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6GEWOC

AI-ENHANCED FIBRE-WIRELESS OPTICAL 6G NETWORK IN SUPPORT FOR CONNECTED MOBILITY

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"Moving from Research Studies and Trials towards an Implementation of Beneficial Use Cases and Innovative Market Applications via the Inclusion of B5G/6G and AI", Infocom, 12 Nov. 2024, Athens

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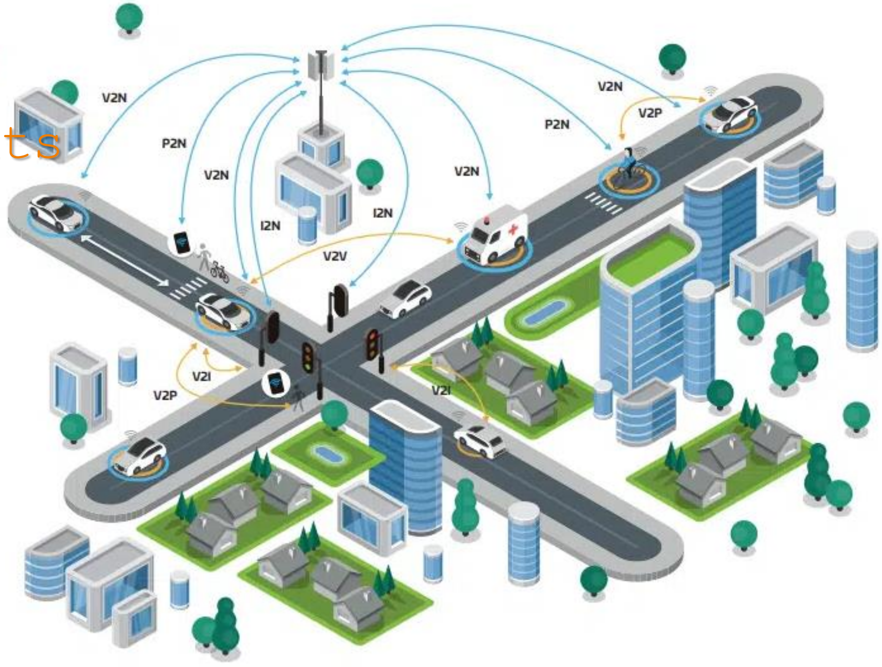


Positioning of 6G-EWOC to 6G-V2X

- **Vision:** Contribution to the transformation of urban transportation
- **Goal:** Development of a multi-access, ultra-high throughput, ultra-low latency, energy efficient, resilient, e2e, photonic-assisted 6G-V2X network **with advanced** communication and sensing capabilities fulfilling the requirements of innovative vehicular use cases and the introduced emerging cutting-edge technologies.

- **6G-EWOC considers many of the 6G features and technologies** (e.g. ultra-high datarates (up to 1 Tbps) and ultra-low latency (<1 ms), AI integration, edge computing, massive device connectivity (10m devices/km^2), energy efficiency, high reliability and availability), **and it implements innovative concepts towards higher safety** (that improve FAVs' situational awareness and accuracy of object recognition and classification), such as:

"Collective Perception": Vehicles and roadside infrastructure share sensory data (e.g., from cameras, LiDARs, RaDARs) to create a unified 3D view of the environment, "illuminating" blind beyond LoS areas

Joint Communication And Sensing (JCAS): Vehicles act as both data transmitters and sensors of the surroundings

"Data fusion": Strategy combining the strengths of different sensors, ranges and signal modalities (camera, RaDAR, LiDAR) to reduce weaknesses/uncertainties of individual sensors.

Simultaneous Localization And Mapping (SLAM): The vehicle needs info about the map of its environment to localize itself in it, while accurate localization is required to build and update the map over time.

