



5GENESIS
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**5th Generation End-to-end Network,
Experimentation, System Integration,
and Showcasing**

Call Topic: ICT-17-2018: 5G End-to-end Facility

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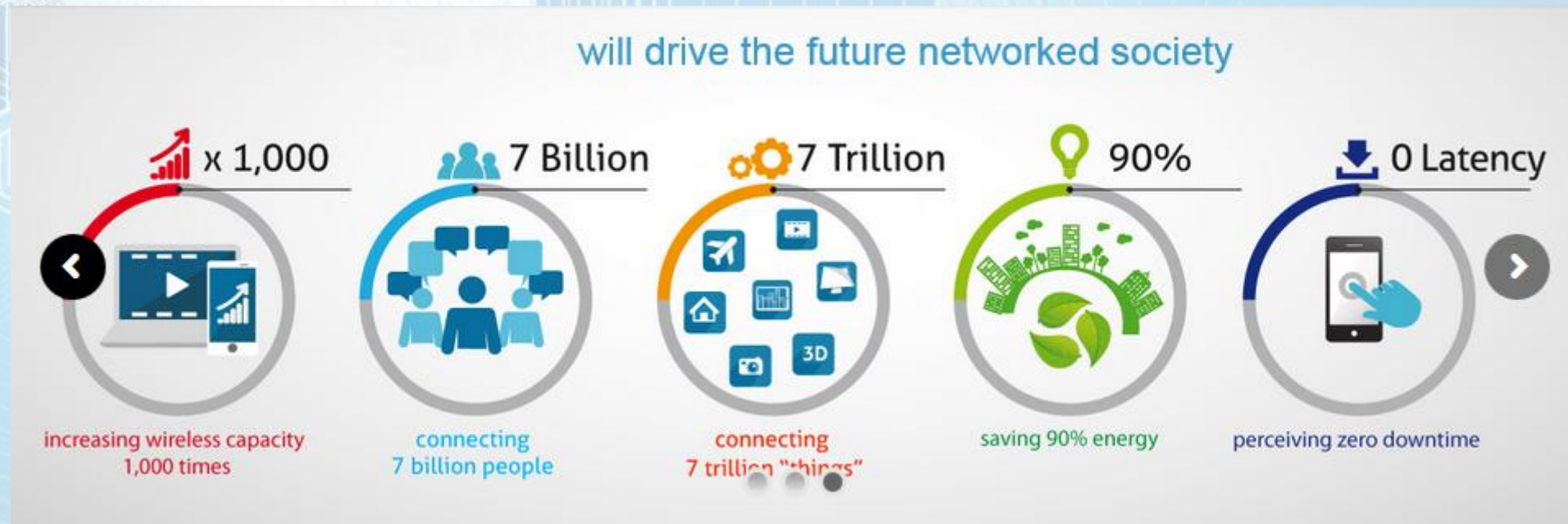
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Motivation and Scope

Validation of 5G KPIs for various 5G use cases, in both controlled set-ups and large-scale events in order to realize an integrated End-to-end 5G Facility.



5GENESIS Platforms

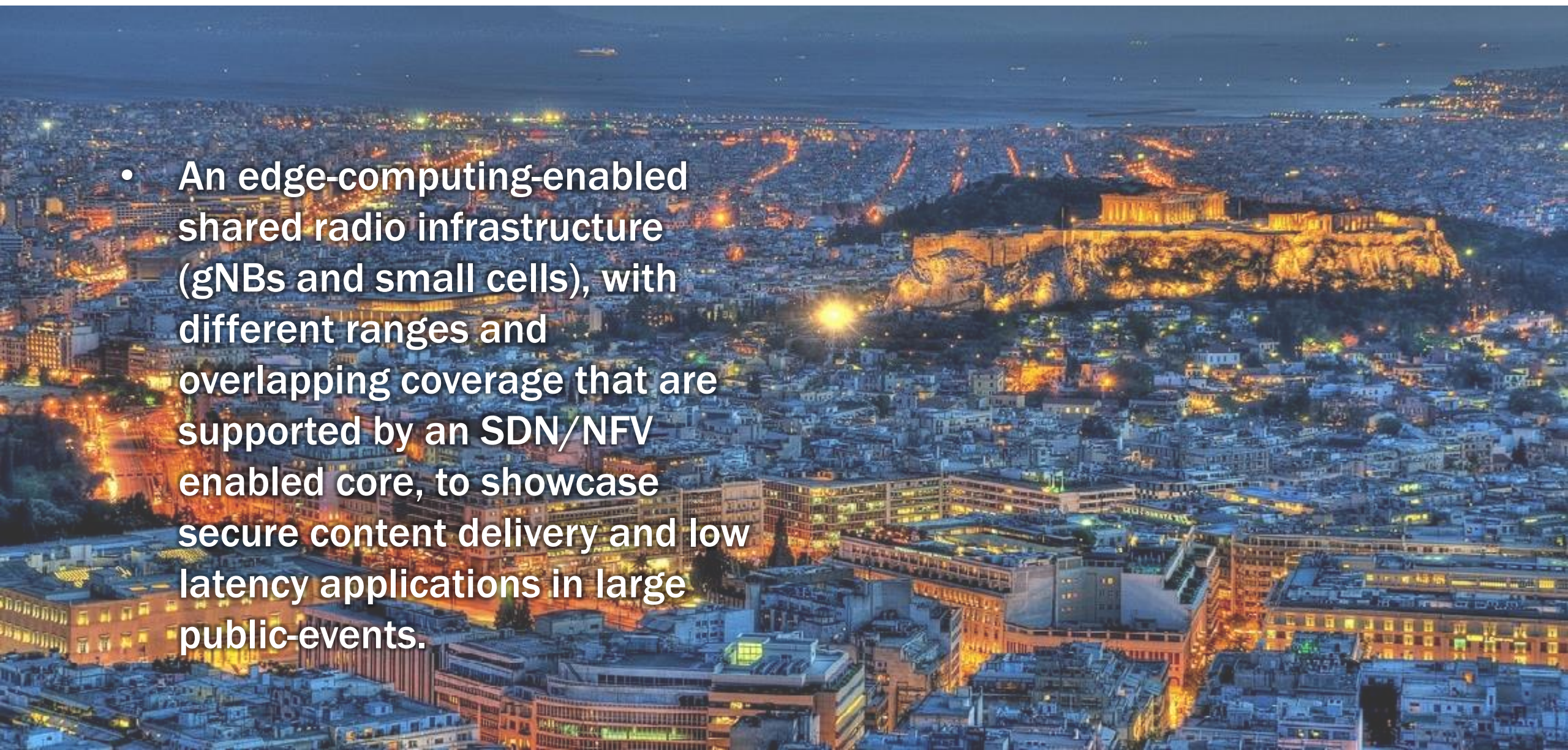
Platforms of the 5GENESIS Facility:

- The Athens Platform
- The Malaga Platform
- The Limassol Platform
- The Surrey Platform
- The Berlin Platform

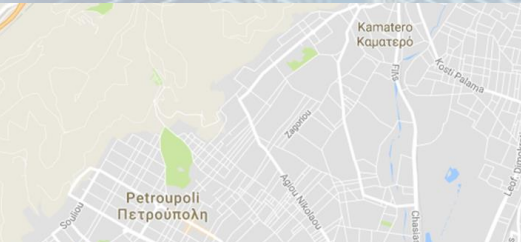


The Athens Platform

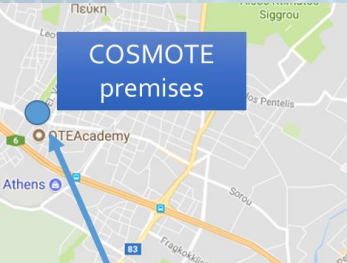
- An edge-computing-enabled shared radio infrastructure (gNBs and small cells), with different ranges and overlapping coverage that are supported by an SDN/NFV enabled core, to showcase secure content delivery and low latency applications in large public-events.



The Athens Platform : NCSR Campus/Stadium of EGALEO / COSMOTE



Municipality of Egaleo Stadium

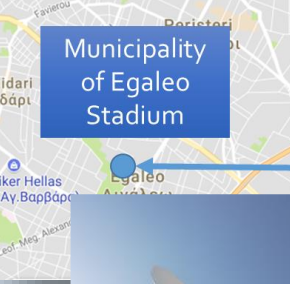
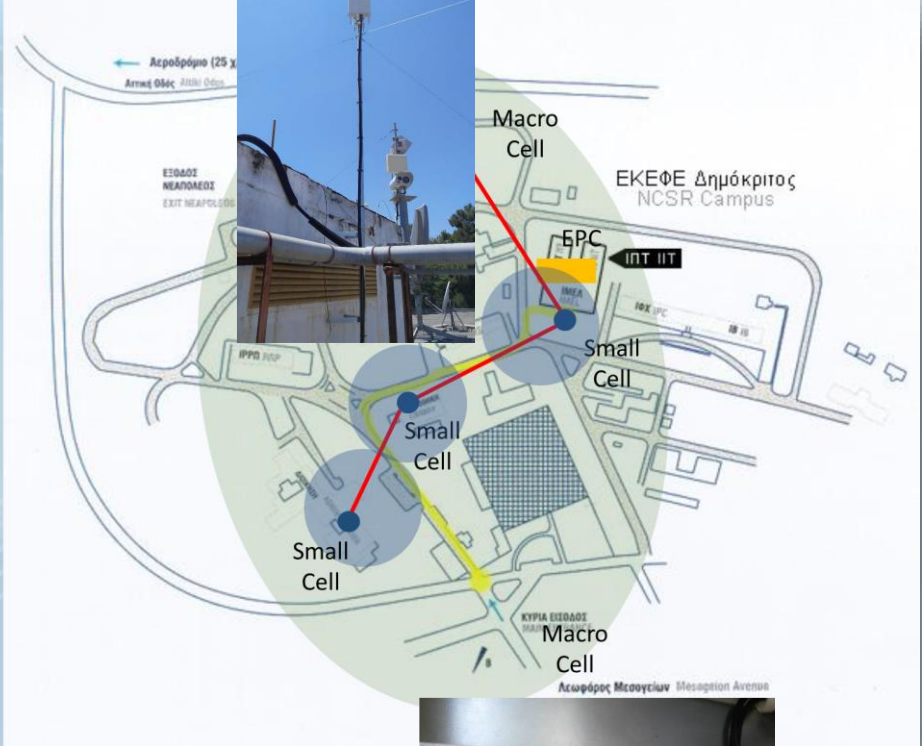


COSMOTE premises

Microwave link / VPN

NCSR "Demokritos" campus

- Fiber link
- EPC
- Small Cell
- Macro Cell



Microwave link / VPN



The Athens Platform : Use cases

Use Case 1: Big event Use case

- Content creation - demonstrate adaptive upstream content transmission
- Low-latency AR applications - edge computing infrastructure will be used to i) host part of the AR application ii) serve the associated content

