SLICES

European Scientific Large-Scale Infrastructure for Computing/Communication Experimental Studies

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SZTAKI

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Prepared with the help of the SLICES community

The SLICES ESFRI program

- What is ESFRI?

- ESFRI, **the** **European Strategy Forum on Research Infrastructures**, is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach.

- SLICES is the first ESFRI program in the field of information technology

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Fully Controllable, programmable Virtualized Digital Infrastructure Test Platform
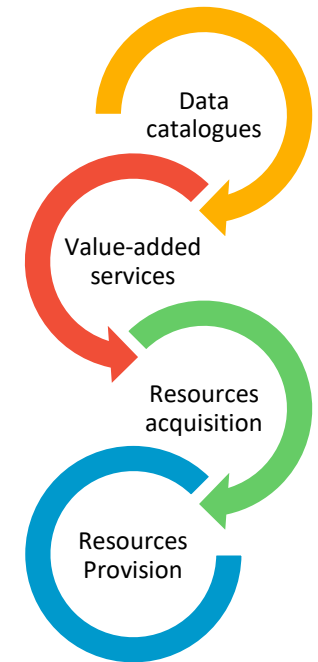

- SLICES will be a highly distributed infrastructure
- The environments we aim to study are themselves distributed, e.g., Fog/Edge computing
- Goal is to support a large variety of viable topologies in distributed computing systems.
- SLICES will provide a fully programmable, remotely accessible infrastructure
- The software architecture of SLICES will organize the different geographically dispersed site facilities in a single pan-European facility
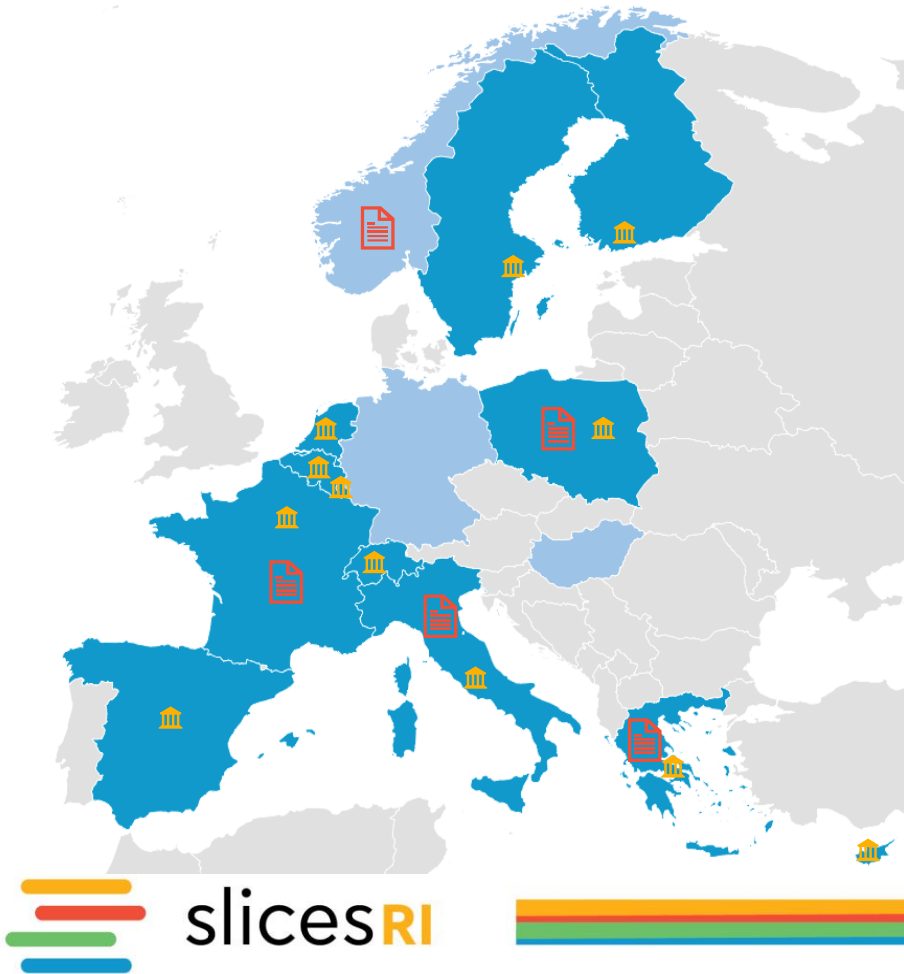
SLICES in a nutshell

- Launched in 2017, **SLICES** is a **RI** to support the **academic and industrial research community** that will design, develop and deploy the **Next Generation** of **Digital Infrastructures**:

    - **SLICES-RI** is a **distributed RI** providing several **specialized instruments** on challenging research areas of Digital Infrastructures, by **aggregating** networking, computing and storage **resources** across countries, nodes and sites.

    - *Scientific domains*: networking protocols, radio technologies, services, data collection, parallel and distributed computing and **in particular cloud and edge-based computing architectures and services**.