6G-EWOC Technological Objectives-Developments

6G-EWOC Wireless Technologies & Devices

- OWC for V2V high-rate Gbps V2I applications, leveraging chip-scale optical beamformers
- Connected laser/radio detection, ranging and communication (Lidar/Radar)

6G-EWOC AI-based Network & Applications

- AI-assisted control and orchestration of resources for the 6G-EWOC network concept
- AI-based applications development for Autonomous Vehicles

6G-EWOC Fiber Fronthaul & Photon. Switching

- PIC and ASIC for tuneable 50-100 Gbps/λ TX & RX for fiber-based fronthaul DWDM links
- SDN-enabled Photonic Switching

PIC: Photonic Integrated Circuit
ASIC: Application-Specific Integrated Circuit

6G-EWOC at a Glance

AI-Enhanced Fiber-Wireless Optical 6G Network in Support for Connected Mobility

Academic and RTOs

Universitat Politècnica de Catalunya - BarcelonaTech
Spain, Barcelona

Centre Tecnològic de Telecomunicacions de Catalunya
Spain, Castelldefels

AIT Austrian Institute of Technology
Austria, Vienna

PIC & ASIC Developer

III-V Lab
France, Palaiseau

Ligentec
Switzerland, Ecublens

Innovative SMEs

Beamagine
Spain, Barcelona

Bifrost Communications
Denmark, Kongens Lyngby

System Integrators and Operator

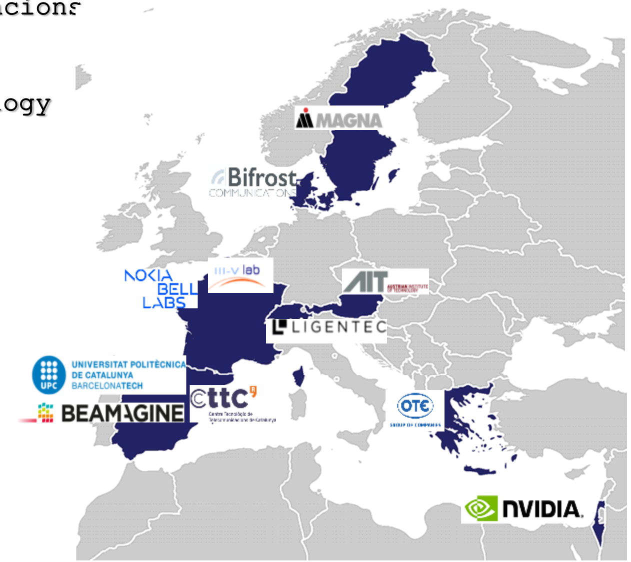
Nokia Bell Labs
France, Paris

OTE
Greece, Athens

Magna
Sweden, Vargarda

Nvidia
Israel, Yoknea

Contribution to a safer and more efficient transport on the road with a focus on autonomous driving in urban environments



11 partners
8 countries
Budget: 5.2 m€
EU-funded: 4.0 m€
Duration: 36M (01/2024 – 12/2026)

Project Coordinator:

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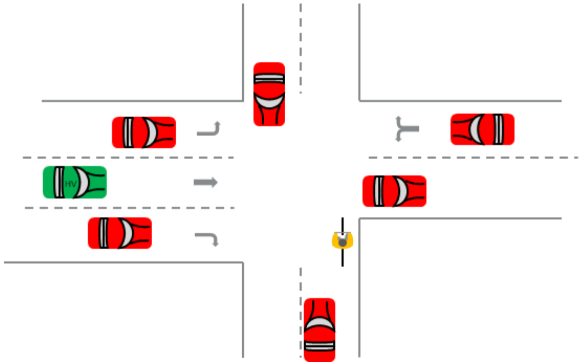
The 6G-EWOC project has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the EU's Horizon Europe research and innovation programme under Grant Agreement No. 101139182.

Use Case #1: Intersection drive-through

Aim: to ensure that FAVs may navigate through complex/busy intersections **seamlessly and collision-free**, despite the presence of other road participants (other vehicles, VRUs) and obstacles like roadworks.

The challenge for FAVs is not only to **rapidly respond to environmental changes** (using data from their own sensors and/or "critical" messages from other road participants), but also to **interact effectively and continuously**, in real-time with these road participants and the infrastructure itself, to **gain a comprehensive understanding of their surroundings**, incl. the capability to see-through obstructions for hidden objects/VRUs, to be informed/predict trajectories (see path planning), to be up-to-date with information from the road network, traffic signals, and other road participants so as to enhance their digital horizon.



