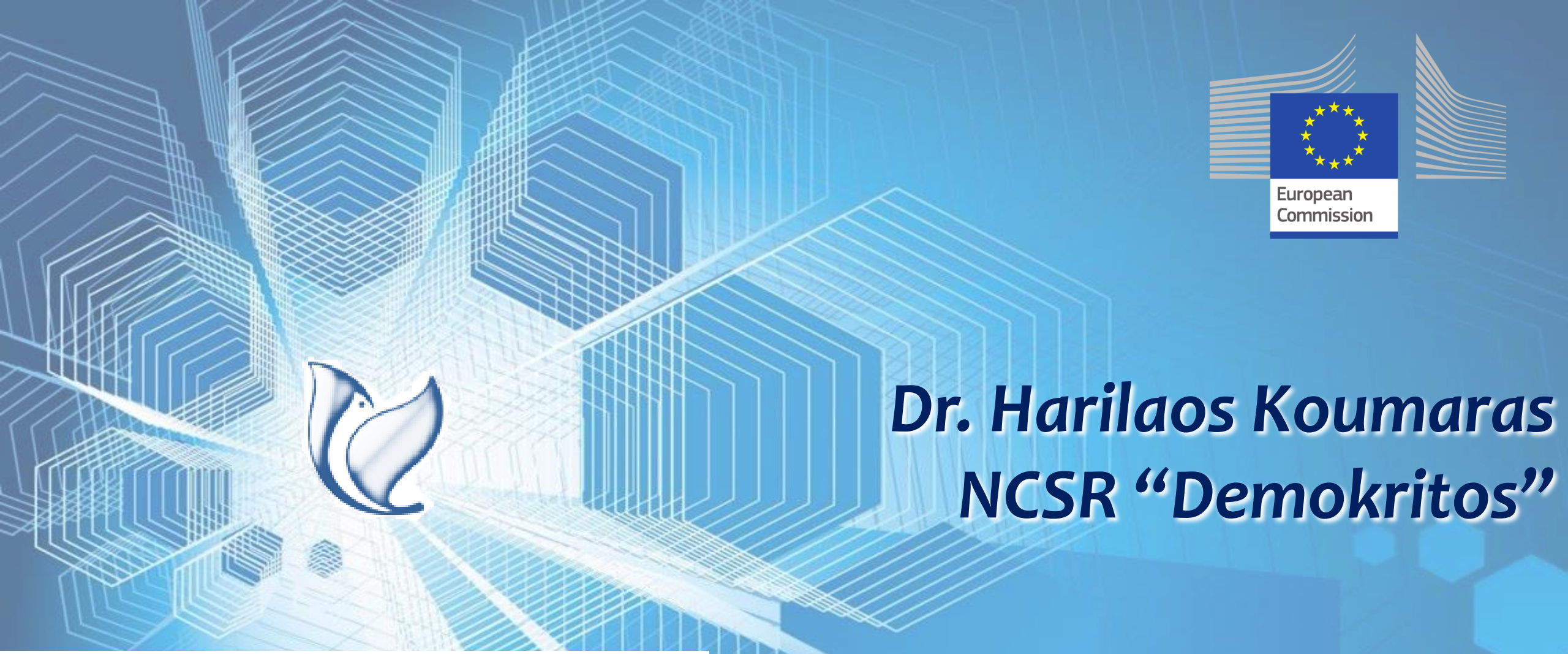

Dr. Harilaos Koumaras
NCSR "Demokritos"

5GENESIS

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

5G Pan-European Ecosystem

5Genesis

5G-VINNI

5G EVE

5GENESIS: ICT-17-2018: 5G End-to-end Facility

Project Coordinator:

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- Dr. Andreas Gladisch, Vice President, VTI, TI-Net, Deutsche Telekom
- Dr. Michael Fitch, Chief Researcher in Wireless, British Telecommunications plc
- Dr. Dan Warren, Head of Samsung Research UK
- Dr. Emilio Calvanese Strinati, Director of Smart Devices/CEA-LETI
- Prof. Sergio Barbarossa, Professor at Sapienza University of Rome
- Prof. Mehrdad Dianati, Professor at University of Warwick

5GENESIS Platforms

5GENESIS will define a 5G experimentation blueprint, that will serve as a common architectural reference. The platforms will emerge as the evolution of existing testbeds, already owned and operated by the 5GENESIS partners, suitable for large-scale field experimentation.

Platforms of the 5GENESIS Facility:

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

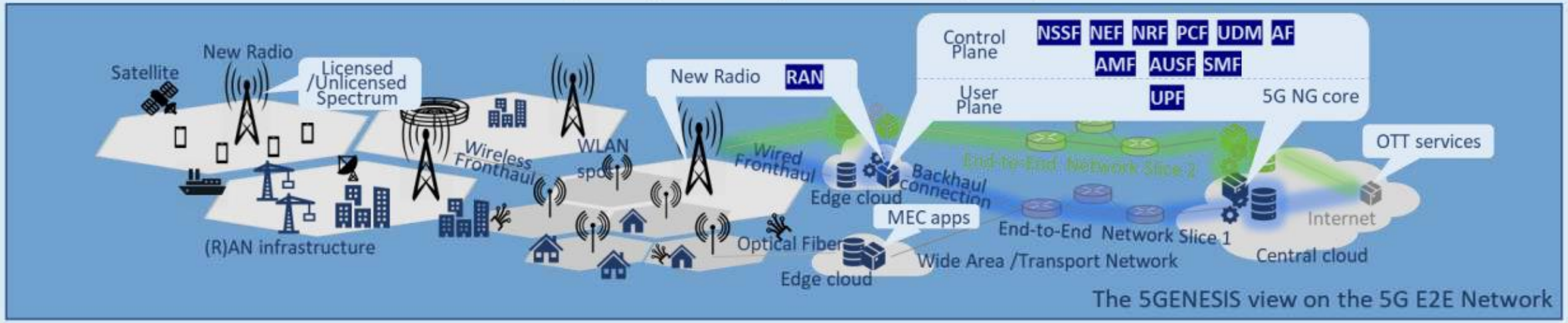
Blueprint of 5GENESIS facility

Early versions of the 5G Standard

Vast experience in 5G-PPP projects

Ownership of key testbeds around Europe

Blueprint of the 5G experimentation facility

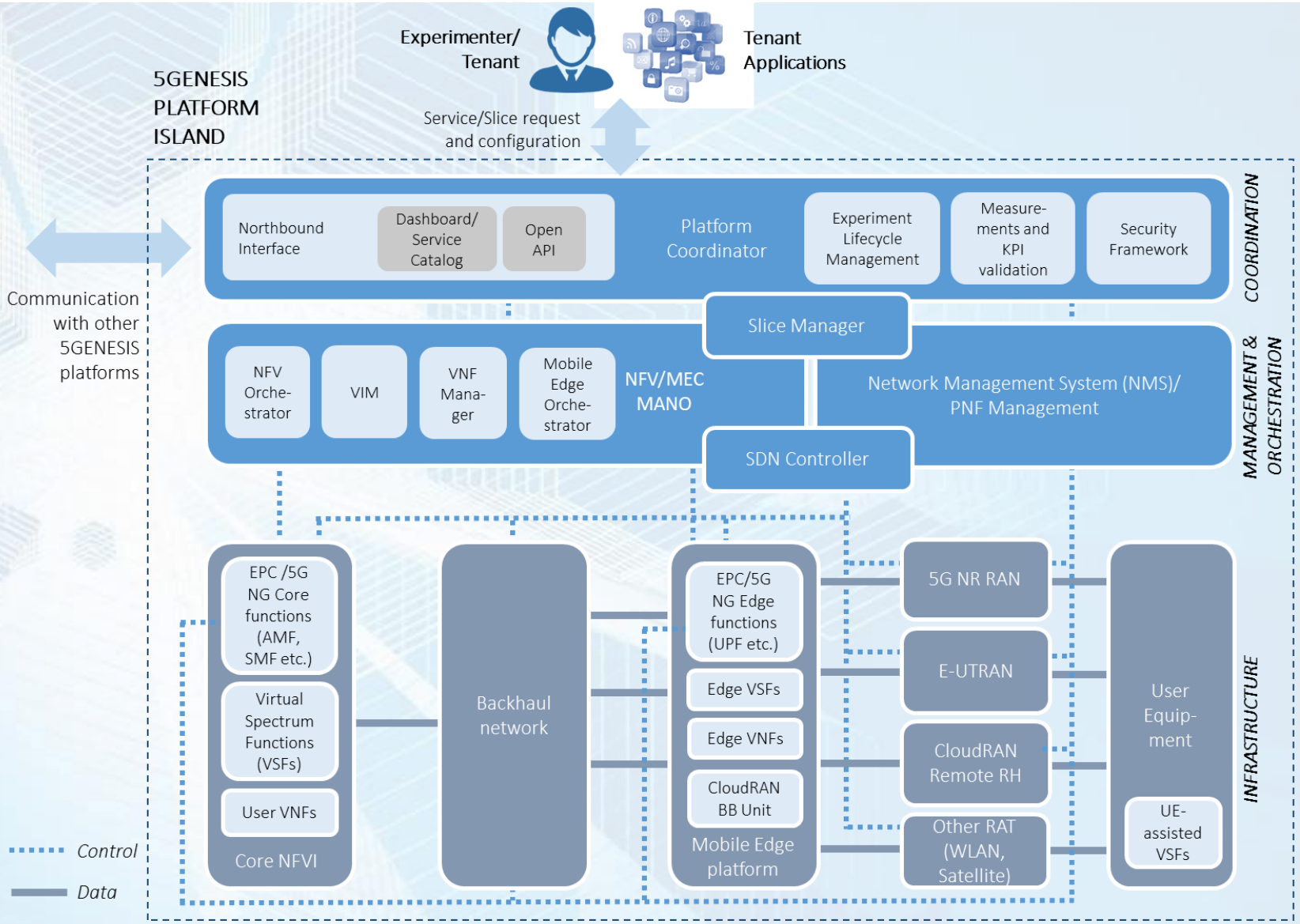


Instantiation of the 5GENESIS Facility

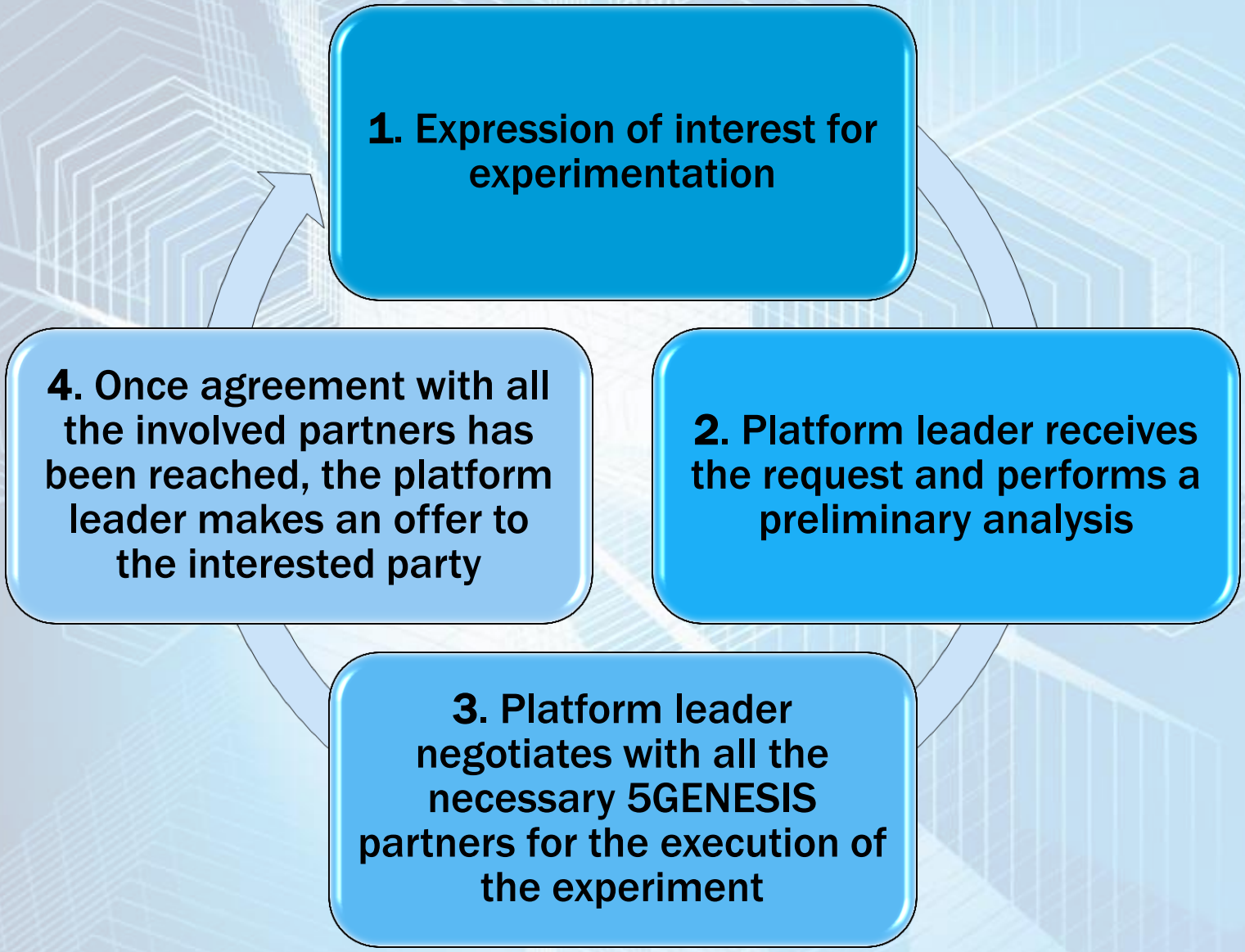
The Athens platform	The Malaga platform	The Limassol platform	The Surrey platform	The Berlin platform
5G Networking Services to be demonstrated in Egaleo City Sport Event	5G Mission Critical Services to be demonstrated in Public Safety Scenario	5G Satellite Services to be demonstrated in Cargo Vessel Route	5G Massive IoT Services to be demonstrated in Surrey Sport Event	5G Immersive Services to be demonstrated in the Festival of Lights

Thorough 5G-PPP KPIs validation in events with multiple users and release of the 5G facility as a portable demonstrator with management API

5GENESIS facility Architectural Blueprint



Engagement Process of Vertical Industries in ICT-19-2019



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5GENESIS Surrey Facility:
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Engagement Process of Vertical Industries in ICT-19-2019

Each platform owner acts as the **single point of contact** for the vertical user/experimenter, negotiating the terms of use/SLA as well as the compensation for the human and technical resources, which will be employed for the support of the experiment.