www.slices-ri.eu

what we offer

Data catalogues

Value-added services

Resources acquisition

Resources Provision
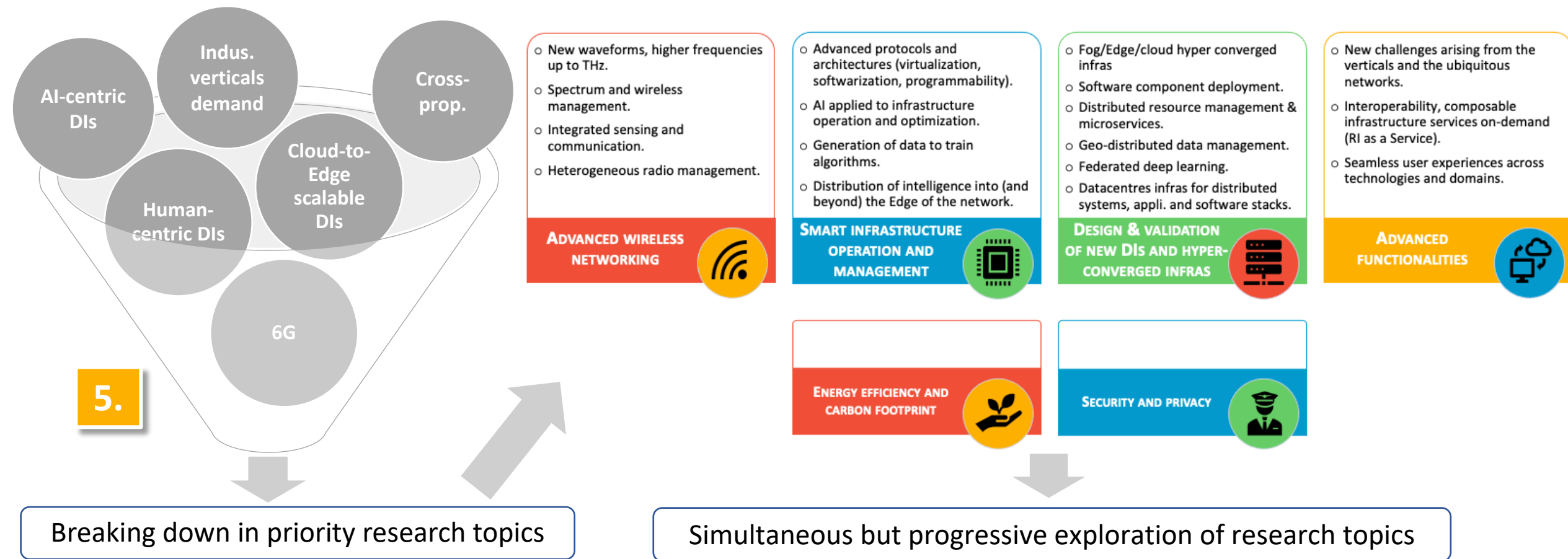
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SLICES for research on DIs

Initiated in 2017, **25 partners** from 15 countries:

- **12 political support** from National Ministries 🏛️

- included in **5 national roadmaps** 📄

SLICES will enable **scientific excellence and breakthrough** and will **foster innovation in the ICT domain**, strengthening the **impact of European research**, while contributing to European agenda to address **societal challenges**, and in particular, the twin transition to a sustainable and digital economy.

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Prioritisation of research topics

What's the methodology behind it?

AI-centric DIs

Indus. verticals demand

Cross-prop.

Cloud-to-Edge scalable DIs

Human-centric DIs

6G

5.

- o New waveforms, higher frequencies up to THz.
- o Spectrum and wireless management.
- o Integrated sensing and communication.
- o Heterogeneous radio management.

ADVANCED WIRELESS NETWORKING

- o Advanced protocols and architectures (virtualization, softwarization, programmability).
- o AI applied to infrastructure operation and optimization.
- o Generation of data to train algorithms.
- o Distribution of intelligence into (and beyond) the Edge of the network.

SMART INFRASTRUCTURE OPERATION AND MANAGEMENT

- o Fog/Edge/cloud hyper converged infras
- o Software component deployment.
- o Distributed resource management & microservices.
- o Geo-distributed data management.
- o Federated deep learning.
- o Datacentres infras for distributed systems, appli. and software stacks.

DESIGN & VALIDATION OF NEW DIS AND HYPER-CONVERGED INFRAS

- o New challenges arising from the verticals and the ubiquitous networks.
- o Interoperability, composable infrastructure services on-demand (RI as a Service).
- o Seamless user experiences across technologies and domains.

ADVANCED FUNCTIONALITIES

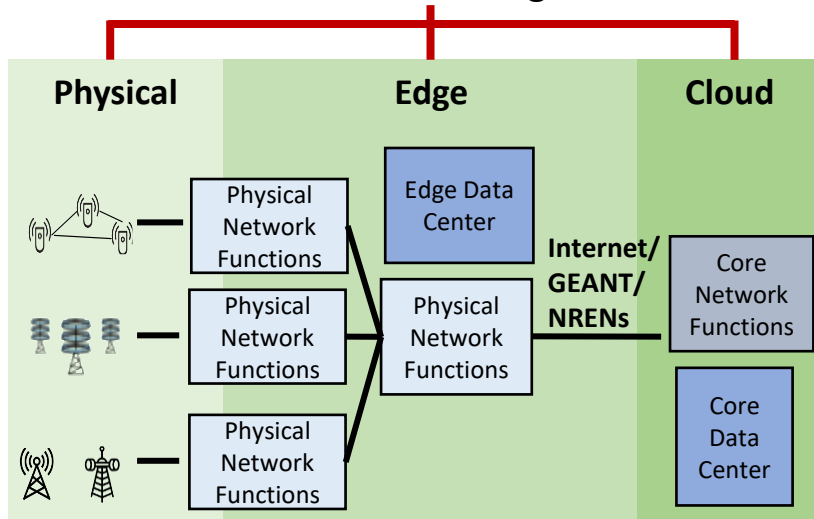**ENERGY EFFICIENCY AND CARBON FOOTPRINT**

SECURITY AND PRIVACY

Breaking down in priority research topics

Simultaneous but progressive exploration of research topics

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Prioritisation of research topics

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SECURITY AND PRIVACY

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SLICES contribution to the development of the EOSC

Objectives: **federate existing research data infrastructures in Europe** and **realise a web of FAIR data** and **related services for science.**

#1 Enable experimentation at multiple network levels through **SLICES RI**

Physical	Edge	Cloud

Physical Network Functions

Edge Data Center

Physical Network Functions

Physical Network Functions

Physical Network Functions

Internet/ GEANT/ NRENs

Core Network Functions

Core Data Center

Allow experimentation with future/emerging digital, IT and network technologies (e.g., 6G, IoT, Edge, AI, hyper-converged infrastructure).

#2 EU-wide availability of **unique Software and App Repositories**

- **ICT research-related services (e.g., testing new infrastructure and network solutions);**
- Applications deployed within SLICES;
- Simulation tools;
- Data analysis tools.

Published in the EOSC Catalog and Marketplace and accessible with different access options.

open access

Orderable via provider channel

EOSC-hub
Orderable via EOSC hub

#3 Interoperability with **Open and FAIR data**

- Producers of unique data;
- **Maximize data reuse by adopting of FAIR data principles in Data Management and Governance;**
- Processing of sensitive and personal information.