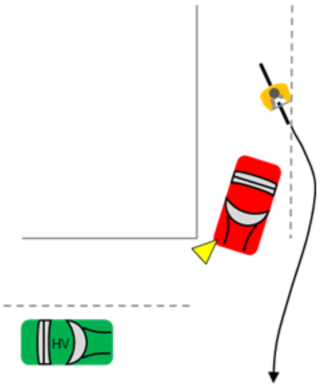
Use Case #2: Enhanced VRU Safety

Aim: VRUs often exhibit unpredictable movements or situated in "blind spots", increasing the risk of accidents. The Collective Perception will increase the level of VRUs safety by enabling the transmission, over-the-air, of critical, time-sensitive information (such as, the position and/or the trajectory of a cyclist) almost instantaneously and reliably to the nearby vehicles.

Note: Two VRU categories:

(a) VRUs equipped with lightweight, low-power (6G) devices, such as smartphones and/or wearable sensors which can be connected to both 5G and OWC/VLC networks (so as to transmit the VRU's position and intent to nearby vehicles) and

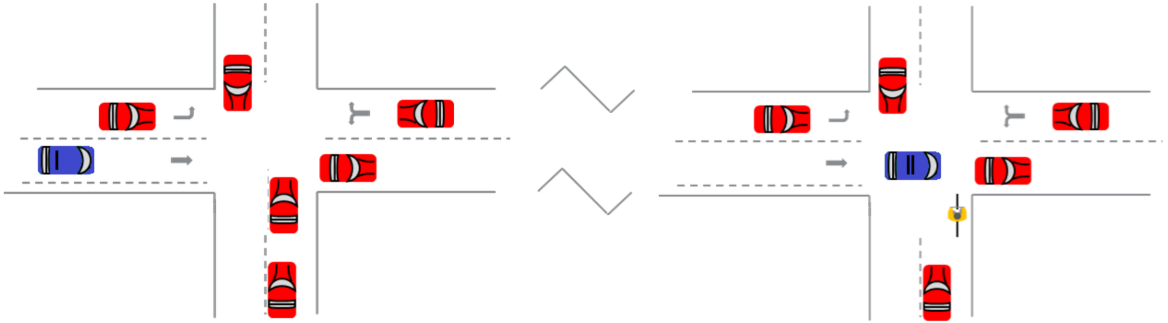
(b) VRUs that do not carry any equipment but are detected by other vehicles and/or roadside infrastructure equipped with advanced sensors (LiDARs, RaDARs, cameras) that communicate their whereabouts to the network for further (AI-based) processing and transmission to nearby vehicles.



Use Case#3: Emergency Services Vehicle Prioritization

Aim: It is two-fold: (a) to achieve **route prioritization** for (FAVs) emergency vehicles (such as ambulances, fire trucks and police cars), in order to reach their destination, the soonest possible but also, (b) to **minimize potential disruptions in regular traffic flow** that could lead to side-effects, such as traffic jams, accidents involving VRUs / other vehicles or delayed commutes, which can directly or indirectly impact the emergency response times.

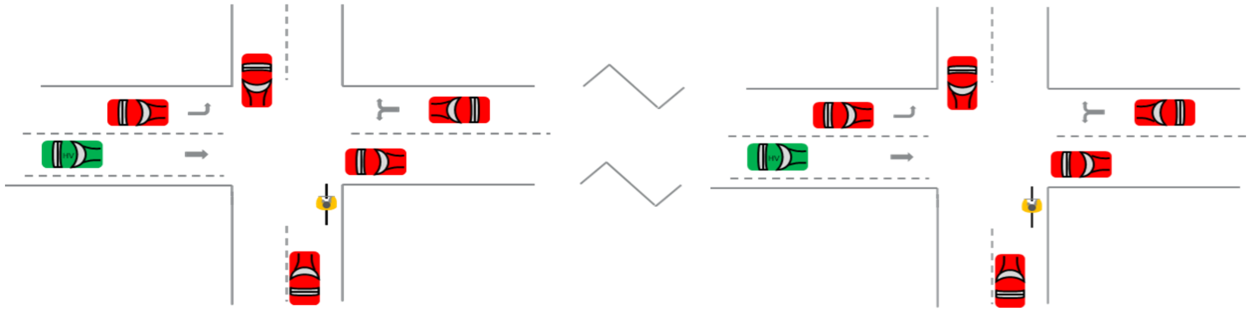
It is evident that in order the emergency vehicles to reach their destinations, may cover big parts of the city, and as such may cross several "busy intersections" (see UC#1).



