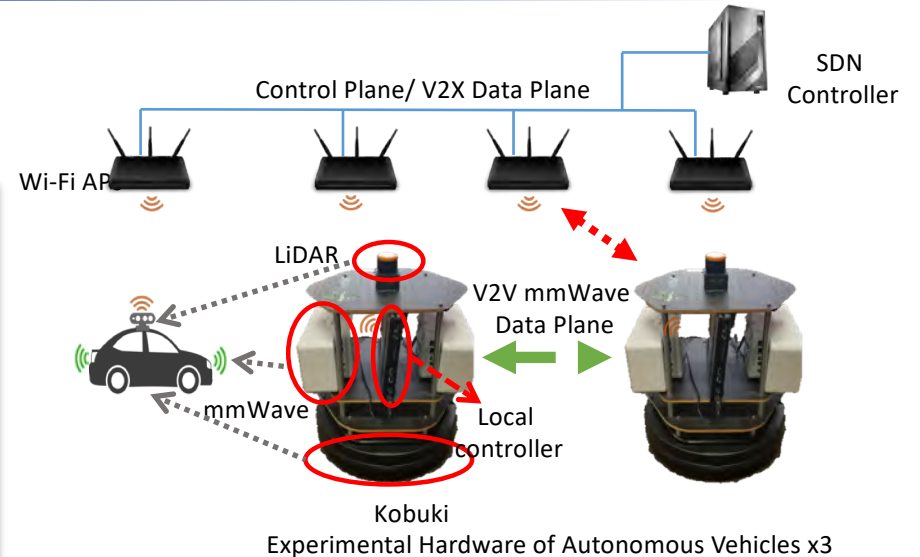
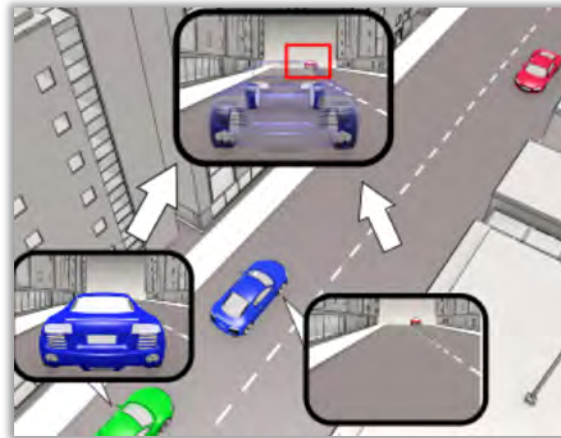


PoC for Automated Driving

● 5G-MiEdge architecture enables;

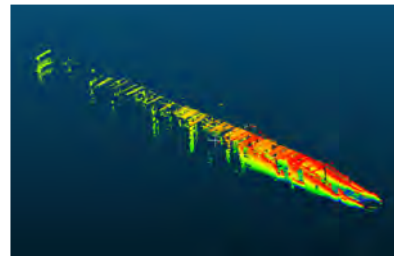
1. Cooperative perception for safe automated driving
2. Exchange sensor data over mmWave V2V and V2X
3. Perform cooperative perception on MEC at OBU and RSU

