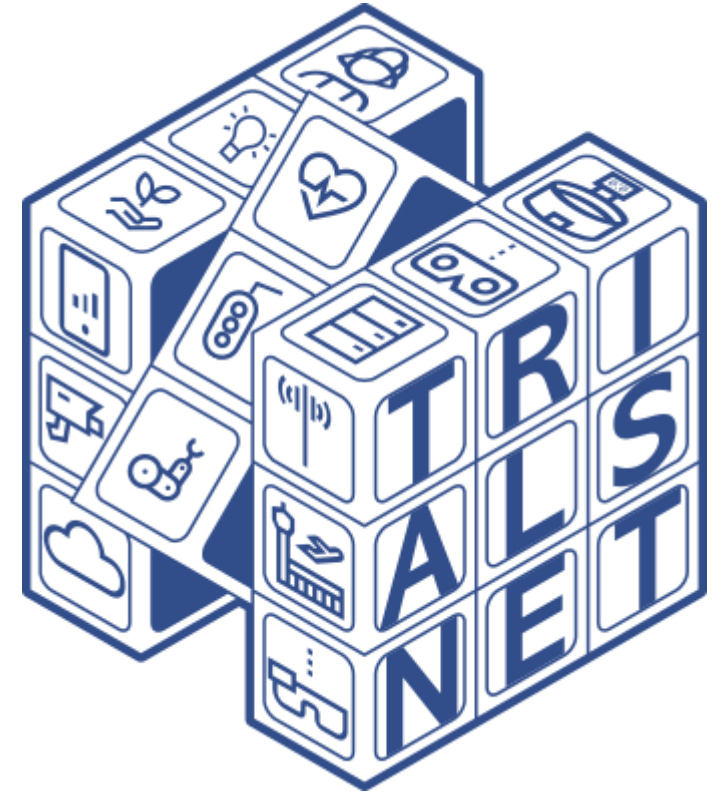# TrialsNet Second Open Call Webinar
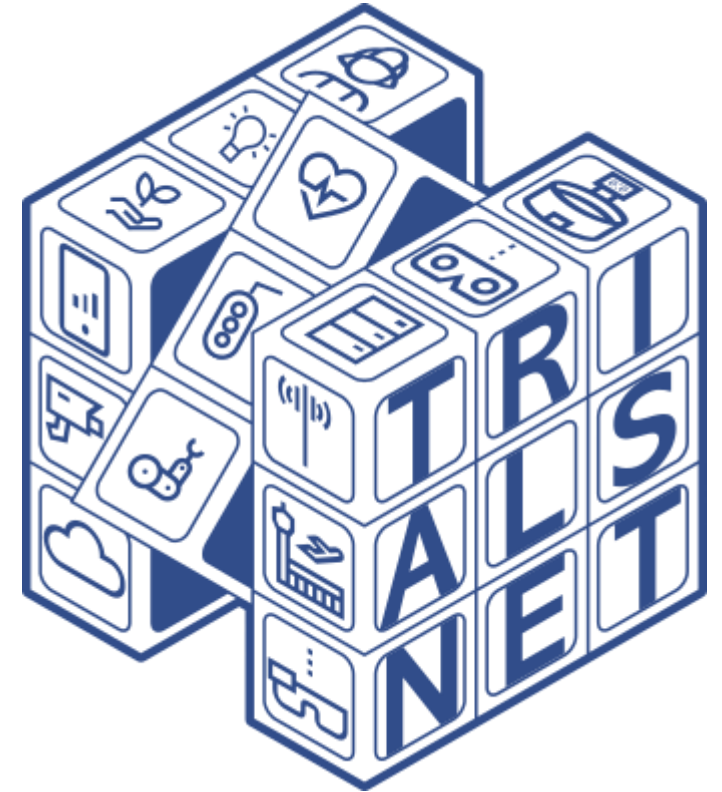
Sites description and KPIs/KVIs framework

Alessandro Trogolo (TIM)
TrialsNet Open Call Team
2023-12-05

TrialsNet Second Open Call Webinar

Agenda

Alessandro Trogolo (TIM)
2023-12-05

Agenda

- 11:00-11:05: Introduction and brief overview of TrialsNet
- 11:05-11:55: TrialsNet clusters (infrastructures and functionalities)
    - Italian cluster (Turin and Pisa)
    - Spanish cluster (Madrid)
    - Romanian cluster (Iasi/Bucharest)
    - Belgian experimental facilities (Antwerp)
    - Greek cluster (Athens)
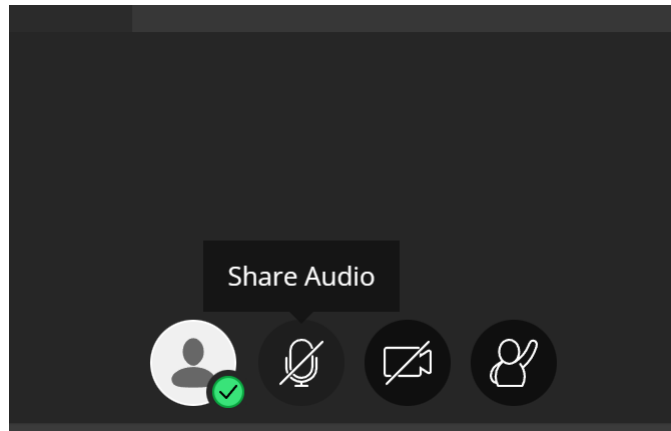- 11:55-12:05: KPIs and KVIs framework
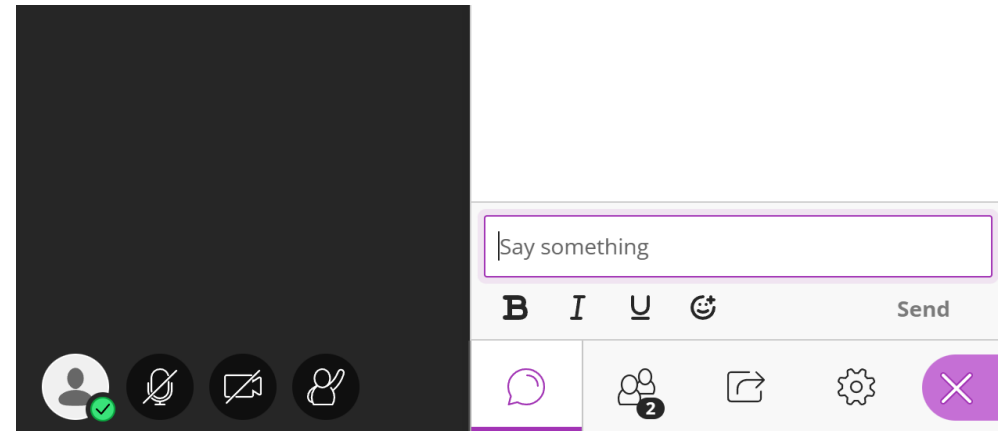- 12:05-12:30: Q&A

TrialsNet
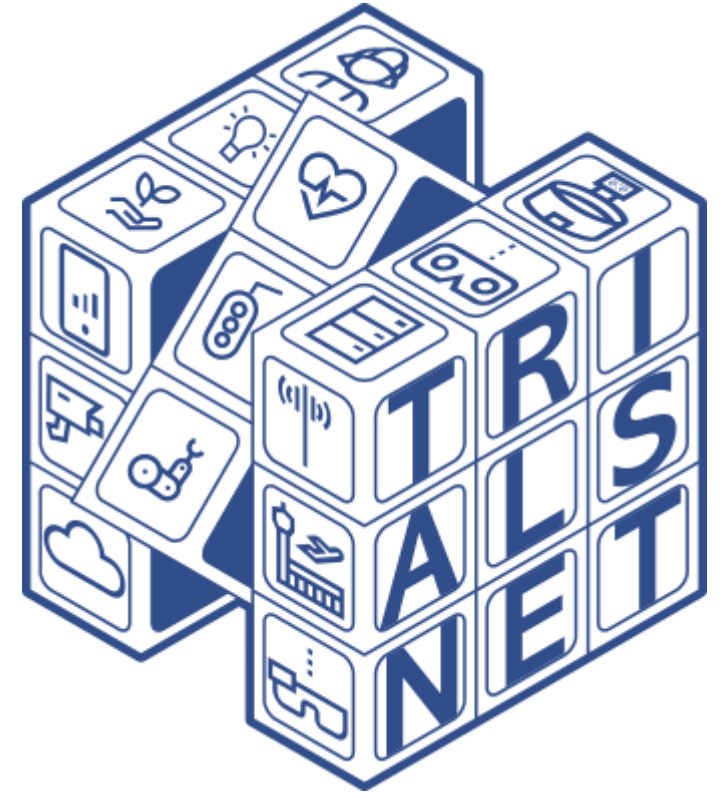
Webinar information

1) Raise hand
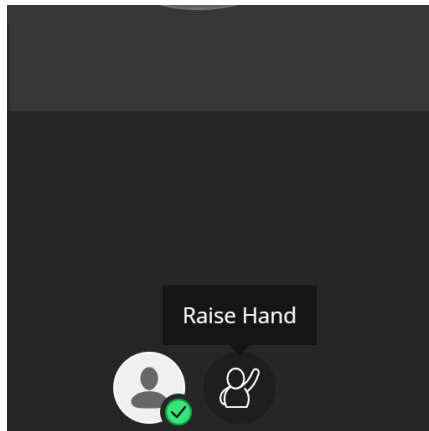
2a) Share audio or

2b) Write your question in the chat

TrialsNet Second Open Call Webinar

Technical highlights

Alessandro Trogolo (TIM)
2023-12-05

Project main objectives

- TrialsNet will deploy **large-scale trials** incorporating the technologies that are currently considered as key enablers for 6G networks

- TrialsNet will implement **13 innovative** use cases in **4 clusters** covering the three vertical domains of:
  - Infrastructure, Transportation, Security & Safety
  - eHealth & Emergency
  - Culture, Tourism & Entertainment

- TrialsNet will develop appropriate **technical and socio-economical assessment frameworks** in order to validate proper KPIs/KVIs

- TrialsNet **expected impacts** will be **further strength** through the **Open Call** that will bring onboard new key actors and vertical use cases

Methodology

TrialsNet Innovations

Deployment

Use Cases definition
(with users involvement)

Optimize

TrialsNet

Trials

Qualitative and quantitative analysis of the user experience to find product/market fit, identify what demand is still not covered, and what it is critical to consider for future network evolution in terms of requirements for the products and services

New network functions, updated infrastructures, new radio bands, update of software components of the applications, etc.

Evaluation

6G requirements
(SDOs, Stream B)

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Open Call application options

- TrialsNet is giving the opportunity to the applicants of the Open Call to participate through two different options:

- **Option 1**:
    - **a) New use case**(s) and field trials **supported by one or more TrialsNet infrastructures** in terms of platforms and network solutions
    - **b) Improvement of its use case**(s) by the integration of software applications, features, devices, new users, and datasets

- **Option 2**: **New use case**(s) leveraging on **new additional field trial infrastructures** such as experimental, private, and/or commercial network deployments

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Main points to be considered

- The use cases should propose innovative 6G applications in one of the three domains that have been identified by the project

- Possible verticals involvement to target specific use cases for which there is a concrete interest

- Use of different technologies and functionalities (at the application and/or network levels) as part of the use case implementation

- Categorization of the trials as «large-scale» in terms of coverage area, number of users, time schedule, different scenarios, data collection, etc.

