



A DISTRIBUTED
CLOUD &
RADIO
PLATFORM FOR
5G NEUTRAL
HOSTS

14/Jun/2018

*Workshop 1
Vertical Industries & Services for 5G (VIS5G)*

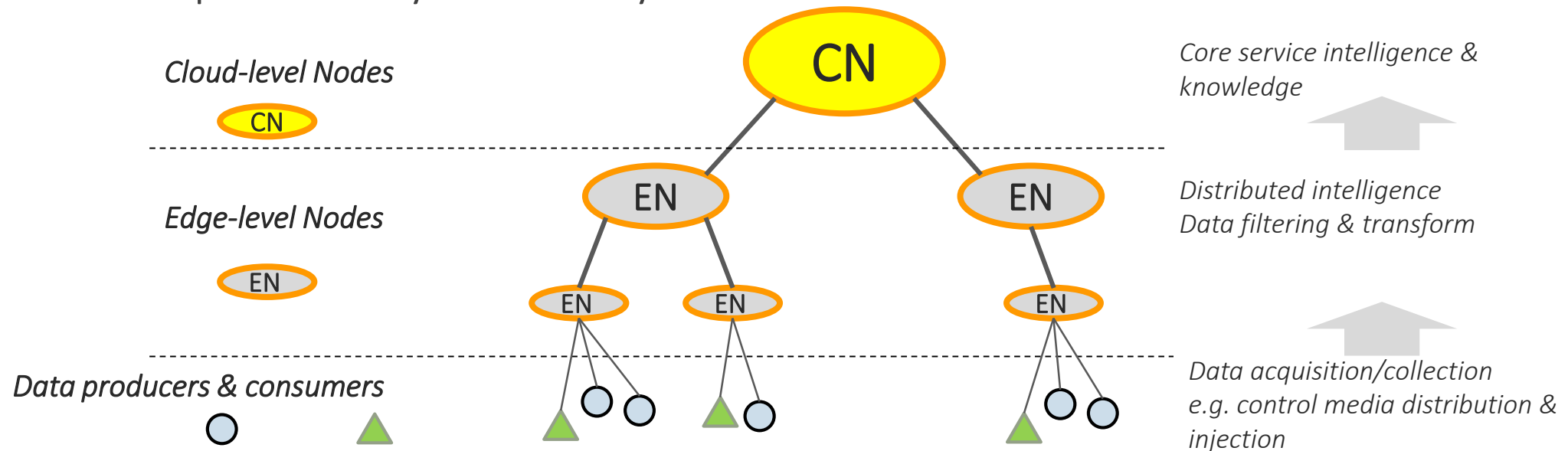
5GCity: Transforming Cities into Hyper-Connected World

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How 5G transformation applies to cities **5GCity**

With 5G, the metropolitan areas are becoming **large interconnected digital fabrics**

- A Smart City is a combination of **heterogeneous sensing and data acquisition networks, pools of computing and storage resources, various fixed/mobile network technologies**
- A complex hierarchy of control layers