Scenario of cooperative perception

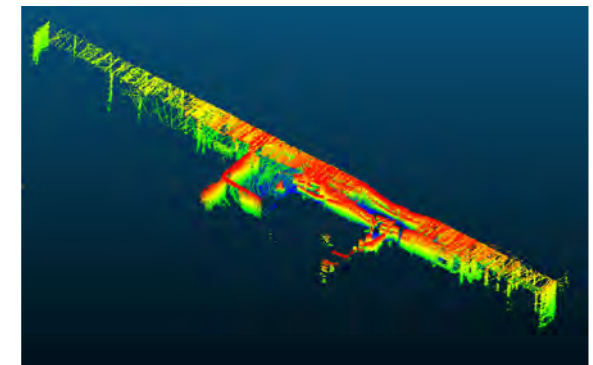


Local Map in Vehicle1

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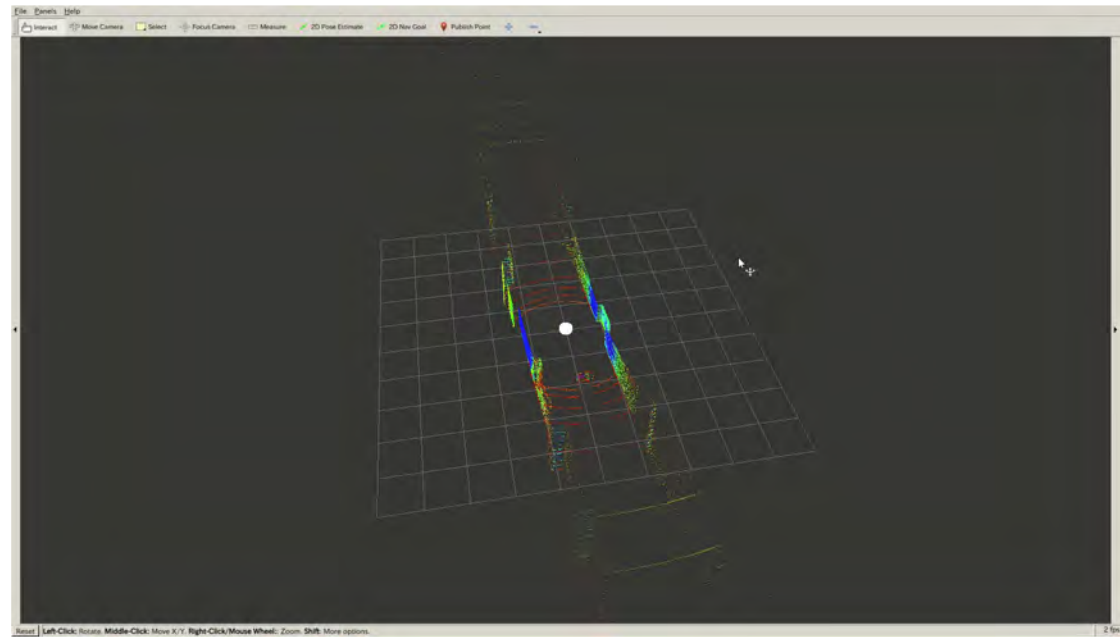


Local Map in Vehicle2



Merged Map in Vehicle2

Demo Videos



5G Technology Enablers for Tokyo Olympics 2020



Proposal of AITS (Artificial Intelligence Transport System) from 5G-MiEdge Project



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Current ITS (DSRC & C-V2X)

- Only equipped vehicles and RSUs exchange cooperative awareness messages
- Only ITS assists maneuvering (braking and route selection) by providing warning to drivers
- More intelligence is needed to realize fully & safe automated driving vehicles

DSRC & C-V2X



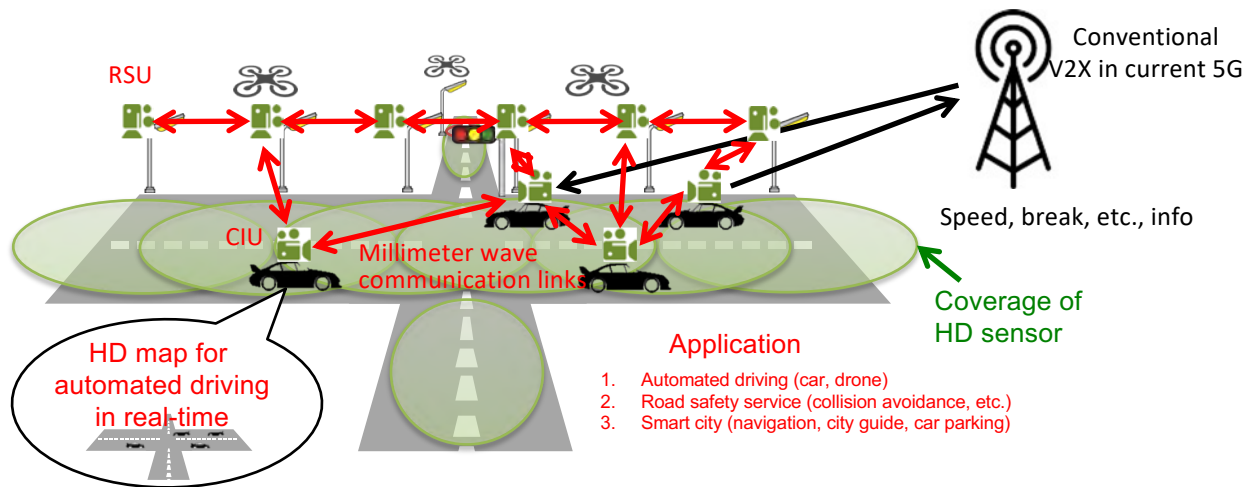
Advanced driver assistance



Proposed AITS (AI + Beyond 5G)

- Full integration of enhanced V2X (extended sensors) and AI driving
- Combination of centralized model learning & distributed optimization (driving)
- Provide zero-accident for AITS vehicles in AITS equipped areas (cities, countries, ...)

Enhanced V2X in Beyond 5G



AITS equipped city