Use Case 2: UAV Use Case – “Eye in the sky” applications

- Control the drone over a low-latency 5G slice
- Transmit HD and 4K real-time video to the ground control station

Use Case 3: Security-as-a-Service (SecaaS) at the edge

- Intrusion Detection System VNF (vIDS) configured to be off-path to avoid introduction of latency due to processing
- Firewall VNF (vFW) configured to be in-line to perform actions on the passing traffic

The Athens Platform : research topics

- 1. Multi-tenancy and end-to-end slicing in small cell infrastructures**
- 2. Interoperability between NFV and MEC management domains, under a common coordination**
- 3. Multi-site NFV/MEC orchestration**
- 4. Optimisation of virtualisation and functional split in 5G small cell infrastructures; integration of 5G NR**

The Athens Platform : KPIs

KPI1 : Coverage

the use of multi-tenant small cells greatly improves coverage and capacity density for indoor underserved areas and crowded events – using an infrastructure which can be provided by the venue owner and can be fully sliced and shared among many tenants.

KPI2 : Latency

perceived latency is significantly decreased through edge processing and caching.

KPI3 : Data rate

the gain due to the upgrade of the radio front-end to 5G NR, compared with LTE, will be measured and assessed. Furthermore, edge processing significantly relieves the backhaul links, since portion of the user traffic is processed/re-routed locally. This will contribute to avoid backhaul congestion

KPI4: Service creation time

significant reduction of edge services is to be expected, due to the automation achieved by the cloud-enabled small cell management framework (CESCM).

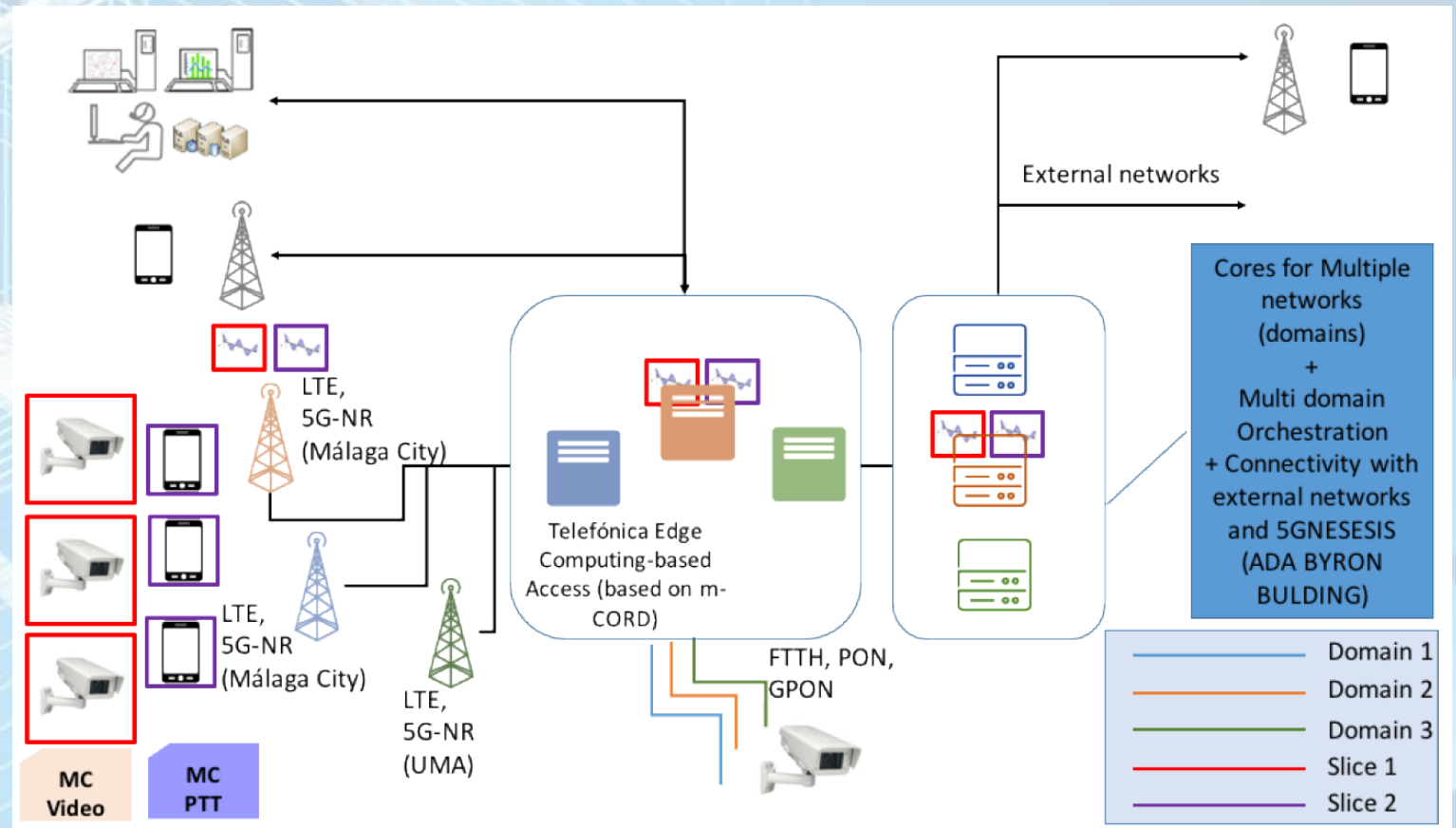
The Malaga Platform

- Automated orchestration and management of different network slices over multiple domains, on top of the 5G NR and fully virtualized core network to showcase mission critical services in the lab and in outdoor deployments.



