# H2020 Metro-Haul: a Metro Network to Support Future Services Enabled by 5G

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5G Applications and Networks: Real-world Operator Case Studies
OFC Conference, San Diego, 6 March 2019

**http://metro-haul.eu**

*METRO-HAUL: METRO High bandwidth, 5G Application-aware optical network, with edge storage, compute and low Latency*

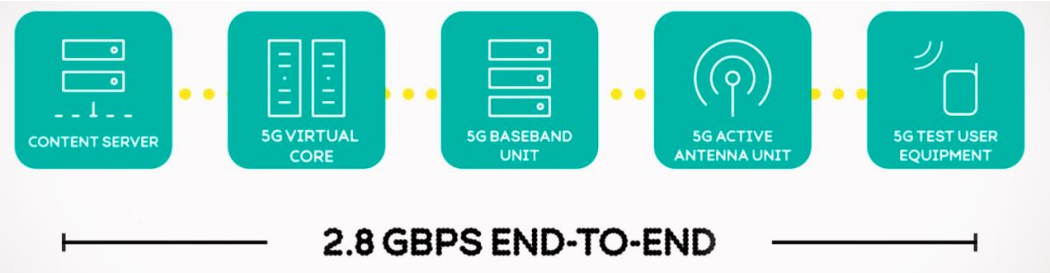
H2020-ICT-2016-2 Metro-Haul Grant No. 761727

# BT Applied Research – 5G RAN

# BT/EE Trials

EE hits 2.8Gbps download speeds in UK-first 5G trial (collaboration with Bristol University, 2017)

http://newsroom.ee.co.uk/ee-showcases-end-to-end-5g-network-architecture-with-28gbps-speeds/

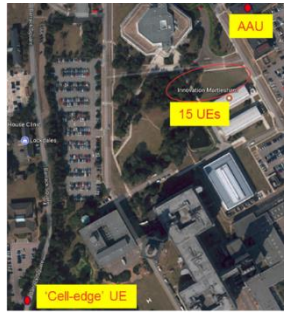



## Canary Wharf 5G Trial

https://newsroom.ee.co.uk/ee-brings-5g-to-the-uk-for-the-first-time-with-switch-on-of-live-5g-site-in-canary-wharf-trial/


**Much more info at: https://newsroom.ee.co.uk/**

Massive MIMO testing @Adastral Park

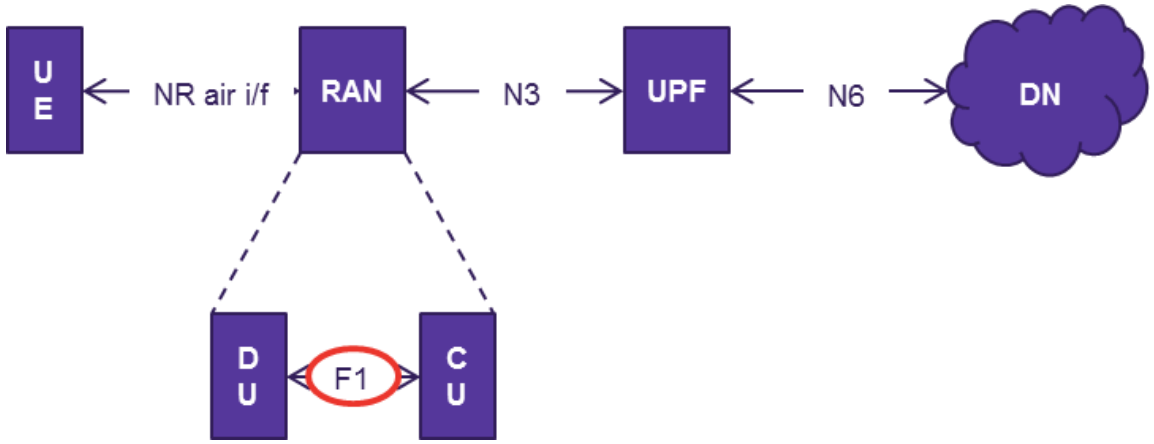




Huawei and BT/EE Showcase 5G Uplink and Downlink Decoupling PoC in ExCeL London

# Disaggregated RAN

- 5G will address
  enhanced Mobile Broadband (eMBB),
  Ultra-Reliable  Low Latency Communications (URLLC)
  and massive Machine Type Communications (mMTC),
  use cases
- 5G requires a new network architecture
- The functional decomposition of the RAN results in DU and CU network elements
- Next Generation Core network can be grouped into two functional blocks, CPF and UPF
- Some RAN functionality will move towards the core whilst the core will move towards the RAN
- Small cells are an essential component of 5G
- URLLC is an overlay and requirements will vary based on use cases
- URLLC use cases, UR use cases and LL use cases…
- Initial MTC use cases will be addressed by NB-IoT (4G)




Next Generation Core network can be grouped into two functional blocks: CPF & UPF

UPF: User Plane Functions
CPF: Control Plane Functions

# 5G Network Latency Modelling

We have done significant analysis of network latency and cost to underpin the 5G Architecture.