#4 Integration of the **SLICES communities to EOSC**

- SLICES community building
  - More than 120 participants to the 1st SLICES workshop;
  - Thousands of users of existing infrastructures.
- Training services

SLICES timeline II.
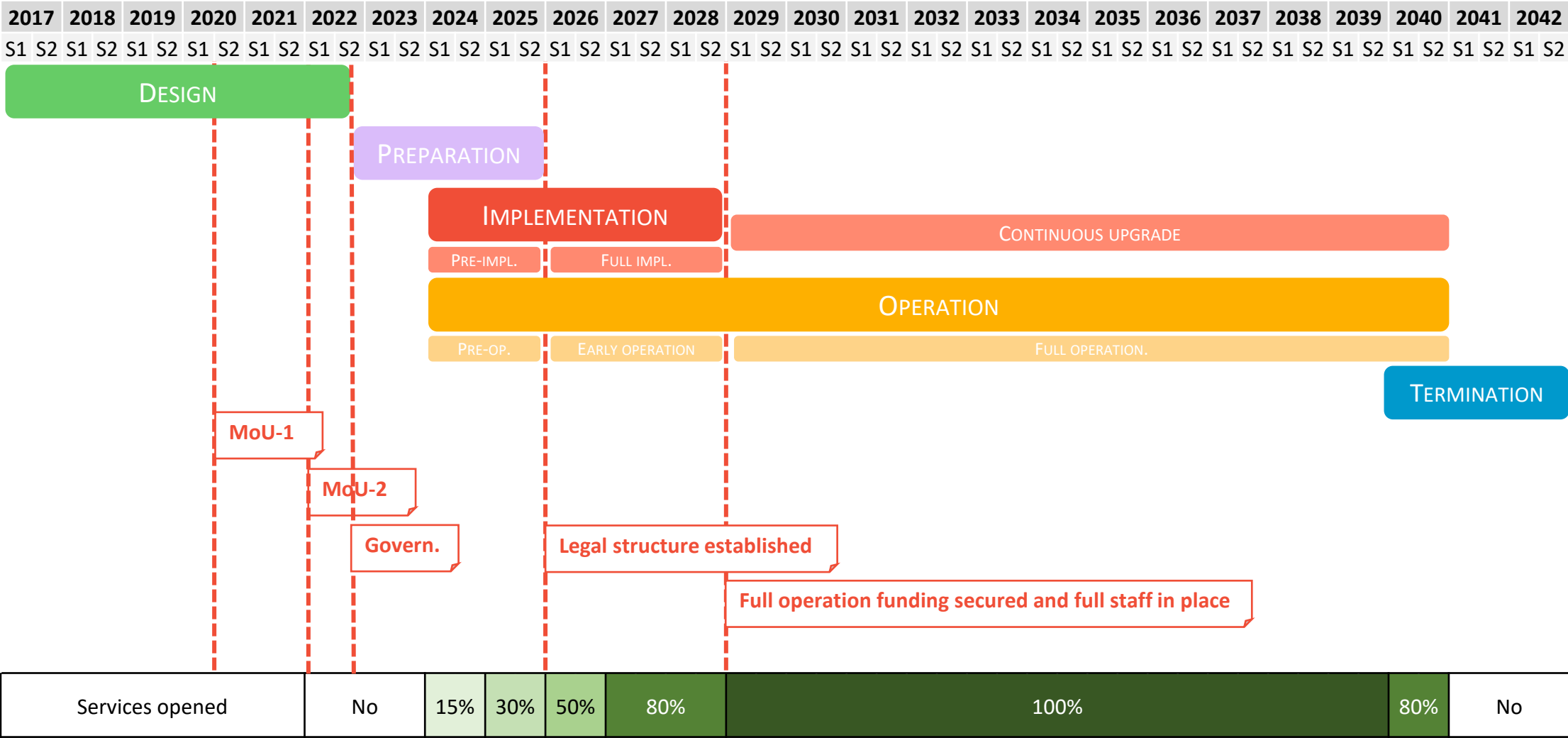
SLICES timeline I.

SLICES-SC, as part of SLICES

2020		2021				2022				2023				2024
Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1