The Malaga Platform : Overview

- The platform will be used to validate 5G PPP KPIs for 3GPP **Mission Critical Services (MCS)**48 and **combines LTE, 5G NR and MEC** with orchestration solutions to offer slices-based E2E connectivity.
- extension of the current 4G/5G platform at UMA used in the European projects FLEX, Fed4Fire, Fed4Fire+, Q4Health, and TRIANGLE



The Malaga Platform : Use Cases

- To create a trial area for evaluation of MCS tools over LTE/5G for Police department. With further extensions, this platform will improve the coverage, availability and quality of the Police media to increase the security of citizens during periodic large-scale events in the city (at least 3 yearly events with more than 50,000 attendees per day)
- To provide a permanent E2E facility to be used by the business environment in the Málaga ecosystem verticals like Public safety, eHealth, Media and Entertainment and Smart Cities
- To create a first 5G trial network that contribute to convert Málaga in one of the first 5G cities in Spain

The Malaga Platform : research topics

- **Aggregation of licensed and unlicensed spectrum** with different radio technologies, including licensed and unlicensed spectrum with LTE, 5G NR and WiFi.
- Integration of **edge computing** to reduce latency;
- **Orchestration of VNFs to support slices for MCS**
- **Real multi-domain orchestration**
- Increasing capacity, performance and security of MCS

The Malaga Platform : KPIs

Capacity:

the aggregation of licensed and unlicensed spectrum with some method evolved from LWIP, including 5G NR will increase the density of users, the peak data rate per user and the global traffic in the area

Latency:

latency at IP level for MCS will be demonstrated in the lab and in the field using edge computing solutions and slicing to prioritize traffic

Speed:

the rest of KPIs will be demonstrated in the context of several mobility scenarios (from stationary to high speed)

Availability:

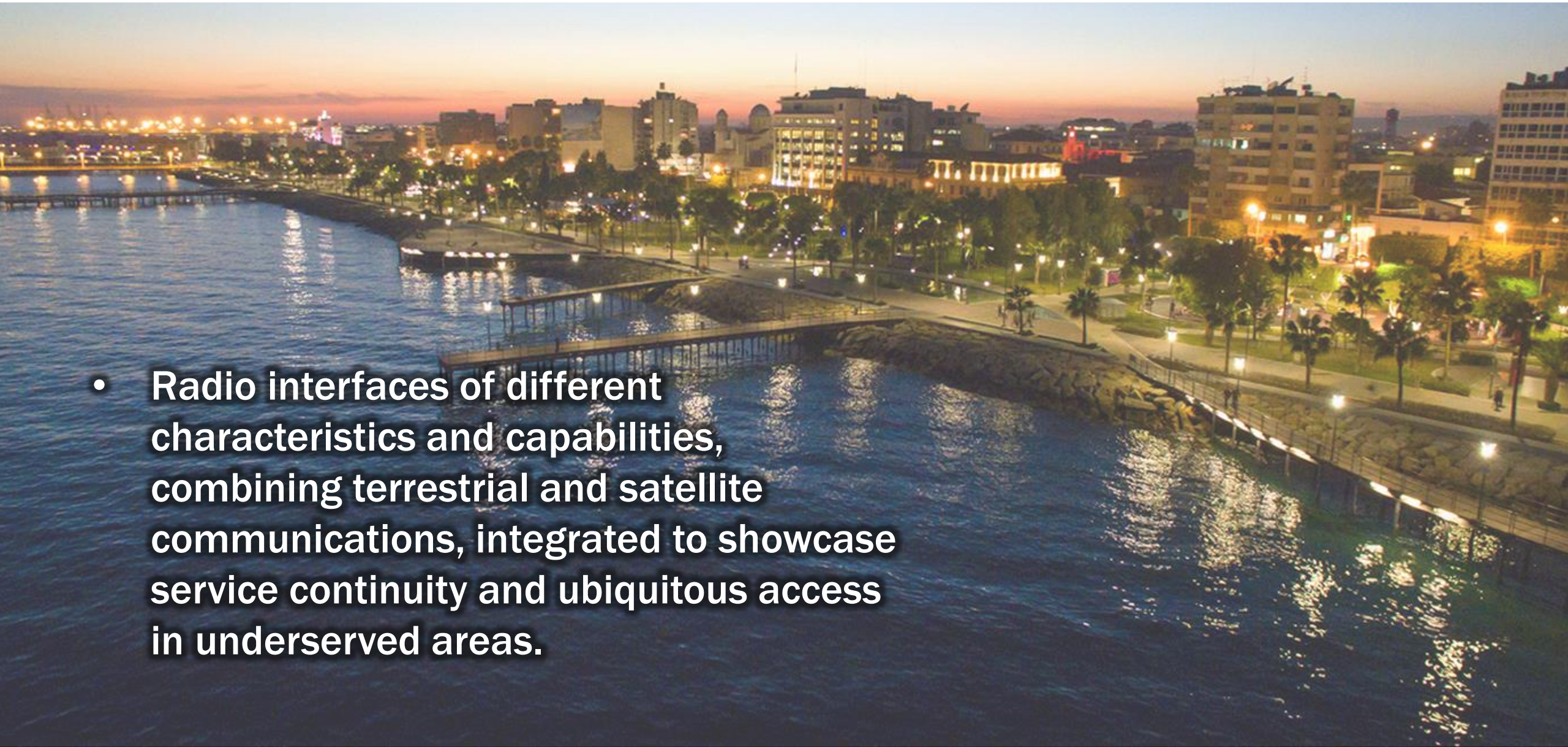
the provision of multiple connectivity with the aggregation (LTE, 5G NR and WiFi) will increase availability of the network connection

