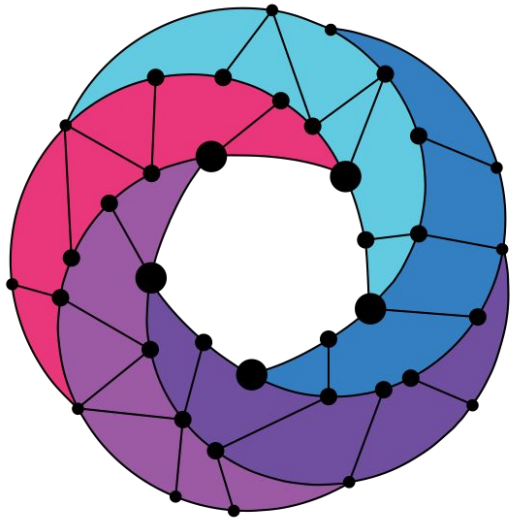

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Orchestration of 5GCity edge computing with OSM: pilot trials and lessons learnt

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Fundación i2CAT

OSM 5G Day @Lucca Nov 2019

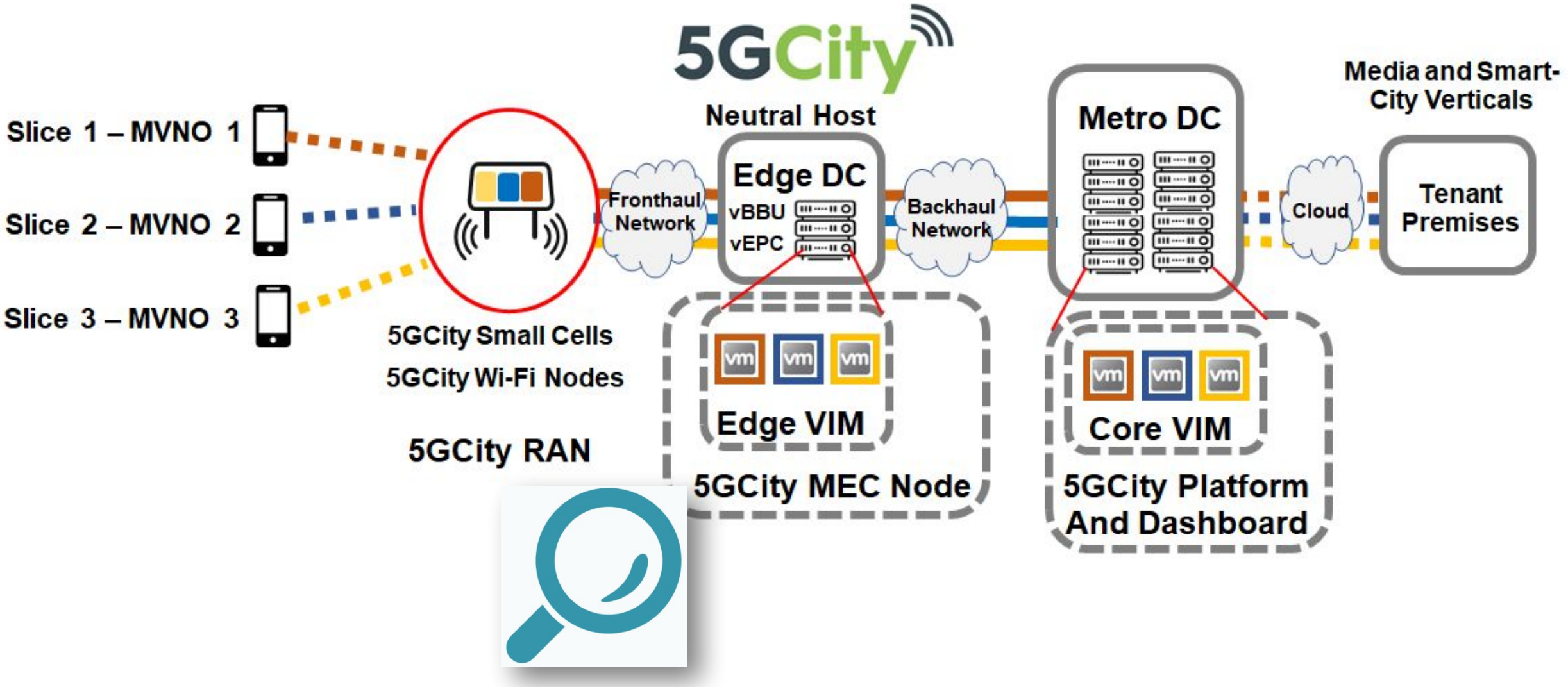
5GCity Project Vision

***Design, develop, deploy and demonstrate**, in operational conditions, a **distributed cloud & radio platform** for municipalities and infrastructure owners acting as **5G neutral hosts** (BCN, Bristol & Lucca)*

Objectives:

- ✔ Build & deploy a common, multi-tenant, open platform that extends the (centralized) cloud model to the extreme edge of the network
- ✔ Distributed, 3-tier architecture with network sharing, slicing & MEC capabilities.
- ✔ MEC node virtualization platform and guest optimizations
- ✔ Network virtualization @ edge
- ✔ Scalable edge management & orchestration and service programming models
- ✔ City-wide pilots' deployment and validation & commercial outreach and standardization

Neutral host and slicing



5GCity architecture principles

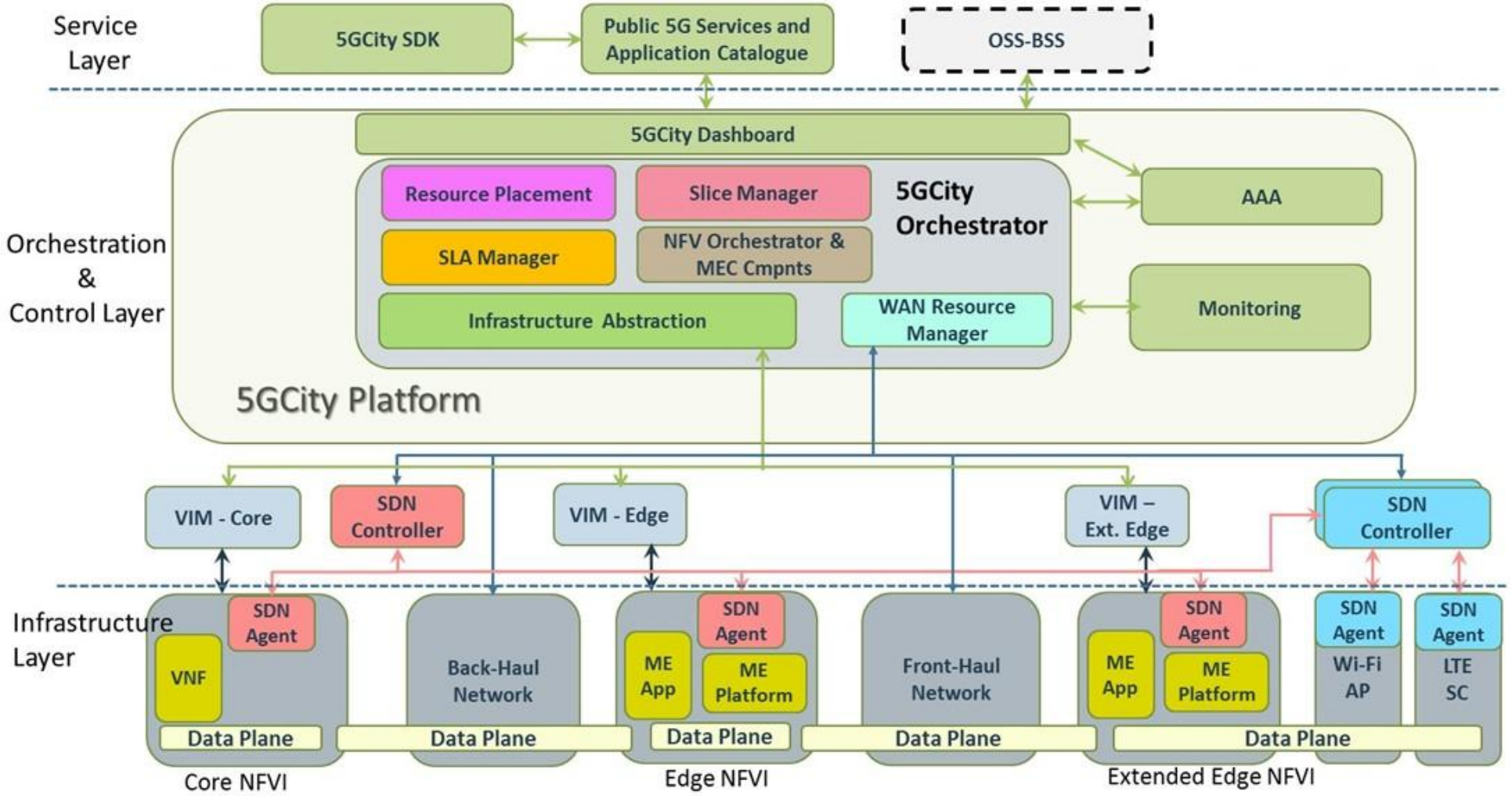
- Split vertically across three layers

  - **Service/Application Layer**
    - specific set of functions/tools of the proposed 5GCity architecture available for the operators of the infrastructure, their customers, subcontractors and any third party actor