- The use cases should be able to stress the current network solutions (i.e. have demanding requirements/KPIs) and possibly be scalable

- The use case should have have high societal and business values (KVIs)

TrialsNet

Expected results

- Ideally, proposals should follow the methodology defined by the project

- Use Cases and trials (including additional platforms and network solutions) need to be properly documented in the project deliverables

- Trials results in terms of KPIs measurements as well as feedback from the users (KVIs) are considered as deliverables towards the project

- How data will be provided to the project might depend on the use case and need to be properly defined

TrialsNet

TrialsNet Second Open Call Webinar

Turin site description

Mauro Agus (TIM)
2023-12-05
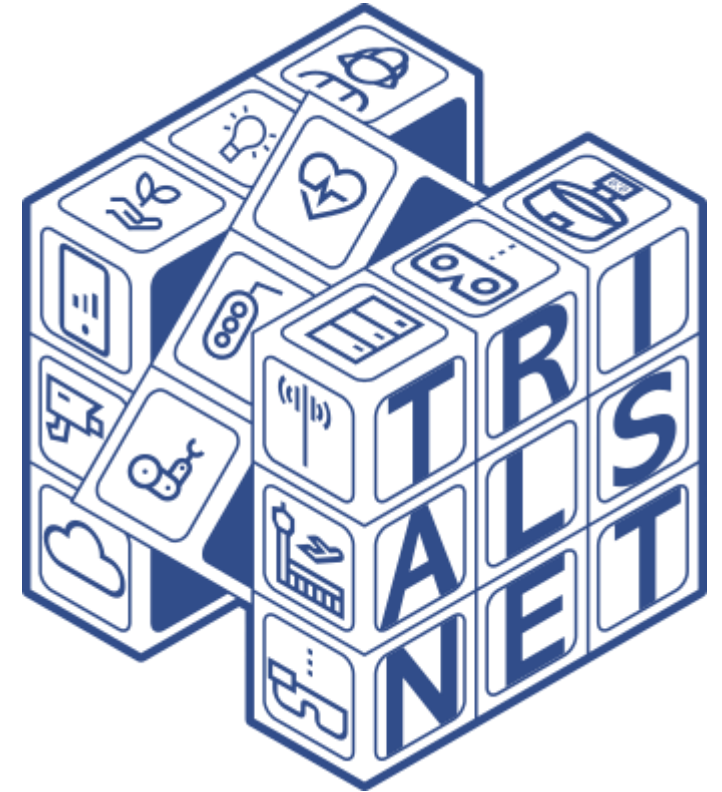
Summary

- Location: Torino, Italy
- Network type: commercial
- Network deployment: NSA, rel.15, 80MHz spectrum @3.7GHz
- Coverage: wide coverage (Urban area, local performances may change)
- Network functionalities: private NFV cloud platform, KPI measurement, private APN
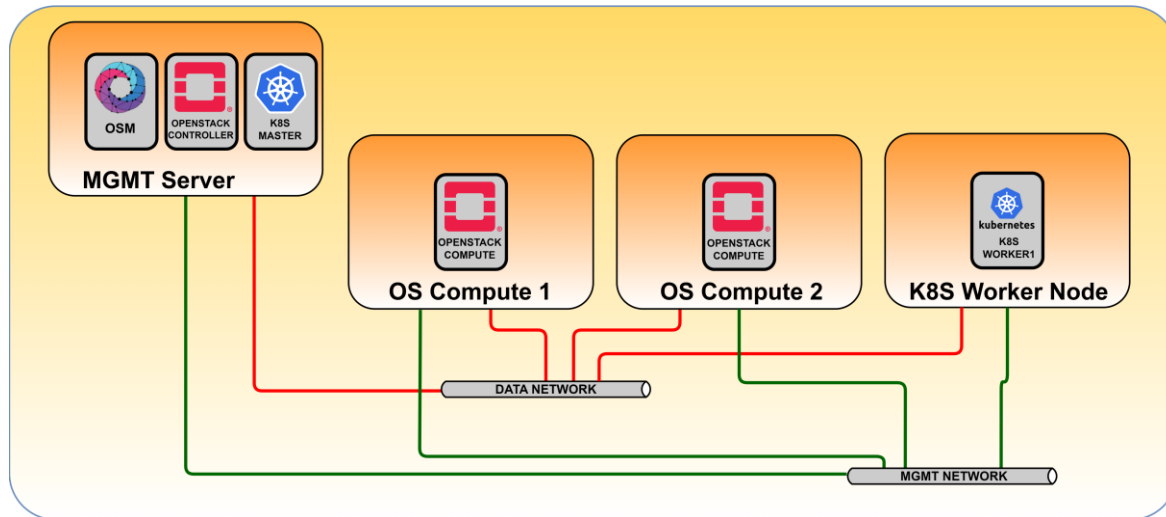- Performances: average throughput 500Mbps DL/150MBps UL, average RTT < 25 ms

Infrastructure
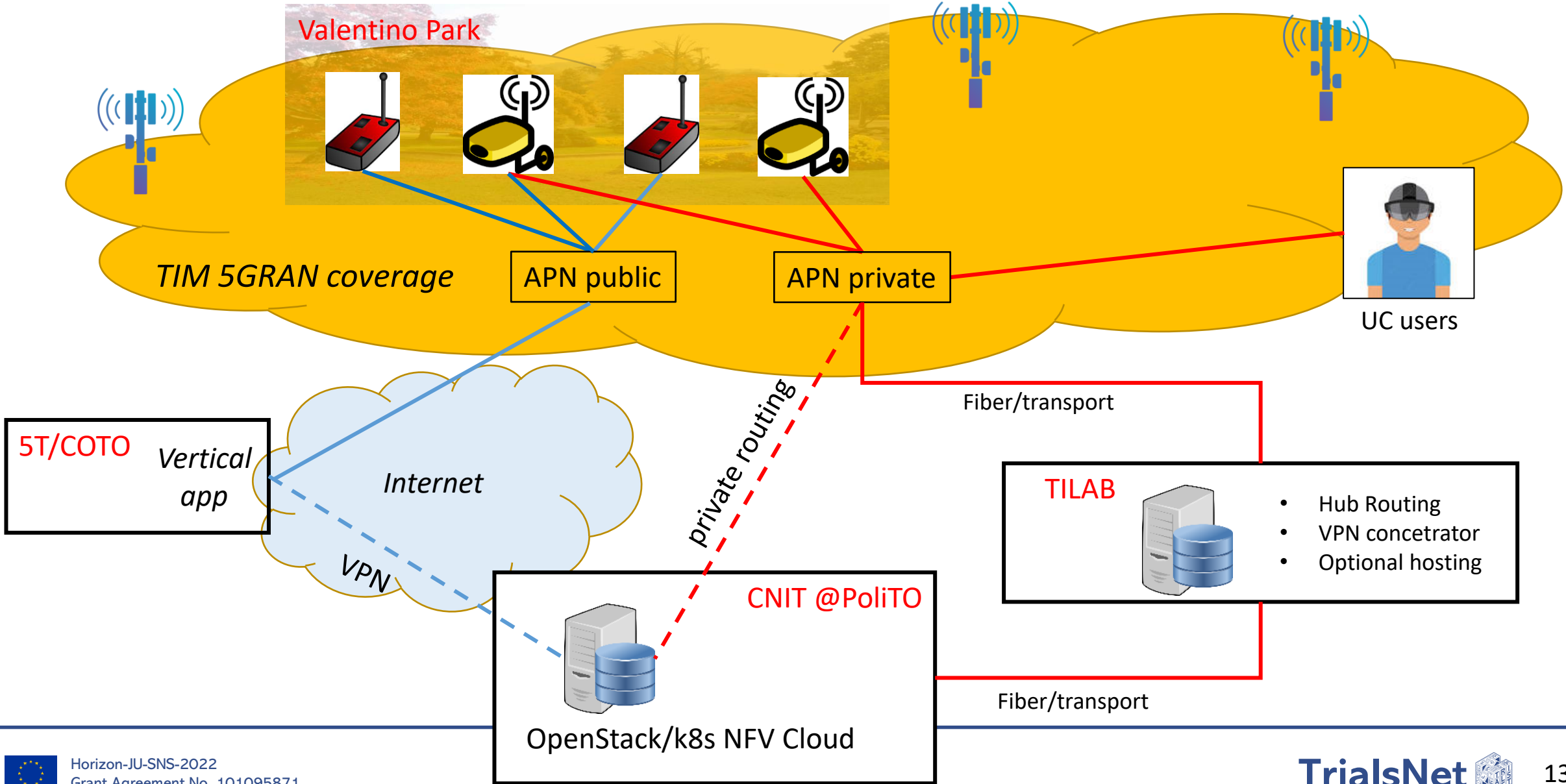
Server platforms

- NFV Cloud platform for running virtualized applications
  - OpenStack for VM based applications and K8s for container-based services
  - Monitoring of network and computing KPIs
  - Carrier grade transport interconnection

Server	CPU	RAM	STORAGE
MGMT	40	128GB	1TB
OS1	40	128GB	1TB
OS2	40	128GB	1TB
K8s Worker	40	128GB	1TB

Current configuration may be improved

TrialsNet

User devices

- User devices are not provided by the site, the applicant have to bring everything is needed (5G devices, Wi-Fi, XR devices…)

- The network is compatible with NSA commercial devices (e.g. smartphones, CPEs, industrial modem/routers)

- Network access need a TIM SIM card, it cannot be provided by the consortium, the applicant has to subscribe it, and it can be enabled to the private APN

Infrastructure availability

- Discuss the logistics of the infrastructure
  - The infrastructure could be 24/7 available, due the commercial coverage. The NFV cloud hosting usage should be evaluated, according with the required computational resources.
  - The SIM cards may access to the public internet ONLY with commercial APNs OR through the backend (as proxy) running on the NFV infrastructure
  - The trial duration have to be agreed with site manager/owners

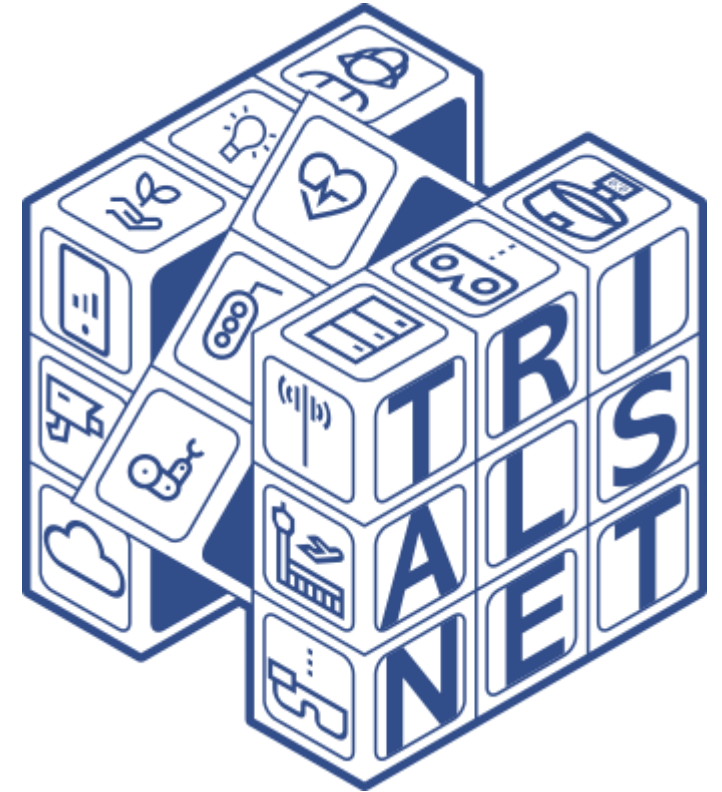# TrialsNet Second Open Call Webinar

Pisa site description

Paola Iovanna (Ericsson Italy)
Giulio Bottari (Ericsson Italy)
Andrea di Giglio (TIM)
2023-12-05

Summary

- Location: CNR Campus area in Pisa, Italy

- Network types: private

- Network deployments:
  - Private: SA Rel. 16, 26 GHz
  - The radio systems natively support 3GPP Rel-16 while 3GPP Rel-17 is available starting from Q32023.