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Expectations for ICT-19 proposers

5GENESIS for ICT-19 proposers provides:

- E2E Experimental Facility
- Automation and Measurement Tools
- Support and Maintenance

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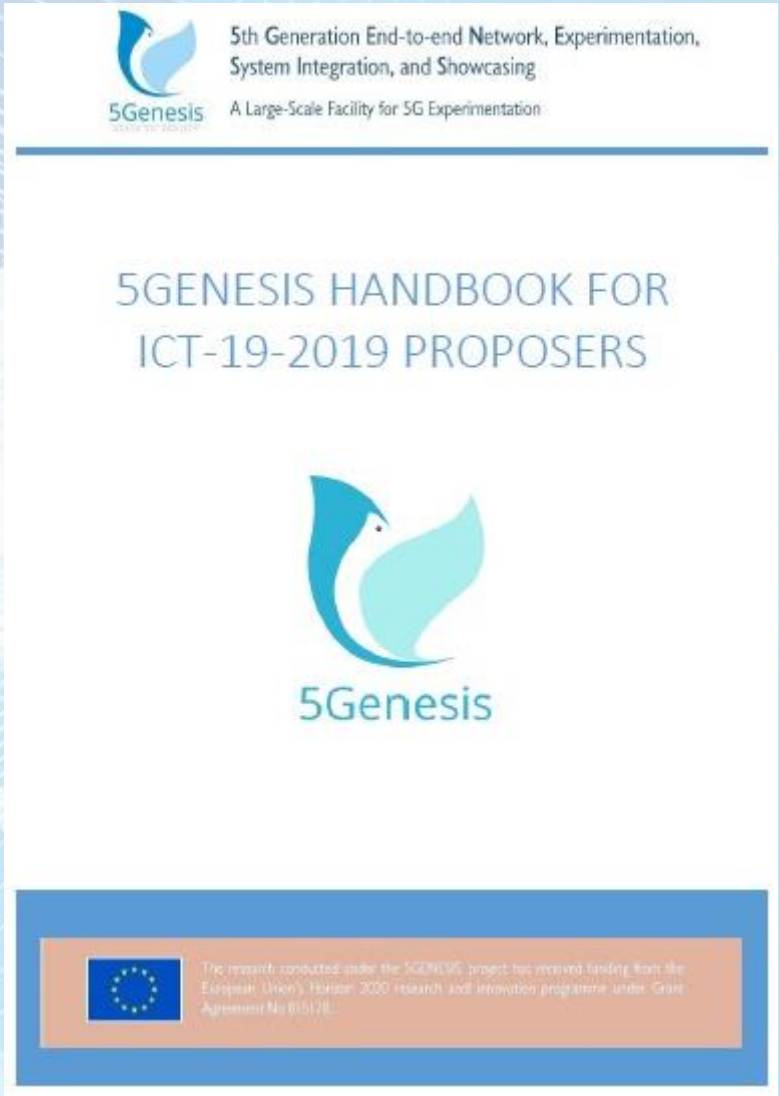

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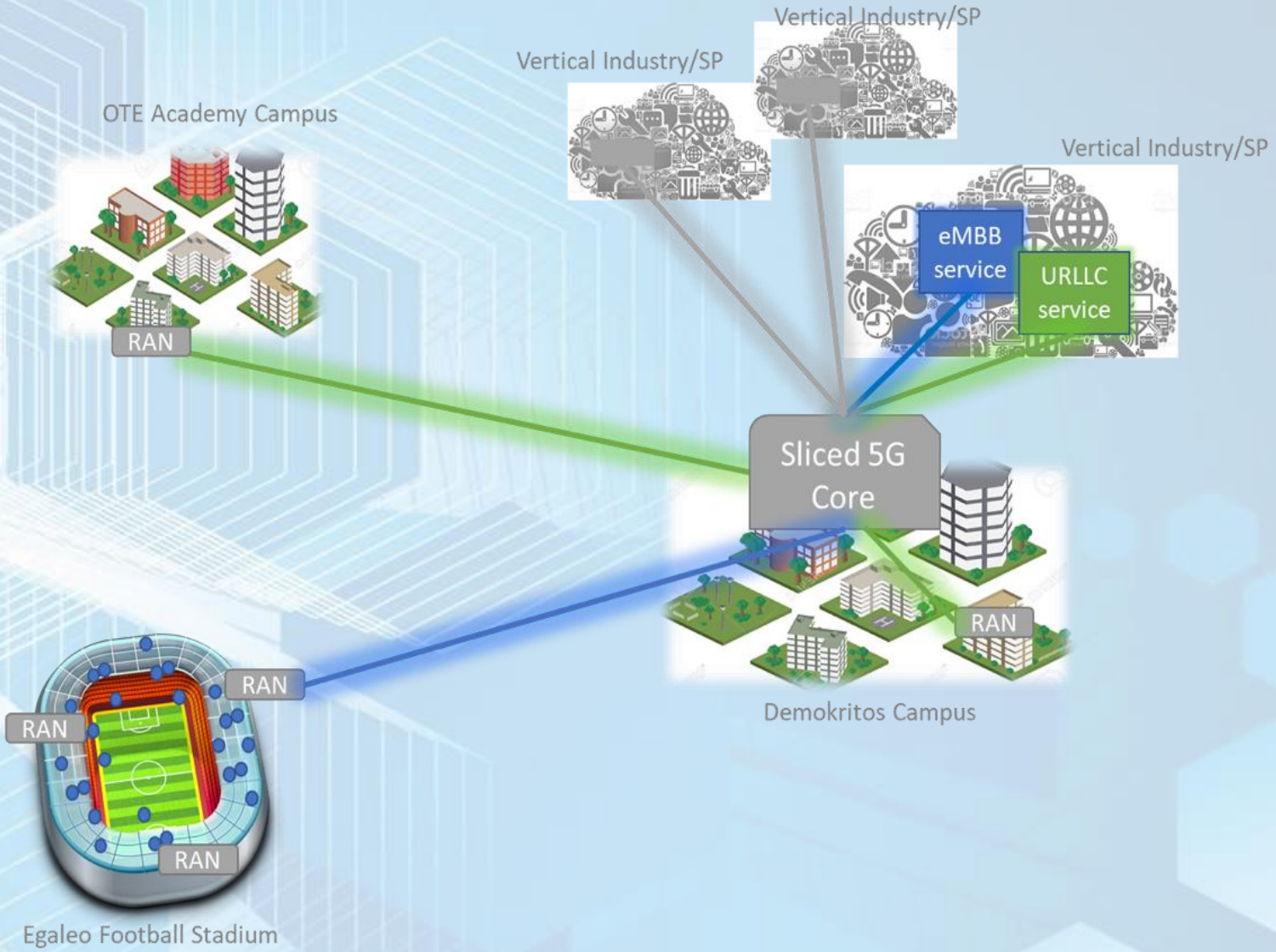
The Athens Platform