Sep. SLICES-DS (24M) **Aug.**

Mar. SLICES-SC (36M) **Feb.**

SLICES-PP

Sep. SLICES PREPARATION PHASE (40M, up to Dec. 2025)...
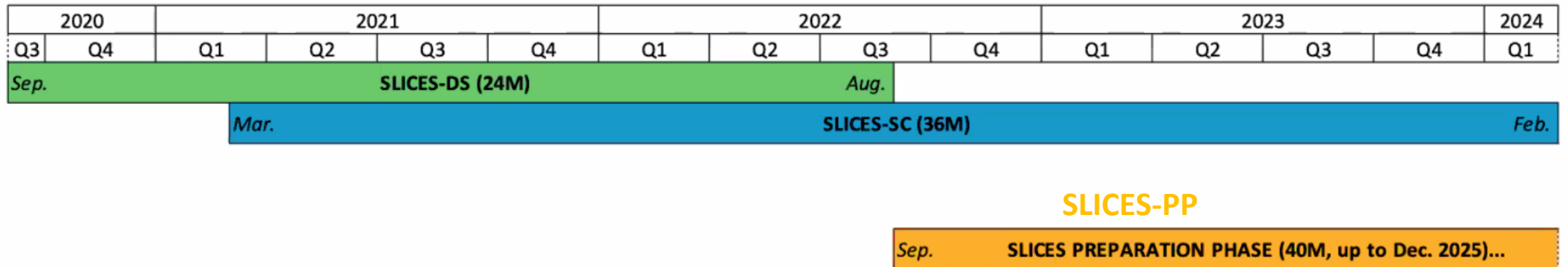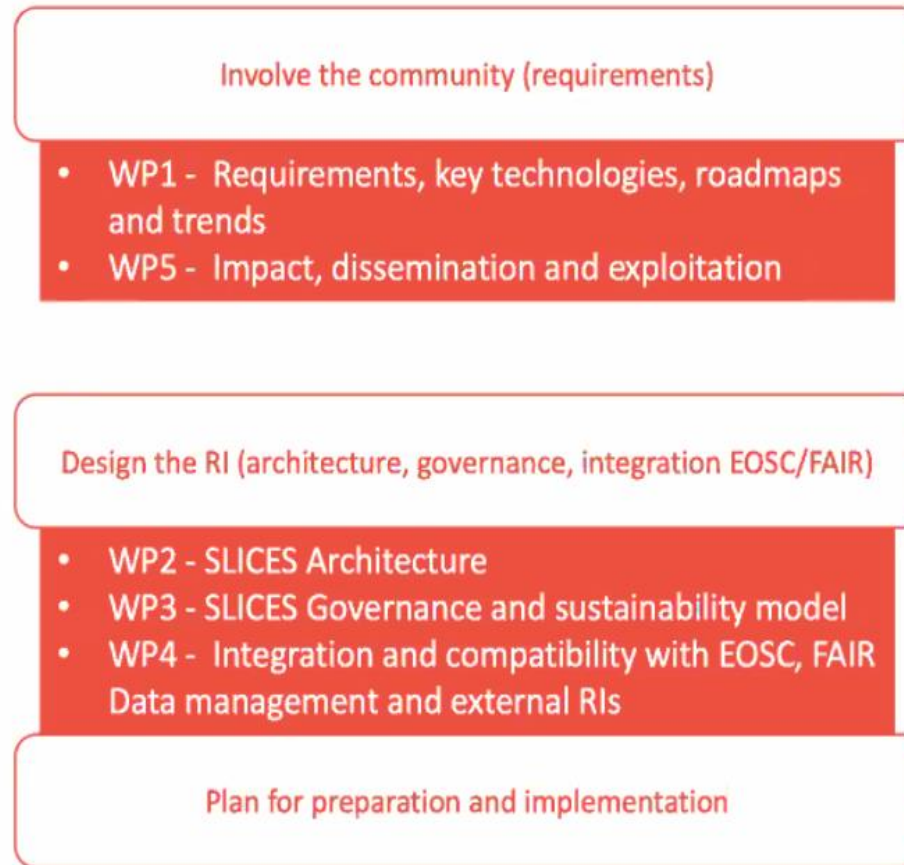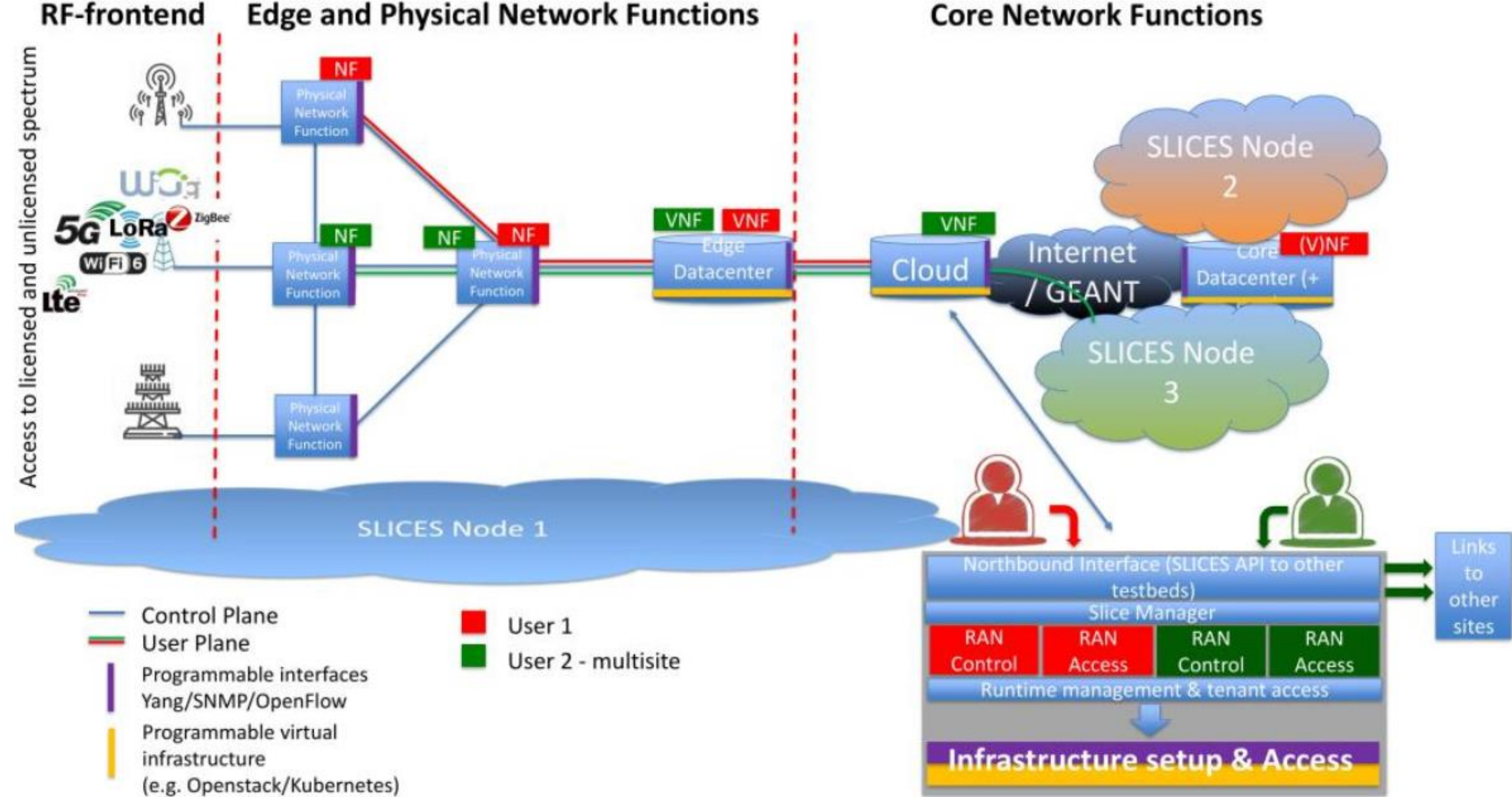
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Figure 1: SLICES Architecture Layout Overview