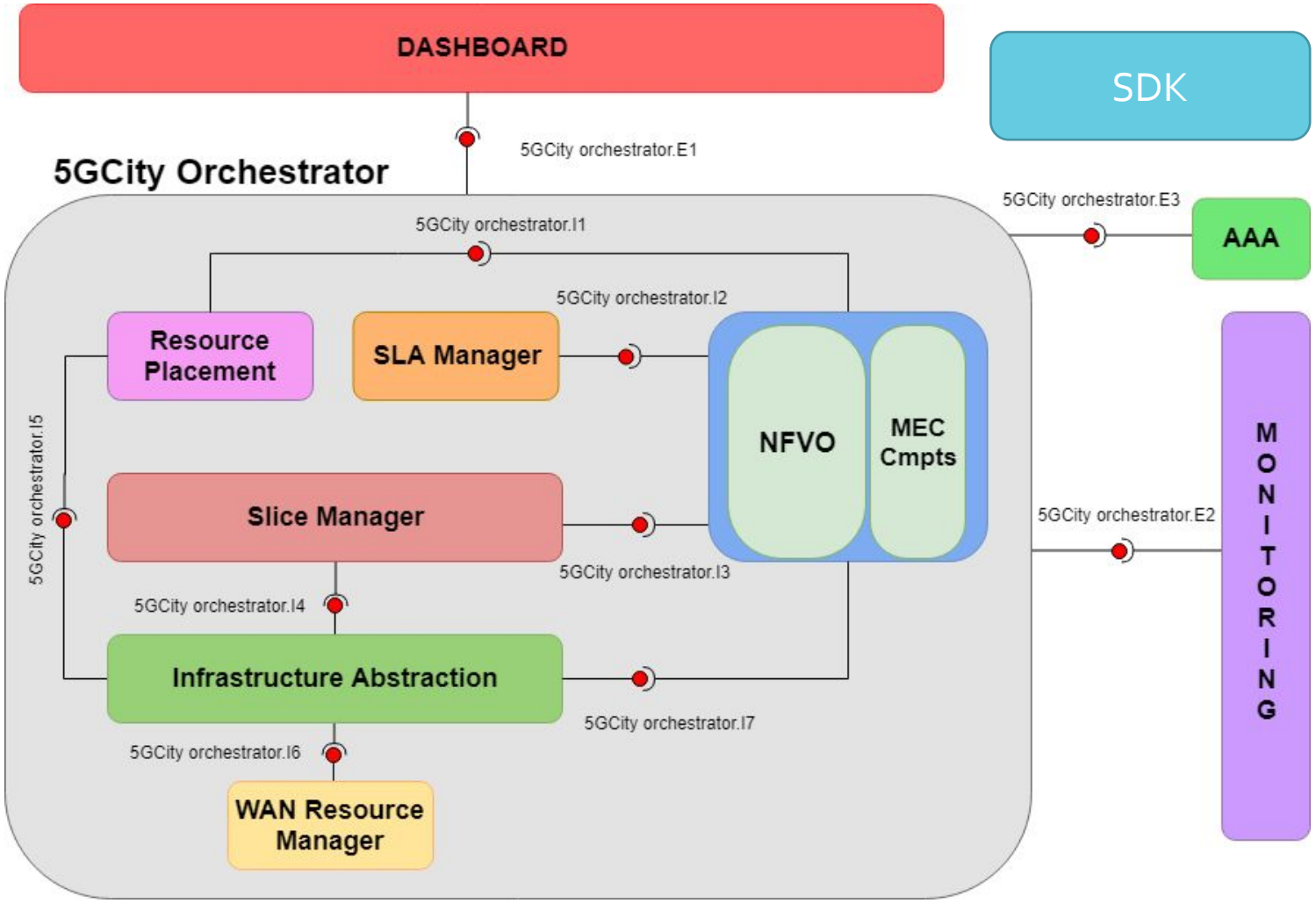
  - **Orchestration & Control layer**
    - entry point of network services (Dashboard), core orchestration components (5GCity orchestrator), as well as control between the central orchestration platform and the infrastructure (WAN managers, VIMs, and SDN controllers)

  - **Infrastructure layer**
    - The actual radio and computing virtualization infrastructure spanning from far-edge to datacenter