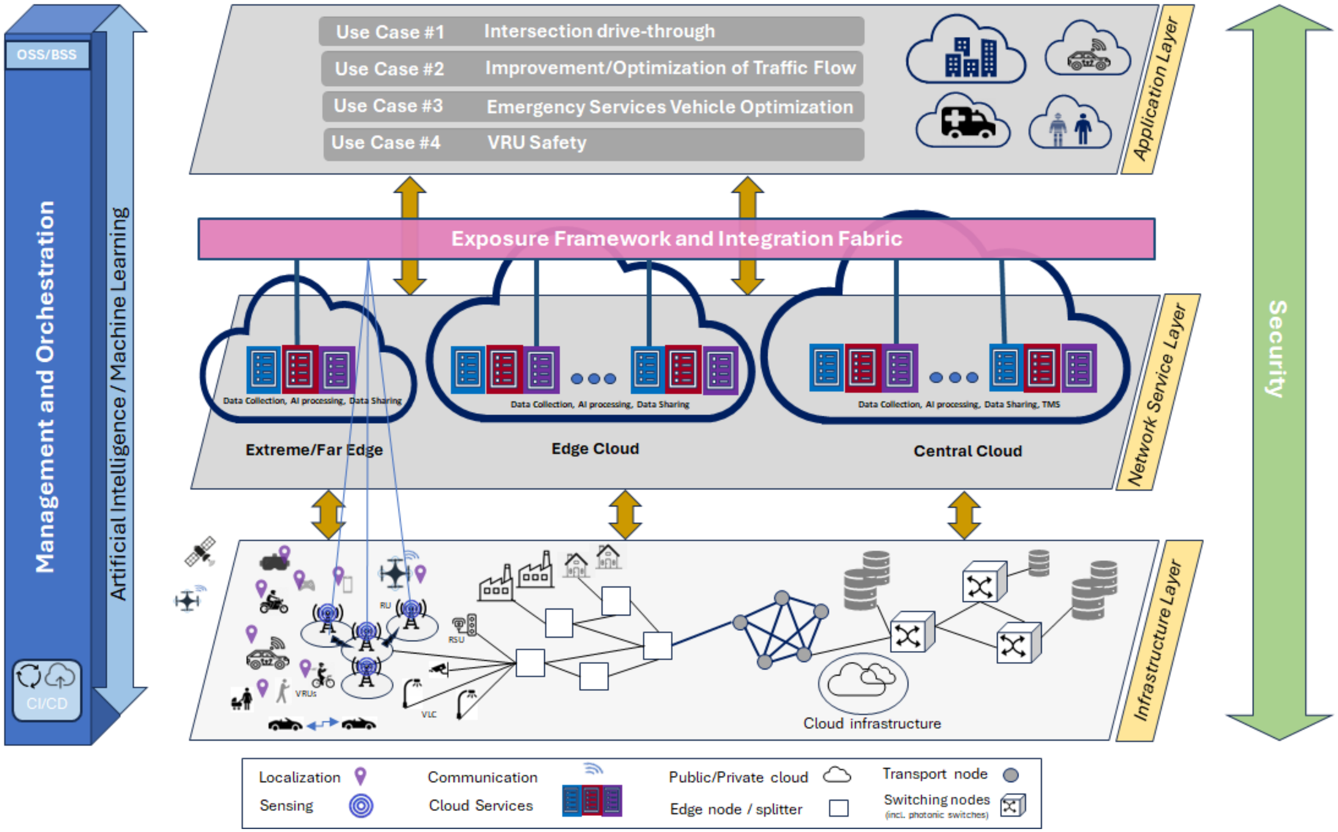
Use Case#4: Optimization of Traffic Flow

Aim: to **efficiently control or at least influence the vehicular traffic flow** in a smart city environment by leveraging the **Collective Perception** benefits.
Towards this end, a subset of the information that is exchanged, for safety reasons, between the vehicles (V2I-I2V) along with information coming from the road infrastructure-related equipment (cameras, RaDARs) and/or e.g., planned roadworks need to be processed at a city-level towards achieving more **coordinated movements** across the city.

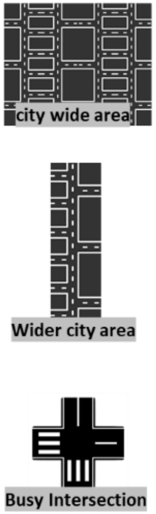
Traffic flow optimization will definitely lead to reduced congestions, reduced travel times, reduced CO_2 emissions and smoother traffic flows, which indirectly may improve the citizens' quality of life.