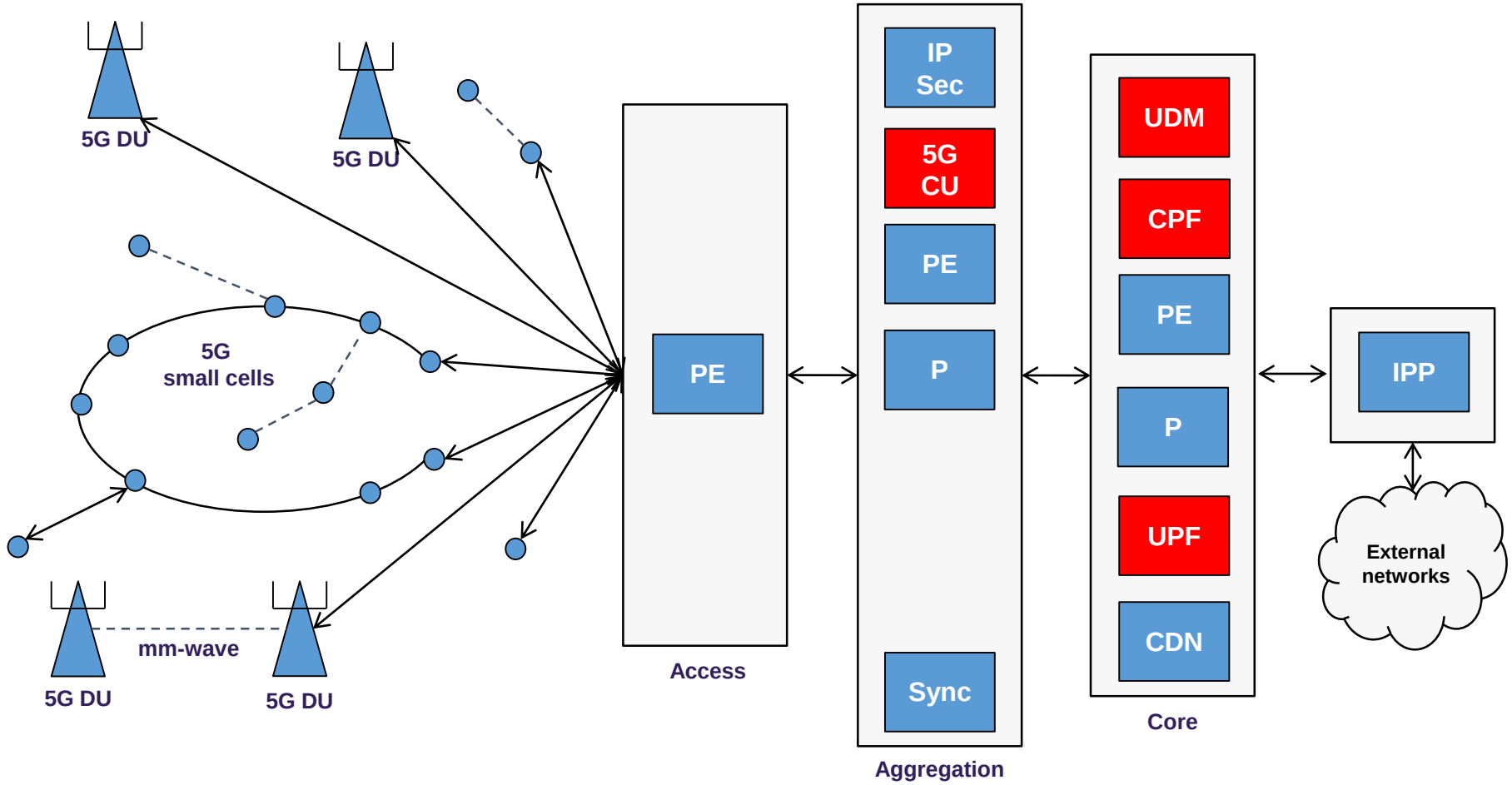
The following figures relate to content served from the same location as the UPF node:

| UPF Location | Access | Aggregation | Core |
|---|---|---|---|
| Number of sites | 1200 | 106 | 10 |
| Transport Latency (1-way)* | 0.6ms | 1.2ms | 4.2ms |
| Estimated 5G Latency (RTT)* | 9.2ms [eMBB] | 10.4ms [eMBB] | 16.4ms [eMBB] |
| | 2.2ms [URLLC] | 3.4ms [URLLC] | 9.4ms [URLLC] |