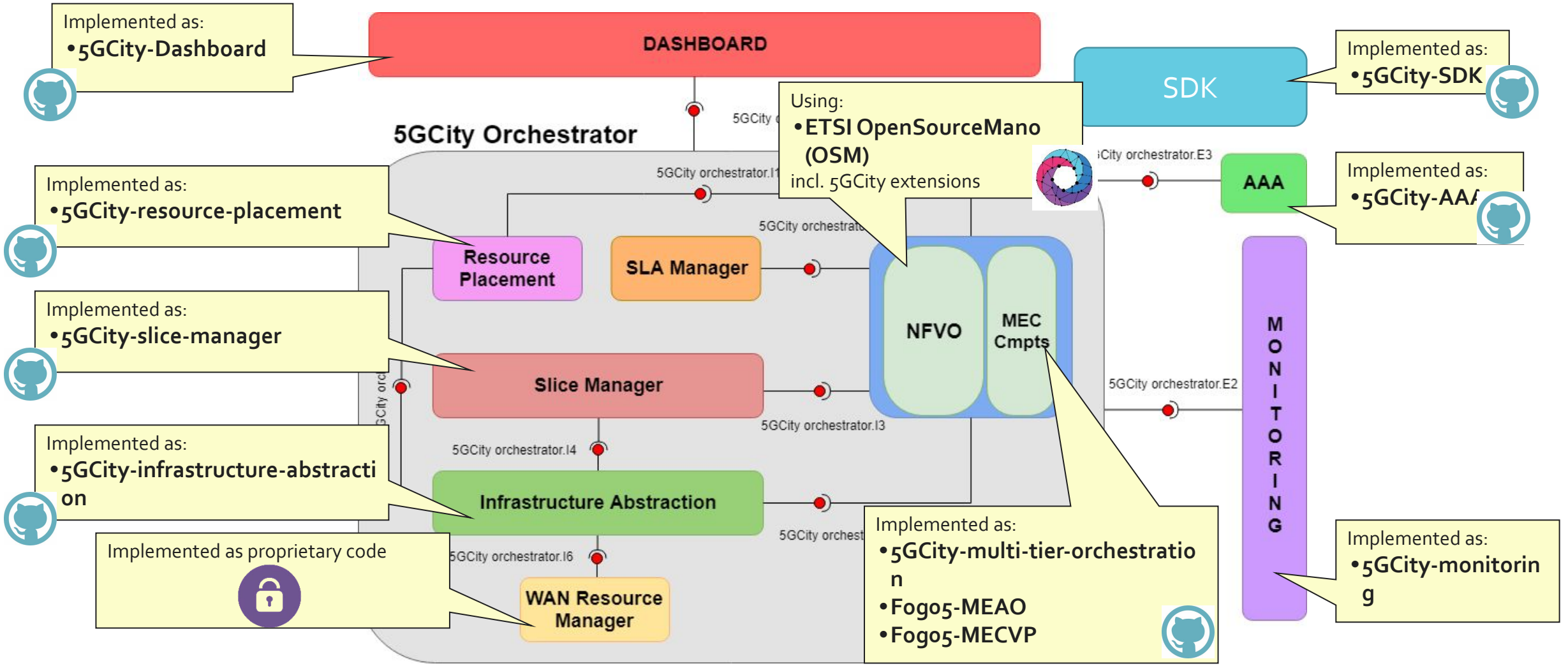
5GCity architecture



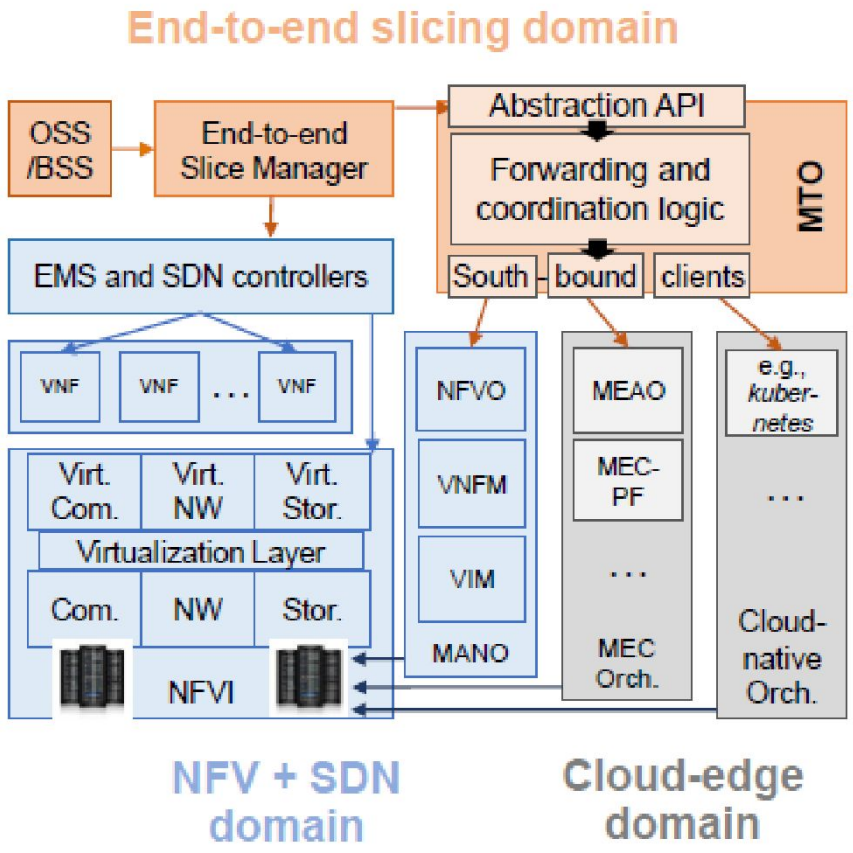
5GCity Platform high level architecture



Mapping into software modules



Multi-Tier Orchestrator



High-level architecture of **multi-tier orchestration** solution [1]

MTO includes:

- an **Abstraction API**, which is used to trigger the required API invocation chains on the different orchestrators when a high-level action is performed
- a **layer of intelligence** (Forwarding and coordination logic), which implements new inter-orchestrator workflows based on the high-level inputs
- a series of **Southbound clients** , which are used in order to connect to NFV, MEC, and Cloud native orchestrators

[1] Miquel et al. "Enhancing the performance of 5G slicing operations via multi-tier orchestration". 23rd Conference on Innovations in Clouds, Internet and Networks (ICIN 2020). **Submitted**

Other “goodies” of 5GCity slices

- 1) Automated **DHCP server** deployment for users connected to a 5GCity slice via Wi-Fi nodes. The **configurations** are **dynamically performed** by the 5GCity platform.

- 2) Automated **DNS server** deployment after a NSD is deployed in a 5GCity slice. Therefore, deployed **VNFs are reachable** inside the **network slice** using the “short-name” parameter of the VNFDs.

- 3) Automated **vEPC instance** deployment to provide **connectivity** between **user equipment** and **deployed VNFs** when LTE is part of the 5GCity slice.