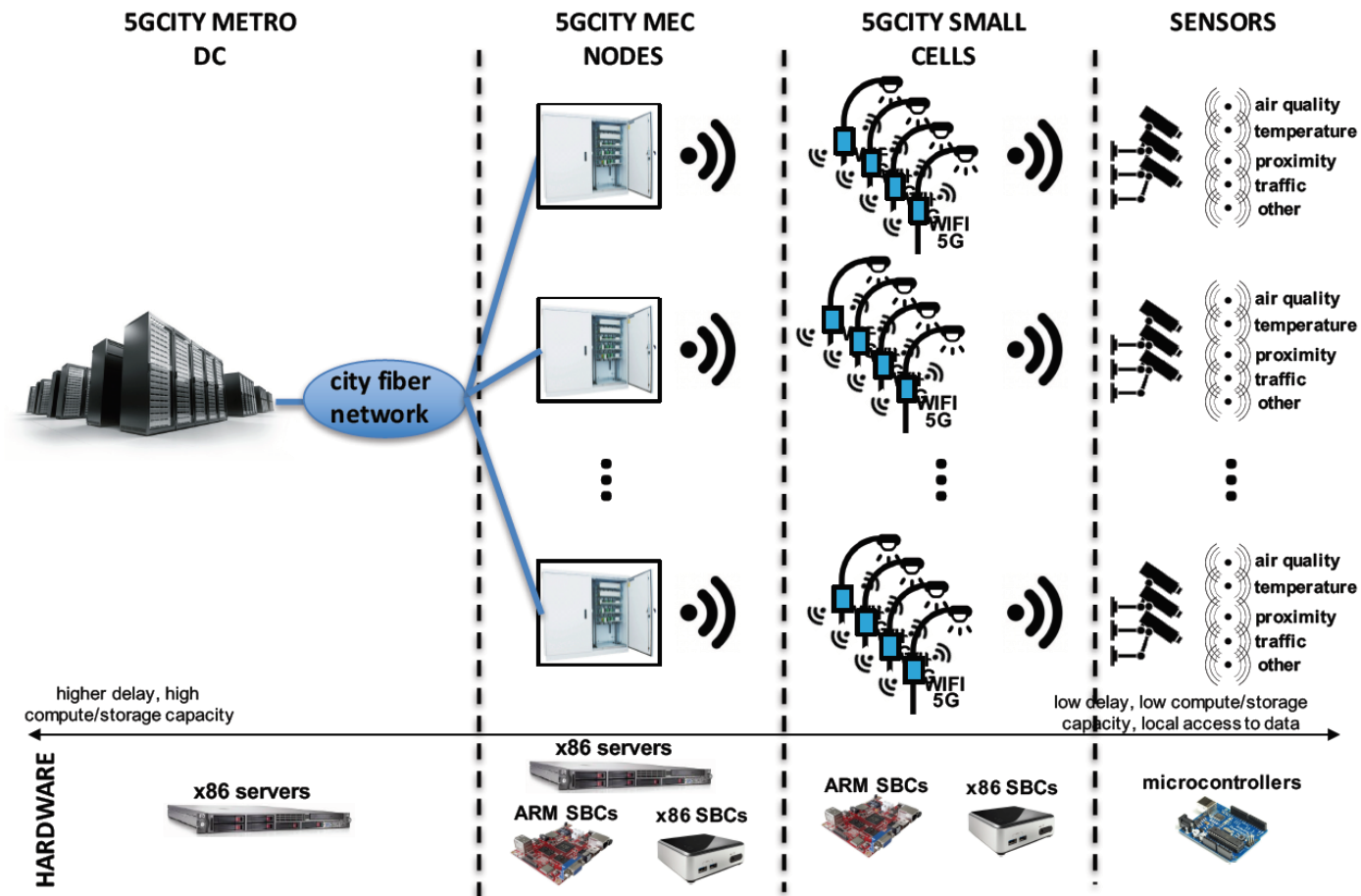


- New “Smart-X” scenarios of location-based media streaming, video-surveillance, gaming, AR/VR, safety & security

5GCity for Barcelona-Bristol-Lucca



Design, develop, deploy
and demonstrate a
distributed cloud and
radio platform for
municipalities acting as
5G neutral hosts



Main elements of innovation



[ARCH] Distributed, 3-tier architecture for network sharing, slicing and mobile edge computing

- **Datacenter(s)**
- 5GCity Mobile Edge Computing (MEC) nodes (i.e., **street cabinets**)
- 5GCity Small Cells (i.e., **street gateways**)

[SW] 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)
- VM-to-VM throughput ≥ 9.5 Gb/s in **street cabinets**, **wireless virtualization** for 802.11 radios with throughput ≥ 3 Gb/s and isolation guarantees in **mesh networks** of up to 20 devices

[SW] Scalable edge management & orchestration, and 5GCity edge service programming models

- **A few seconds for edge service instantiation**, orchestrator response, **streaming analytics** for monitoring, reallocation of service flows, VM migration