Service creation time and management cost:

the automated orchestration of VNFs and slicing will reduce the time to create, to deploy and to setup services, and will also contribute to the reduction of management cost

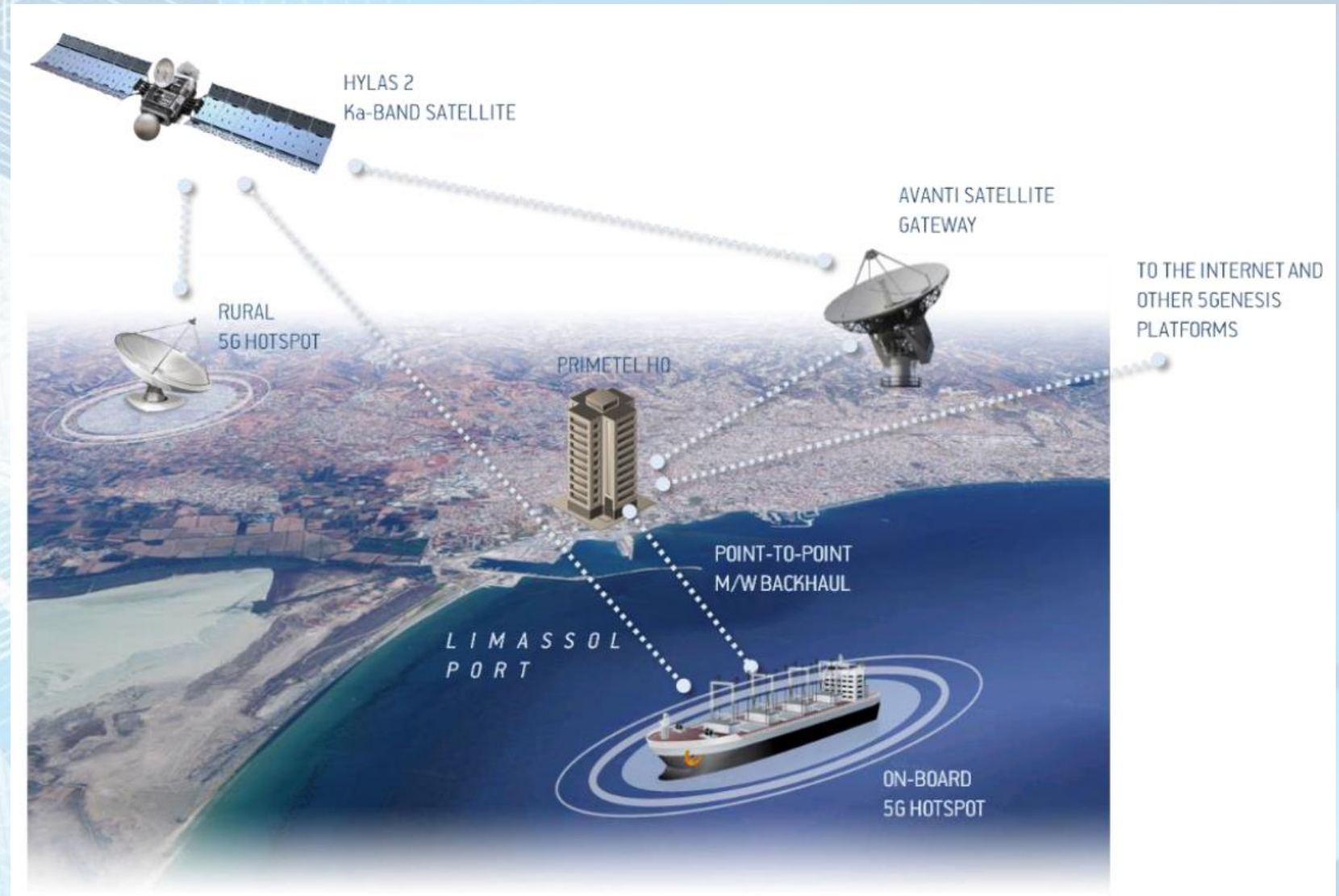
The Limassol Platform

- **Radio interfaces of different characteristics and capabilities, combining terrestrial and satellite communications, integrated to showcase service continuity and ubiquitous access in underserved areas.**



The Limassol Platform : Overview

- Limassol 5G platform will integrate several infrastructures in the city of Limassol, Cyprus, in order to form an interoperable multi-radio facility, **combining terrestrial and satellite communications** with the ultimate aim of efficiently extending 5G coverage to underserved areas



The Limassol Platform : Use cases

5G maritime communications:

Validation of the “5G hotspot” on the vessel (tanker), served by a hybrid satellite/terrestrial backhaul and evaluating local and remote real-time multimedia communication, as well as sensor network interconnection. Candidate users: Shipping companies (passenger and cargo ships), yacht owners, oil rig holders etc.

5G capacity-on-demand in rural/underserved areas:

Ad-hoc deployment of a “5G hotspot” in areas not (adequately) covered by the existing cellular network infrastructure. Scenarios will include capacity boost for a flash crowd event, and/or the dynamic provision of network slices for multimedia services for large-scale events in rural/underserved areas. Candidate users: Event organisers, local authorities, first responders, hotel owners, broadcasters (next-generation Satellite News Gathering)

The Limassol Platform : research topics

- **Integration of satellite communications with NFV/SDN software networks**
- **Interoperability between link aggregation/WAN optimisation functions and 5G NG core functions**
- **Adaptation of MEC operations and signaling for satellite networks**
- **Slicing over hybrid satellite/terrestrial networks**

The Limassol Platform : KPIs

Coverage:

almost ubiquitous coverage is expected thanks to the use of the satcom component.