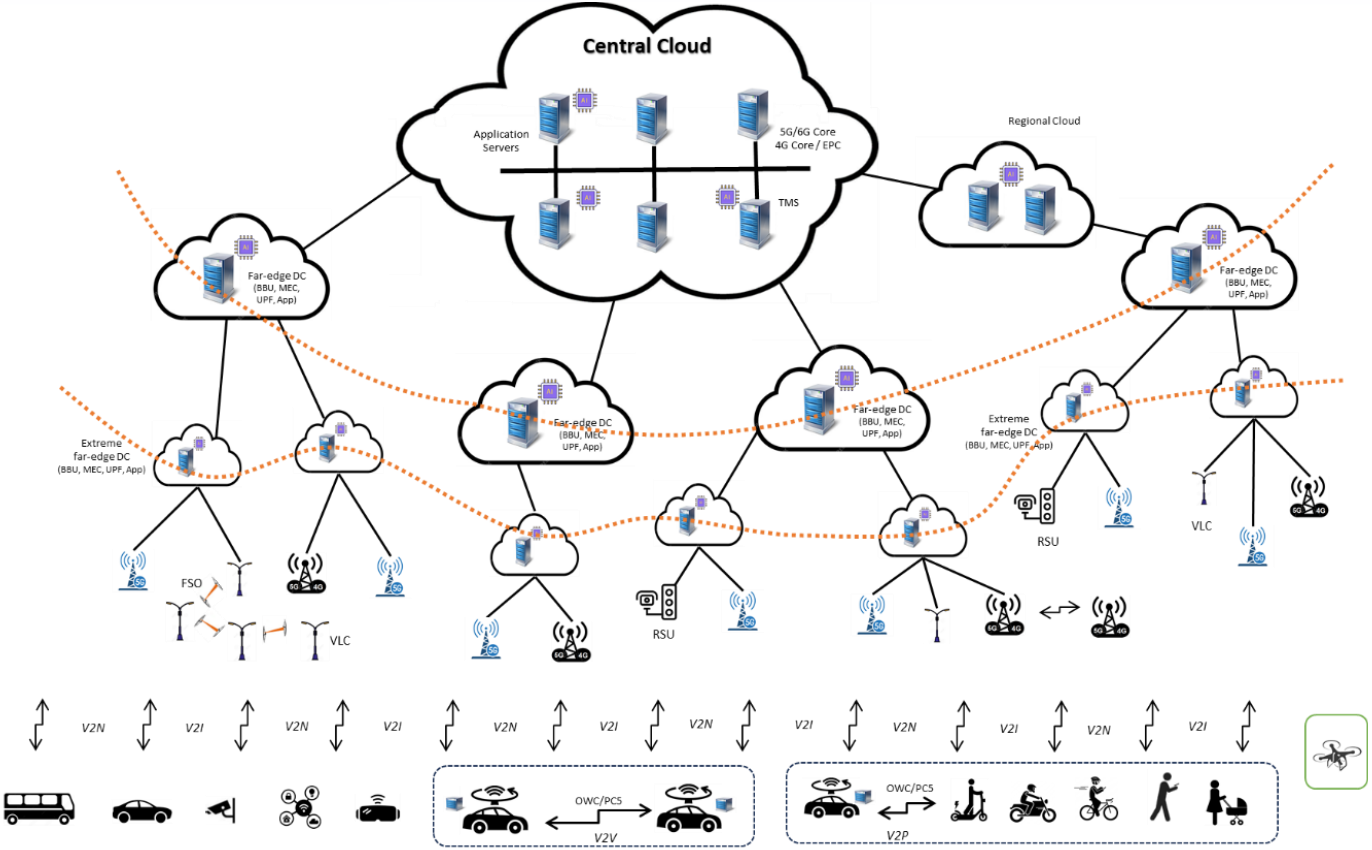


6G-EWOC High-Level Architecture

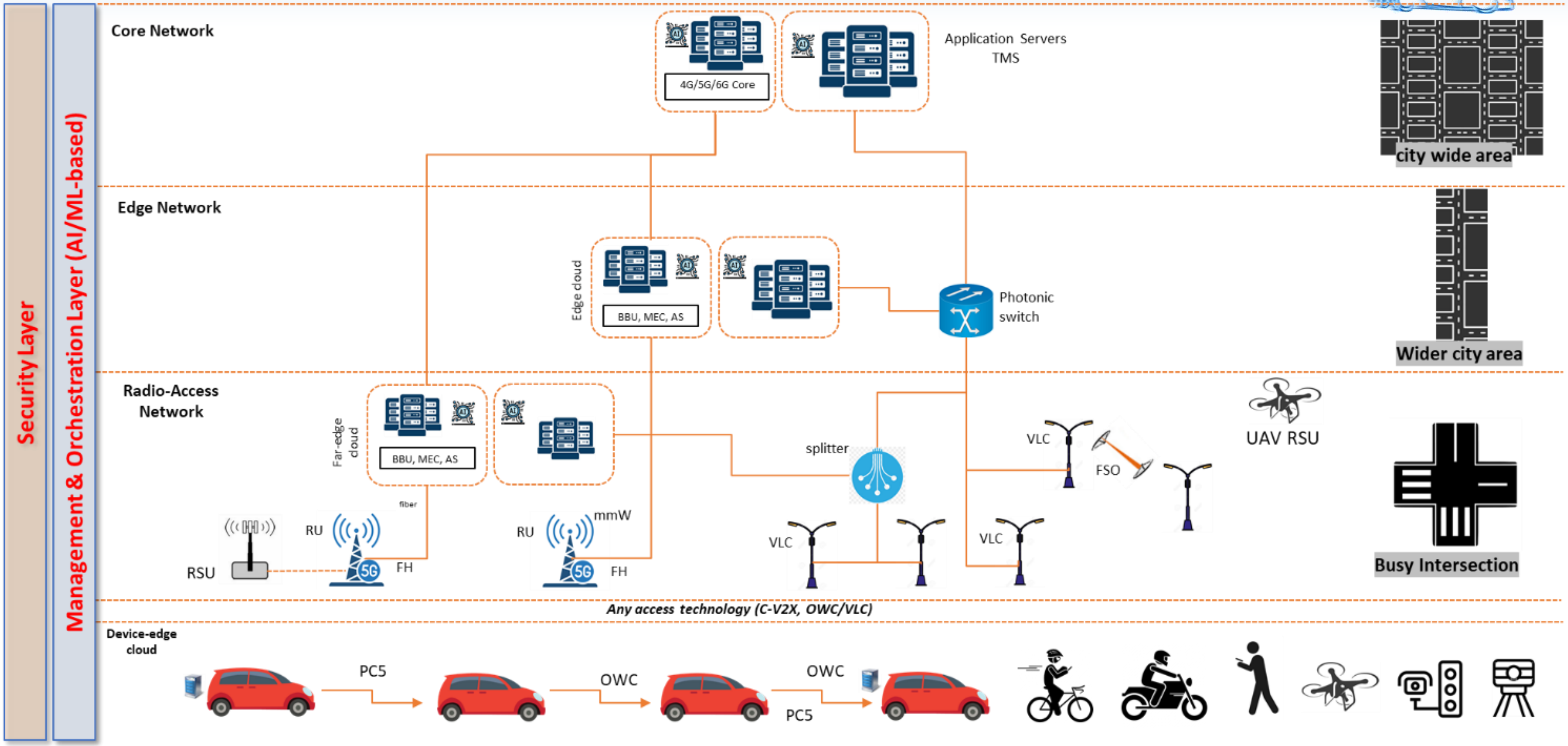


6G-EWOC Network Deployment Options





6G-EWOC Nodes at the network domains



Demos (1/3)

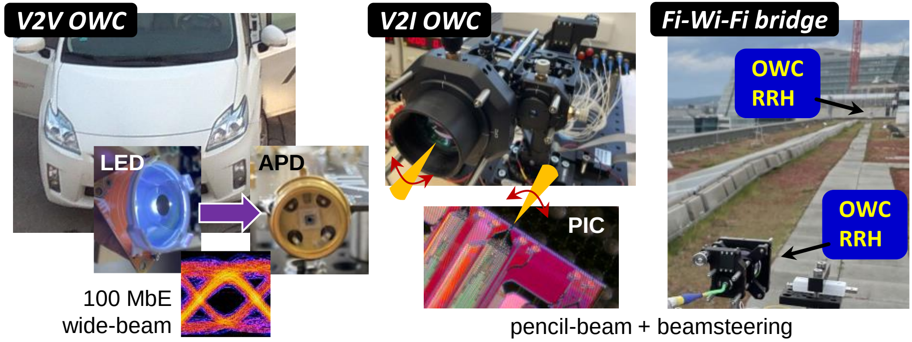
#1: OWC connectivity (indoor and outdoor environments)