- Private 5G SA network coverage:
  - An indoor area, with coverage provided by an indoor antenna, in a dedicated room
  - An outdoor area covered by an outdoor antenna in a dedicated part of the campus parking
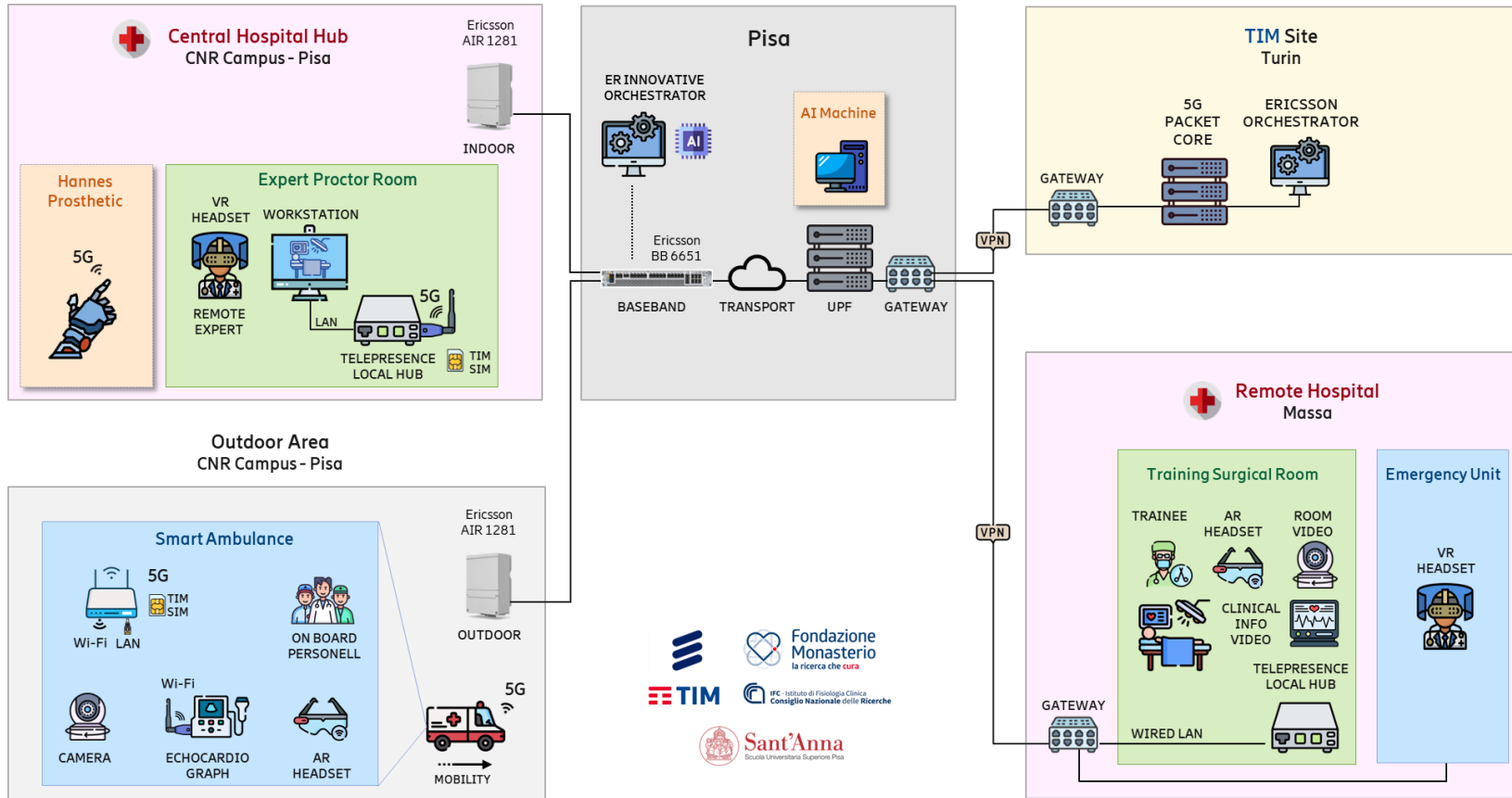
TrialsNet
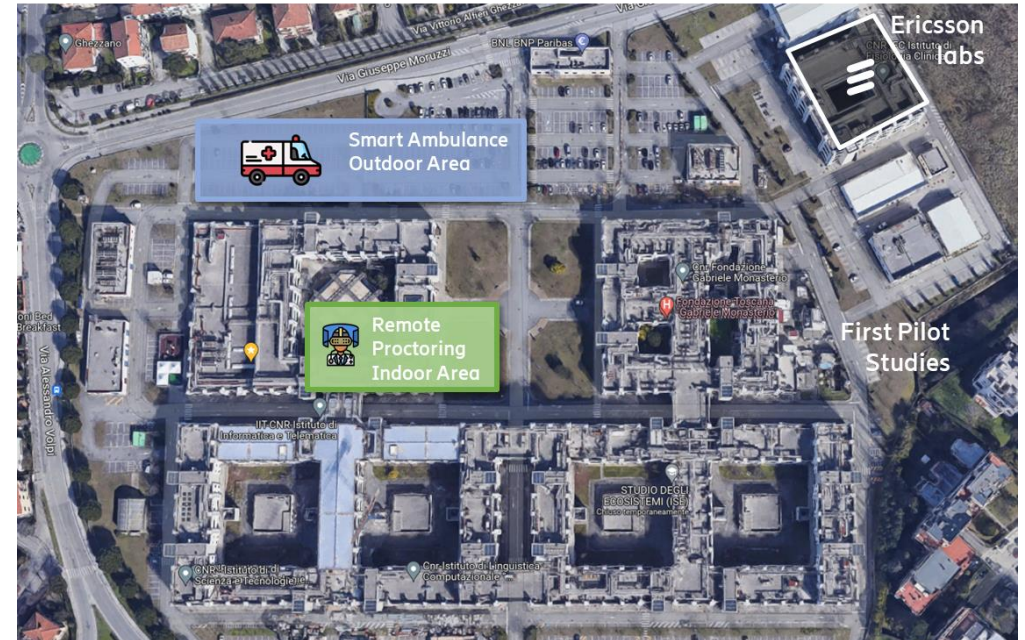
Summary

- EDGE 5G SA network functionalities:
  - 5G Local UPF breakout in Pisa (starting from early 2024)
  - 5G Rel.16 Slicing (eMBB)
  - UPF is delivered in a Packet Core Gateway that fulfils the following functions
    - 3GPP – UPF
    - Non 3GPP – CGNAT, Firewall, Multi Service Proxy,
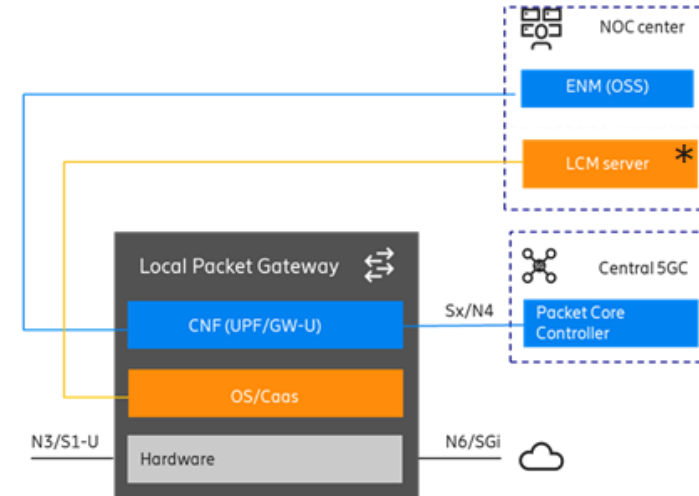
Infrastructure

HW Components

- **Baseband 6651** serving both indoor area (Central Hospital Hub inside CNR campus - Pisa) and outdoor area.
- **2 x AIR 1281 n258B, AC** (one for indoor area and one for outdoor area)
- On mmW spectrum (26900:27100, 200 MHz)
- Transport node to be defined

Use Case's Devices

Rods & Cones Telepresence

GE Versana Active 4D Ready Ultrasound imaging machine

Metaquest 2 VR/MR

Vusix M400 AR

Server platforms

- ## 5G Lab Edge compute infrastructure
  Compute servers:

  LPG is based on Dell EMC™ PowerEdge™ R640, a general-purpose rackmount server equipped with two CPUs based on Intel® Xeon® Scalable processor product family
  - 1x Rack Unit
  - 2x 26C Xeon Gold 6230R CPUs + Heatsinks
  - 12x 32GB RDIMMs (384GB)
  - 2x 960GB 2.5" SSD SATA RI 1DWPD Hot Swap
  - 3x I-XXV710 DP 10/25GbE SFP28
  - 1x I-X710 DP 10GbE SFP+ & i350 DP 1GbE
  - Sliding Ready Rails (w/o Cable Mgmt. Arm)
  - 2x AC PSUs 750W

  Virtualization platforms offering support for deploying both VMs & Containers on top of the infrastructure
  - CaaS: SUSE K3s
  - Host OS: SUSE enterprise Linux Host-OS

User devices

- Available devices for experimentation
  - 3 CPEs ZTE MC889A Stand Alone (26GHz)
    - ZTE 5G Outdoor WiFi Router
    - 2.5Gigabit Ethernet Port
    - IP65 Dustproof and Waterproof
    - Qualcomm SDX62 Chipset
    - Support R16, NR CA
    - mmW 5G Frequency Band

- Devices provided by the applicants

Infrastructure availability

- The **network** has been set up **from scratch** specifically for TrialsNet eHealth experiments (UC 7-8-9), which means that it may not be able to support other experiments that would require specific configurations.

- Since the site is **in a hospital**, any access to the infrastructure is subject to verification that considers security and ethical aspects.

- Therefore, to integrate and test use cases proposed from open call's applicants, it's important to **plan** and **coordinate well in advance**, including verifying and agreeing upon site and network access requirements.

- No real patients will be involved. It would have been too burdensome from an administrative point of view (privacy, security, use of systems at the edge of technology, and therefore which could still have problems, on real patients). At the end, the involvement of real patients would not add anything to what we intend to verify.
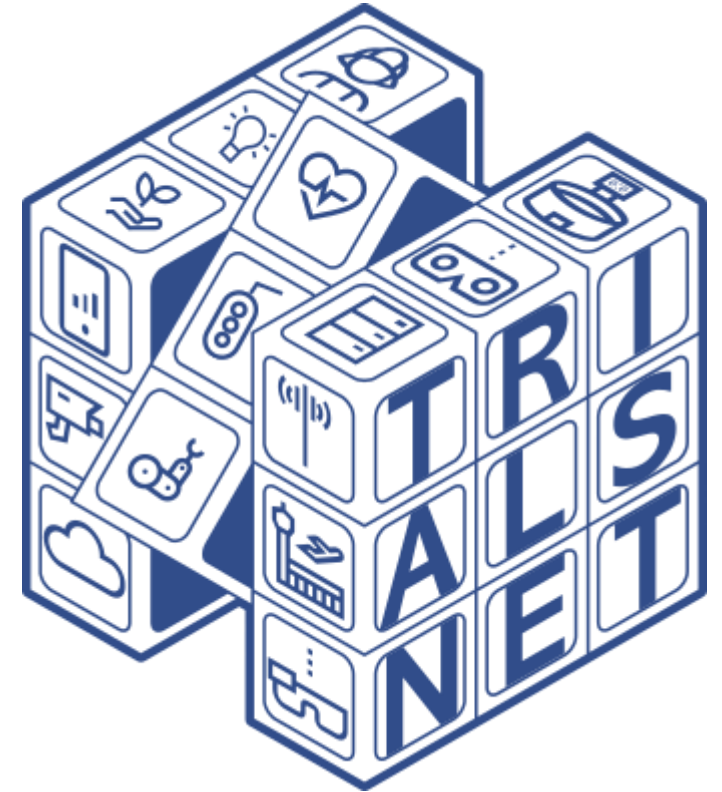
TrialsNet Second Open Call Webinar

Madrid site description

Aruna Prem Bianzino (UC3M)
Isaac Quintana Fernandez (Ericsson Spain)
Fernando Beltrán González (Ericsson Spain)
2023-12-05