Architecture layout

- WiFi AP — DU
- RU
- eNB — DU
- gNB — DU
- IoT GW
- V CPU
- V RAM
- V STORAGE

Multi–domain Orchestrator

SLICES API

Infrastructure Manager

RI1 RI2 . . . RIX

VNF1 VNF2 VNFX

Internet

Legend:
- ■ Control Plane
- ■ Data Plane
- ■ Network Functions
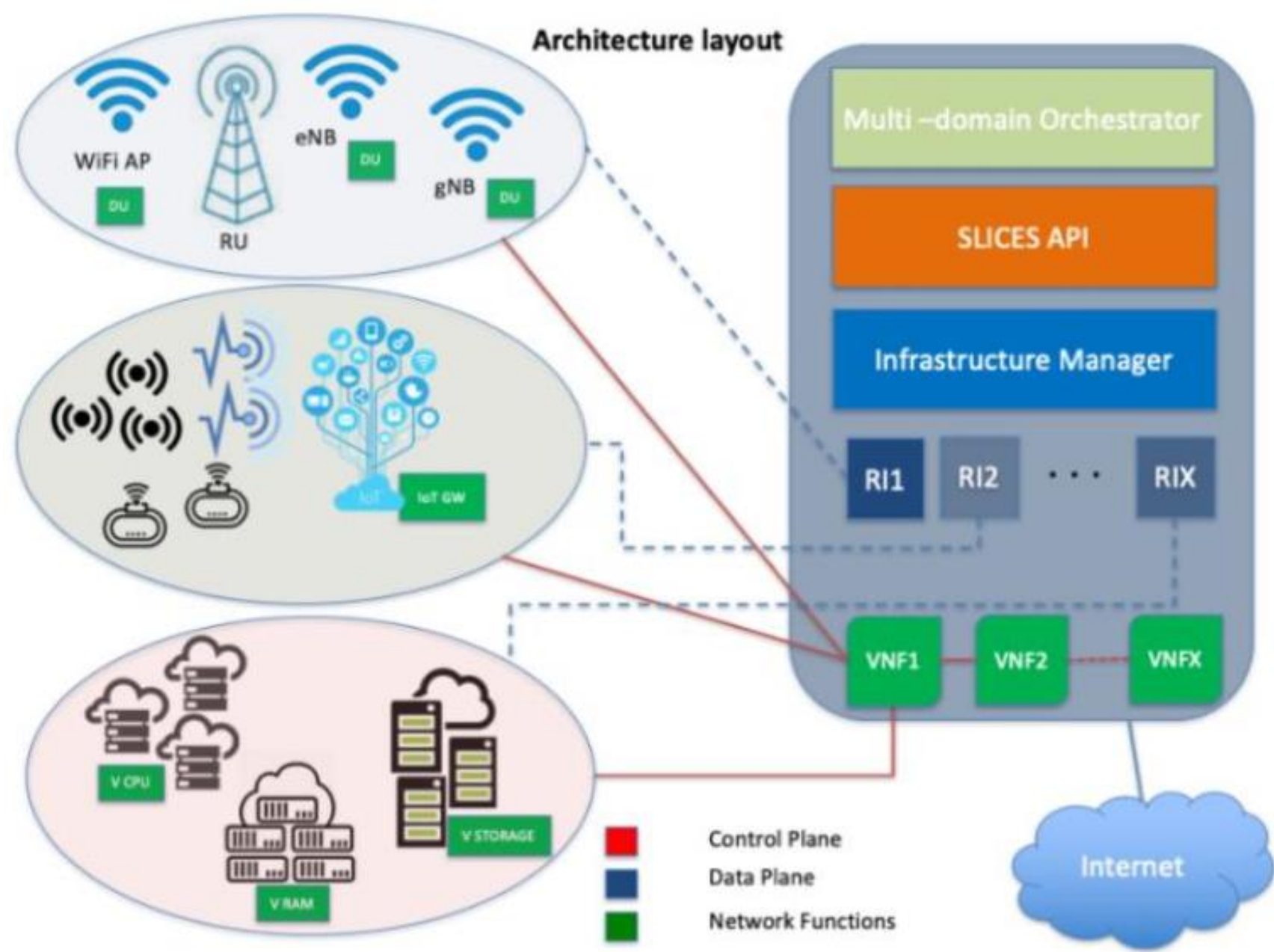
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Figure 3: SLICES conceptual architecture

SLICES-SC web page: https://slices-sc.eu/

SLICES Ris
https://slices-sc.eu/infrastructures/

- Sorbonne University
- University of Thessaly
- National Research Council
- PSNC
- Imdea Networks
- Imec
- EURECOM
- Cosmote
- SZTAKI
- University of Oulu
- Inria
- Technical University of Munich

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Imec IDLab iLab.t infrastructure

The node at iMEC exists out of 5 testbeds at two locations in Belgium (Gent and Antwerpen) (https://doc.ilabt.imec.be):

• Virtual wall (Gent): to perform wired networking, cloud, distributed software, service backends and scalability experiments. 550+ installed servers.
• w-iLab.t (Gent): pseudo shielded environment for wireless and IoT research with over 150 wireless nodes (fixed and mobile), including software defined radios
• Officelab (Gent): a real office environment for wireless and IoT research with over 110 embedded PCs spread over the building.
• GPULab (Gent and Antwerpen): testbed with 125+ GPUs with over 570.000+ cuda cores and 1.8TB+ GPU RAM for AI research and everything which needs GPUs
• CityLab (Antwerpen): testbed for wireless networking experimentation in the unlicensed spectrum in the city of Antwerp. 50 nodes are spread over an area of 1 square km.
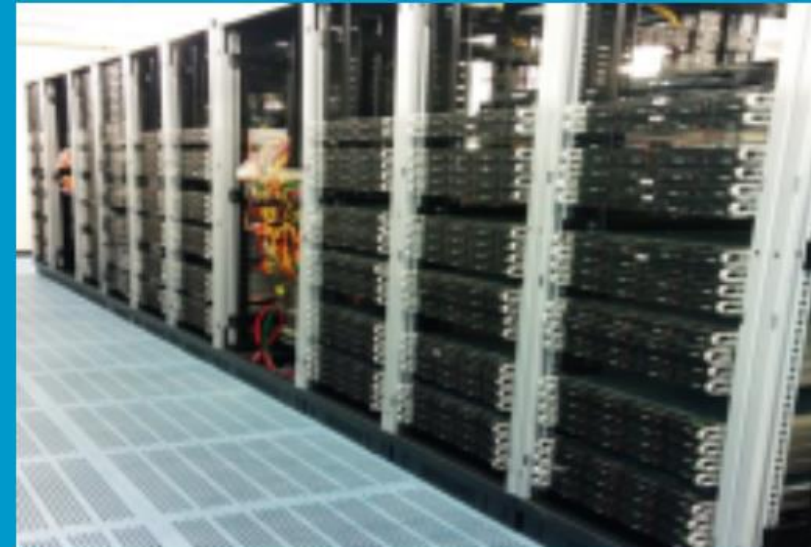
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PSNC	Imdea Networks	Imec
EURECOM	Cosmote	SZTAKI
University of Oulu	Inria	Technical University of Munich

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OneLab Cloud Infrastructure

- The facility is located in the campus Sorbonne Université at Paris

- Provides bare-metal, cloud compute and storage resources to run Cloud-based experiments