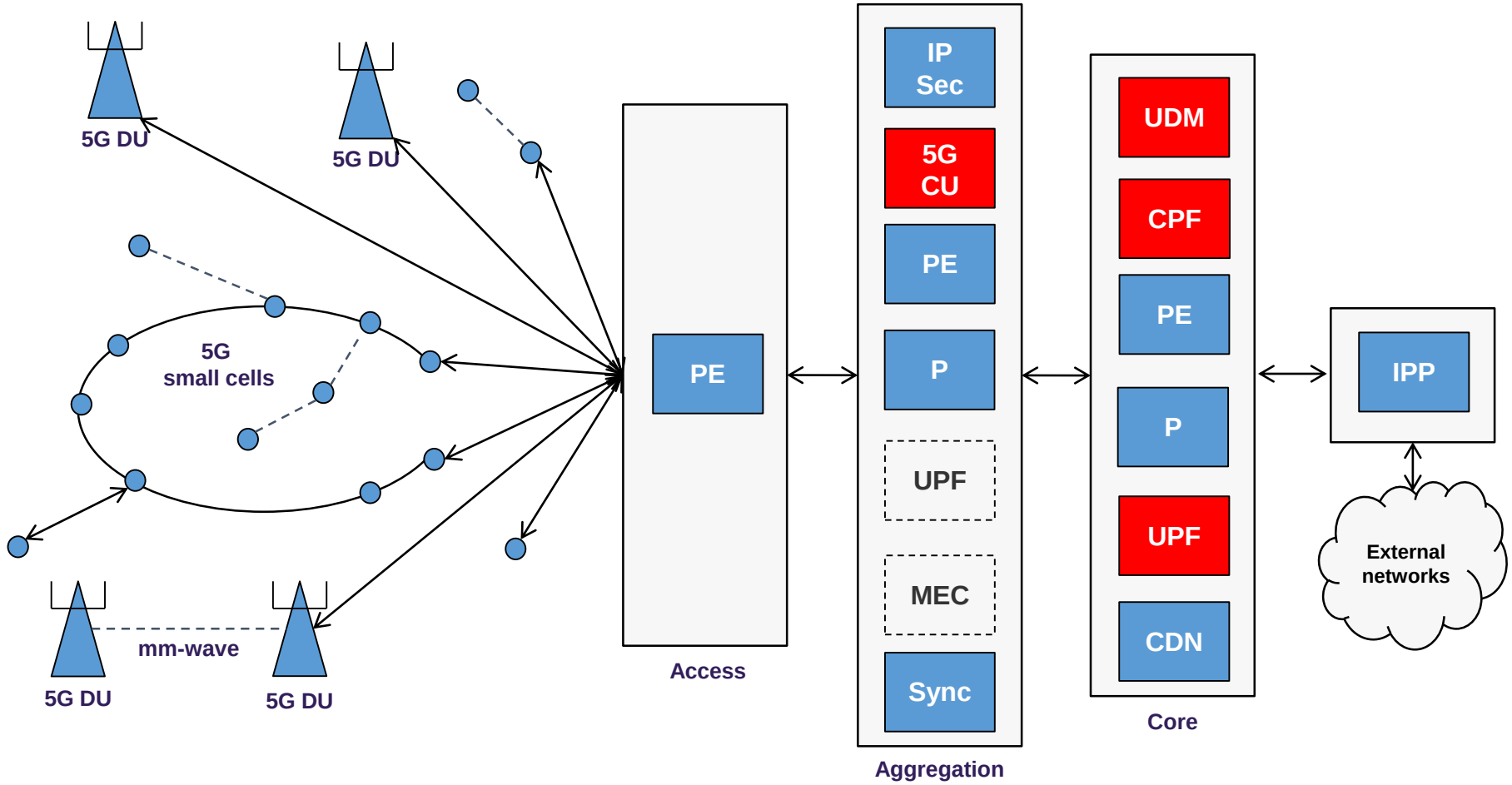
* *Assumptions:*

- *Latency figures based on 95$^{th}$-percentile of transmission delay (i.e. 95% of cell sites are within this) + overhead for IP*
- *5G RTT assumes 8ms overhead for 5G New Radio & Next-Gen Core (eMBB case) - 1ms for URLLC (as per 3GPP 5G)*

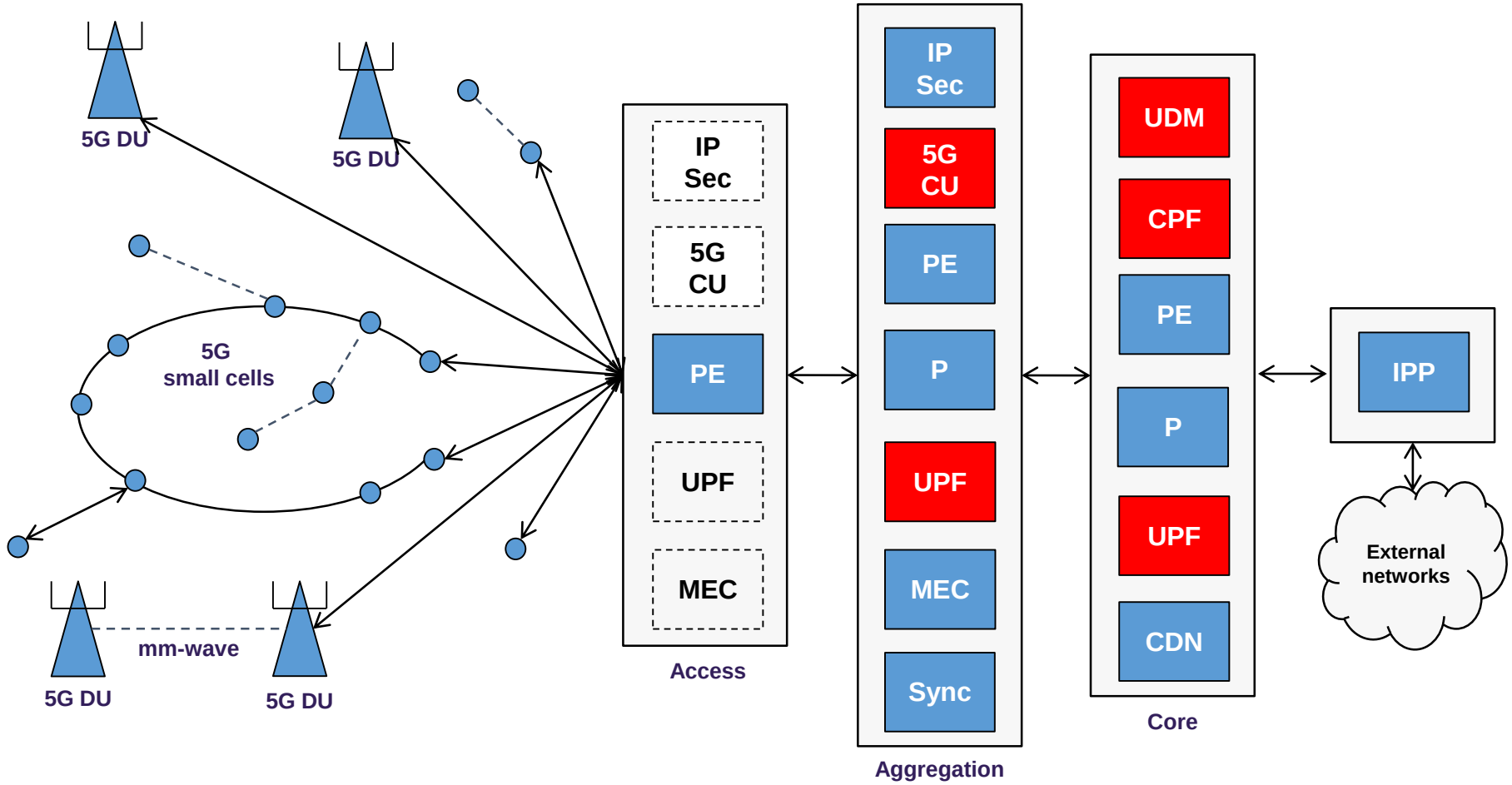
# Conceptual 5G Network Architecture (1)