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 Overview

Three sites:

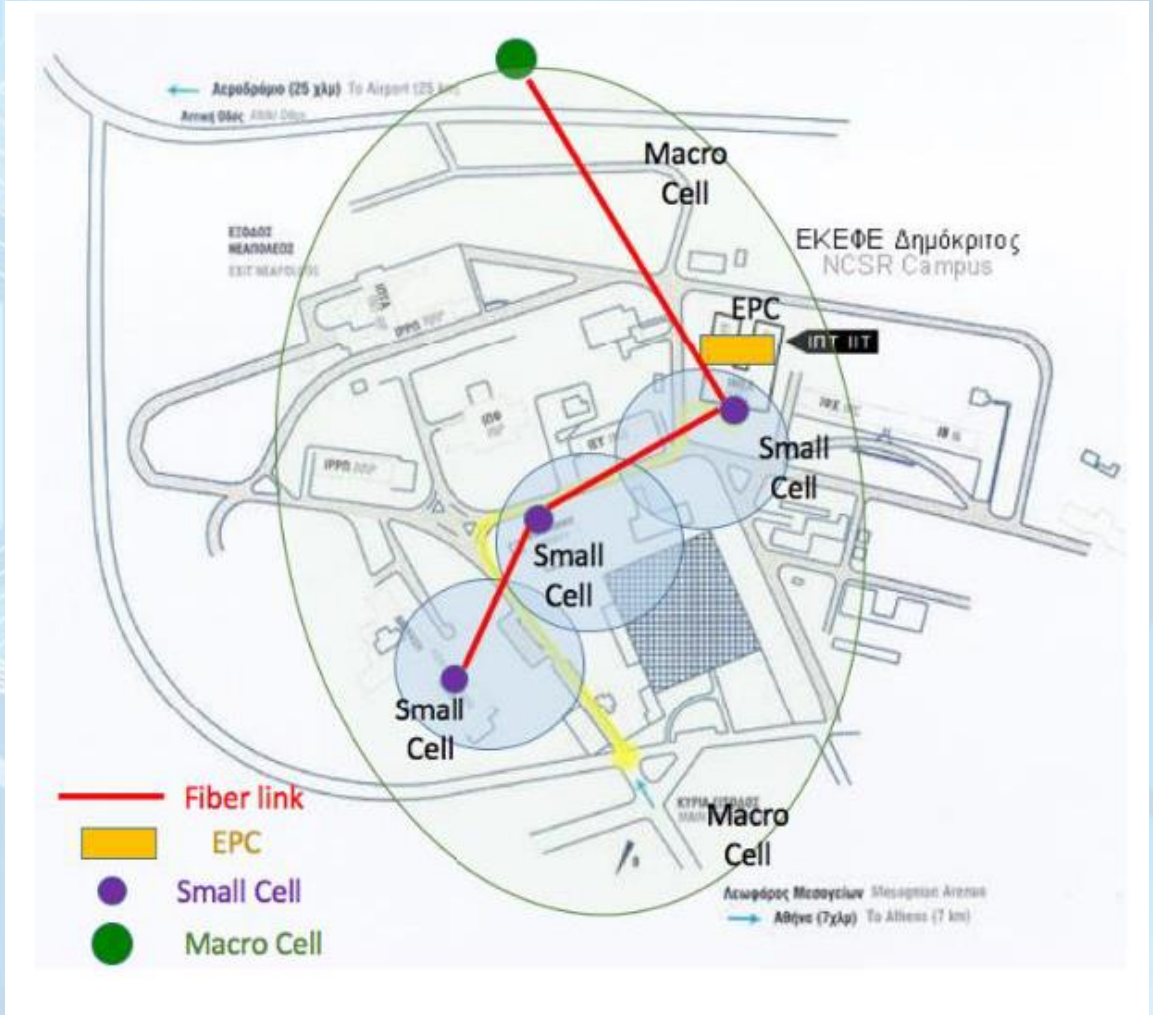
- Demokritos Campus
- COSMOTE Premises
- Egaleo Football Stadium



The Athens Platform : NCSRD Campus

The NCSRD campus:

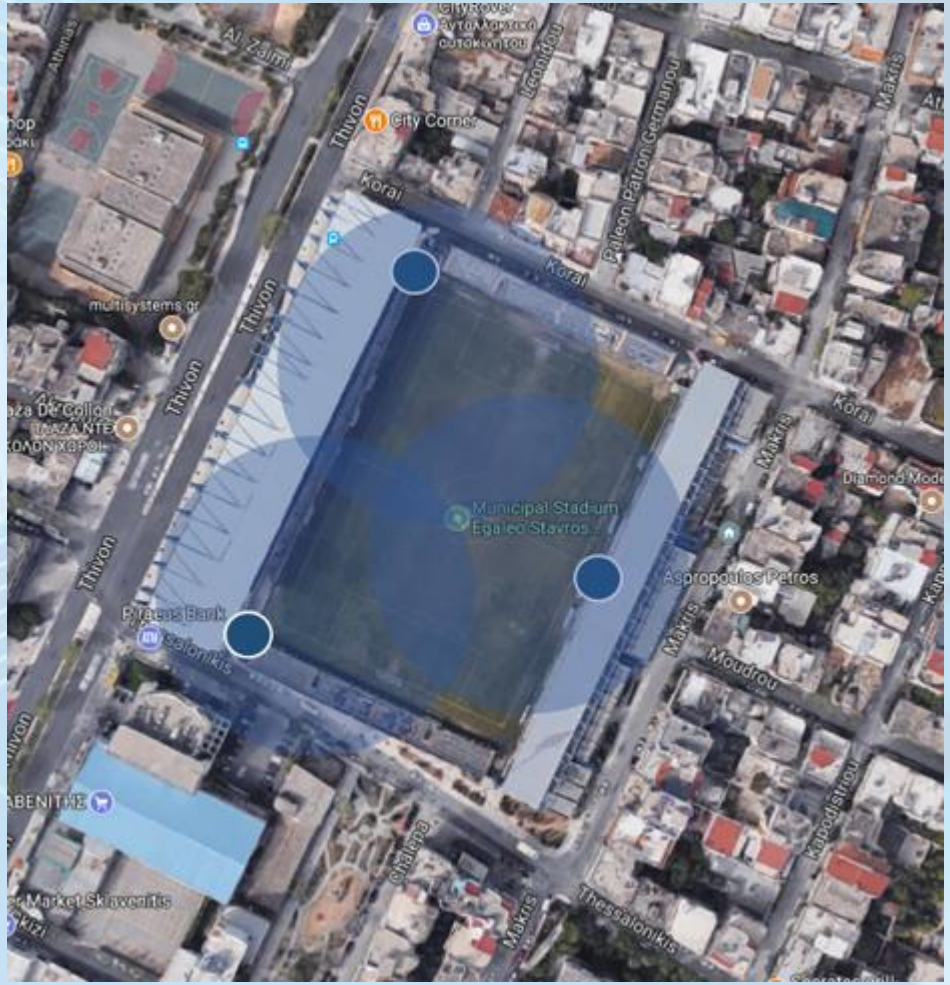
- core network
- backhaul network
- access network
- SW-defined macro - small cells
- mobile terminals
- distributed cloud deployments
- computing, storage & networking resources.