[TESTBED] 5GCity city-wide pilots deployment and validation

- Demonstration in three different cities: **Barcelona, Bristol, Lucca**

5G Neutral Host model

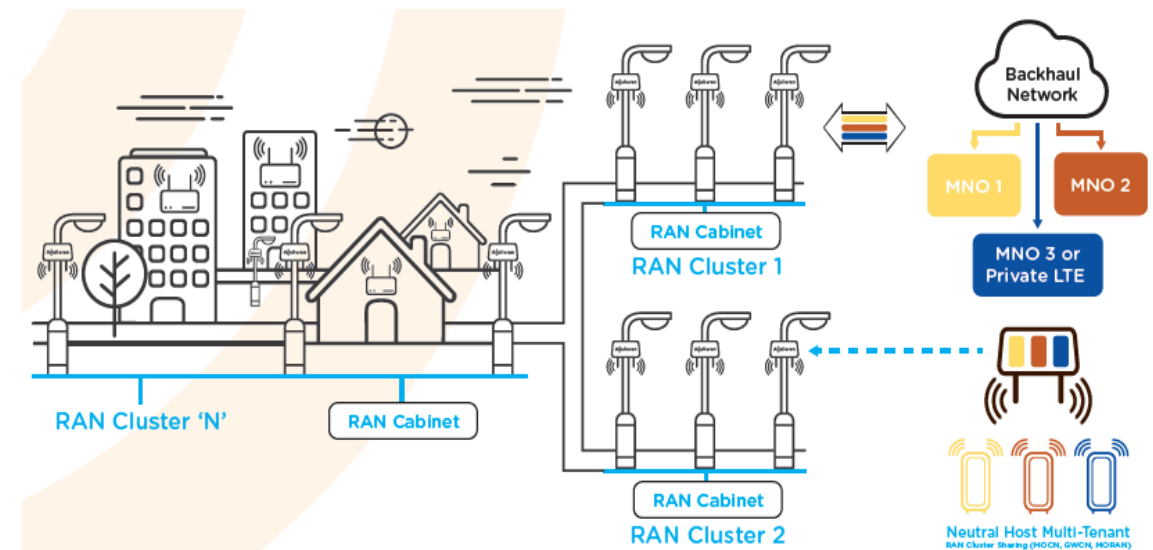


Network slicing mechanisms developed in 5GCity

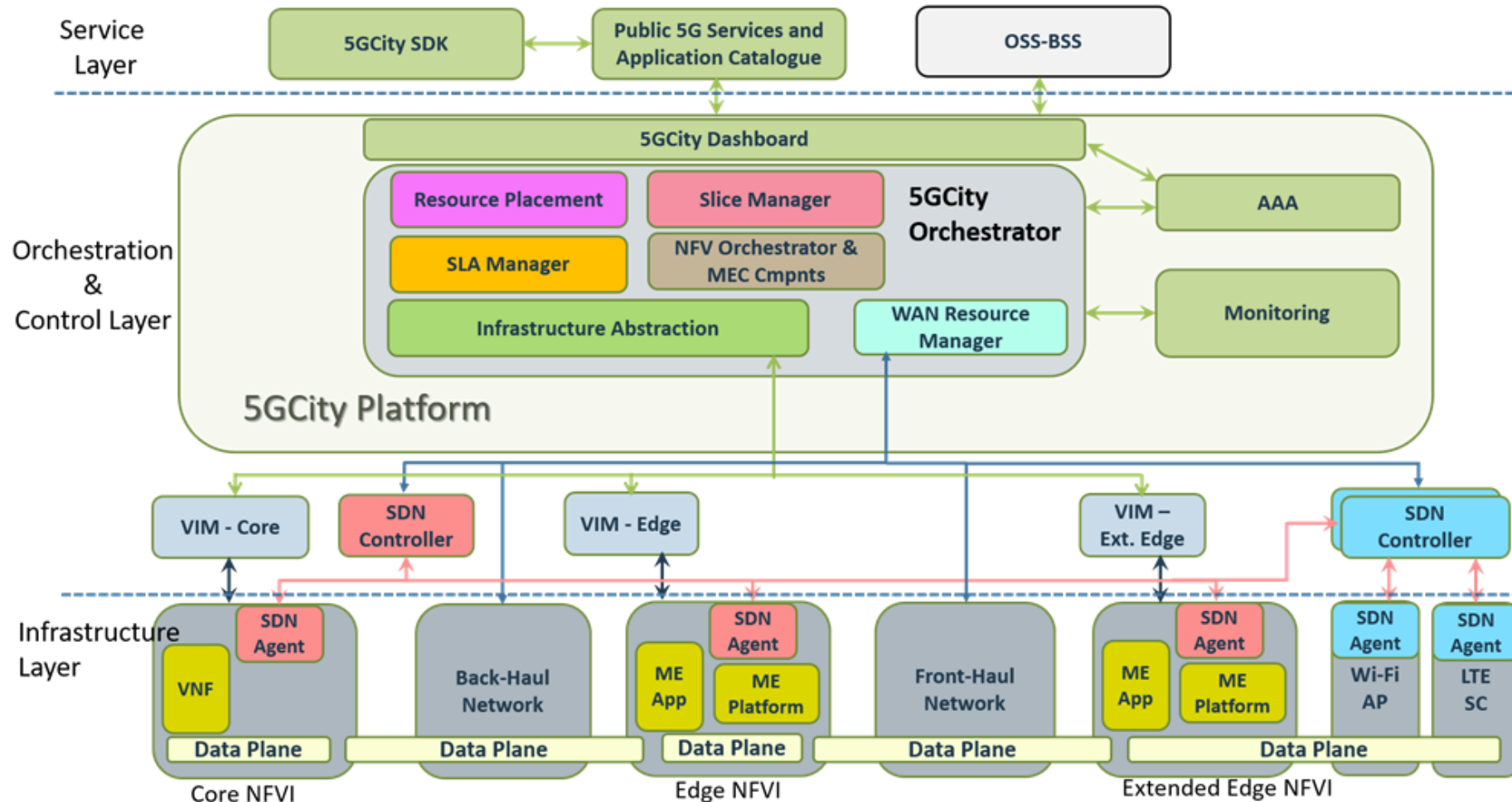
- The network infrastructure hosts any entity that, in turn, uses this slice to provide services to end-users
- The “**Neutral Host**” (infrastructure owner) is able to operate a partition of its resources and to arrange them in a set of homogeneous tenants (or slices)

Architectural approaches for neutral 5G operator in 5GCity

- **MOCN – Multiple Operator Core Network**
 - The cabinet hosts centralised Small Cell components dedicated to the control of a cluster of physical Small Cells deployed in lampposts and other urban furniture
 - Spectrum is shared among different Mobile Operators
- **MORAN – Multi-Operator Radio Access Network**
 - Each Mobile Operator uses his own spectrum portion
 - The different physical single carrier Small Cells support different bands that can be dedicated to a particular Mobile Operator
 - Centralized Small Cell cluster functions in the cabinet to offer a “virtual” MORAN view of the physical small cells deployed in the lampposts