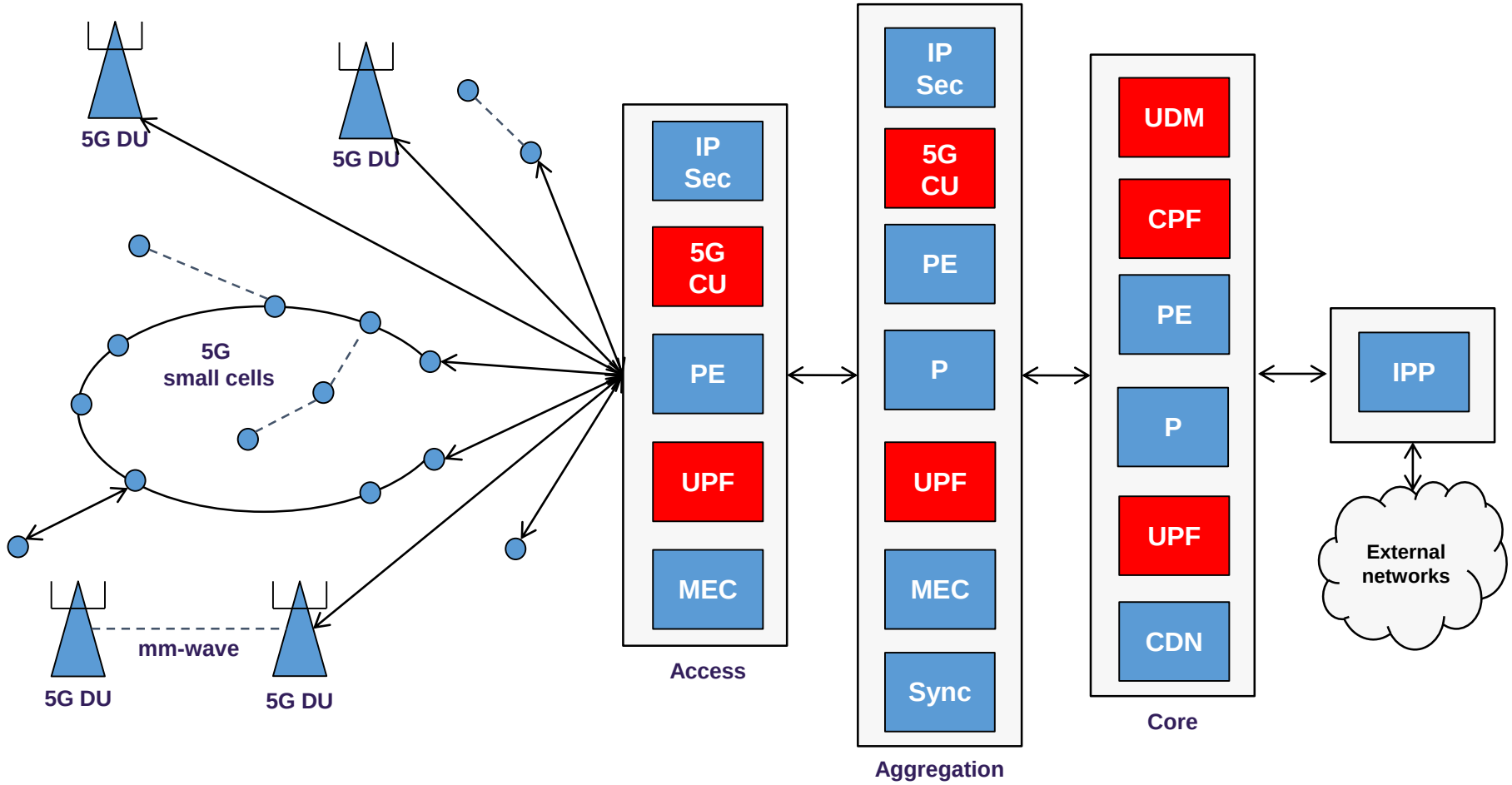
# Conceptual 5G Network Architecture (2)