The Athens Platform : The Egaleo municipal stadium

Egaleo Municipal Stadium:

- showcasing the value of 5G in big sports and/or cultural events.
- 3 low-power virtualisation - capable cells
- multi-tenant infrastructure is owned by the stadium operator
- host edge services
- connection with the NCSRD campus via a dedicated point-to-point microwave link.



The Athens Platform : COSMOTE testbed

COMSOTE Academy Campus:

- Openstack-based cloud infrastructure (>220 CPU cores, >30 TB HDD, >340 GB RAM).
- eight NOKIA 4G/4G+/WiFi Small cells distributed in two floors
- flexible, scalable, e2e IoT platform
- broadband connection over GRNET - backhaul

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 5GNR, 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 Athens Platform : Indicative Use Cases

Big event/Media and Entertainment Use case

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

UAV Use Case – “Eye in the sky” applications

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

Security-as-a-Service (SecaaS) at the edge

- Deployment and automated configuration of security VNFs for the identification and mitigation of security incidents

The Malaga Platform

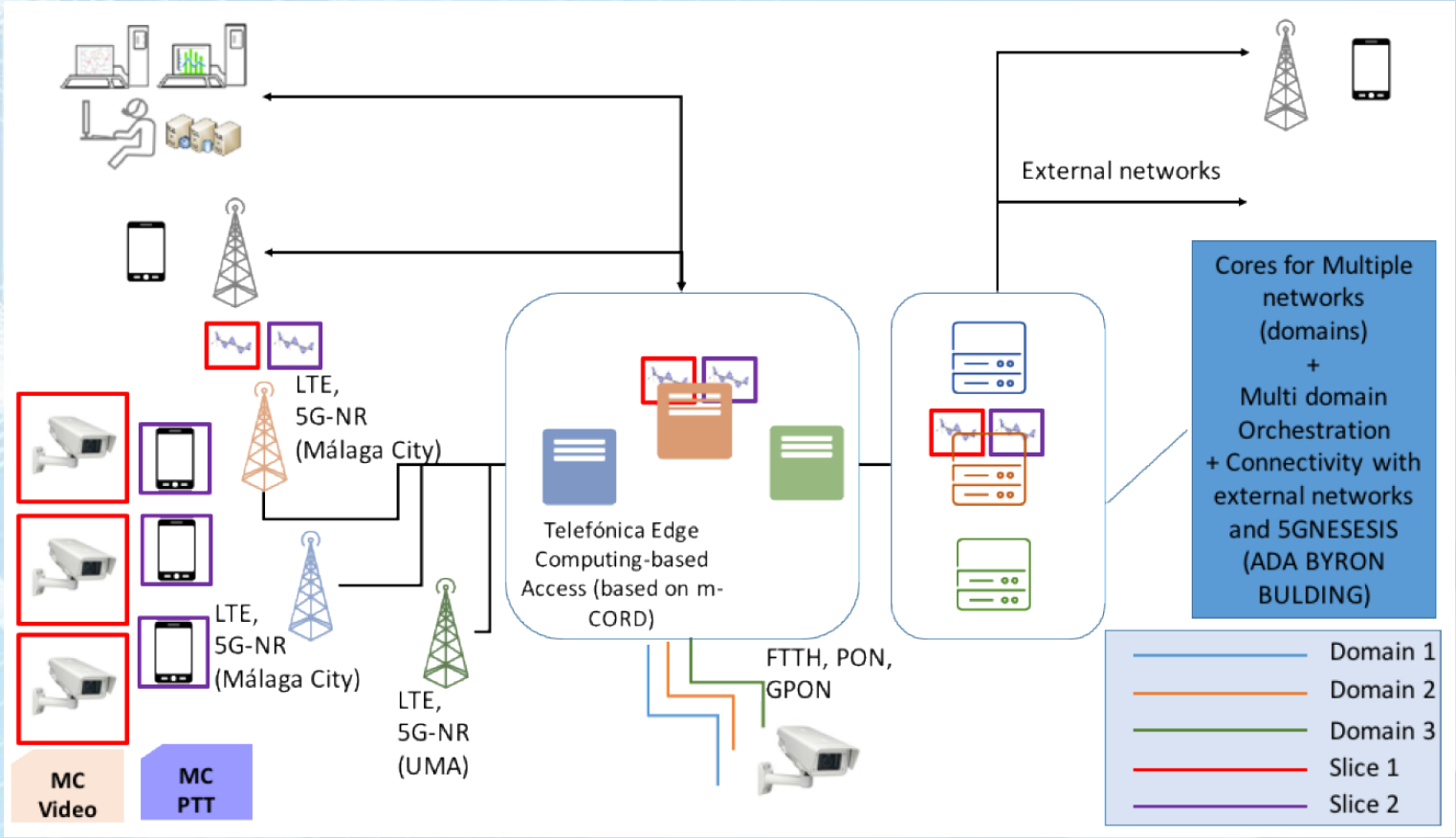
The Malaga Platform Overview

Three sites:

- Univ. of Malaga
- Telefonica Edge Computing
- Malaga City

The Malaga Platform : Overview

- The platform will be used to validate 5G PPP KPIs for 3GPP Mission Critical Services (MCS) 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 : Infrastructure and key components

1. the current indoor UMA testbed TRIANGLE
2. one LTE/5G outdoor deployment in the UMA campus
3. one LTE/5G outdoor deployment in the city center of Málaga using locations provided by the Police department
4. the Telefonica Edge computing infrastructure to be deployed in Málaga; e) the orchestration solution by ATOS from projects like 5G TANGO
5. ATH VNFs for LTE and 5G Core network
6. 5G NR access nodes provided by RUNEL
7. 5G NR UEs provided by ECM
8. the MCS software solutions by AB and NEM as the reference service.

The whole platform will be connected to other 5GNESIS platforms using Géant.