5GCity platform high level architecture



5GCity SDK



A **graphical environment** to compose functions in end-to-end services

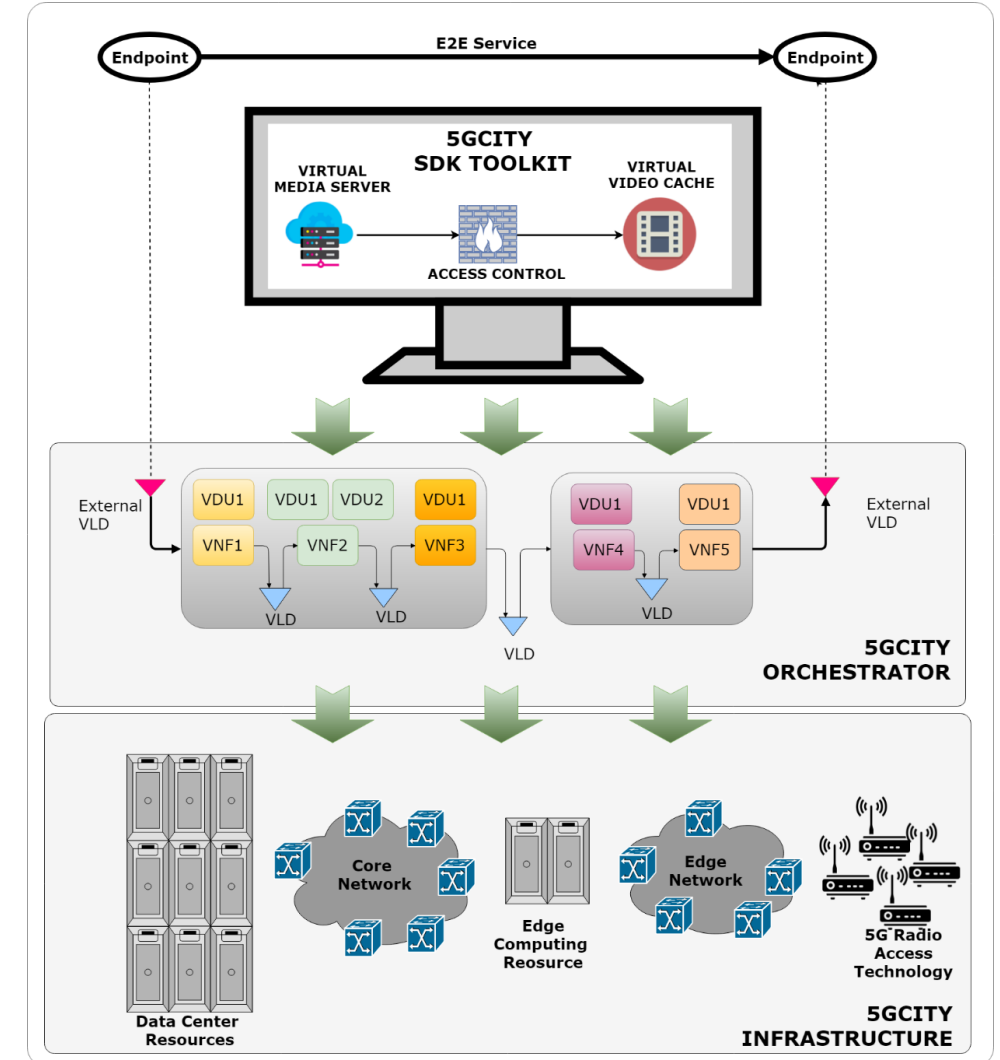
- Wire, in an arbitrary sequence, a pre-defined set of functions defining a logical service chain
- Create & reuse service templates, ready to be deployed in 5GCity infrastructure

An **adaptation layer**

- to hide the complexity of the infrastructure and automatically translate functional components and business requirements into an operational service

A **validation module**

- to perform the formal validation of the service templates and verify the consistency of the end-to-end service pattern

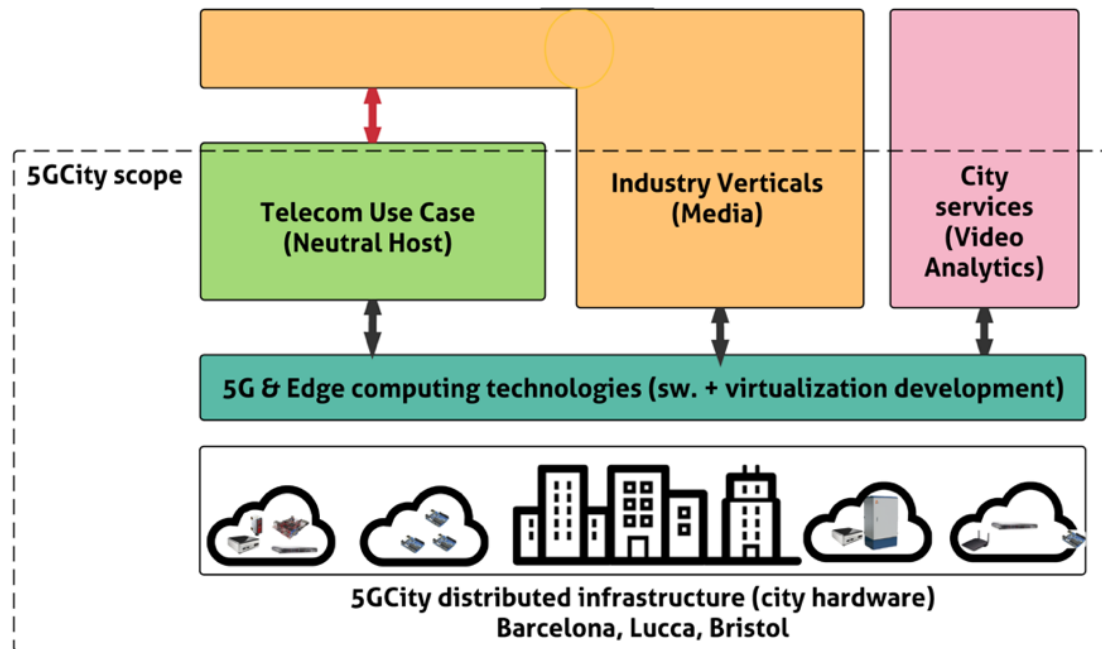


6 key use cases to evaluate 5G impact on Smart Cities



3 Groups (Telco, Media, Security)

- Great focus on Media



UC ID	Use Case	City		
		BCN	BRS	Lucca
UC1	Unauthorized Waste Dumping Prevention			✓
UC2	Neutral Host	✓	✓	✓
UC3	Video Acquisition and Production + Community media engagement in live events	✓	✓	
UC4	UHD Video Distribution Immersive Services		✓	✓
UC5	Mobile Backpack Unit for Real-time Transmission	✓		
UC6	Cooperative, Connected and Automated Mobility (CCAM)	✓		