# Conceptual 5G Network Architecture (3)

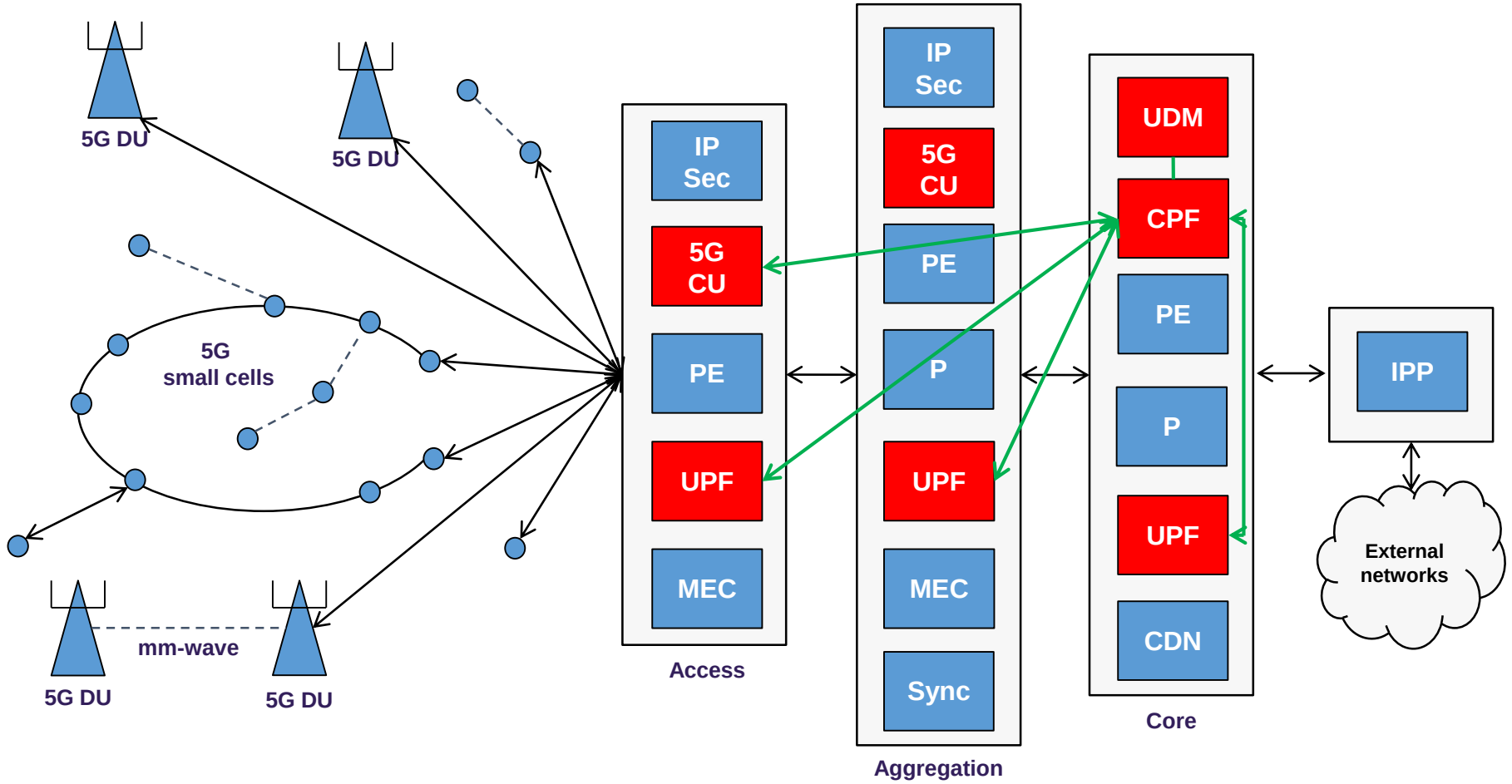


# Conceptual 5G Network Architecture (4)

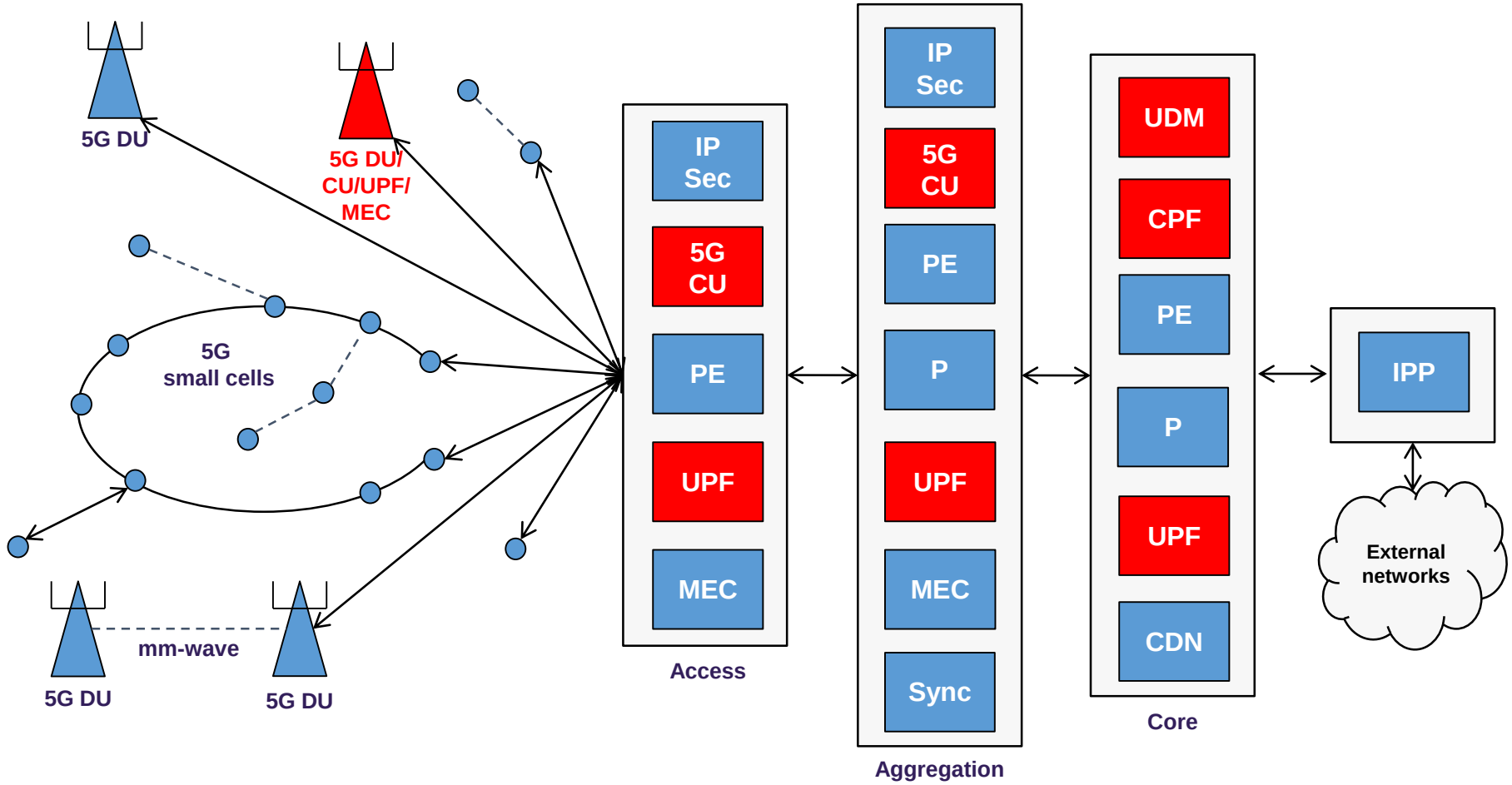