- Serge Fdida serge.fdida@lip6.fr

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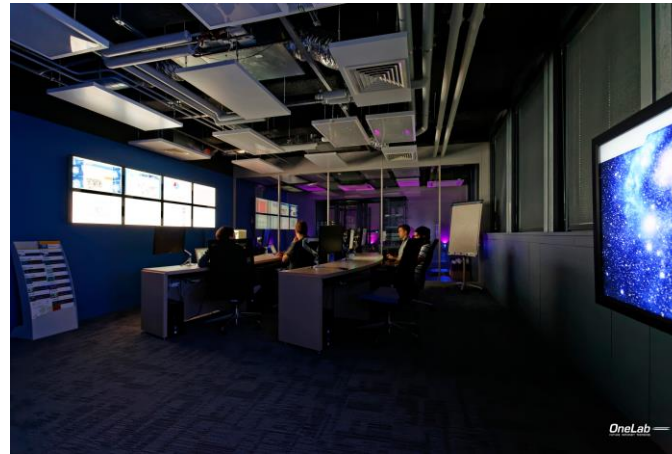
CloudLab: Paris Cluster

- Collaboration with the NSF's CloudLab US project

- Related to the development and deployment of Cloud Software Stack components and services

- Control over compute, storage and network resources and visibility all the way down to the bare metal

- Access all CloudLab sites infrastructure using a OneLab Credential

OpenStack Cloud Automation

- Automate the provisioning and configuration

- Provides customizable Virtual Servers on the OpenStack Cloud

- Composed of 3 controller nodes and 9 compute nodes, it provides over hundred of compute cores to experimenters.

- Connected to a 10G SFP+ network switch

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Accessibility

- The resources are available in our portal
- Option to automate the resources configuration with ansible-playbooks supports
- Access via SSH directly or via a gateway

Select resources (3 Maximum)

medium-2vcpu-4ram
- VCPU: 2 Cores
- Storage: 15GB
- RAM: 4GB

Add

medium-2vcpu-8ram
- VCPU: 2 Cores
- Storage: 20GB
- RAM: 8GB

Add

xlarge-8vcpu-16ram
- VCPU: 8 Cores
- Storage: 20GB
- RAM: 16GB

Add

medium-4vcpu-8ram
- VCPU: 4 Cores
- Storage: 20GB
- RAM: 8GB

Add

large-4vcpu-16ram
- VCPU: 4 Cores
- Storage: 20GB
- RAM: 16GB

Add

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The offer of the Polish Node for academia, industry and SMEs

Bartosz Belter bartosz.belter@man.poznan.pl

Poznan Supercomputing and Networking Center

SLICES-PL: the Polish Node of SLICES-RI

- The target RI will be based on projects from National Roadmap of Research Infrastructures in Poland:

  - **PIONIER-LAB**: National Platform for Integration of Research Infrastructures for Innovation Ecosystem

  - **5G-LAB Polska**: National Laboratory for Advanced 5G Research

  - **NLPQT**: National Laboratory for Photonics and Quantum Technologies

- All projects are currently in progress. Infrastructures in operation from Jan 2024.

SLICES-PL: the Polish Node of SLICES-RI

- Currently, only limited research services and resources are available for the 2nd Open Call for Experiments in SLICES-SC:
  - Cloud services
  - Multimedia services
  - Optical and measurement equipment

- At this moment the only API for accessing resources and services is email-based.

- All requests with the description of the experiment and required resources and services should be directed to the manager of the SLICES node (Bartosz Belter bartosz.belter@man.poznan.pl) and the internal mailing list at PSNC (slices@man.poznan.pl).

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SLICES-PL: the Polish Node of SLICES-RI

- **Cloud services**
  - Total: 512 vCPU, 2 TB RAM, 40 TB of disk space
  - Single reservation max 16 vCPU, 64 GB RAM, 1,25 TB of disk space

- **Multimedia services**
  - 8K Visualization Lab. A 6-meter-wide screen with native 8K resolution.
  - 8K recording set, consisting of 4 SONY F65 cameras with the ability to record and live stream of 8K signal.
  - Motion-capture equipment.
  - 3D scanning station.
  - High-order ambisonic sound equipment.

Selected examples of the use of SLICES Research Infrastructure by SMEs:
  - Distributed Deep Learning Platform: https://www.fed4fire.eu/demo-stories/oc1/ddlp/
  - Realtime ultrahigh definition medical collaboration platform: https://www.fed4fire.eu/demo-stories/oc1/ubimed4k/

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Open5GLab

- Open5GLab at EURECOM is one of 3 experimental 5G sites in France.

- Construction began in July 2018 and 5G experimentation is now available.

- The site is interconnected with similar sites in Europe in the 5G-EVE network.

- Open5gLab provides experimental 5G services including so-called Enhanced Mobile Broadband (eMBB) and massive machine-type communications

- It is the main experimental playground for OpenAirInterface (OAI) and Mosaic-5g (M5G) software packages.

- The site's cluster computing resource makes use of RedHat's OpenShift 4.2 Kubernetes container platform.

- The cluster is used for radio-access, core network and mobile-edge functions.

- Some bare-metal nodes with in-lab 5G-capable radio devices can be used with a Kubernetes cluster.

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5G test network of University of Oulu, Finnland