Summary

- Location: Leganés (Madrid South) in 5Tonic Labs at IMDEA Networks
- Network type: Experimental
- Network deployment: Stand alone covering 3 areas + mobile solution for Radio Access Network and User plane functions, Rel16 mid-band (3,5 GHz)
- Coverage: An indoor area and an outdoor area, with an antenna each, plus an indoor lab with dot antennas
- Network functionalities: KPI measurement support
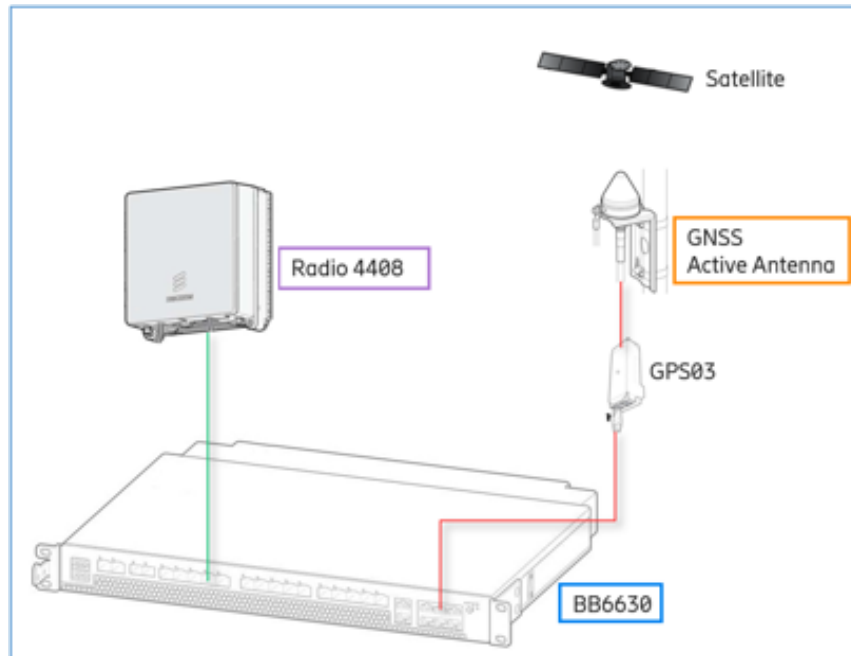- Performances: average throughput 700Mbps DL/150MBps UL average RTT < 20 ms

TrialsNet

Infrastructure

- **Basketball court coverage**

- **X3 Room coverage**

- **1s4 Lab coverage**
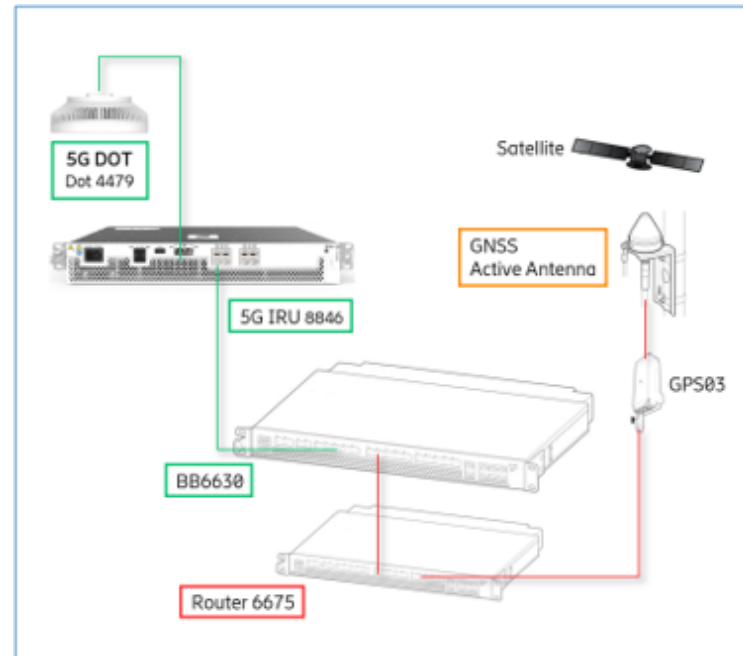
- **Portable system**

TrialsNet
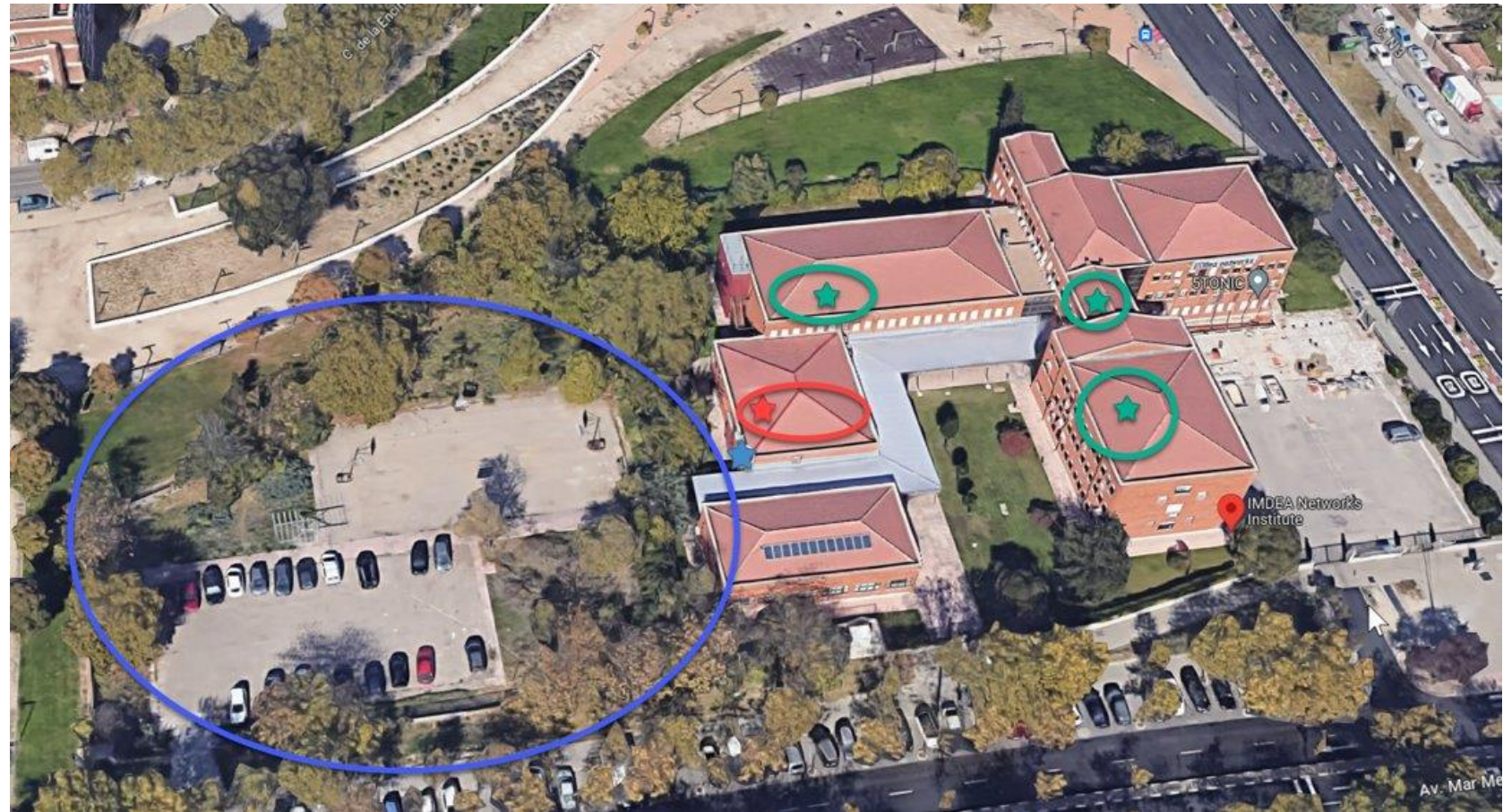
Infrastructure

- **Basketball court coverage**

- **X3 Room coverage**
  - Radio 4408 + Antenna 6524
  - Baseband 6630
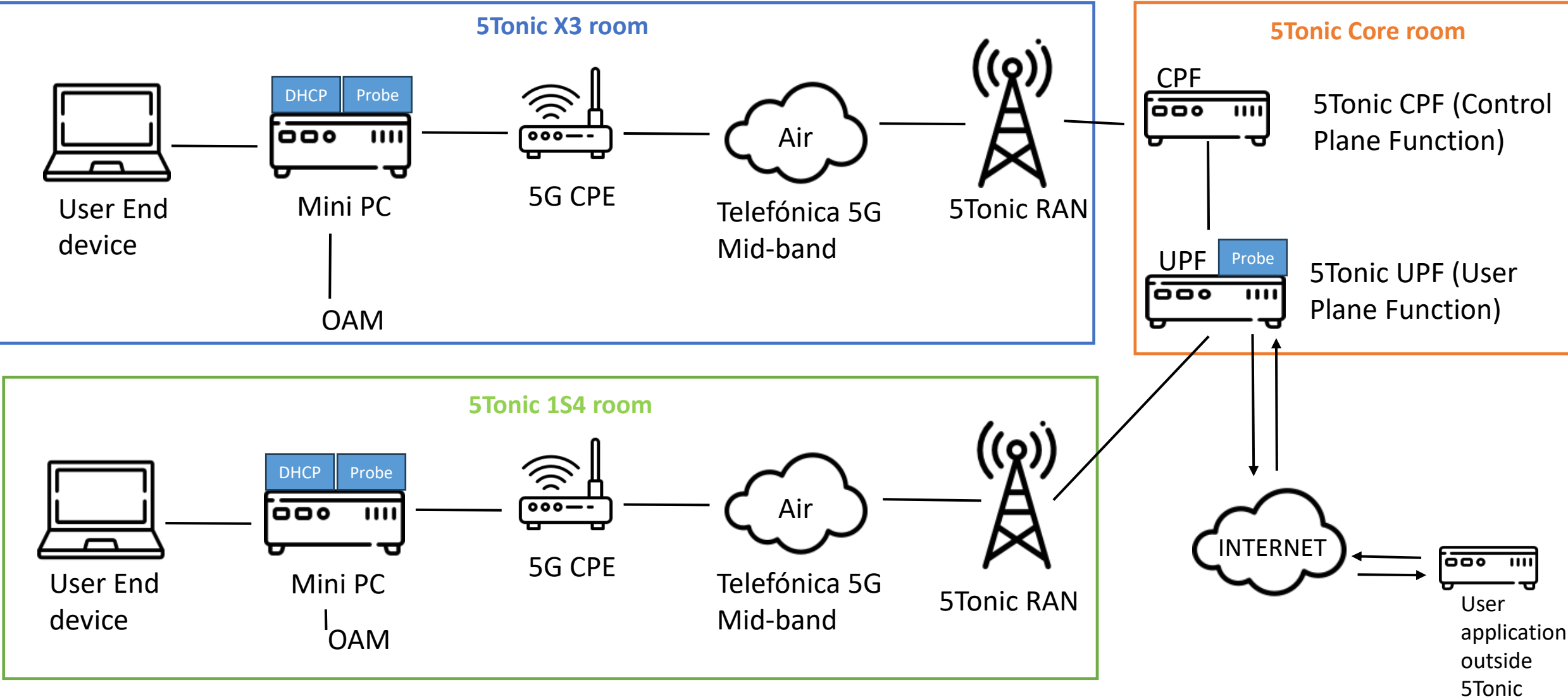 - Router 6675
  - GPS receiver

- **1s4 Lab coverage**
  - 5G DOT (MIMO antenna)
  - 5G Indoor Radio Unit
  - Baseband 6630
  - Router 6675
  - GPS receiver

- **Portable system**
  - Non-Public Network
  - radio access network and user plane function
  - IPSEC secure connection to 5Tonics control plane
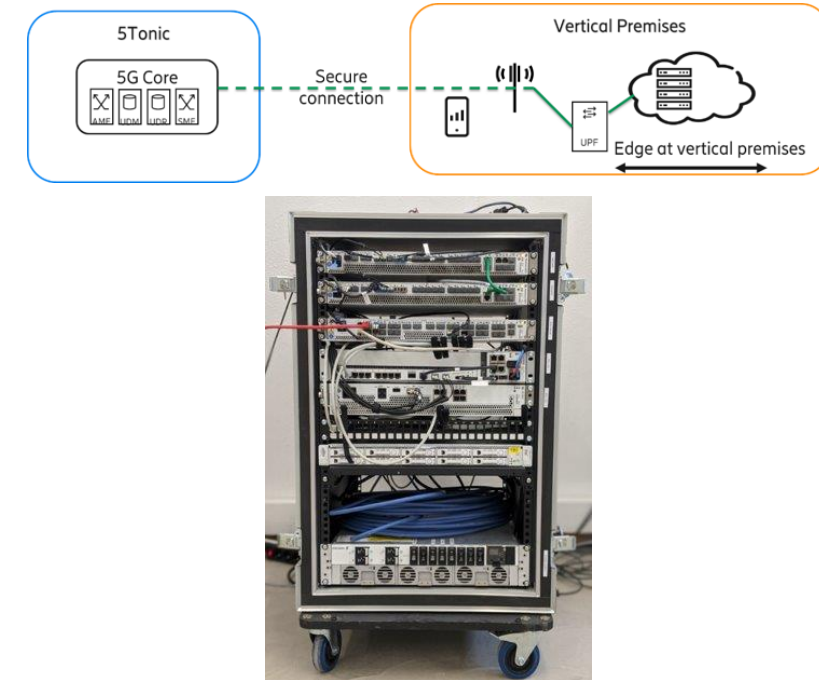
Infrastructure - Lab testing setup