5GCity: distributed, 3-tiers architecture

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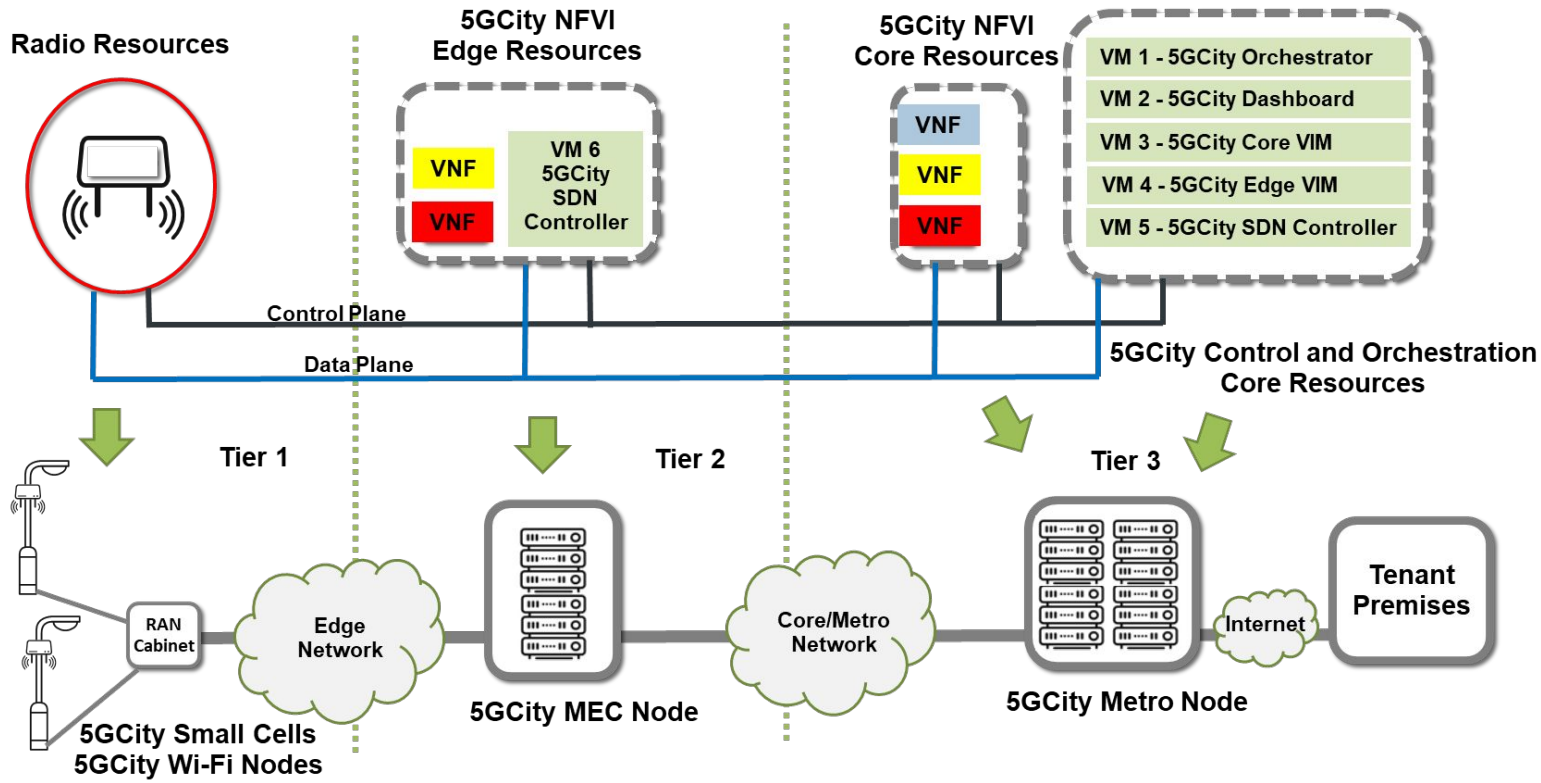
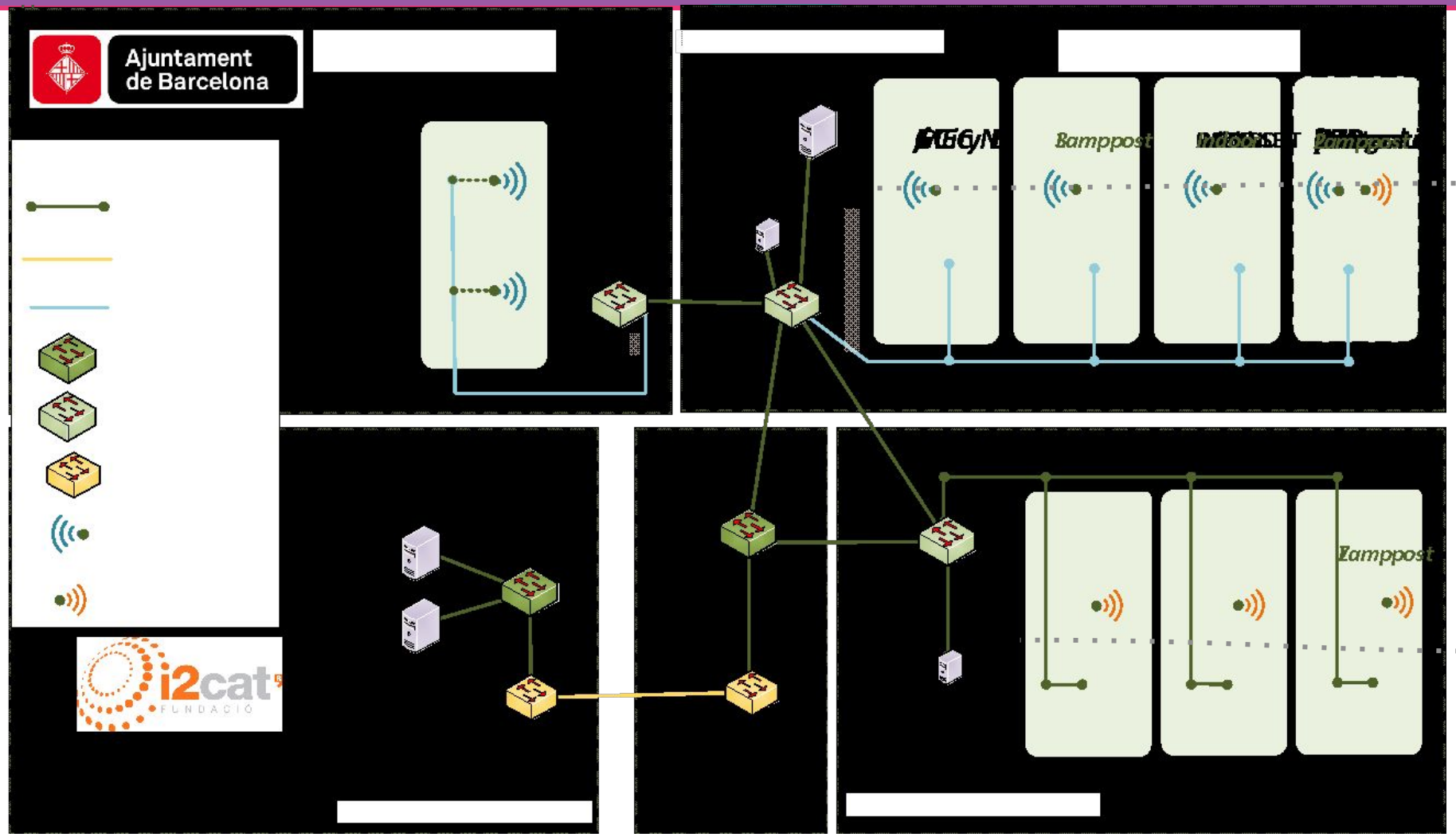
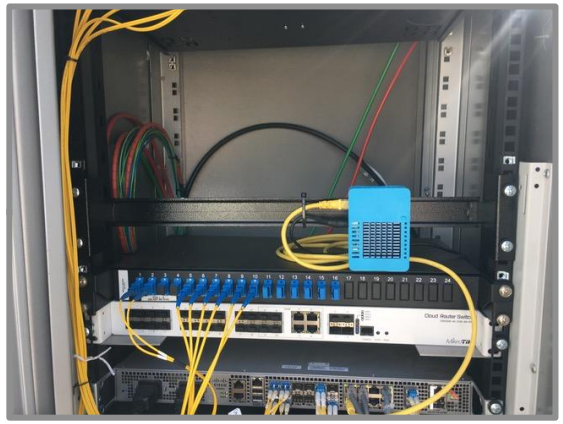
Which edge computing do 5GCity have ?

- **MEC Node Virtualization Platform and Guest Optimizations**
  - **Unikernels and containers for reduced boot times** (i.e. in 10s-100s ms depending on CPU arch) and **lightweight images** (i.e., in the few MBs)
  - **EdgeVIM and EdgeNFVI** for attestation capabilities and isolation at the hardware level by leveraging VOSYSmonitor and ARM TrustZone
- **Innovative RAN virtualization**
  - **Slicing of physical wireless interface (LTE and Wi-Fi) among a set of tenants**
- **Scalable edge management & orchestration and SDK**

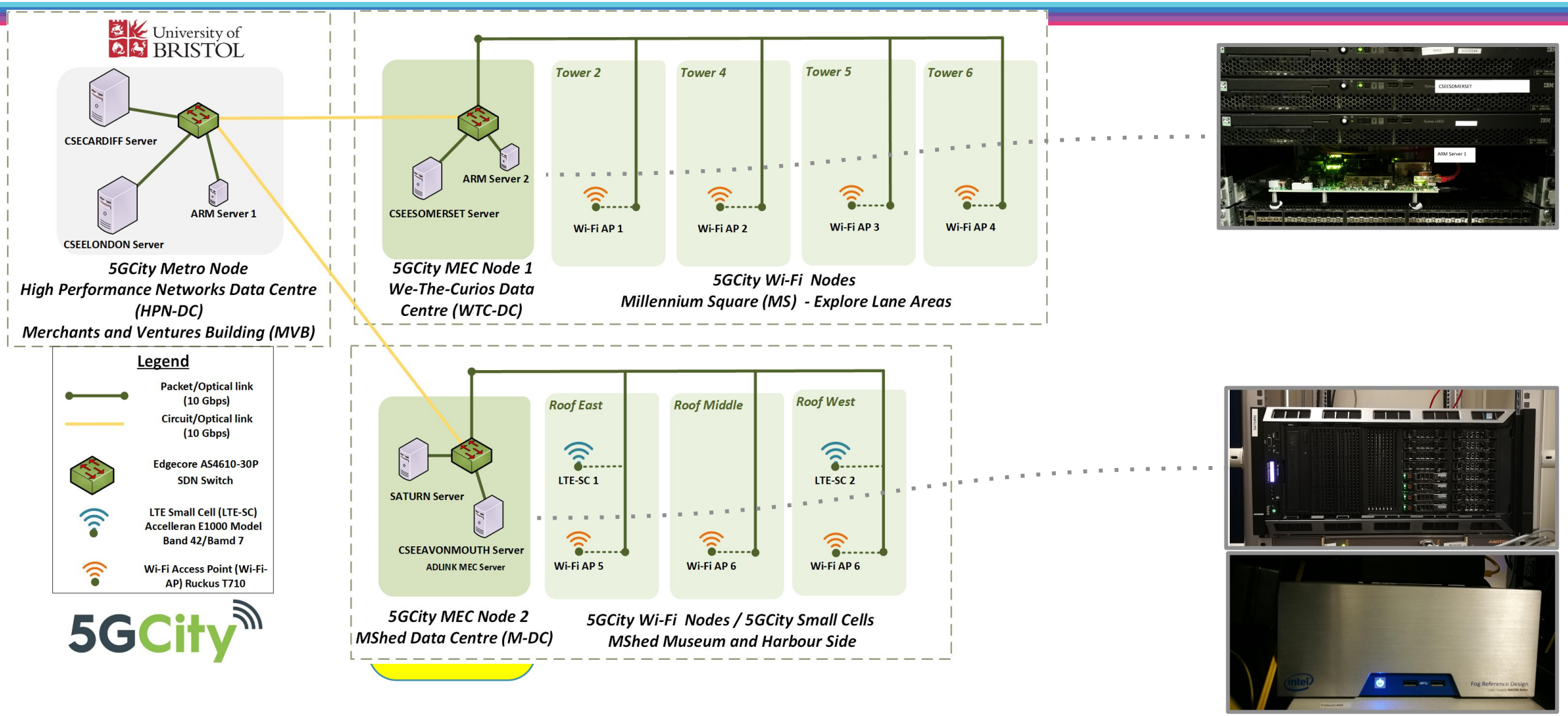


5GCity Edge in Barcelona (ES)