WiFi and IoT networks integrated

5G Test Network

IoT Network

WiFi

5G
LTE

Radio Access

MEC

Cloud Core

Services

10Gb VPN

5GTNF Interconnections

Other 5G Test Networks

From LTE evolution to 5G radio access

Mobile Edge Computing to bring services close to users access

Core network in a cloud environment

Cloud systems for applications available
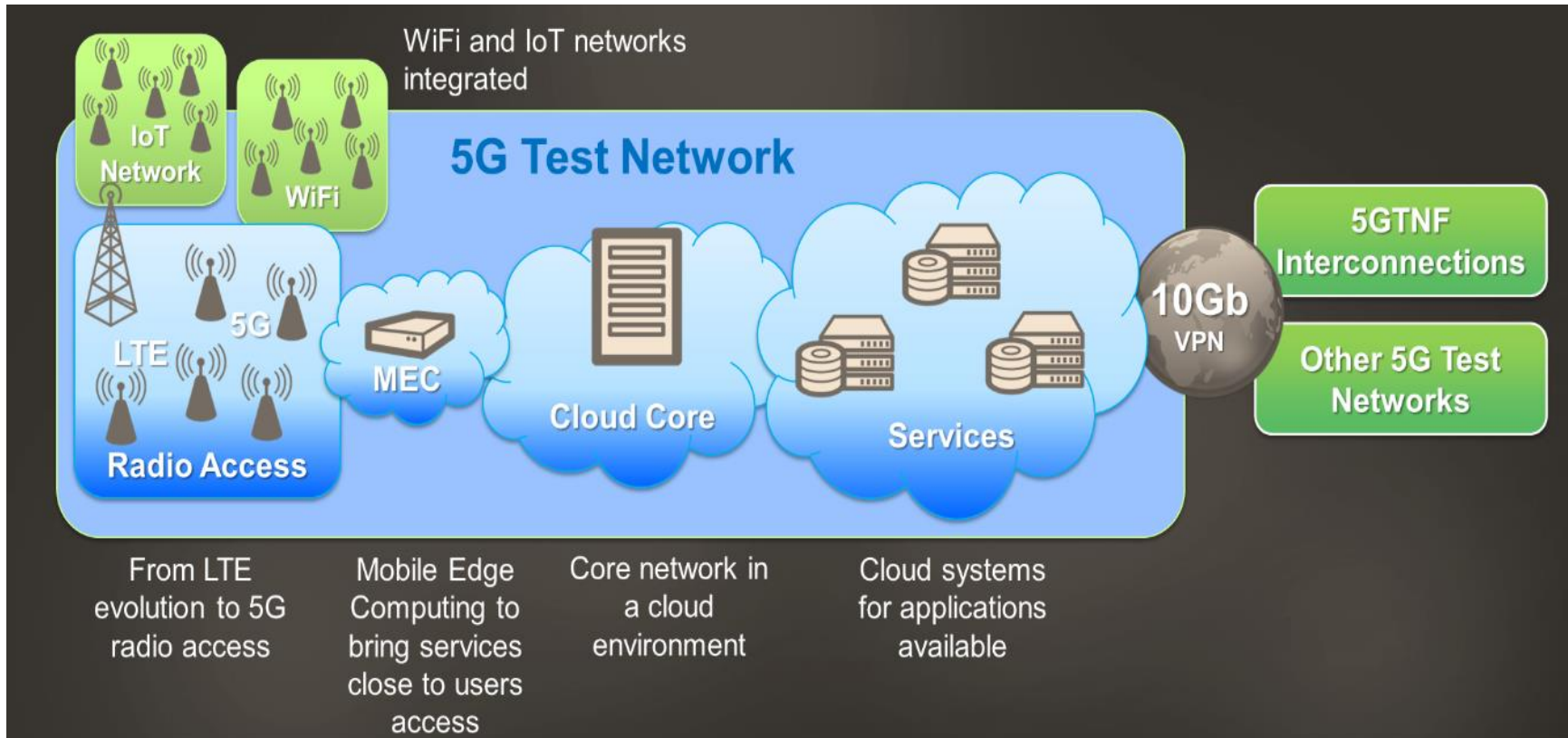
- Full-scale 5G test network supports
  - using 5G devices,
  - higher frequency bands,
  - cognitive management functionalities,
  - system testing tools for new solutions.
- The 5G Test Network feature evolution follows 5G research and standardisation progress
- **Acting as verification platform for theoretical 5G research.**

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NITOS testbed: a heterogeneous environment for 5G and beyond experimentation

Nikos Makris

nimakris@uth.gr

Dept. of ECE, University of Thessaly

Background Information

- Founded in 1984

- Located in Volos, Thessaly, Greece

- Network Implementation Testbed Laboratory (NITlab)

  - Head: Prof. Thanasis Korakis

  - 30 researchers (research engineers, postdocs, PhD students, master students)

  - Research activities in the field of wired and wireless networking, cloud, smart cities

  - Strong participation in EU projects

  - Website: https://nitlab.inf.uth.gr

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Team mission/goals

- The lab members focus their research in the following domains:
  - Research driven by experimentation with 5G, 4G, Wi-Fi, and mmWave wireless and programmable wired communication networks.
  - Research on Cloud and Edge Computing, virtualization of network and computing resources
  - Research on IoT (Internet of Things) technologies with the development of new platforms for testing wireless sensor networks, integrating various wireless communication technologies, and visualizing measurements.
  - Research on the application of Machine Learning for optimizing the network operation
- Key tool for the research is the **NITOS wireless testbed**

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NITOS Testbed
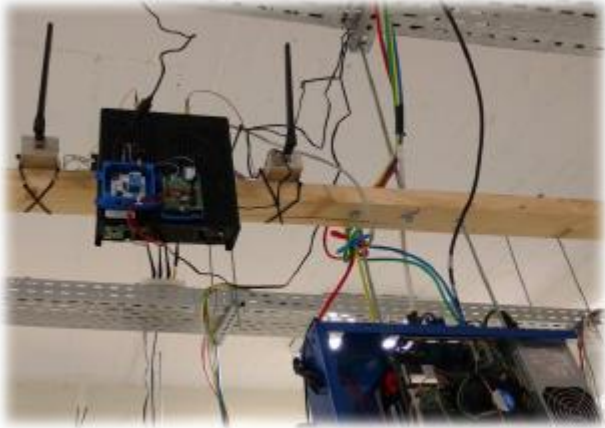
Several components allow experimentation with emerging 5G and beyond technologies

- **Open-Source 5G** with Software Defined Radios
- **Edge cloud** deployments for minimized latency (<10ms for 5G access)
- Antennas with programmable attenuation for **mobility emulation**
- Point-to-multipoint mmWave units with beam-steering capabilities for **Fixed Wireless Access**

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Inria

Technical University of Munich

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5TONIC Facility

Carmen Guerrero

carmen.guerrero@uc3m.es

University Carlos III of Madrid

IMDEA Networks

What is 5TONIC?