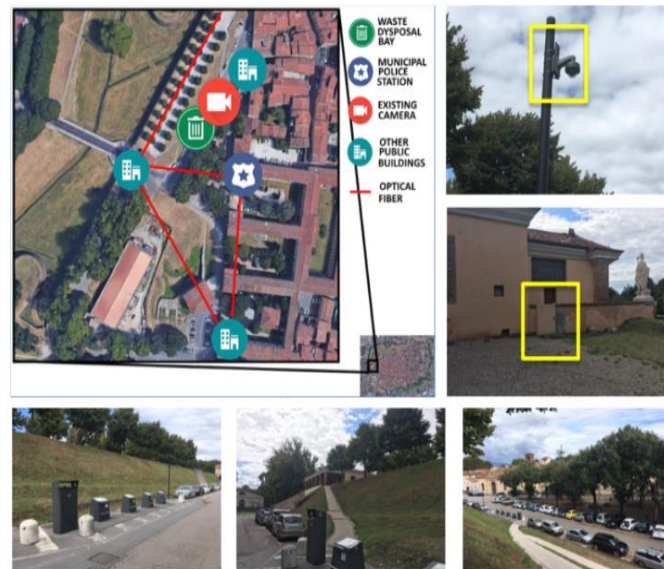
Quick overview on use cases



Lucca

UNAUTHORIZED WASTE DUMPING PREVENTION

- **Service Objective:** Monitor urban areas under the risk of environmental abuse, to prevent unauthorized dumping of waste

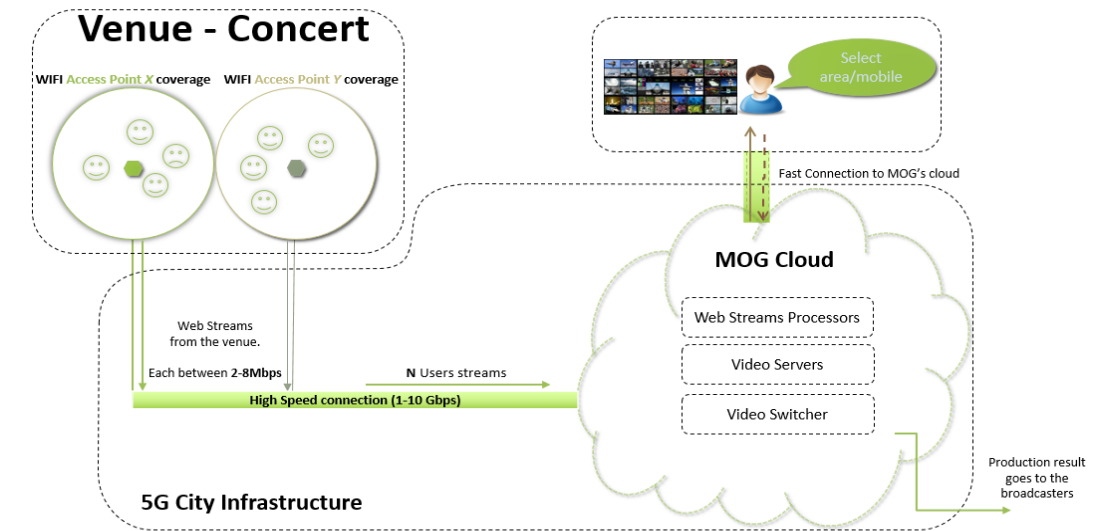


VIDEO ACQUISITION AND PRODUCTION



Barcelona Bristol

- **Service Objective:** Acquire HQ videos via mobile applications at events and stream them through the 5G Network

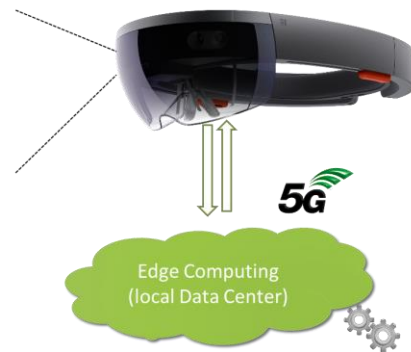


Quick overview on use cases (2)



UHD VIDEO DISTRIBUTION & IMMERSIVE SERVICES

- **Service Objective:** Develop an application that uses Mixed Reality, user movement tracking and computer vision algorithms to create an augmented tourist guide that can work both indoors and outdoors