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)

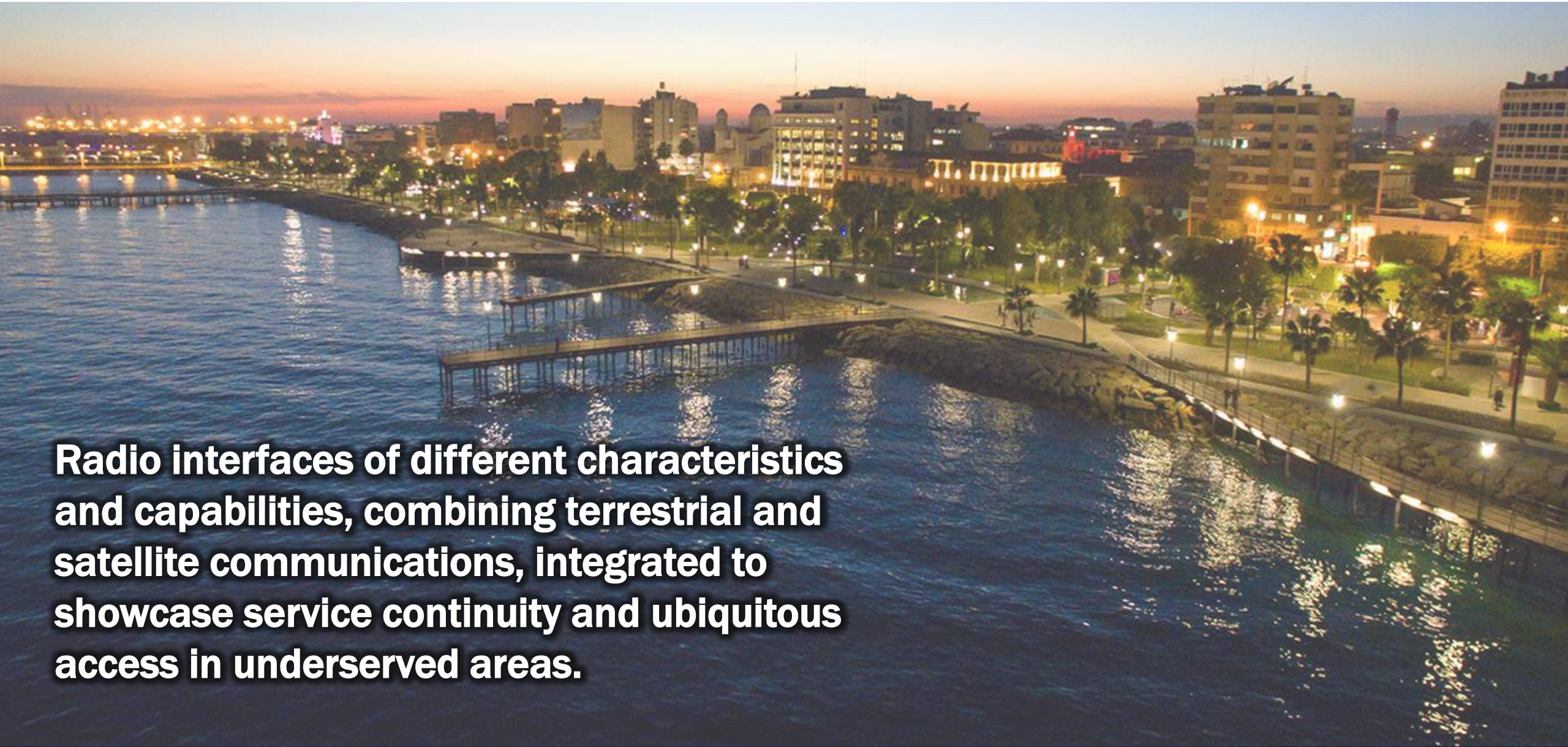
Availability:
the provision of multiple connectivity with the aggregation (LTE, 5G NR and WiFi) will increase availability of the network connection

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 Malaga Platform : Indicative Use Cases

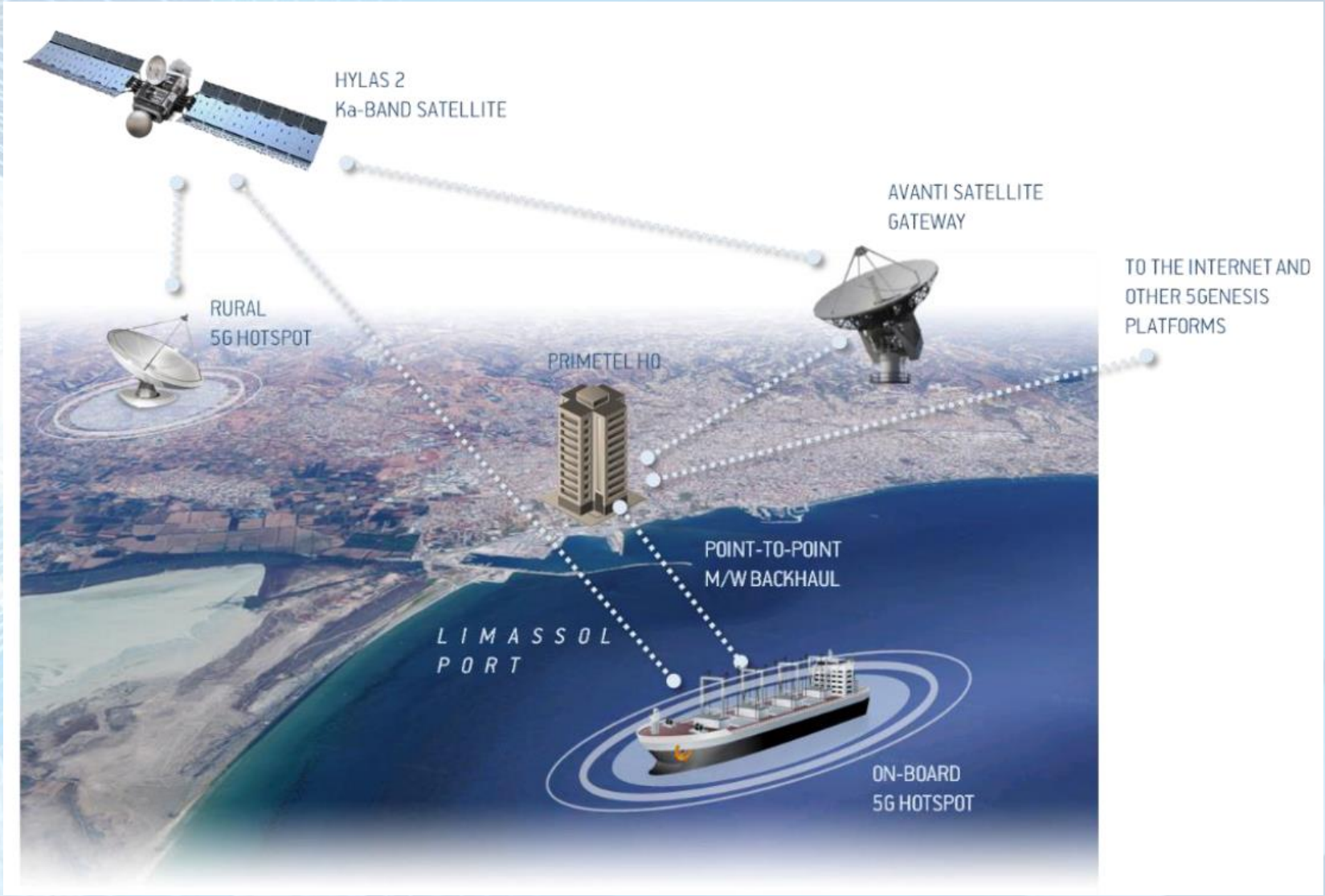
- Automotive and road transport
- Transport
- Public Safety
- Media and Entertainment
- eHealth
- Factory of the Future / Industry 4.0
- Smart Cities
- Energy
- FinTech
- Smart Buildings

The Limassol Platform



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 : Infrastructure and key components

Satellite Gateway at Makarios Earth Station, Cyprus:

- support SDN/NFV services

HYLAS 2 and HYLAS 4 satellites:

- 28 GHz bandwidth Ka-band satellite providing coverage through 66 beams across Europe and Africa
- Inter-spot beam and inter-satellite handover mobility

PLC central building and testbed:

i) hosting, in its private Data Centre, all the management components and services for the platform
ii) providing the interconnection to the Satellite Gateway and the Internet, as well as to the other 5GENESIS testbed
iii) host the microwave connection to the ship.