Latency:

the virtualised data plane components locally deployed in the remote network are meant to significantly alleviate the high satellite latency.

Reliability:

the multi-radio aggregation, powered by SDN and NFV, will help to eliminate the effect of network outages by rapidly switching to failover links.

Data rate:

the multi-radio aggregation, powered by SDN and NFV for multipath delivery, will combine the high data rate of 5G backhails with Ka-band satcom in order to deliver data rates much higher than the ones currently experienced in maritime/rural access scenarios.

Capacity:

the impact of the use of efficient multicast services over the satellite link to offload high data rate traffic from cellular unicast services to devices

The Surrey Platform

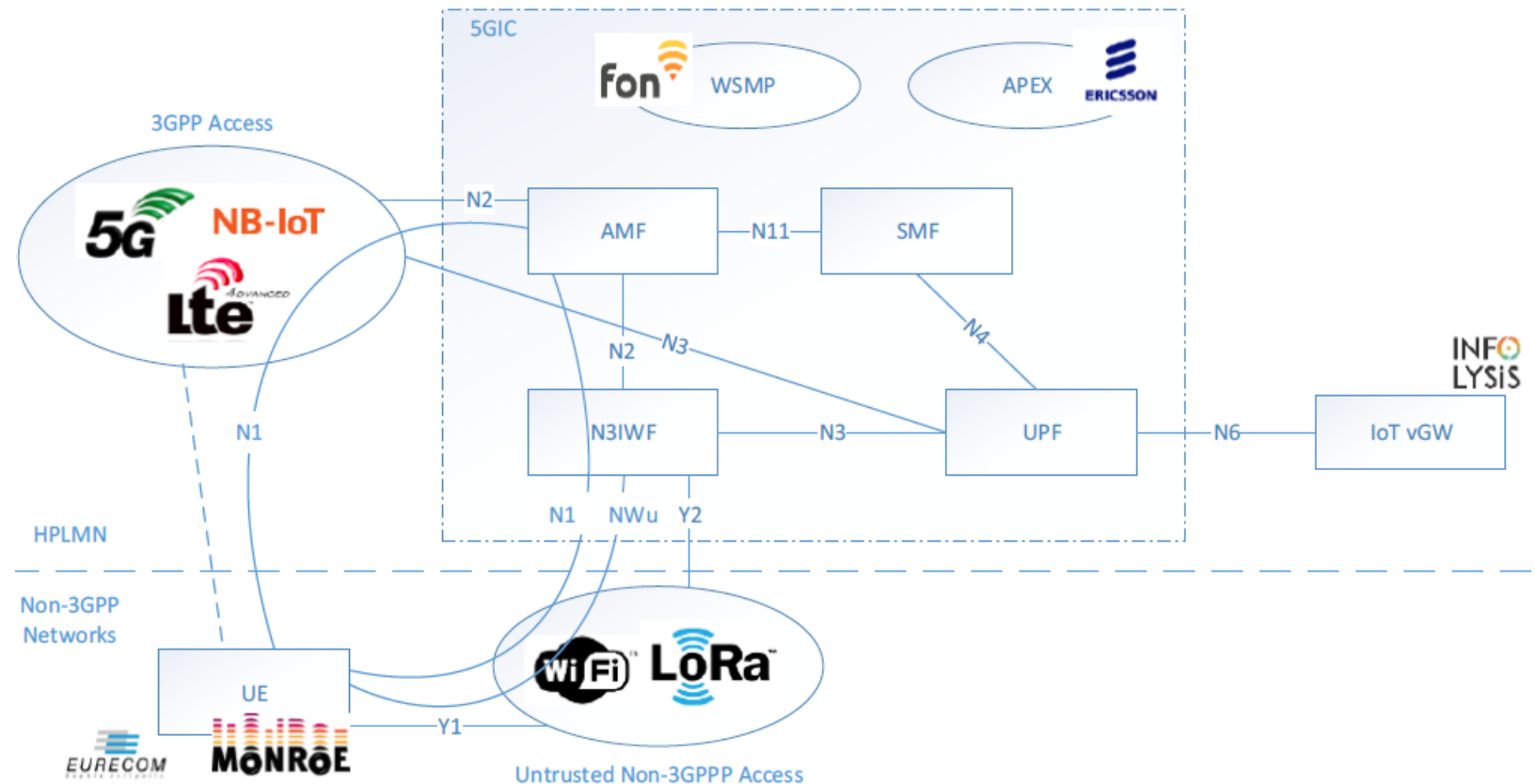
- Multiple radio access technologies that can support massive Machine Type Communications (mMTC), including 5G NR and NB-IoT, combined under a flexible Radio Resource Management (RRM) and spectrum sharing platform to showcase massive IoT services.



The Surrey Platform : Surrey Sports Park

The 5GENESIS Surrey platform will comprise a heterogeneous **5G NR and IoT multi-RAT network**, to be deployed in the Surrey Sports Park (SSP) area, which will include:

- A **5G NR network**, with a number of gNBs providing coverage over the SSP area.
- A set of open **5G UEs** to demonstrate enhanced RRM and spectrum management procedures.
- An LTE-A network
- The **NB-IoT and LoRA networks**, to support mMTC traffic.
- The **FON WiFi network**, to be tightly coupled with the 5G NR deployment.