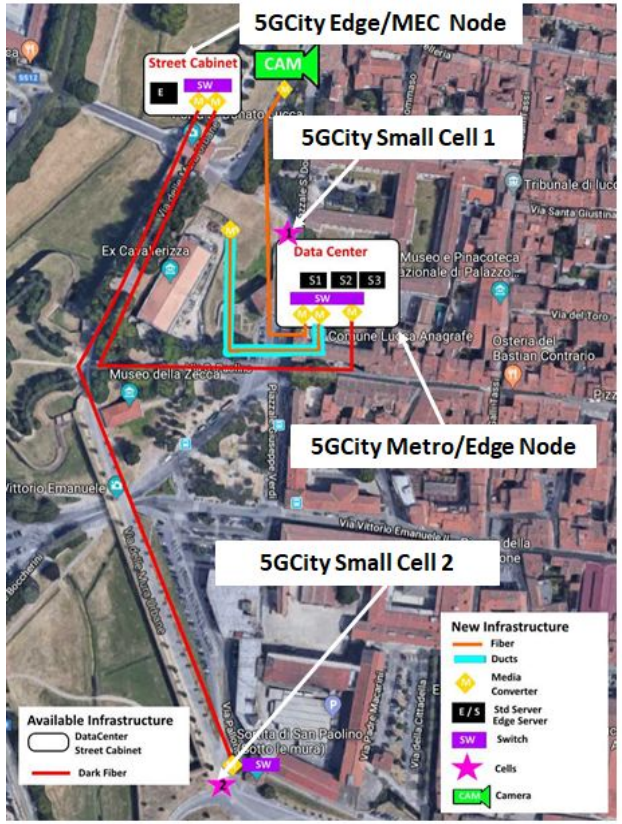




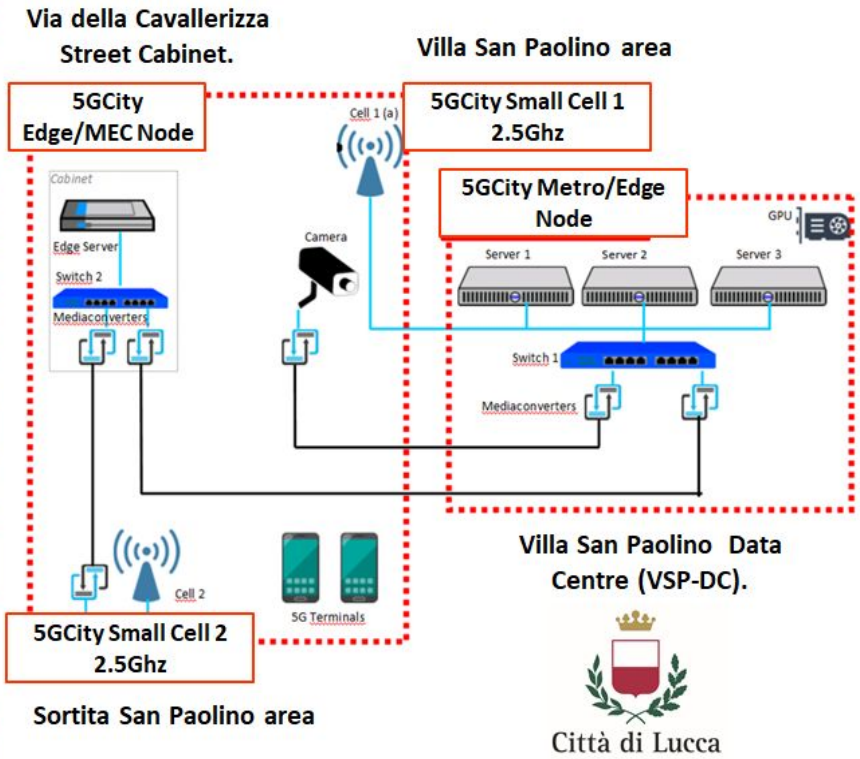
5GCity Edge in Bristol (UK)



5GCity Edge in Lucca (IT)



a)



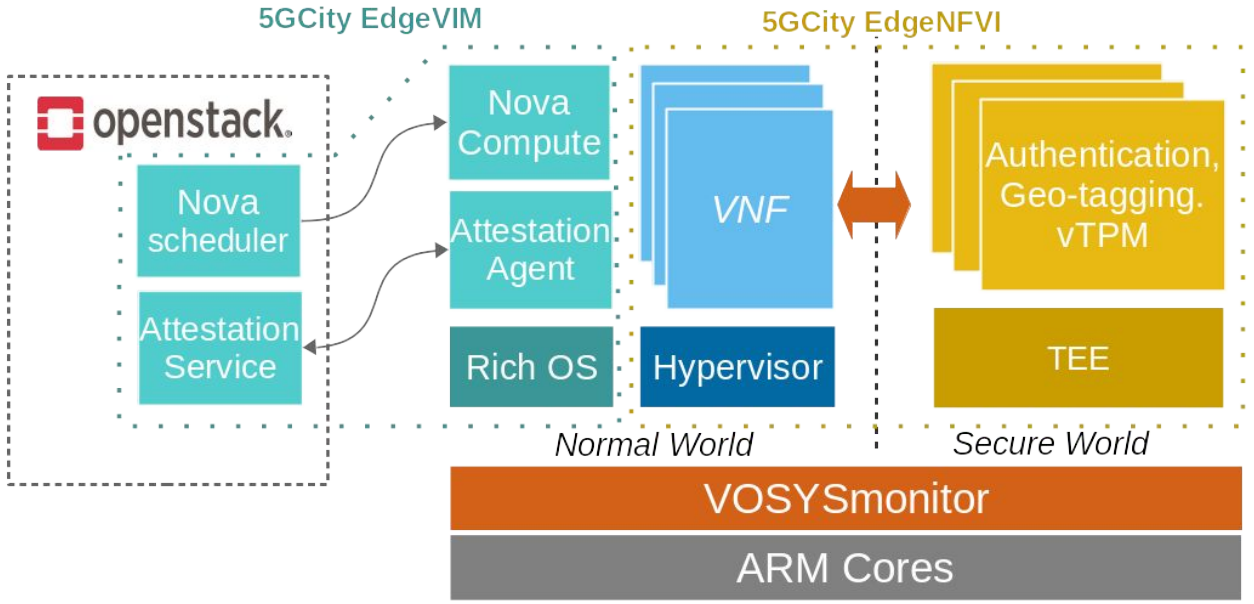
b)

5GCity EdgeVIM and EdgeNFVI

- **Motivation**
  - Security Hardening of the 5GCity Virtualized Infrastructure
    - Authenticated devices, geo/asset tagging and secure storage
  - Why does this matter in smart cities environments?
    - Distributed architecture
    - Privacy issues related to the sensitive data used (cameras, mobility services, health, etc.)