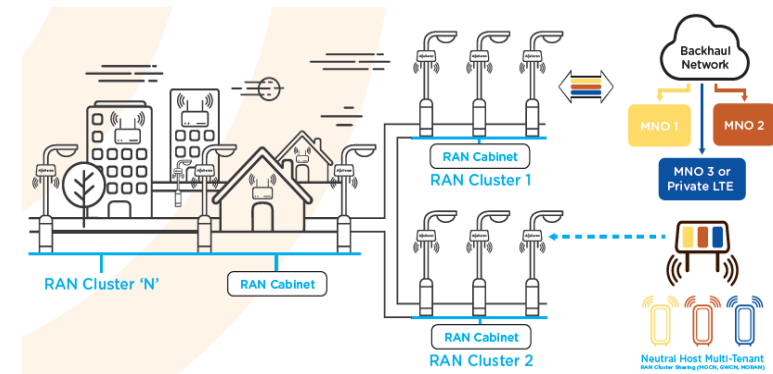


Visual Search algorithm

MOBILE BACKPACK UNIT FOR REAL-TIME TRANSMISSION



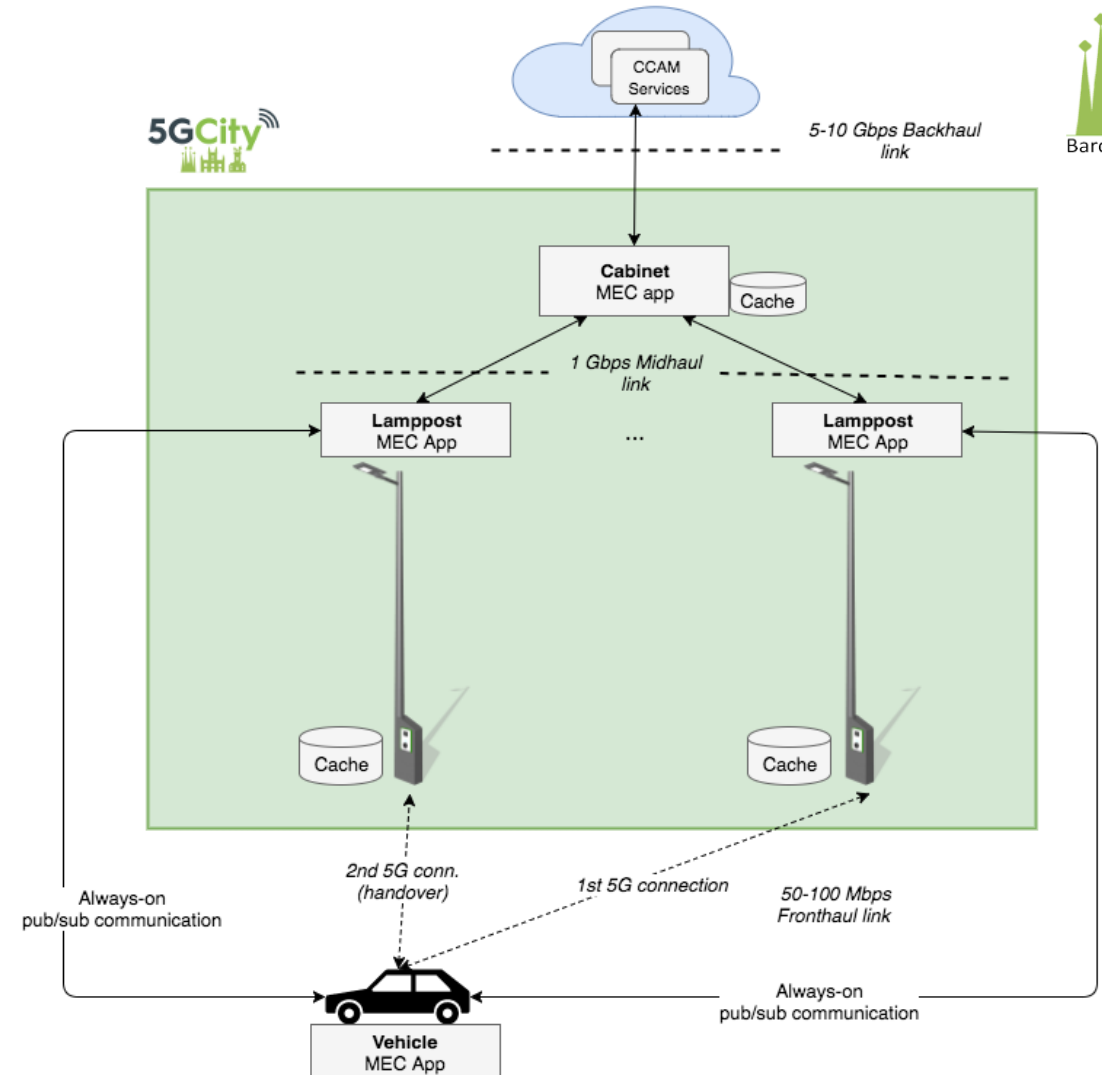
- **Service Objective:** Acquire HQ videos via mobile applications at events and stream them through the 5G Network



Quick outlook on use cases (3)

Cooperative, Connected and Automated Mobility (CCAM)

- **Service objective:** Use 5G, NFV and MEC for V2X/CCAM to significantly improve road safety, comfort of driving and smarter coordination between connected autonomous cars, road infrastructure and cloud services
- MEC application running in street cabinets to implement an always-on connection to the central cloud service
- Vehicle can subscribe only to data (alerts) occurring within its surrounding area (tuneable parameter)
- Cloud service to store in proximity cache relevant data for the vehicle
- Vehicle to stream down this cached data immediately and publish any relevant data collected by the car's own intelligence system



Getting ready for city-wide deployments



Street surveillance cameras
Lucca



Street cabinet- compute
and fiber - Barcelona



Street Lamp post
Barcelona



3.5GHz Small Cell and local
video server integrated on
City of Barcelona lamp post



Plans for City trials and demonstrations



Current focus on 5GCity infrastructures deployment

- Barcelona and Bristol about to start validation
- Lucca to start after the summer

Come visit us at **BOOTH #6**

Demonstrations of some 5GCity technologies here at our booth

- **Neutral Hosting**
- **Guest Optimization in 5GCity** (Unikraft)
- **5GCity far-Edge Orchestrator & VIM** (fog05)

Use case pilots from Q3-2018

- In Lucca: planning coverage for **Lucca Comics&Games**, major cultural events, etc.
- In Barcelona: planning pilots around **MWC2019**
- In Bristol: planning trials in the city for **Spring 2019 events**

City	M1 Jun.2017	M6 Nov.2017	M12 May.2018	M18 Nov.2018	M24 Jun.2019	M30 Nov.2019
Barcelona						
<i>Metro DC</i>		D		T	V	
<i>MEC node</i>		D		T	V	
<i>Network</i>		D		T	V	
<i>RAN</i>			D	T		V
Bristol						
<i>Metro DC</i>	D			T	V	
<i>MEC node</i>		D		T	V	
<i>Network</i>		D		T	V	
<i>RAN</i>			D	T	V	
Lucca						
<i>Metro DC</i>			D	T		V
<i>MEC node</i>			D		T	V
<i>Network</i>			D		T	V
<i>RAN</i>			D		T	V
Legend	D	Deployment	T	Testing	V	Validation

Thank you!