Server platforms

- The network offers Internet connectivity to reach external services (e.g., AWS)

- In the case, no performance assurance is offered, nor security guarantee (the security should be provided by the external service, in the case)

User devices

- User devices are not provided by the site

- The network is Data centric, and not voice centric
  - May have issues with User Equipment (e.g., Samsung S22, Meta Quest 2, iPad, etc.), instead of Customer Device Equipment (5G Industrial Router)

- Devices need a SIM card (provided by 5Tonic)
  - Devices need 5G SA connectivity
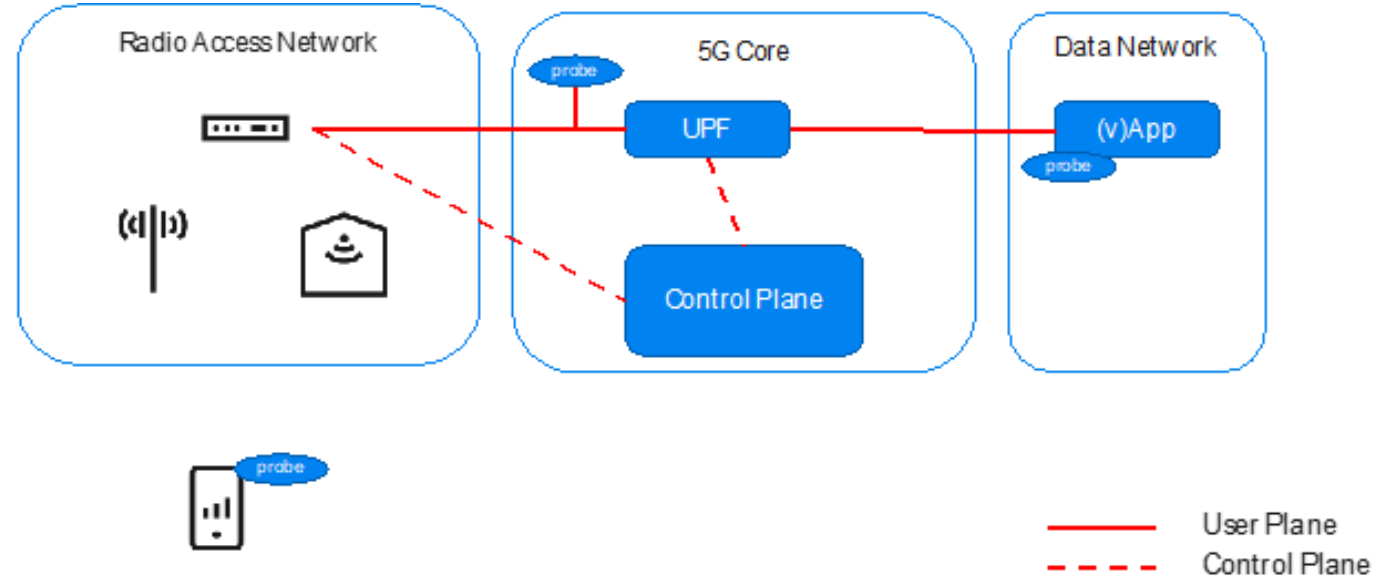
TrialsNet

Infrastructure availability

- Use Case testing:
  - 1 month notice for set up the trial
  - 1 week duration, in which the infrastructure will be provided as a commercial network, without continuous support/monitoring

KPI support

- Probes are deployed in the cluster to support Use Case experiments
- Probes allow to measure
  - User Experienced Data Rate
  - Cell/Network Data Rate
  - Latency
  - Jitter
  - Network availability
  - Network reliability
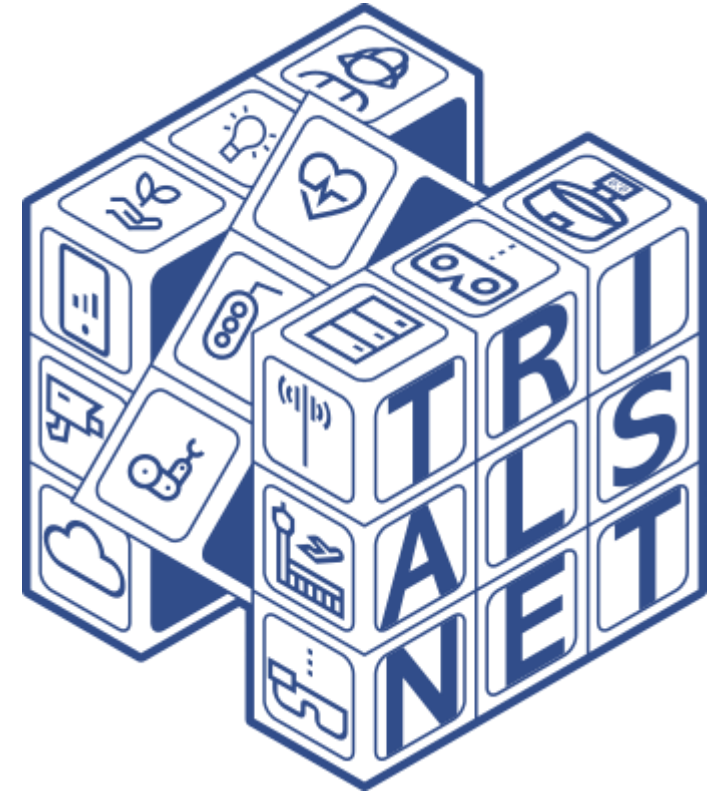 - Packet loss rate
  - Packet order rate

TrialsNet Second Open Call Webinar

Iasi/Bucharest site description

Razvan MIHAI (Orange Romania)
Marius IORDACHE (Orange Romania)
2023-12-05

Summary

- Location: Iasi & Bucharest, Romania
- Network types: commercial & private
- Network deployments:
  - Commercial: NSA Rel. 15, N78 Band, 100MHz of bandwidth
  - Private: SA Rel. 16, N78 Band, 100MHz of bandwidth
- Commercial 5G NSA network coverage:
  - Complete coverage in Iasi & Bucharest
- Private 5G SA network coverage:
  - Bucharest 5G Lab workspace area, inside the UNSTB Campus
    - 2 cells (1 in an anechoic chamber)
  - Iasi 5G Lab workspace area, inside the TUIASI Campus
    - 1 cell
  - Stefan cel Mare pedestrian alley, Iasi (starting from late 2024)
    - 3 sectors
  - Podu Ros intersection, Iasi (starting from late 2024)
    - 3 sectors
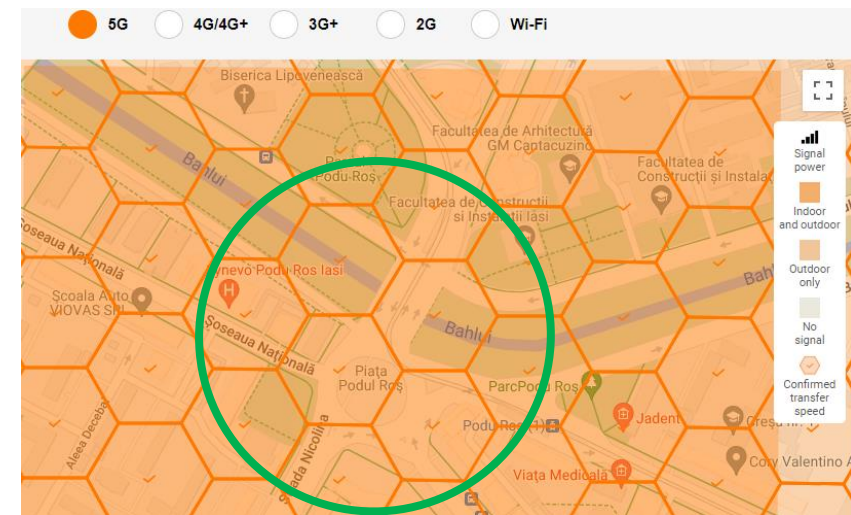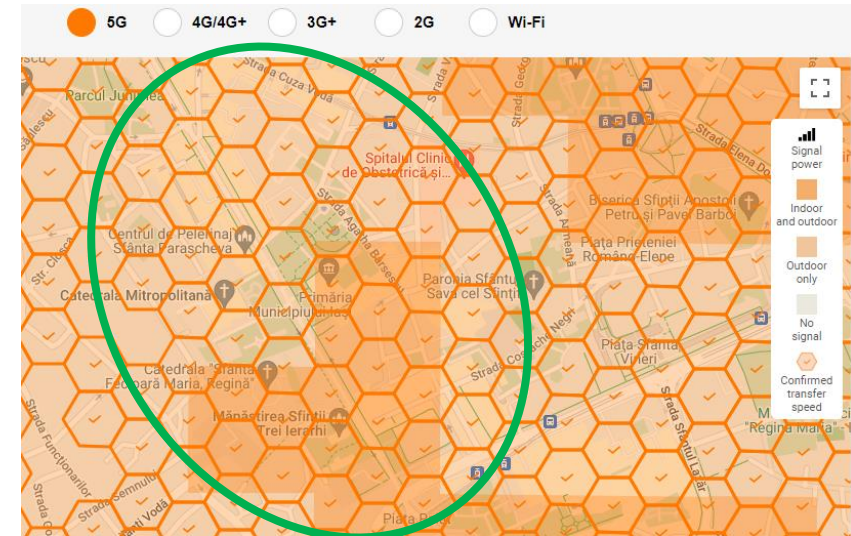
# Summary

- Commercial 5G NSA network functionalities:
  - Private APN that connects to the 5G Lab Edge computing infrastructure

- Private 5G SA network functionalities:
  - 5G Local UPF breakout in Iasi (starting from early 2024)
  - Edge computing (in Bucharest & starting from early 2024 in Iasi)
  - 5G Rel.16 Slicing (eMBB and URLLC)
  - Compute and slicing orchestration platform for applications onboarding
  - Infrastructure and applications resources monitoring platform
  - IP FABRIC transport network design allowing for automations

- Performances:
  - Commercial 5G NSA network
    - up to 1.5 Gbps DL / 100 Mbps UL throughput
    - less than 20ms E2E latency
  - Private 5G SA network
    - eMBB slice
      - up to 1.5 Gbps DL / 150 Mbps UL throughput
      - less than 12ms E2E latency
    - URLLC slice
      - up to 40 Mbps DL / 40 Mbps UL throughput
      - less than 8ms E2E latency