# Consider Control Plane Latency

## Potential for distribution?



# Ultra-Low Latency Service Optimisation



# METRO-HAUL:
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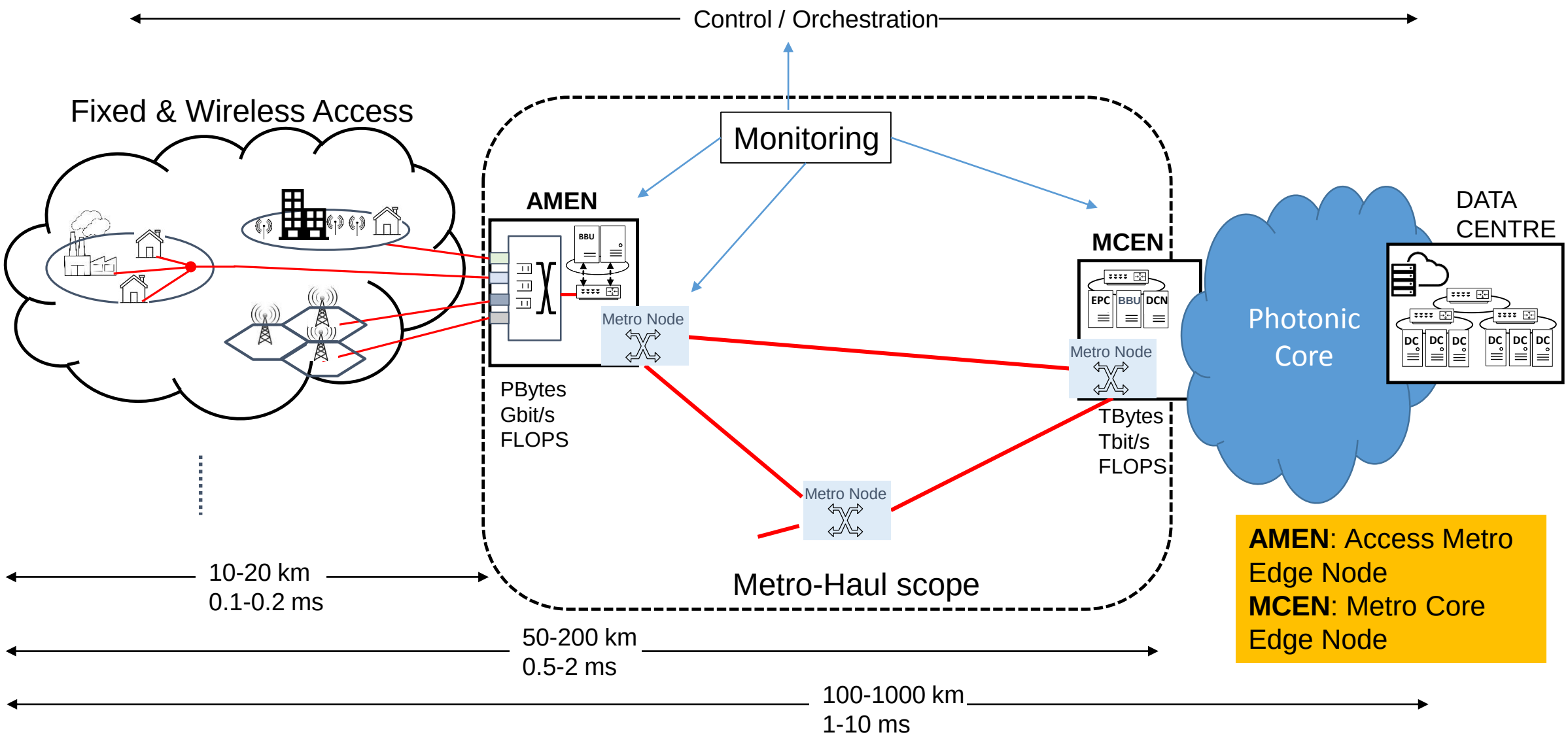
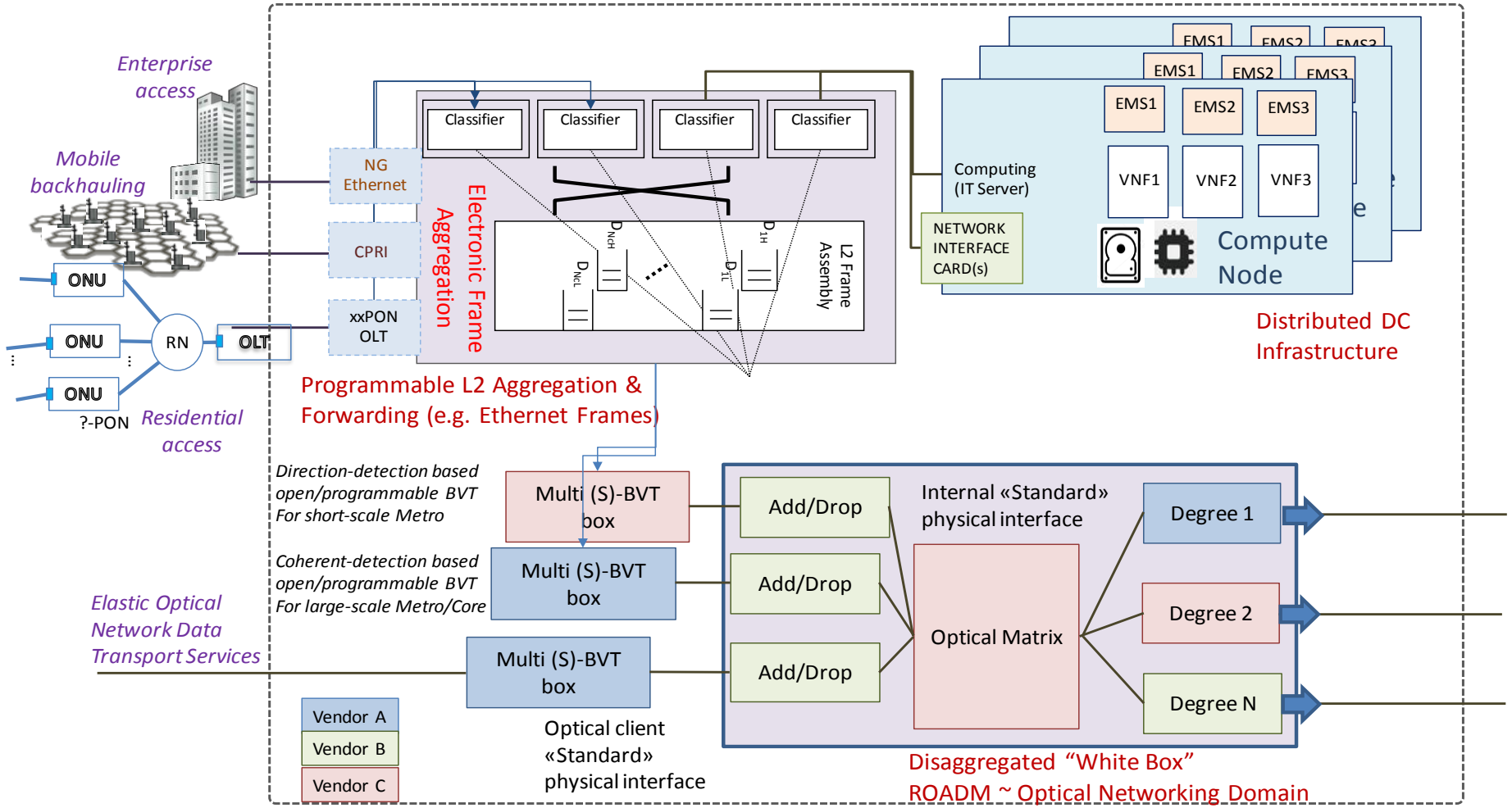
# Metro-Haul Architecture & Scope