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[@5GCity](https://twitter.com/5GCity)



<https://www.linkedin.com/groups/8607896>



<https://www.youtube.com/channel/UCqakofF2vjTdyEihpadfvLQ>

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BACKUP

More details on 5GCity use cases

Unauthorized Waste Dumping Prevention



Service Objective

- Monitor urban areas under the risk of environmental abuse, to prevent unauthorized dumping of waste

Approach

- Exploit the 5GCity edge infrastructure to e.g., deploy video surveillance and video analytics at the edge
- Edge-core virtualized infrastructure for video acquisition and management
- SDN/NFV MANO for 5G service LCM
- Media service design offered to the slice owner

Expected benefits

- Reduce ratio between recorded and transmitted video
- Reduce time spent by human operator in the process of identifying the abuse from dd/hh to mm/ss
- Reduce energy consumption of the video surveillance devices



Video Acquisition and Production



Service Objective

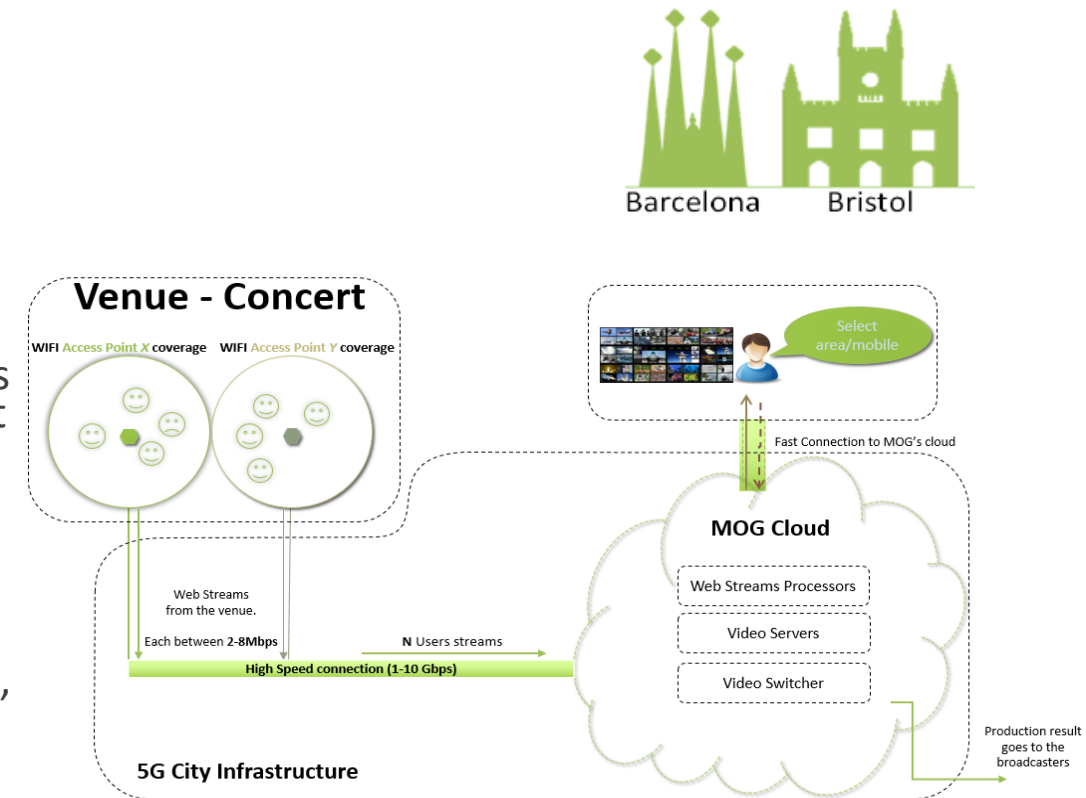
- Acquire HQ videos via mobile applications at events and stream them through the 5G Network

Approach

- 5GCity platform capable to communicate with the media services, configure them and establish the communication channels
- Cloud-based application capable of receiving multiple streams from the 5G City platform and dynamically switching different videos inputs based on the producer/director commands

Expected benefits

- Quality of Experience* – personalized content as the output of the application with improves quality for the audience
- Lower costs* – automatic switching of the content in the cloud, instead of using an expensive dedicated video switcher, cameras
- Ensuring transmission rights* –engagement of the audience in the application can lower the number of unauthorized people who will spread/publish media content
- Increase of revenues – increase the average number of people attending a live event and subsequently corresponding revenues