The Surrey Platform : Use Cases

deploy multiple RATs and combine them in a novel scalable and flexible RRM framework, in order to fulfil the requirements of mMTC and eMBB traffic:

- **providing an immersive experience** with pervasive connectivity during ad-hoc and large scale cometogethers (sport events, concerts, special events).
- **massive IoT network slice combined with a dynamic eMBB slice** will facilitate the use of information provided by the audience terminals and by a variety of sensors deployed in the venue
- **real-time monitoring of athletes' healthcare information** during a sports event

The Surrey Platform : research vectors

- **Velocity of bands (re)allocation: from month-based to minute-based,**
- **Real-time and performance-based RAT selection and spectrum sharing,**
- **New user plane and control plane for a multi-service access stratum,**
- **Dynamic multi-spectrum access for multi-services scenarios**

The Surrey Platform : KPIs

i) coverage:

due to the vast numbers of people attending large scale outdoor events

ii) energy efficiency:

through the provision of protocols to support low processing power operation of the sensing devices

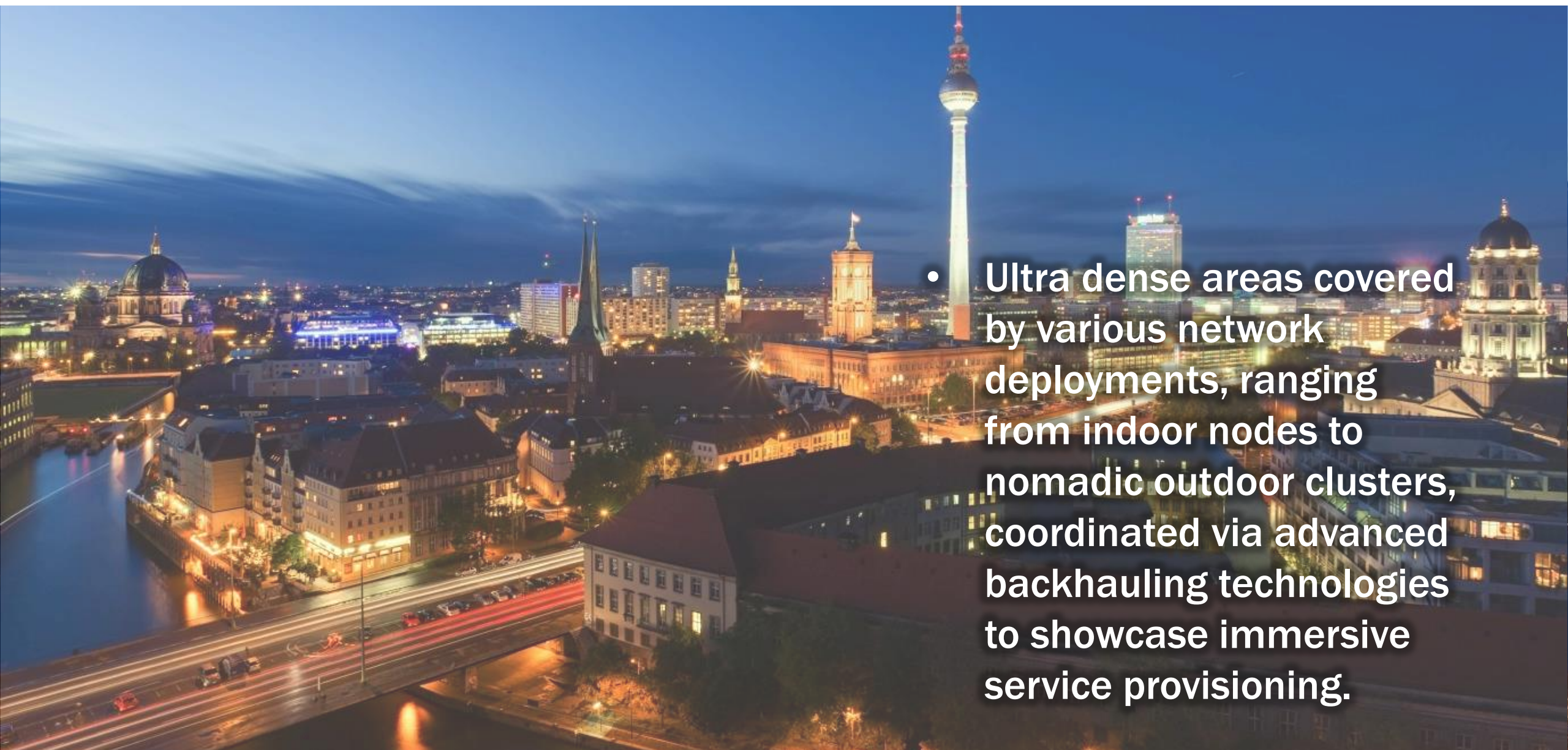
iii) low latency:

through efficient RRM and resource allocation and through developments on both the terminal and the core network side, to ensure that the collection, analysis and processing of the multimedia content will be made in real-time, and

iv) reliability:

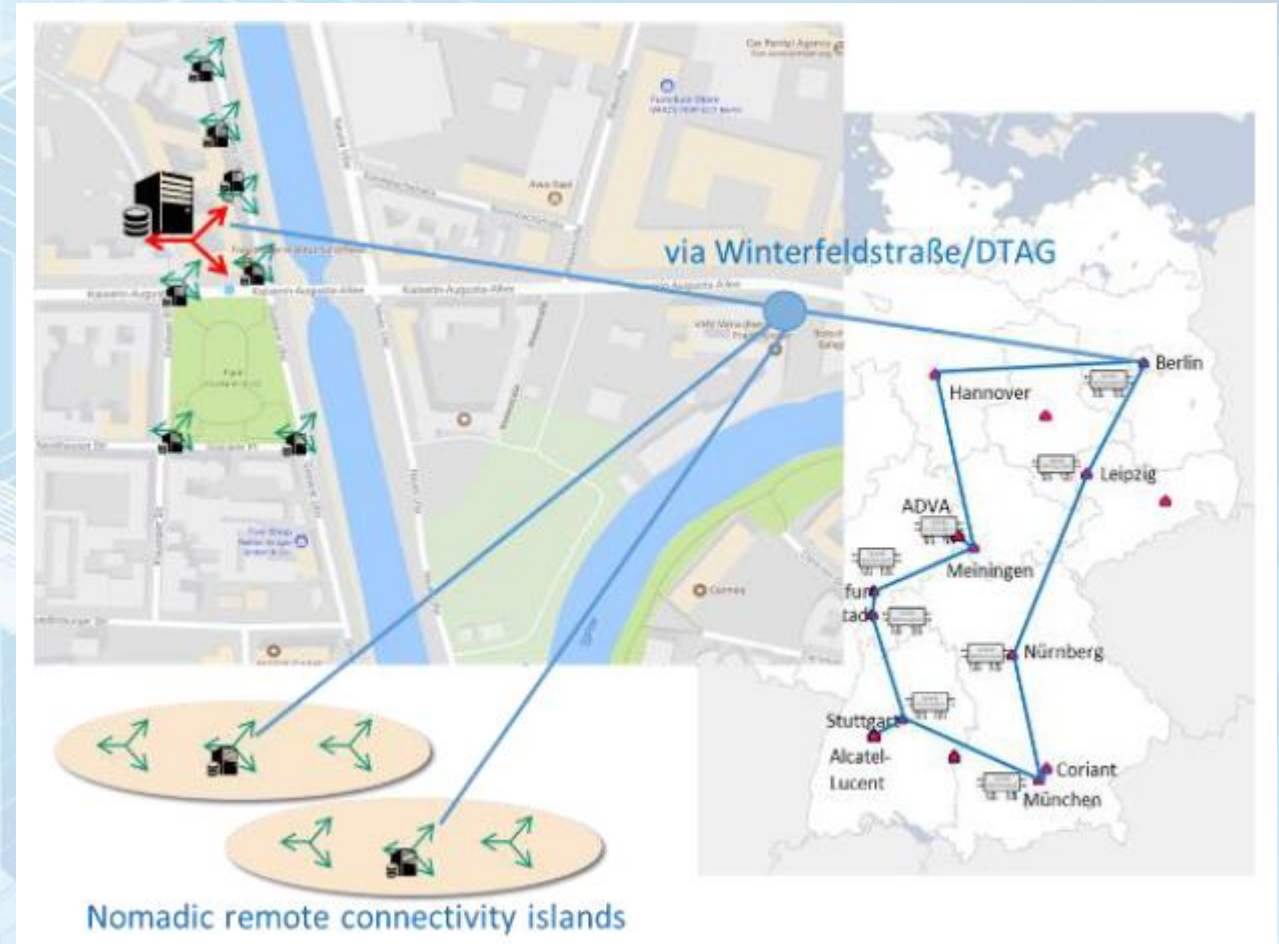
especially in the case of healthcare information monitoring

The Berlin Platform

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- Ultra dense areas covered by various network deployments, ranging from indoor nodes to nomadic outdoor clusters, coordinated via advanced backhauling technologies to showcase immersive service provisioning.

The Berlin Platform : Overview

- The Berlin platform will provide an integrated **5G E2E infrastructure that can be used by R&D projects, industry, and SMEs in order to assess 5G PPP KPIs for their business-specific needs**, or to evaluate the interoperability and performance of new 5G prototypes. The Berlin platform will enhance and integrate existing testbeds, each providing distinct multi technology features, also extending the outdoor coverage of the existing Berlin testbed to include major parts of the Berlin city center, thus allowing for large-scale, dense-city environment use case evaluations.



The Berlin Platform : Use Case

“Dense Urban Use Case” realizing 360deg VR streaming

- Demonstrate to future European R&D projects, industry, and SMEs that the Berlin platform can be used for 5G evaluations **involving a large number of public users**
- The chosen 360deg VR application is of interest to the city of Berlin and local (media) business, which is likely to increase the visibility of the trial
- It allows evaluating the performance of the platform and the 5G PPP KPIs for that use case in a realistic urban environment during a large-scale event.

The Berlin Platform : research topics

- **Mobile edge computing to reduce latency**
- **VNFs to support slicing**
- **Reduction of service creation time**
- **Link aggregation across multiple RATs to increase reliability**

The Berlin Platform : KPIs

User density:

number of users provided service to during a large-scale event

Reliability:

multi-RAT and link aggregation w.r.t. the 5G mmWAVE backhauling used in deploying the nomadic remote island will be assessed in terms of network outages

Service Creation Time:

the capability of the 5G Packet Core will be assessed in terms of latency involved in dynamically deploying computational capabilities at the edge / virtualised network functions.

Data rate:

upon availability of the 5G NR, e.g., provided via the MONROE SDRs, provided data rates will be assessed.



**THANK
YOU!**

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