# Metro-Haul Network Node Elements – HW + SW Disaggregation



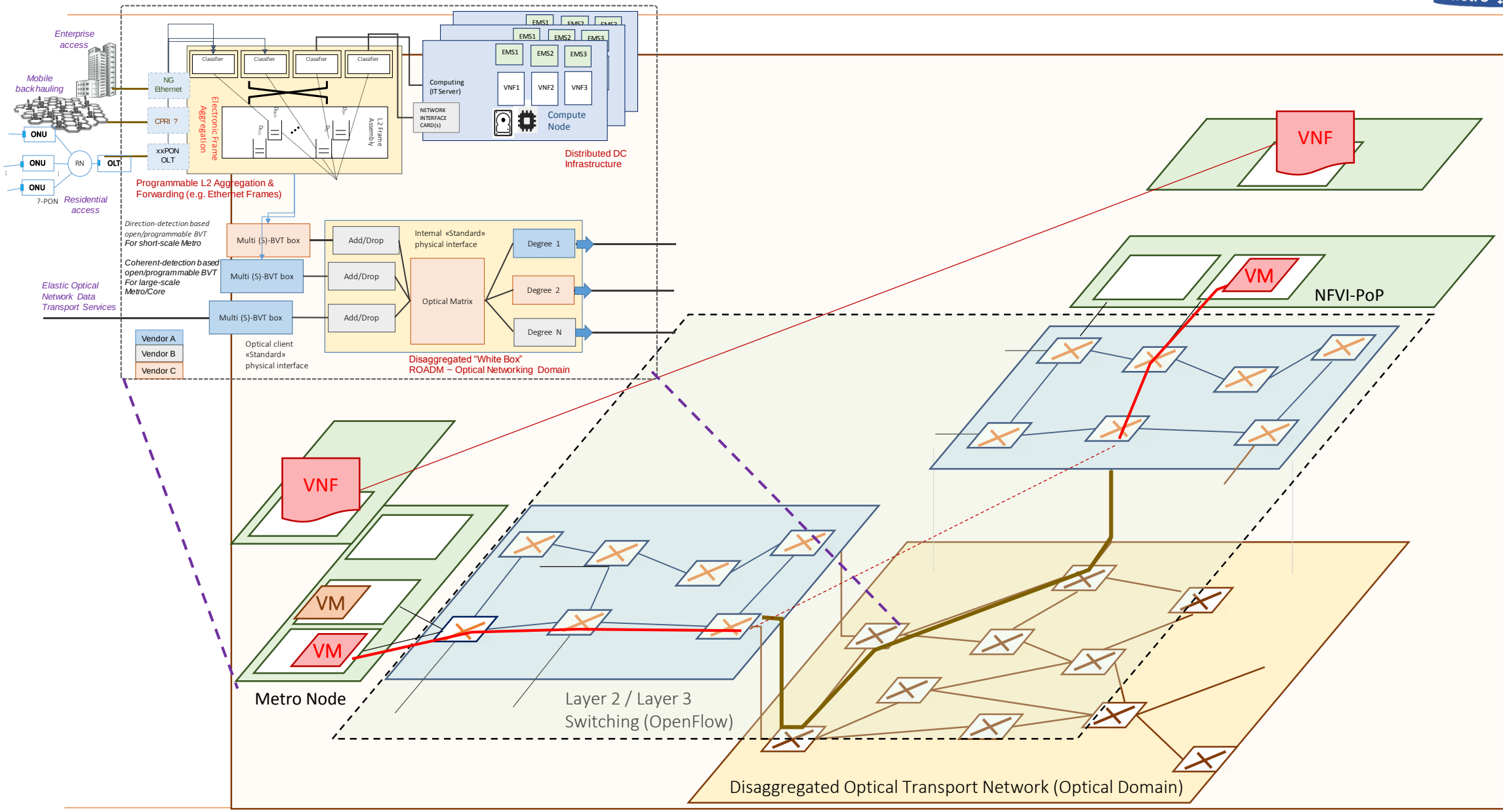
# Metro-Haul Main Objectives – Unpacked

- Architect and design cost-effective, energy-efficient, agile and programmable metro networks
  - Scalable for 5G access and future requirements
  - Design of optical metro nodes (including full compute and storage capabilities)
  - Interface with both 5G access and multi-Tbit/s elastic core networks

- Challenges:
  - Optical challenge, cost effective and agile, involving both the optical architecture and also innovative new optical component technologies -> disaggregated white boxes
  - Network management challenge. SDN/NFV control framework supporting 5G operational and both end-user and vertical orientated services, including slicing
  - Monitoring challenge. Implementation & AI-based tools for interpreting vast amounts of data

- Use Cases
  - Video Security for Smart Cities - Intelligent video security based on automatic object/person identification and tracking
  - Crowdsourced Video Streaming - Simultaneous sourcing of video from different individuals in an event with a large crowd
  - Additional demonstrations will be planned to be showcased in relevant event

# Why is it complex? 5G services : deployment across Metro-Haul nodes



# Analysed Service Use Cases

| Vertical | Use Case | CoS |
|---|---|---|
| **Media & Entertainment** | Content Delivery Network | eMBB |
| | Live TV Distribution | eMBB + URLLC |
| | 6DoF Virtual Reality | eMBB + URLLC |
| | Crowdsourced Video Broadcast | URLLC |
| **Cloud Services** | Service Robotics | eMBB + URLLC |
| | Enterprise Access with NG Eth | eMBB + URLLC |
| **Utilities** | Utility Metering | mIoT |
| **Automotive** | Intelligent Transport System & Autonomous Driving | eMBB + URLLC |
| **Industry 4.0** | Smart Factories | eMBB + URLLC + mIoT |
| **Public Safety & Environment** | Real Time Low Latency Object Tracking & Security | URLLC |
| **Operator orientated** | Secure SDN Control – Video Distribution | BB + URLLC |
| | 5G Fronthaul Architectures | |

Mapping Service KPIs onto the Metro-Haul Architecture resulting in Metro Network Requirements (KPIs)

# THANK YOU

## Acknowledgements


- Metro-Haul Consortium