“MARAN HELIOS” tanker:

- For demonstrating the 5G maritime communications scenario, an on-board remote network will be installed on a cargo vessel,

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 backhauls 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 Limassol Platform : Indicative Use Cases

- Automotive and road transport
- Transport
- Maritime
- Public Safety
- Media and Entertainment
- eHealth
- Factory of the Future / Industry 4.0
- Smart Cities
- Energy
- FinTech
- Smart Buildings

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 : Infrastructure

The 5G Innovation Centre (5GIC) testbed:

- Distributed Cloud (FDC) 5G Architecture
- inter-connect with and support different RAN configurations (C-RAN, D-RAN or hybrids of both (H-RAN)), according to available transmission options

The FON 5G/WiFi Integration:

- provide the WiFi Service Management Platform (WSMP)
- provide and integrate WiFi APs in the Surrey platform

The LMI APEX and D-MIMs:

- provide self Adaptive Policy EXecution (APEX)
- APEX instances run in the cluster controller for each cluster
- APEX instances in each cluster use Distributed Managed Information Models (D-MIMs)
- APEX and D-MIM components integrated in the platform coordination/MANO planes and in particular into the Slice Management functionality

The SRL and KAU MONROE testbed:

- transnational open platform for independent, large-scale, E2E measurements and experimentation in commercial MBB networks
- conduct a wide range of experiments, including bandwidth demanding video applications

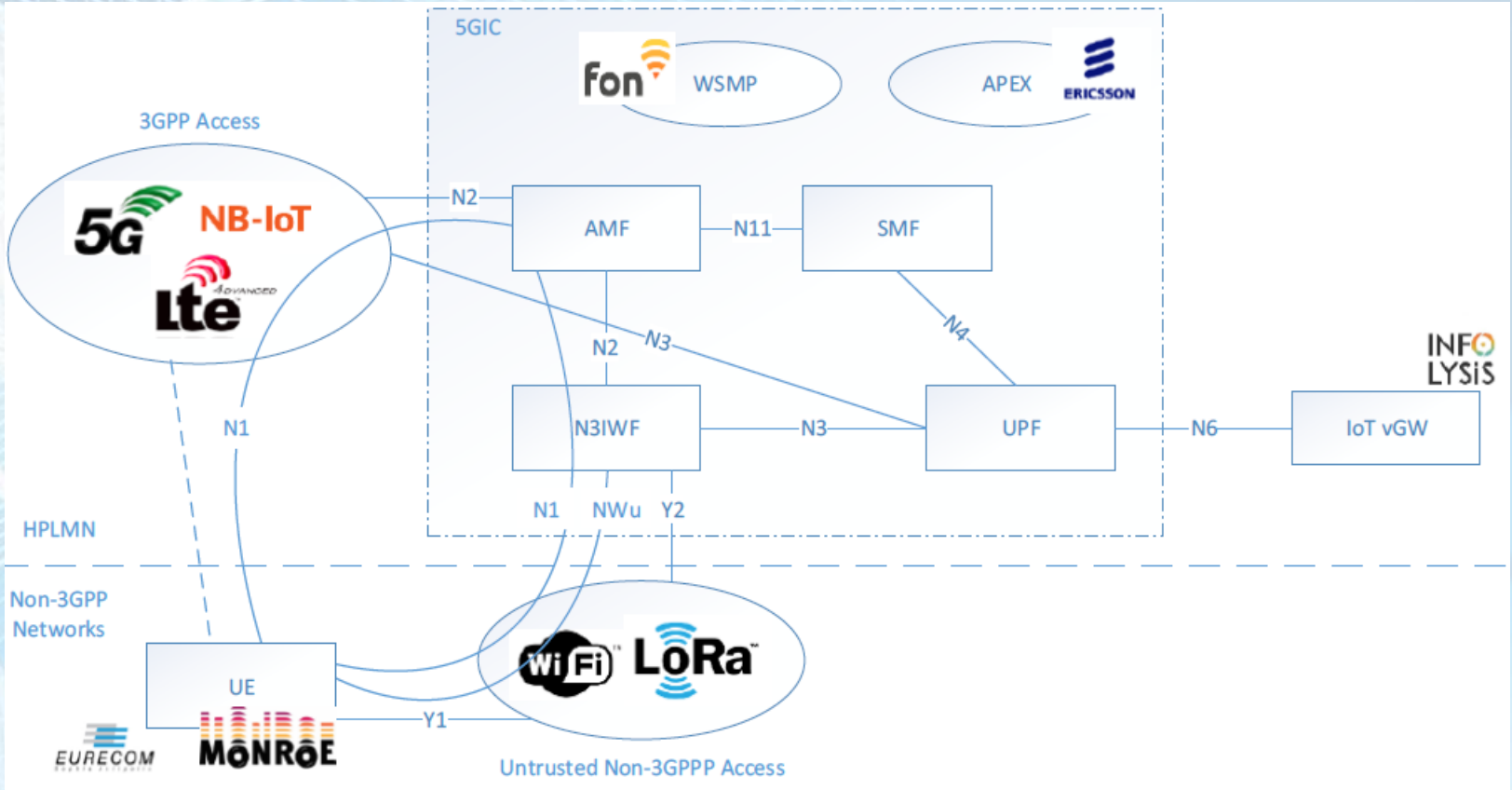
The INF IoT vGW:

- proxy VNFs for popular IoT data protocols
- IoT vGW acts as an aggregator, exposing data and interfaces in a homogeneous way

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 : 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 Surrey Platform : Indicative Use Cases

- IoT
- eMBB, URLLC and massive MTC
- Connected & Autonomous Transport
- Public Safety
- Media and Entertainment
- eHealth
- Factory of the Future / Industry 4.0
- Smart Cities
- Satellite Backhauling