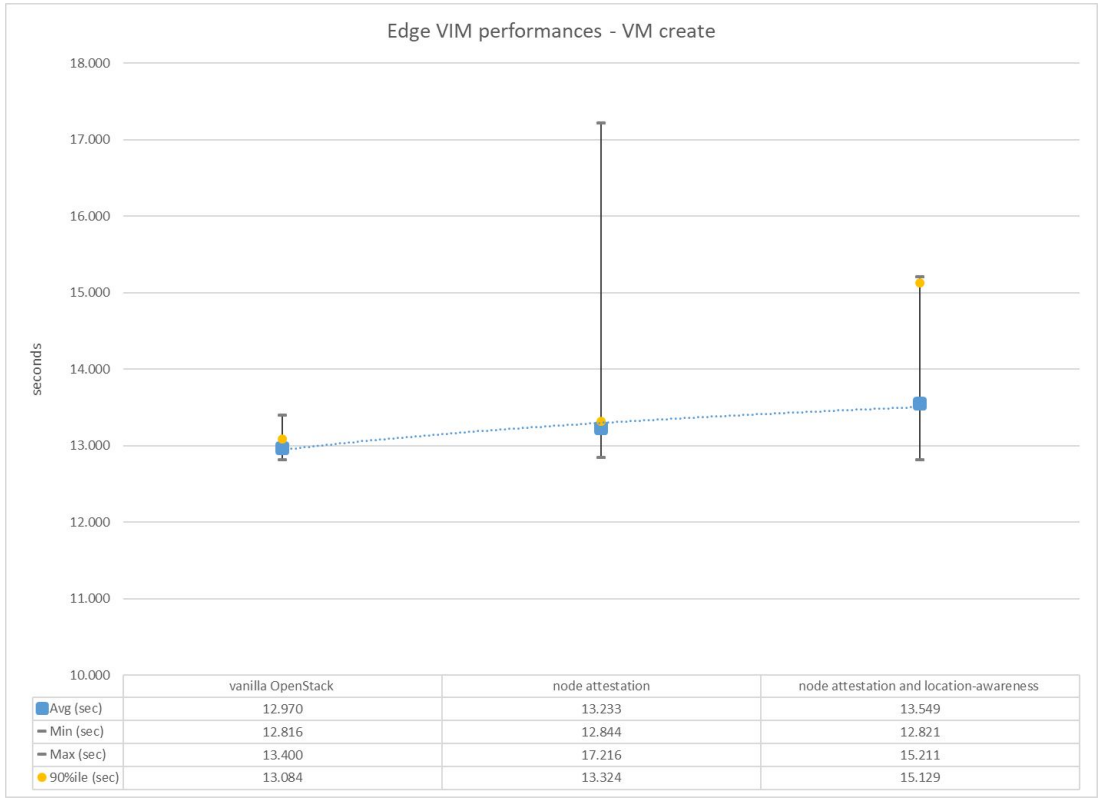
Components

- **EdgeVIM** - based on OpenStack with added attestation capabilities
- **EdgeNFVI** - isolation at the hardware level by leveraging VOSYSmonitor and ARM TrustZone
- **Security Services**: running inside a Trusted Execution Environment



EdgeVIM/NFVI performances

m1.tiny flavor (1 VCPU, 1GB Disk, 512MB RAM) for CirrOS cloud image guest OS



	vanilla OpenStack	node attestation	node attestation and location-awareness
Avg (sec)	12.970	13.233	13.549
Min (sec)	12.816	12.844	12.821
Max (sec)	13.400	17.216	15.211
90%ile (sec)	13.084	13.324	15.129

	vanilla OpenStack	node attestation	node attestation and location-awareness
Avg (sec)	2.378	2.388	2.414
Min (sec)	2.350	2.356	2.353
Max (sec)	2.550	2.620	2.595
90%ile (sec)	2.390	2.395	2.556

- ~+2% average overhead during VM creation with node attestation, ~+4% overhead if we add location awareness
- VM deletion process not affected

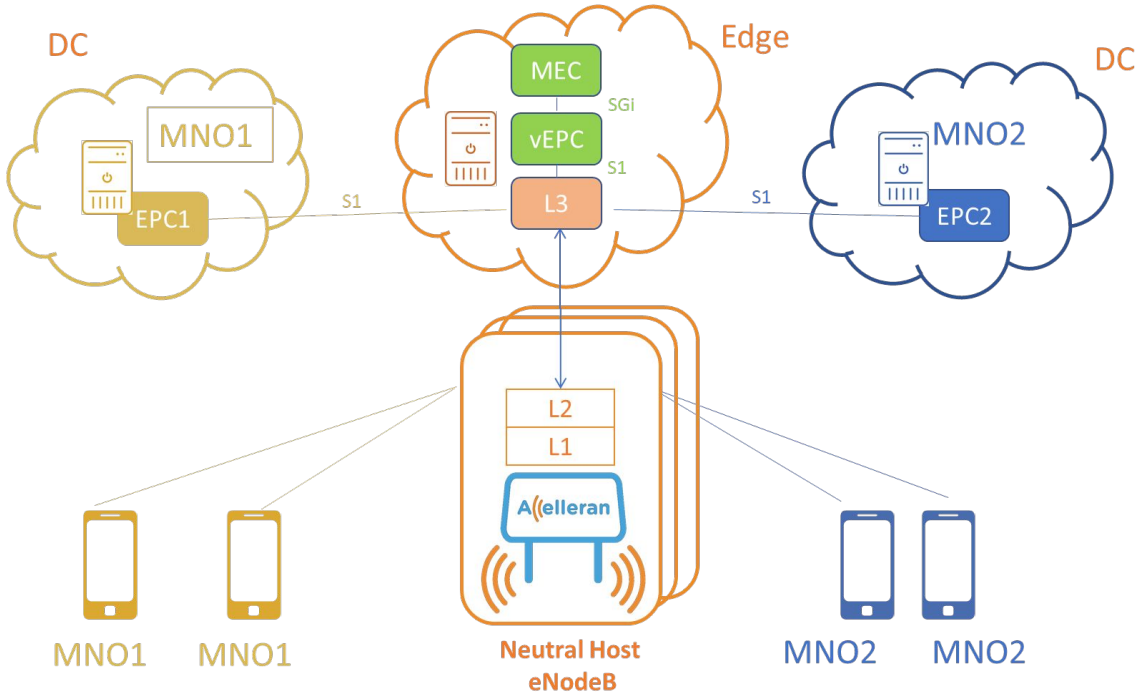
OpenStack (release Pike) controlling:

- One x86 controller node: Intel(R) Xeon(R) CPU E5-2623 v4 @ 2.60GHz, 32GB memory, Ubuntu 16.04.4 LTS, KVM-enabled 4.4.0-128 Linux kernel
- One ARM64 compute node: Xilinx Zynq UltraScale+ MPSoC ZCU102 with a quad-core ARM Cortex-A53, 4GB memory, Ubuntu 18.04.4 LTS, KVM-enabled 4.14.0 Linux kernel

5GCity RAN Virtualization

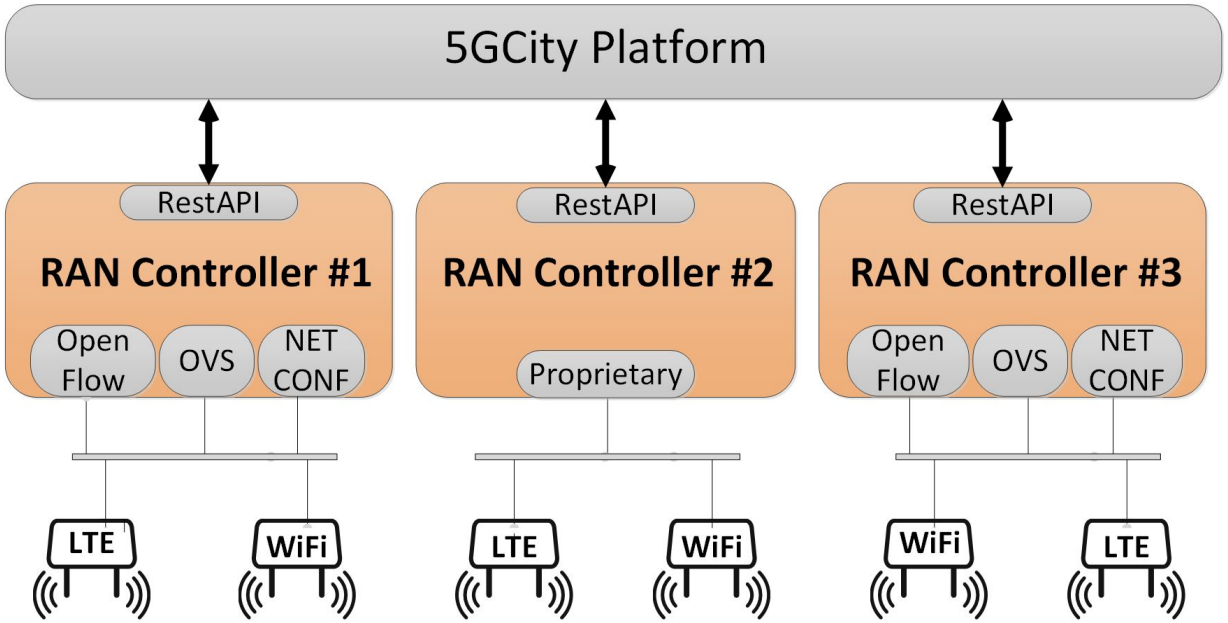
eNodeB SPLIT for Neutral Host

- For lower latency and local traffic breakout conditions, virtual EPC and virtual vL3 function are co-located at edge