Infrastructure
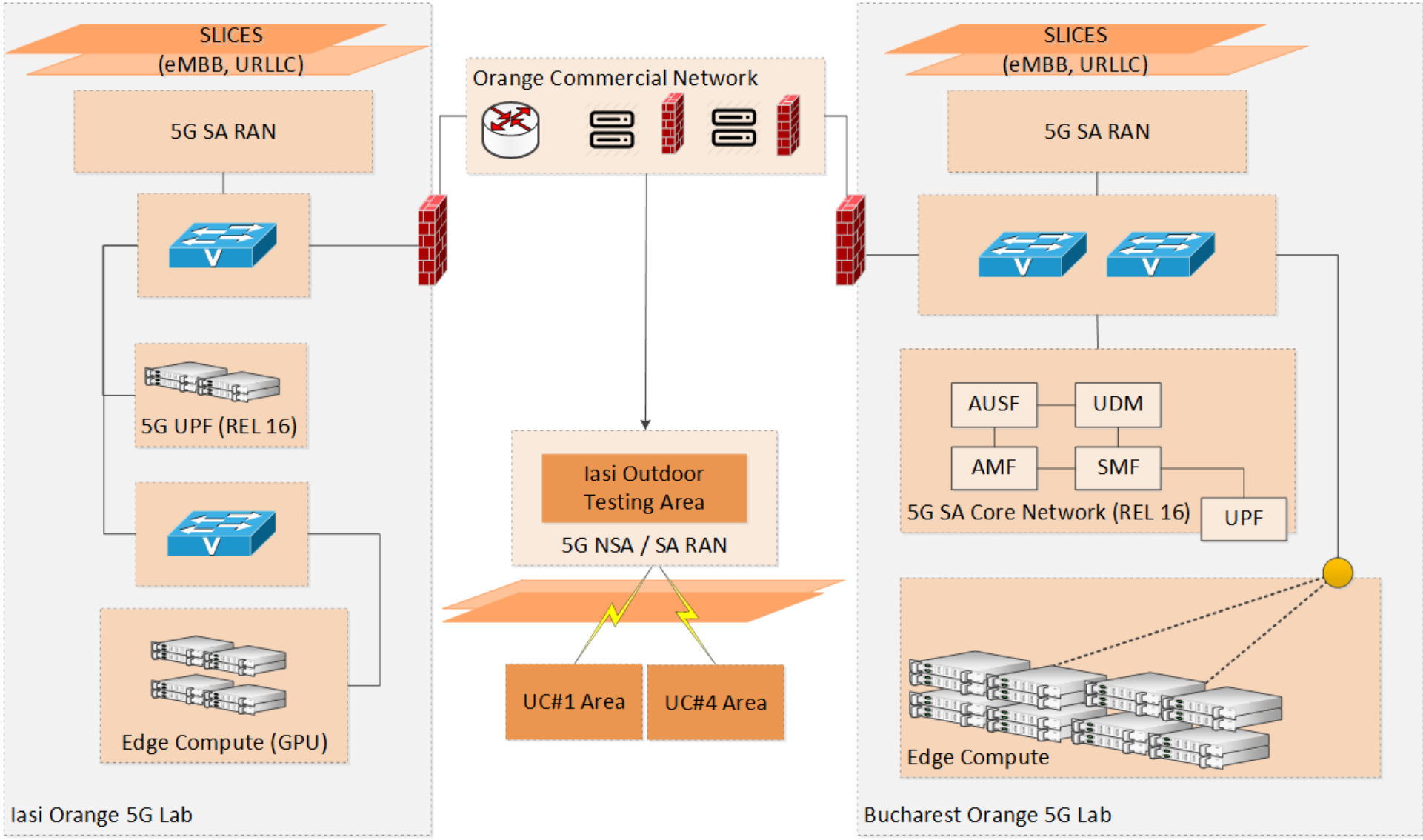
Server platforms

- 5G Lab Edge compute infrastructure
  - Compute servers
    - 15x HPE ProLiant DL360 Gen10
      - 2x Intel(R) Xeon(R) Gold 5118 (12C)
      - 192 GB RAM
      - 1200 GB RAID Redundant Storage
      - 4x 1Gbps Network Ethernet Ports
      - 2x 16Gbps Network SFP Ports
      - Hosting virtualization software (OpenStack, VMware vSphere, Kubernetes cluster)
    - 2x HPE ProLiant DL360 Gen10 Plus
      - 2x Intel(R) Xeon(R) Gold 6348 (28C)
      - 1024 GB RAM
      - 4TB SSD RAID Redundant Storage
      - 2x 25Gbps Network SFP Ports
      - 1x GPU Nvidia Tesla T4 16GB VRAM
  - Virtualization platforms offering support for deploying both VMs & Containers on top of the infrastructure
    - OpenStack cluster
    - VMware EXSI cluster
    - Kubernetes cluster
  - Secure access to the resources
    - 3rd parties can access the testbed using a VPN client and the given credentials
- Interconnection of 3rd parties compute infrastructures to ORO's 5G Lab testbeds
  - Through Site-to-Site IPsec VPNs established between the two entities
  - Option available for both Cloud (AWS, GCP etc.) and Private compute infrastructures

User devices

- Available devices for experimentation
  - 5G evaluation boards and modems (Quectel RM500Q-GL)
  - 5G CPEs (Nokia FastMile Receiver 5G14-B, Huawei CPE Pro 2)
  - 5G Industrial routers (Teltonika RUTX50, Digi TX64, InHand ER805, Siemens Scalance MUM856, Cradlepoint R1900)
  - 5G Phones (Huawei P40 Pro, OnePlus 10 Pro, Motorola Edge 30 Pro, Xiaomi 12 Pro)
  - 5G Cameras (Milesight AI Pro Bullet Plus)

- Devices provided by the applicants
  - Connection to the commercial 5G NSA network
    - Through commercially available SIM cards provisioned with the public/private APN
  - Connection to the private 5G SA network
    - Through a private batch of SIM cards that can be provisioned within the eMBB or URLLC slices
    - Special SIM cards can be provisioned with a multi-APN profile (supporting both eMBB & URLLC)
    - From our experience, smartphones need custom ROMs in order to support 5G SA

Infrastructure availability

- Commercial 5G NSA network
  - Infrastructure available 24/7, with minimal interruptions 99,9999% uptime
  - Trials are not limited in duration or traffic

- Private 5G SA network
  - Infrastructure available 24/7, but can suffer unexpected interruptions
  - Trials using the indoor coverage should be capped at maximum 1 week / session due to logistics reasons
  - Trials using the outdoor coverage are not limited in duration
  - No traffic limitations

- Edge compute
  - Infrastructure available 24/7, but can suffer unexpected interruptions and performance drops
  - Trials using this compute infrastructure should be capped at maximum 1 week / session in order to avoid blocking compute resources
  - Compute resources limitations could be imposed for GPUs usage

TrialsNet Second Open Call Webinar

Antwerp site description

Nina Slamnik-Kriještorac (IMEC)
2023-12-05
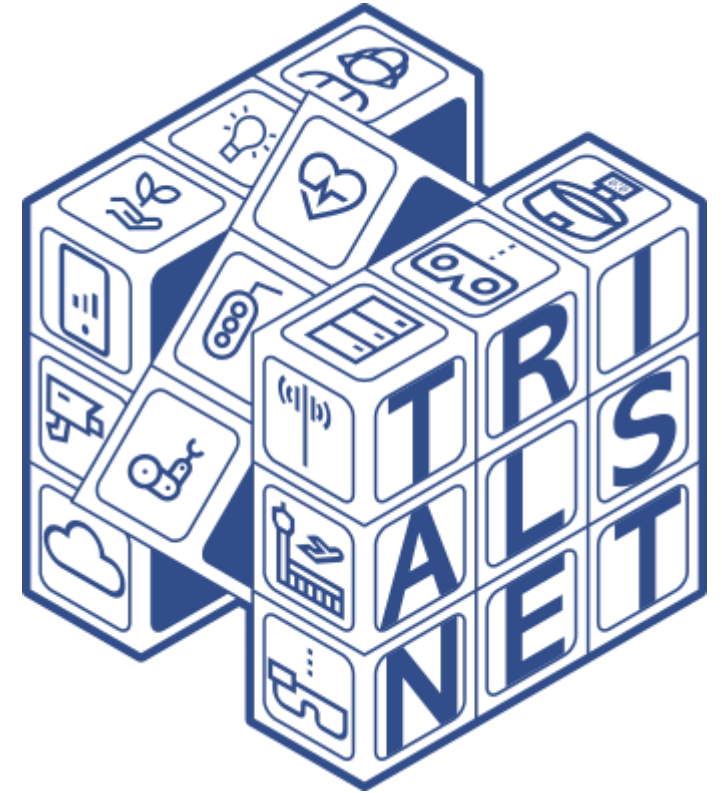
Summary

- Location: Antwerp, Belgium

- Network type: Experimental

- Network deployment: SA, Release 16, 3810-3860MHz

- Coverage: 2 areas with 2 gNodeBs connected with 5G Core

- Network functionalities: Edge computing, network slicing, service orchestration

- Performances: Average 15ms end-to-end latency, average uplink throughput 40 Mbps

Infrastructure

Smart Highway

OpenRAN
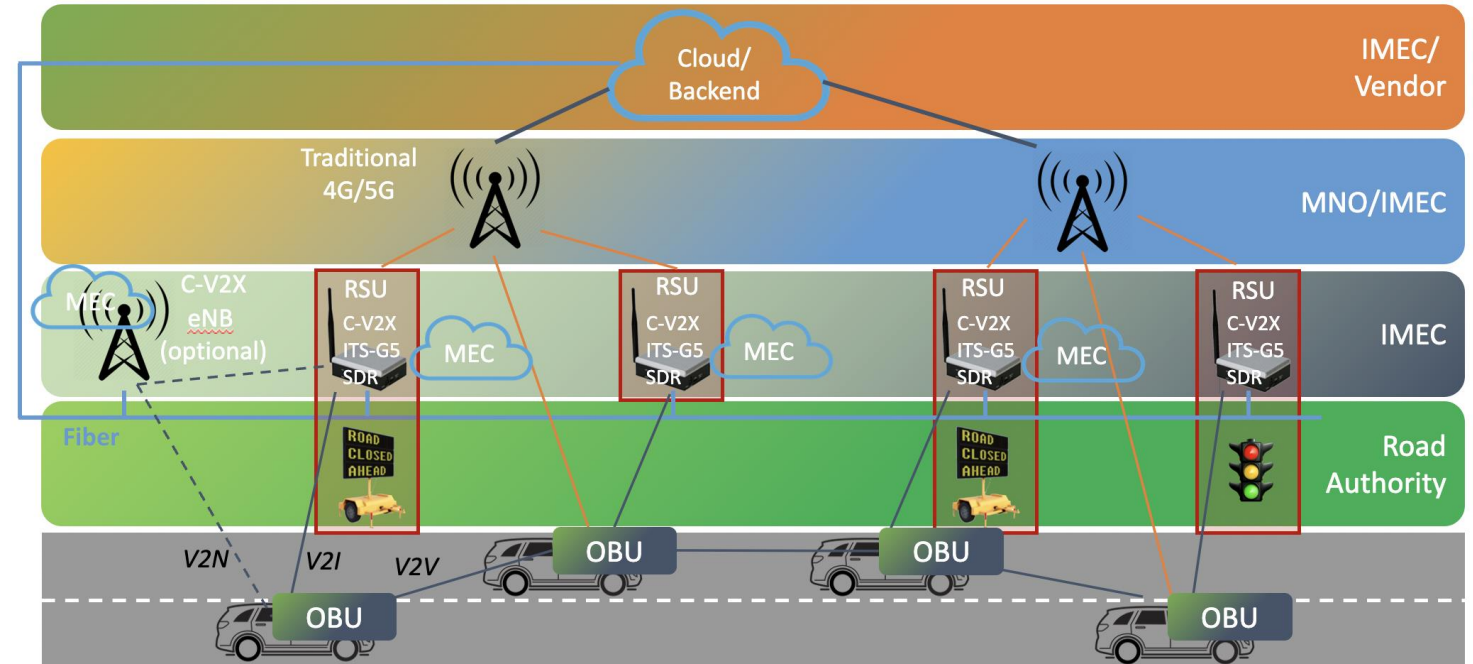
Server platforms

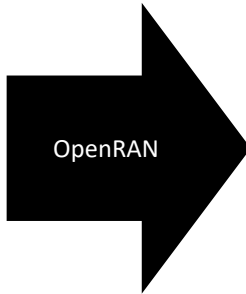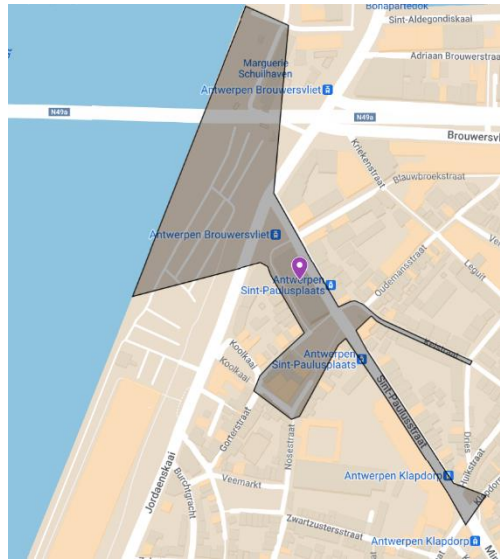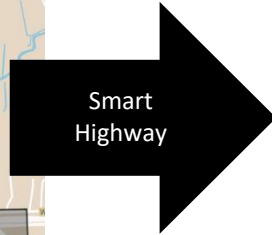## Smart Highway testbed