UHD Video Distribution Immersive Services



Service Objective

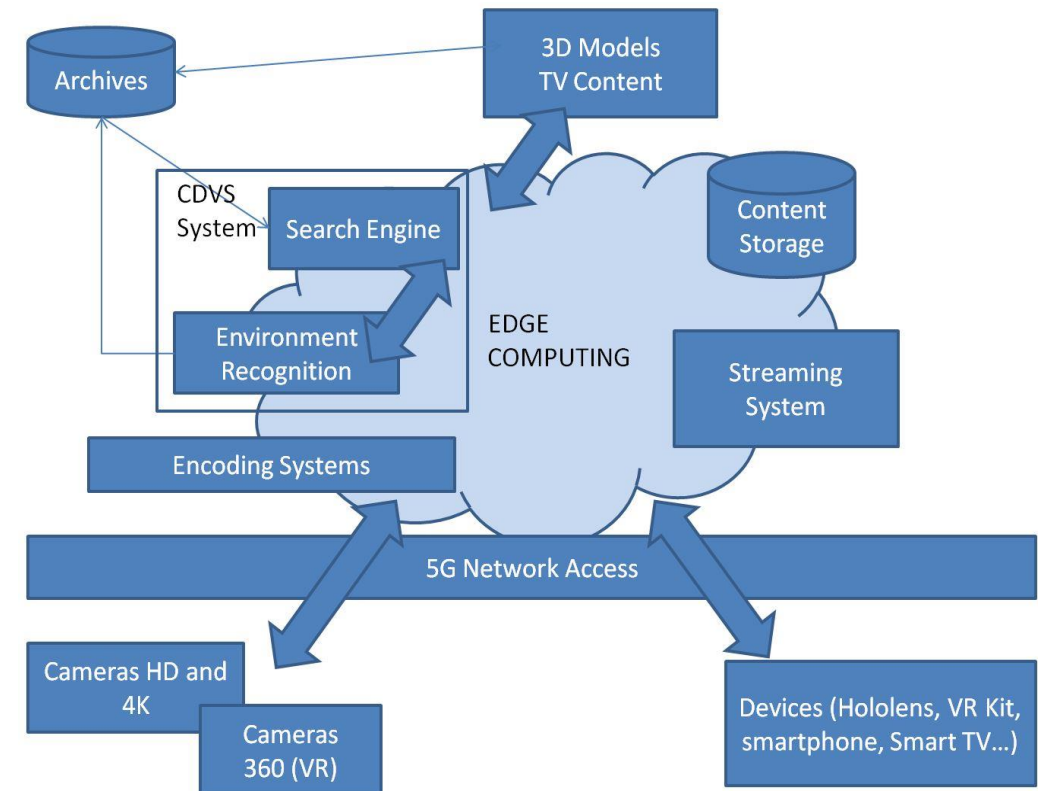
- Develop an application that uses Mixed Reality, user movement tracking and computer vision algorithms to create an augmented tourist guide that can work both indoors and outdoors

Approach

- 2 two phases: Production & Consumption (User viewing)
 - In each phase cover acquisition or distribution of UHD, Video 360, 3D Models, Additional Content
- 5G Access to connect devices (cameras, HoloLens, smartphones, VR Kits) to edge and down in the core network
- Deploy automatically virtualized functions for Encoding System, Streaming System, Search Engine, Access to the TV archives, Content Storage and 3D models repository

Expected benefits

- Increased service and network performance compared to those available with 4G, with particular reference to user experience of content usage
- Availability of UHD contents, VR in a place on a variety of technology platforms (5G smartphones, VR viewers, smart TVs, multimedia totems)
- Valorisation of cultural events taking place within the territory of the cities
- Broaden the media coverage of events by helping to deliver content to tourists present or transiting through the city



Mobile Backpack Unit for Real-time Transmission



Service objective

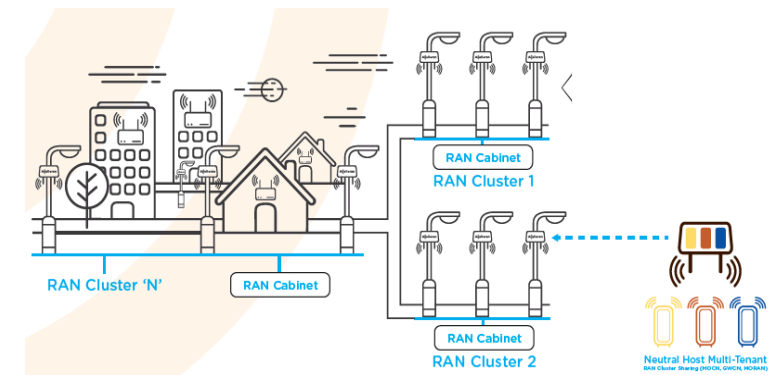
- Improve video quality of connections (real-time transmission) for live TV content production

Approach

- Enable the mobile unit to utilize more bandwidth (provisioning a specific slice with a guaranteed QoS)
- Use of edge computing processing capabilities for production/conditioning of video contents at the edge
- Use of direct and edge-mediated communications from backpack to the TV studio to send the images/videos produced in the streets

Expected benefits

- Improve video quality of live connections (real-time transmission)
- Increased service and network performance compared to those available with 4G



Cooperative, Connected and Automated Mobility (CCAM)



Service objective

- Use 5G, NFV and MEC for V2X/CCAM to significantly improve road safety, comfort of driving and smarter coordination between connected autonomous cars, road infrastructure and cloud services

Approach

- Ultra-reliable and low-latency communications (uRLLC) channel between vehicles, infrastructure and network
- Centralised cloud service for the aggregation of both crowd-sourced and 3rd party safety mobility data
- MEC application running in street cabinets to implement an always-on connection to the central cloud service
 - Vehicle can subscribe only to data (alerts) occurring within its surrounding area (tunable parameter)
 - Cloud service to store in proximity cache relevant data for the vehicle
 - Vehicle to stream down this cached data immediately and publish any relevant data collected by the car's own intelligence system

Expected benefits

- Extremely low end-to-end overall packet loss and latency
- Very fast instantiation of different MEC applications across the different domains
- Seamless handover process with uninterrupted data flow between the vehicle's application and the other running on the edge