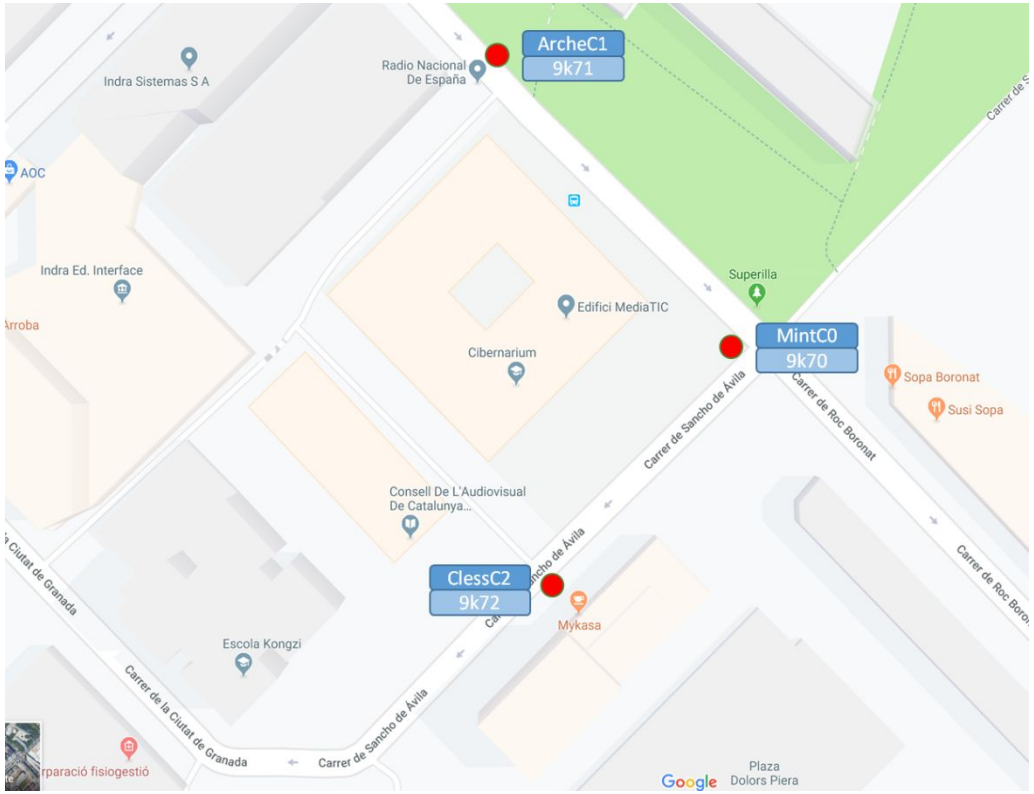


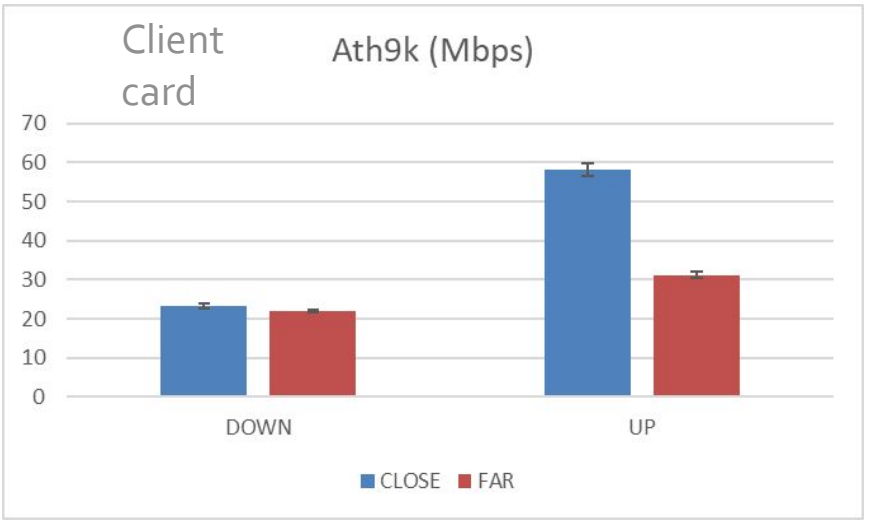
Infrastructure abstraction

- Support different RAN controllers by 5GCity platform and integration of the underlying RAN technologies



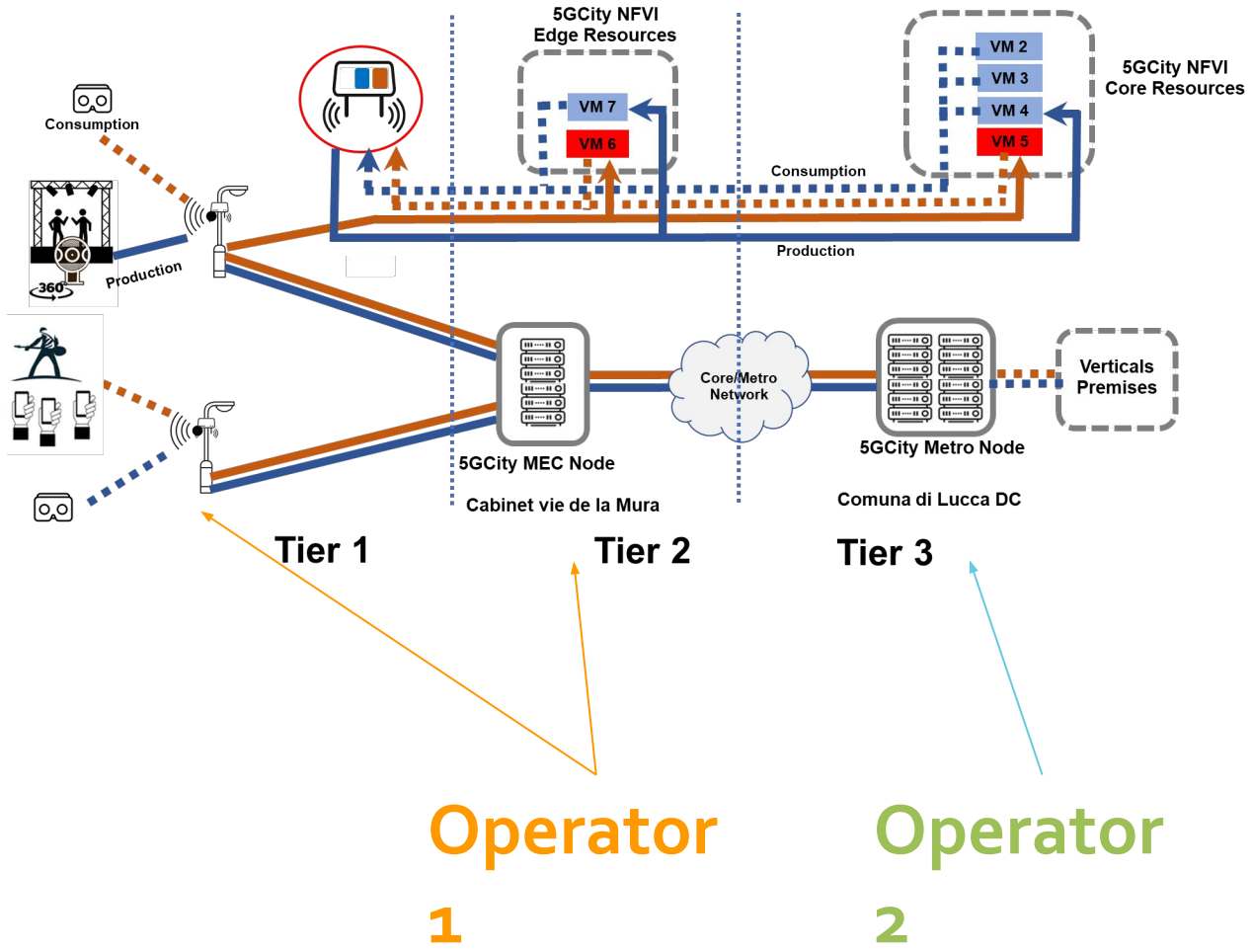
RAN Virtualization performances





- Differences in throughput can be explained by different distances (close/far) and the use of different chipsets in client cards (ath9k, ath10k).