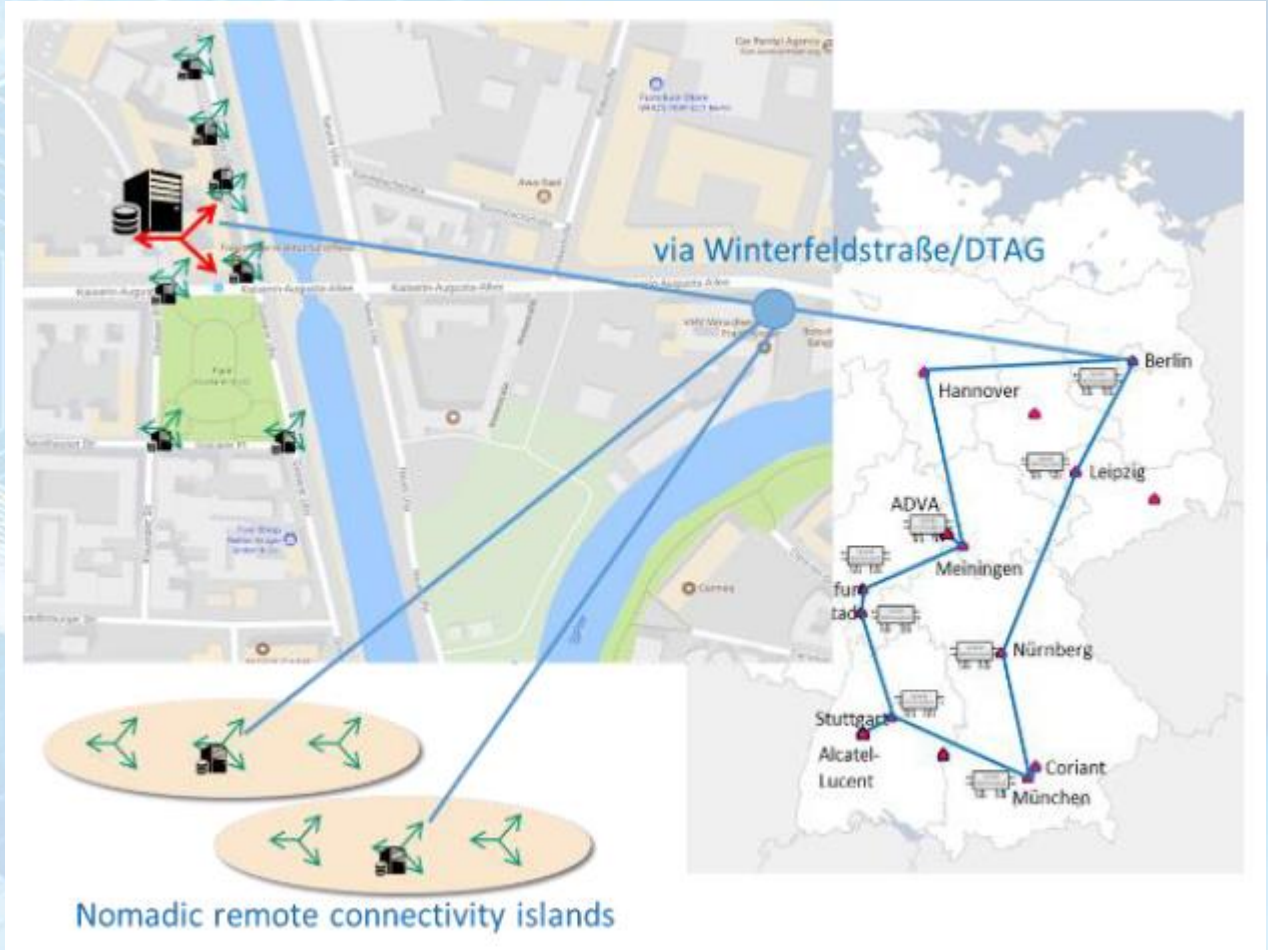
The Berlin Platform

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 asses 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 : Infrastructure and key components

The Fraunhofer FOKUS 5G Berlin testbed:

- E2E trial infrastructure, integrating HW and SW prototypes, providing customised, sliced network services to verticals
- connectivity over 5G/4G LTE/NB-IoT/WLAN and LoRA access networks
- edge-central functionality split depending on the use case scenario and on the available backhaul
- Synchronised edge-central network support for different levels of privacy

The IHP testbed:

- dedicated characterisation of mmWave components
- long term measurements in different outdoor environments
- real time implementation of mmWave links with a data rate of up to 4 Gbps

The Humboldt-University (HU) testbed:

- nomadic, remote island of the FOKUS 5G Berlin testbed
- include 5G mmWave backhauling,
- edge-node computation facilities,
- non-3GPP RAT, and 700 and 3500 MHz 5G RAT.

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

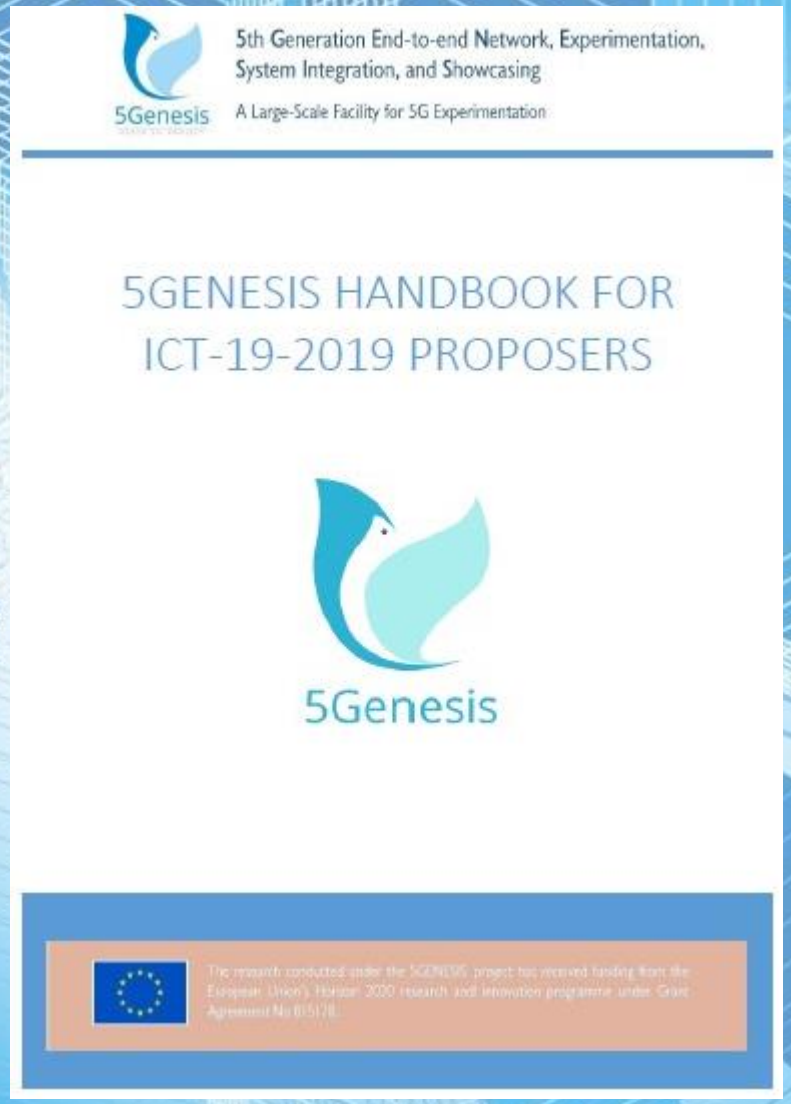
Service Creation Time:
the capability of the 5G Packet Core will be assessed in terms of latency involved in dynamically deploying computational capabilities at the edge / virtualised network functions.

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

The Berlin Platform : Indicative Use Cases

- Smart Cities
- Automotive and road transport
- Public Safety
- Media and Entertainment
- eHealth
- Factory of the Future / Industry 4.0
- Parking deck and surrounding Fraunhofer FOKUS premises.

Thank you !



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