GPCU	Supermicro CSE-512F-350B; 19", rack-mountable IPMI-module, 2x 1GigE, 2x USB3, 2x USB2, 1x VGA Intel Xeon Broadwell E5-2620V4 @2.1GHz (8 Cores) 32GB DDR4-2666 2Rx4 LP ECC 1TB Samsung 860 EVO SSD Supermicro AOC-STGN-i2S PCIe Renkforce 7 + 2 port USB 3.0 Navilock NL-8012U

RSU

SDR: Ettus USRP N310	10MHz -> 6GHz frequency range 4 RF Channels with separate TX and RX connector per channel Upto 153.6 MS/s (mega-samples/second) 2x 10GigE SFP+ ports for high-bandwidth data transmission 1x 1GigE Management Ethernet port Internal 50ns-accurate GNSS receiver PPS-input port (to allow for synchronization against an external clock source)

OBU processing unit: Nvidia AGX Xavier	8-core ARM v8.2 64-bit CPU 512-core Volta GPU 16GB 256-Bit LPDDR4x 32GB eMMC storage

OBU

Open5G testbed

- Proxmox enabled Supermicro servers with 128GB RAM, two Intel Xeon E5-2620 CPUs (8 Cores, 16 Threads each), and one USRP X310 over 10GB link

- Open-Source MANO (OSM) and Kubernetes-based orchestration solutions

- AI-enhanced service orchestration solutions

- Network and service monitoring system

- 5G Network slice orchestration solutions

- Framework for designing Network Applications

User devices

Smart Highway testbed

OBU

V2X processing unit: NUC7iDNKE	I7-8650U Processor 8GB system memory 120GB SSD
ITS-G5: Cohda Wireless OBU	Cohda MK5 OBU Mobilemark MGW-303 antenna two 5.9GHz antennas for DSCR with an active GNSS antenna
C-V2X: Cohda MK6c EVK	C-V2X PC5 (Qualcomm 9150) Bandwidth 10 MHz 2 C-V2X antennas 1 GNSS antenna Security; SXF1800 FIPS 140-2 level 3 compliant
GPS module: AsteRx-m2a	RTK receiver PolaNt-x MF antenna
Lidar sensor: Velodyne VLP-16	100m range 16 channels Rotation rate between 5Hz – 20Hz Field of view: +15.0° to -15.0° (vertical) Field of view: 360° (horizontal)

Open5G testbed

- 5G New Radio (NR) based on OAI and srsRAN, with following specifications: RTX 3060 GPUs, Intel i7-11700K (8 Cores, 16 Threads), 62GB RAM, USRP B210, and Benetel Radio 550 N78 over 10GB link

- User Equipment (UE): Intel NUC with 32GB RAM, and Intel i7-10710U processor) with Quectel modules (RM500Q)

Infrastructure availability

- Where is Antwerp infrastructure used in TrialsNet?
  - Smart Traffic Management use case
  - Testing and validating Zero-touch service management

- Testing frequency
  - <u>Vehicle</u>: availability on-demand, to be arranged with the infrastructure owners
  - <u>5G SA network testing sessions</u>: to be arranged with the infrastructure owners
  - <u>Compute infrastructure</u>: Available 24/7, remote access possible

TrialsNet

TrialsNet Second Open Call Webinar

Athens site description

Andreas Georgakopoulos (WINGS)
2023-12-05

Summary

- Location: Greece, WINGS testbed

- Network type: Private and Commercial

- Network deployment: 5G NSA at 3.5GHz (80-100 MHz bandwidth)

- Coverage: Private infrastructure has 3 5G NSA small cells (gradually will be upgraded to SA).

- Network functionalities: Cloud, Mobile Edge Computing (MEC), Extreme Edge and IoT functionalities. Also, WINGS testbed utilizes AI mechanisms to support diagnostics, intelligent management, and orchestration.

- Performance: RTT in WINGS private infrastructure measured to around 30ms

Infrastructure
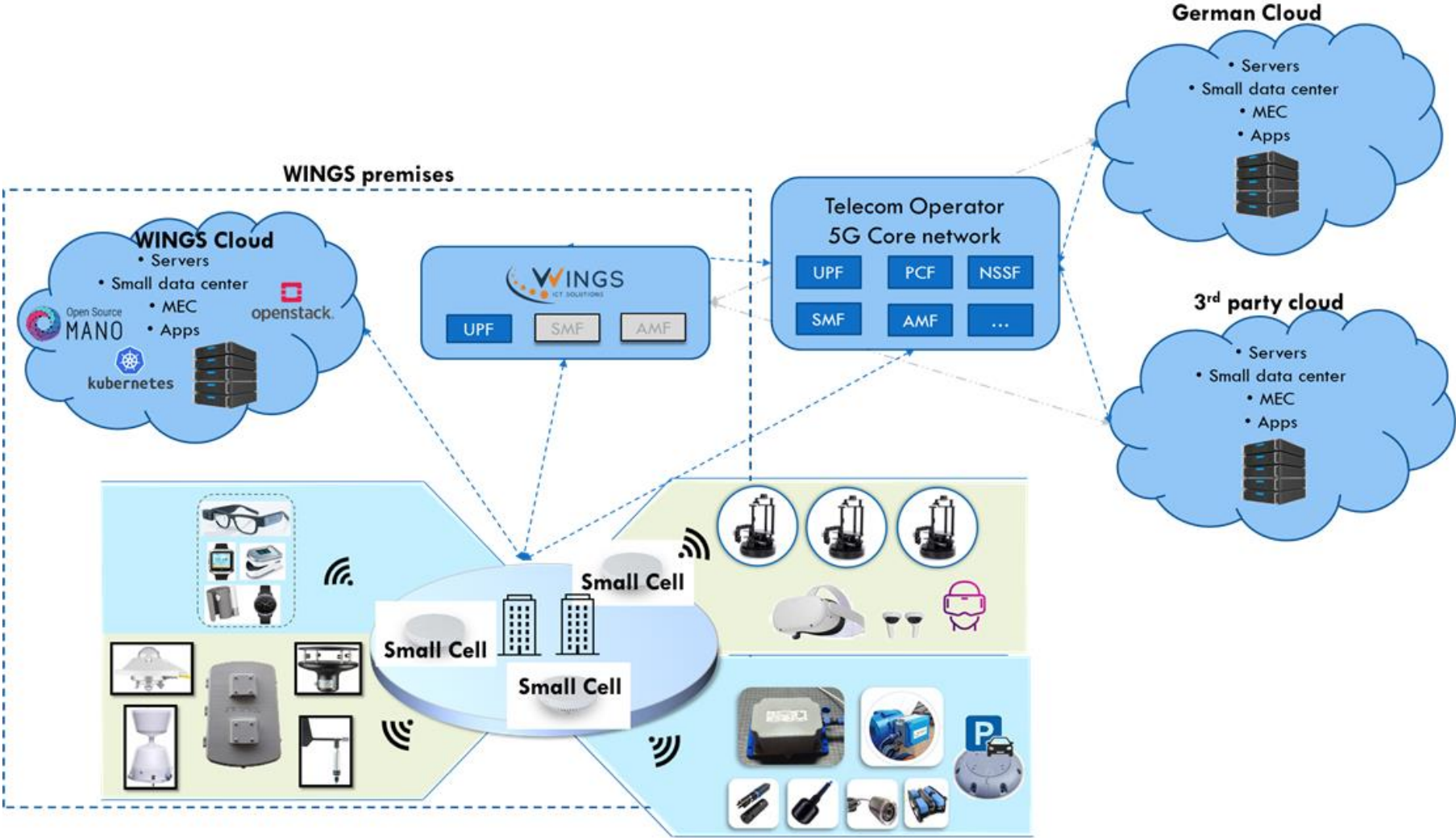
Server platforms

The WINGS testbed utilizes open-source software to provide a flexible and scalable infrastructure for verticals such as:

- Openstack
- Kubernetes
- OSM MANO
- Kafka
- MQ Telemetry Transport (MQTT)
- Robot Operating System (ROS)

These components can support VMs, containers, and serverless execution of code from cloud to extreme edge devices such as Raspberry pi.

The WINGS testbed prioritizes protection and privacy-preserving mechanisms to ensure reliability, security, privacy, confidentiality, and integrity of data.

- Strong authentication, user management, and secure services will be provided with minimum effort from the verticals.
- The solutions selected will comply with General Data Protection Regulation (GDPR) article 5 to ensure appropriate security and protection against unauthorized or unlawful processing, accidental loss, destruction, or damage.

Devices

Clearpath Robotics Jackal
Unmanned Ground Vehicle
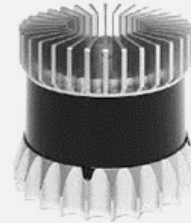
Ouster OS1
Sensor

Tarot Quadcopter Custom
Drone + PixHawk controller

Intel RealSense Depth
Camera D455

Raspberry pi 4

Vision RTK 2

Devices

Samsung Galaxy S10 5G

Intel® RealSense Depth Camera D435

Smart watch (A16) providing vital sign measurements Aitaer Technology Co., Ltd

Quectel RM500Q-AE wireless module

LoCoBot WX250

NUC8i3BEH MiniPC

Infrastructure availability

Supported use cases by Greek site infrastructure

- UC2: Proactive Public Infrastructure Assets Management
- UC3: Autonomous Apron
- UC6: Mass Casualty Incident (MCI) and Emergency Rescue in Populated Area
- UC11: Service Robots for Enhanced Passengers' Experience
- UC13: Extended XR museum experience

Commercial 5G NSA network

- Infrastructure available 24/7
- Trials are not limited in duration or traffic

Private 5G NSA network

- Infrastructure available during working hours (access in the office is needed), but unexpected interruptions may happen
- Up to 10 sim cards are available for connecting to the private 5G network (access from outside is not possible)

Edge compute

- Infrastructure availability in agreement with owners
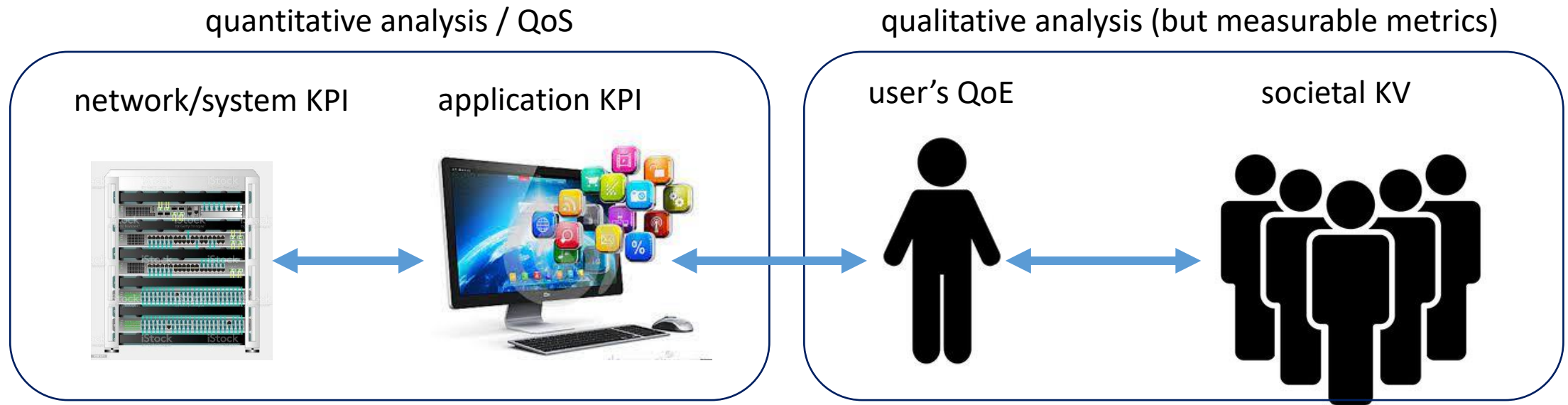
TrialsNet