A practical problem with edge on-street



RATIONALE

- 5GCity will be deployed in the 3 cities with different underlying infrastructures
  - BCN, BRS and LUCCA have different layouts
- Some variations from pilot to pilot
  - E.g. access to cameras in Lucca
  - L2 capabilities in BCN and BRS
  - Optical transport in BRS,
  - …

☐ No unified deployment model can be offered

- In principle, infrastructures may belong to single or multiple administrative operators

☐ Inherent configuration of 5GCity 3-tiers architecture as multi-operator infrastructure

Live HD TV streaming from Torre Guinigi to Real Collegio, Lucca (IT) – 6-7 June 2019

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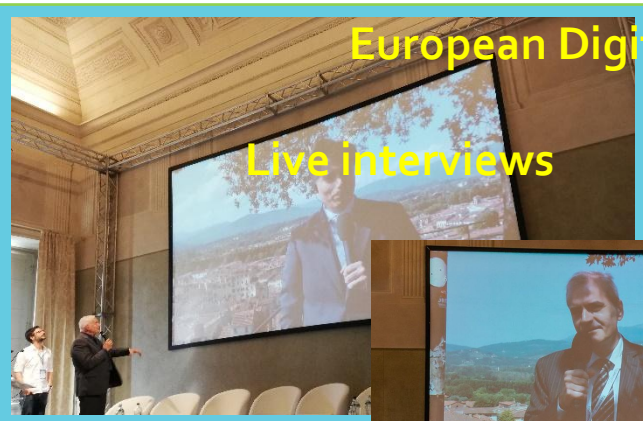
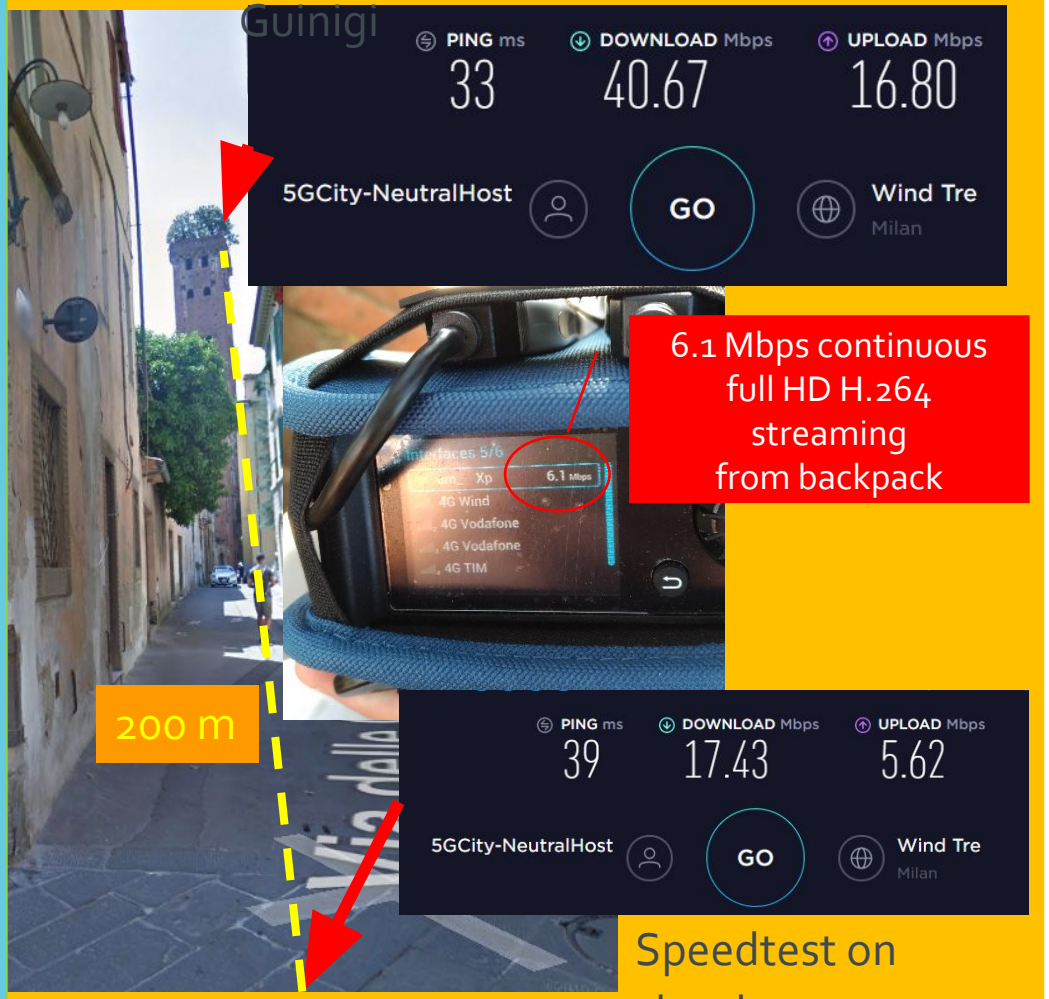


Speedtest on Torre Guinigi



Live HD TV streaming from #Valencia5Gweek, Valencia(ES) – 18-20 June 2019

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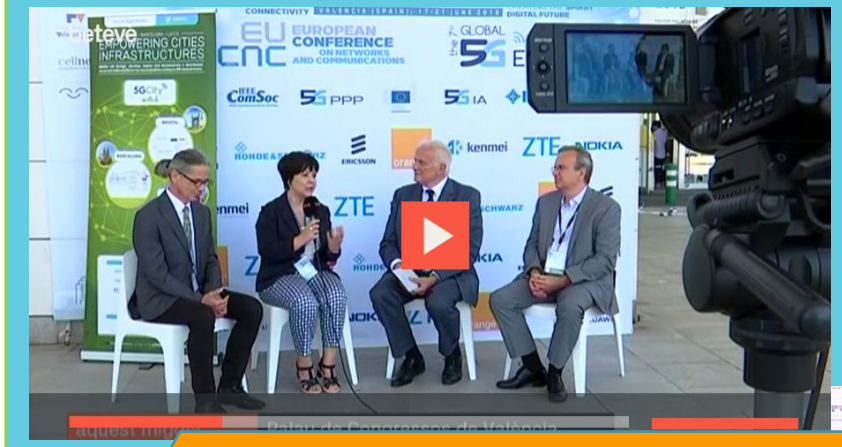
#Valencia5Gweek
2019
Live interviews



18-June | EBU, ESA, 5GTours project talking about 5G, Media & SATs

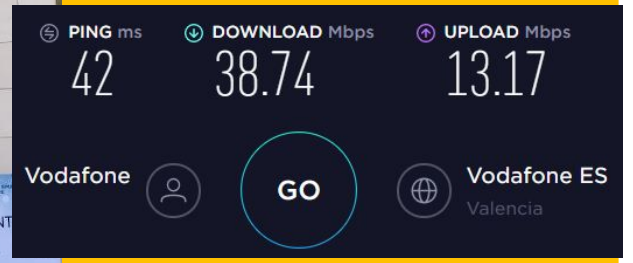
19-June | EC & 5G IA talking about status of 5G in Europe

19-June | RTVE CTO talking about 5G & broadcasting

Speedtests at Valencia Conference

SC
B43
Platform
&DC

Camera
backpack



~6 Mbps continuous full HD streaming from backpack camera

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Thank you!

www.5gcity.eu

@5GCity

ETSI