Objectives

- OWC for V2V and high-rate (Gb/s) V2I apps, leveraging chip-scale optical beamformers

Key Features

- OWC transceivers & beamformers
- Wide-beam for V2V, Pencil-beam for V2I
- LiDAR/RaDAR technology



Targeted KPIs

- V2V data rate > 100 Mb/s, range > 100 m
- V2I data rate > 1 Gb/s, range > 200 m
- User data rate > 10 Gb/s
- Transparency of Fi-Wi-Fi bridge via loss of < 13dB for FPA-enabled mid-range (100m) OWC channel.

Demos (2/3)

#2: Fiber-optic transmission and networking

Objectives

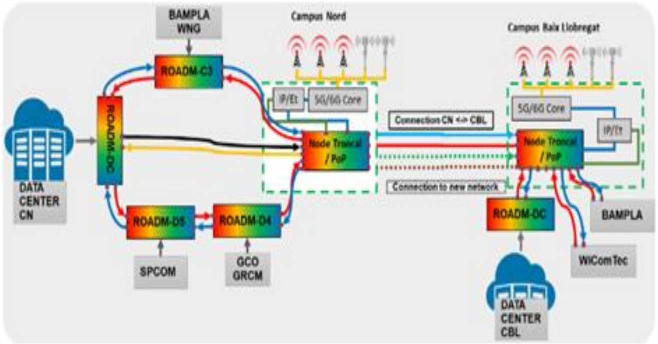
- PIC and ASIC for tunable Tx/Rx concepts for fiber-based fronthaul
- SDN-enabled low-energy photonic switching

Key Features

- PICs combined with quasi-coherent (QC) technologies for fronthaul
- Novel photonic chip with 10 mW output on chip tunable Local Oscillator (LO) for QC techs

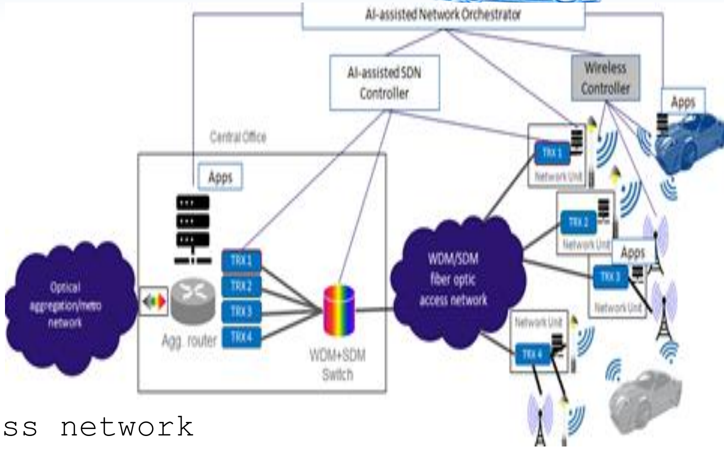
Targeted KPIs

- 50 Gb/s and 100 Gb/s per λ over DWDM fiber links
- 9 dB fiber-to-fiber loss and sub-msec (50us) reconfiguration time at photonic 16x16 switches
- Chip integration with photoreceptor up to 100GHz BW



Demos (3/3)

#3: Integrated 6G Network Operation



Objectives
- AI-assisted control and orchestration of resources
- AI-based applications development for AVs

Key Features
- Smart mngmnt & orchestration of packet optical net
- Combined OWC and fiber-optic communications in the access network
- AI-based and collaborative apps for AVs

Targeted KPIs
- Provisioning of traffic flows achieving 50% reduction of the energy consumption
- Provisioning of traffic flows in < 60 sec, considering packet and optical layers
- AI-assisted energy-efficiency algorithm(s) and/or heuristics for packet/optical networks
- Demo of a data fusion sensor suite with low parallax error based on connected LiDARs / RaDARs
- Incremental reconstruction of scenes from multi ego-poses and detection of elements with range precision > 0.5m and accuracy > 60%.

Thank You!

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