TrialsNet Second Open Call Webinar

KPIs, KVs, and KVIs overview

Dr. Hassan Osman (Real Wireless)
Prof. Paolo Giaccone (CNIT)
2023-12-05

KPIs vs KVs

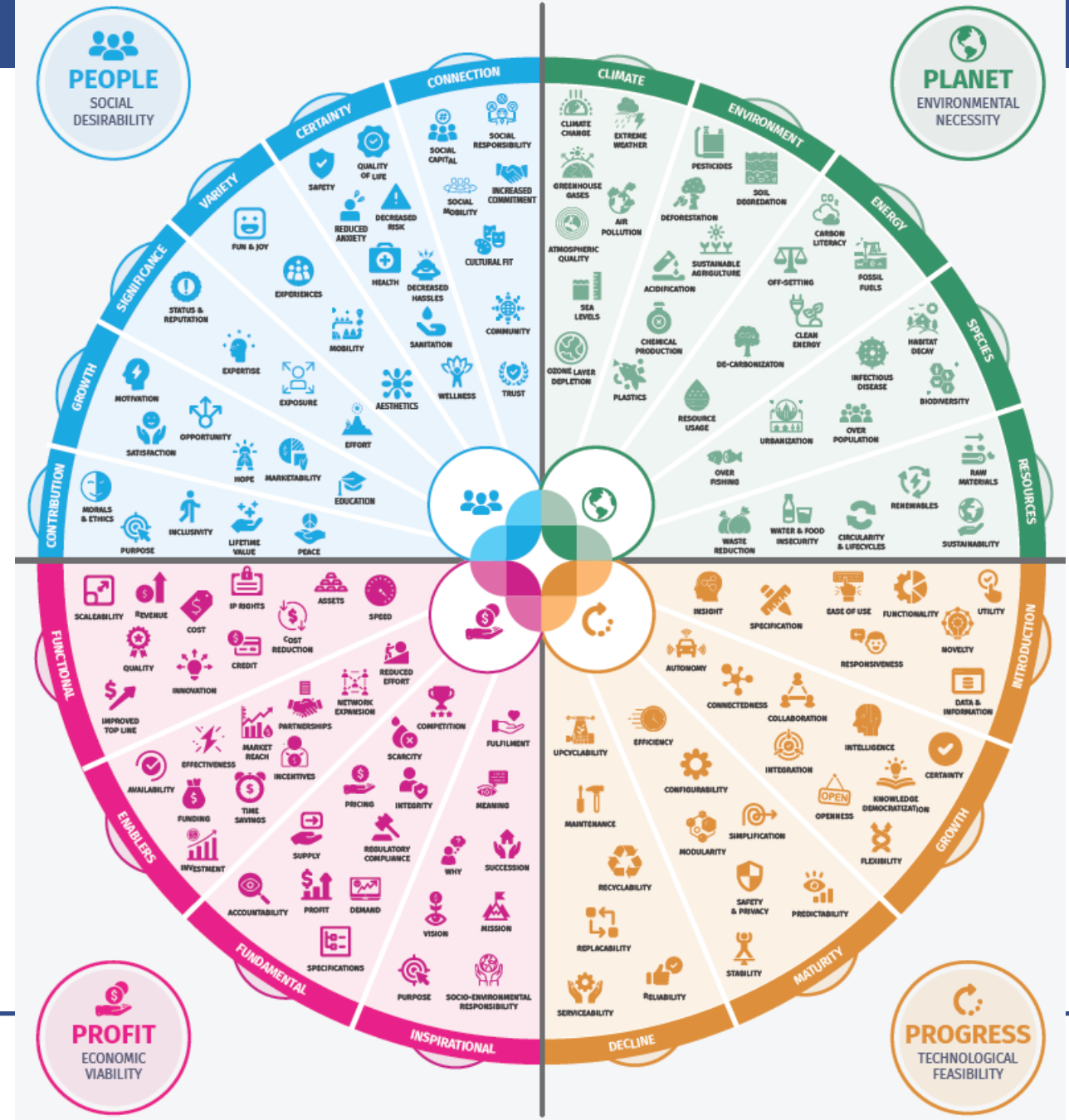- Key Performance Indexes (KPIs) vs Key Values (KVs)

quantitative analysis / QoS

qualitative analysis (but measurable metrics)

network/system KPI application KPI

user's QoE societal KV

Technical definition & assessment of KPIs

- Goals
  - definitions of measurable results for the targeted applications and use cases
  - definition of the requirements on the performance of the network infrastructure

- general taxonomy for KPIs across all the use cases
  - coherent naming and definitions
  - Kpis grouped in the following categories: capacity, latency, compute, availability/reliability, and localization

- all use cases in the open call are supposed to measure all the relevant KPIs

Value type wheel

- Over 130 values are shown in the Figure to the right.

- In [1] these values are divided into 4 categories:
  - People: Social
  - Planet: Environmental
  - Profit: Economic viability
 - Progress: Technological feasibility

[1] https://www.explorerlabs.co/thinking/130-value-types-wheel-for-sustainabiltity-business-innovation

Our focus

- We propose to categorize the values as illustrated in the Figure to the right,
  - Economical
  - Environmental
  - Societal

- This categorization will ideally help with the prioritization of KVs for each use case depending on the direction of the business and funding model.

KVs categorization

Economical

Environmental

Societal
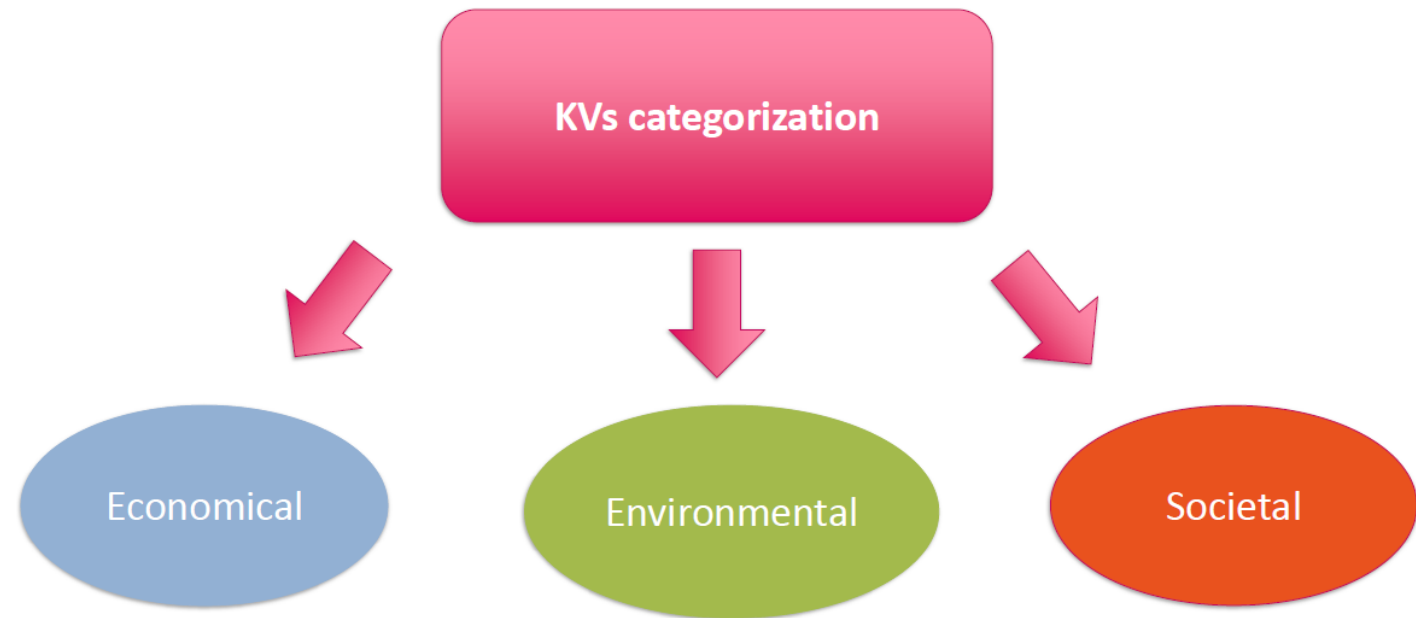
Roadmap: KPIs' vs. key value [6G-IA]

|	
Key Value (KV)	*What are the values that we care about? What are the values that hold significance for us?*
Key Value Indicator (KVI)	*What are the key indicators of those values? How could we measure or assess those values?*
Enablers	*What factors contribute to the promotion of those values? what are the factors that make those values possible? e.g. 6G features, low latency, reliability, etc ..*
KPIs	*What are the technical impacts of those values? e.g. coverage, capacity, energy efficiency, device access density and localization accuracy*

What do we mean by Sustainability

- **Societal Sustainability:**
  - *Societal sustainability is the ability of a society to develop and prosper over time. It involves creating and maintaining conditions that promote social well-being.*

- **Environmental Sustainability**
  - *Environmental sustainability refers to the responsible management of natural resources to ensure their long-term health and preservation for future generations.*

- **Economical Sustainability**
  - *Economic sustainability refers to the ability of an economic system or society to support long-term prosperity, growth, and well-being while considering* **social** *and* **environmental** *factors.*

Economical Sustainability

These three dimensions of sustainability are deeply _interconnected_

Environmental Sustainability

Societal Sustainability
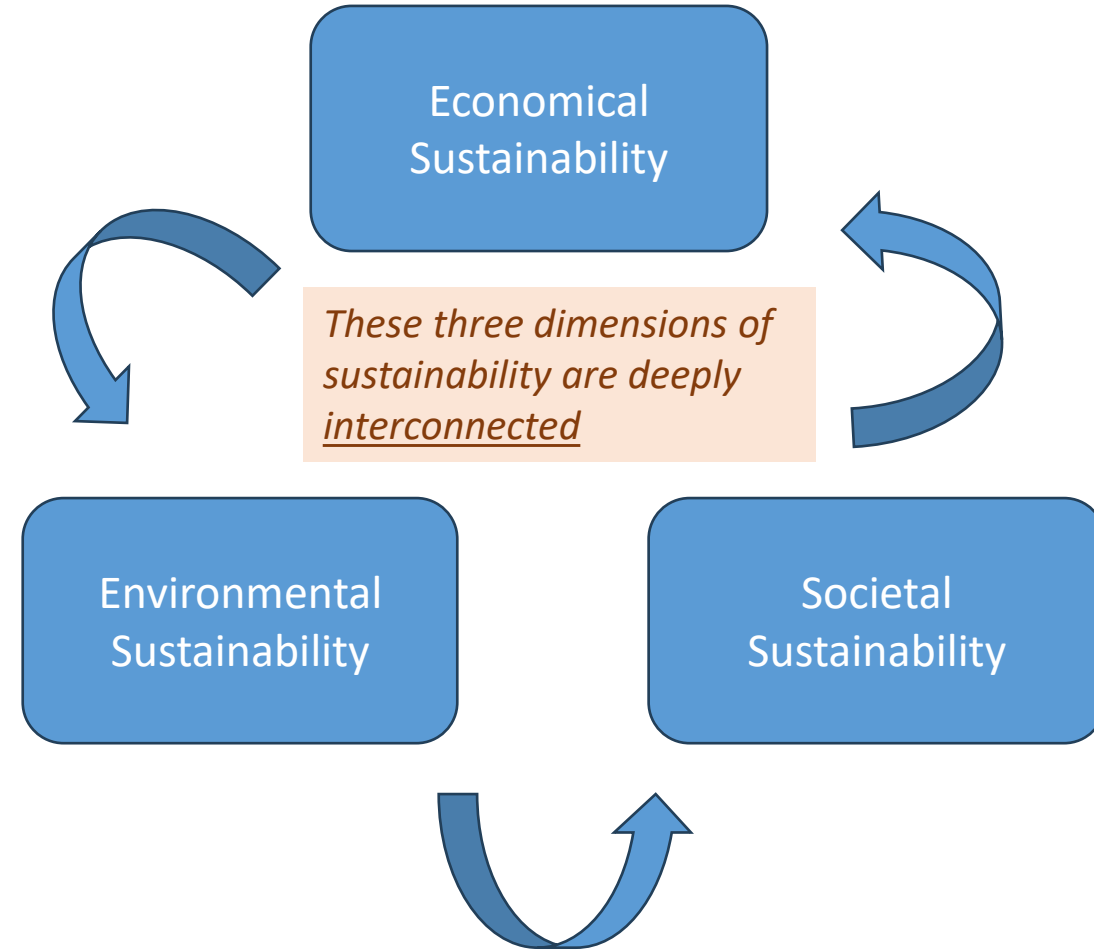
Reference document

- List of reference KPIs at application level

- Methodology to define the KVs and KVIs

[D6.1 First report on validation and dissemination activities](#)

available on

https://zenodo.org/records/10058287