LTE Radio: Long Term Evolution Radio
NB-IoT: Narrowband Internet of things

5TONIC Main Site: IMDEA Networks

- Standalone building

- Access both to open ground and rooftop, for the installation of radiating elements

- Equipment center, hosting the equipment of members and collaborators

- 10 Gbps internet connection

- Auditorium and facilities for public presentations and events

- Additional facilities at Telefónica and Ericsson offices

- Access to UC3M facilities both in Leganes and Madrid city center

5TONIC objectives

5TONIC is an international **open co-creation laboratory** focusing in **5G/6G technologies**, founded by Telefónica, IMDEA Networks and University Carlos III of Madrid and based in Madrid
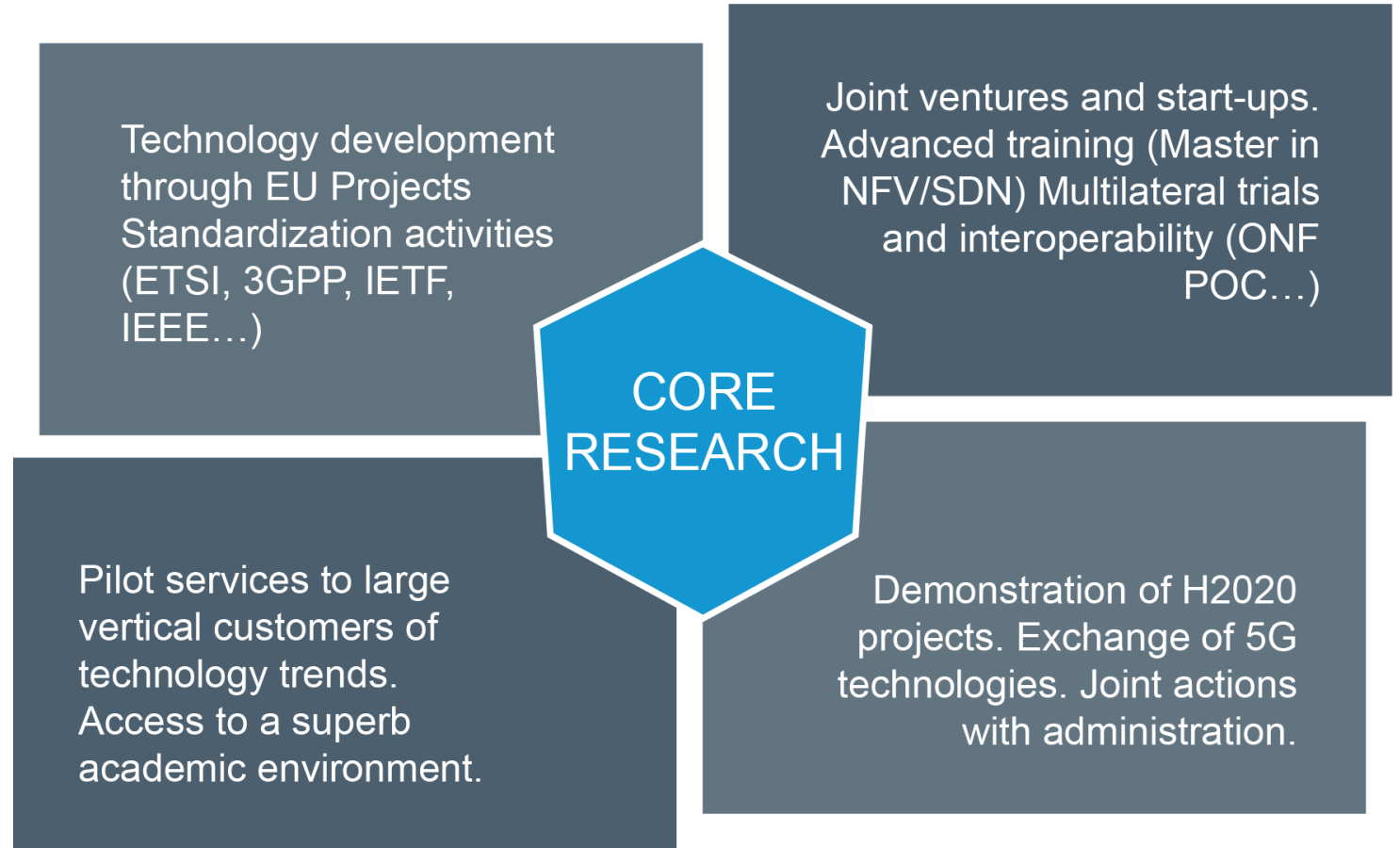
Technology development through EU Projects Standardization activities (ETSI, 3GPP, IETF, IEEE…)

Joint ventures and start-ups. Advanced training (Master in NFV/SDN) Multilateral trials and interoperability (ONF POC…)

CORE RESEARCH

Pilot services to large vertical customers of technology trends. Access to a superb academic environment.

Demonstration of H2020 projects. Exchange of 5G technologies. Joint actions with administration.

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COSMOTE Exploitation Options

IoT Testbed/Playground – RT Mode

A "site" with various sensors (energy, environmental, door/window, activity, etc.) integrated (*)

RT data acquisition – via MQTT
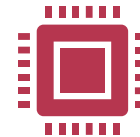
(Cloud) WebGUI for sensor measurements depiction, manipulation/actuation, automations, etc.
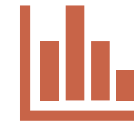
NRT and historical sensors' data visualization

(*) Possibility to incorporate additional sensors residing in other locations | anywhere

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R2lab: Reproducible Research Lab

Walid Dabbous, Thierry Parmentelat, Thierry Turletti, Damien Saucez

(firstname.lastname@inria.fr)

INRIA Sophia Antipolis Research Center

January 19th 2023

R2lab: Reproducible Research Lab

Hardware
- An RF isolated anechoic chamber
- 37 PCs with 2 WiFi cards
- With s/w radio devices
  (USRP, limesdr, LoRa…)
- 2 COTS mobile phones
- To come: RRU & P4 switches

Experimental features
- Wholesale reservations
- Full control of nodes
- OS images store

Software
- OpenAirInterface for 4g/5g
- GnuRadio for USRP
- nepi-ng experiment controller

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For more information

- The R2lab web site:
  - https://fit-r2lab.inria.fr/

- Several tutorials are available at:
  - https://fit-r2lab.inria.fr/tutorial.md

- Publications related to R2lab can be found at:
  - https://fit-r2lab.inria.fr/papers.md

- To sign up:
  - https://fit-r2lab.inria.fr/tuto-010-registration.md

- Contacts:
  - fit-r2lab-users@inria.fr, Thierry.Parmentelat@inria.fr.

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SLICES-ITA

The SLICES-ITA infrastructure node is a combination of heterogeneous testbeds independently operated by CNR, CNIT and CINI. In the following, we provide a brief description of these testbeds. It is important to point out that, while CNR, CNIT and CINI are all members of the SLICES initiatives, only CNR participates in the SLICES-SC project. Thus, transnational and virtual access activities will primarily be supported using CNR facilities.

Pisa – Italy
protocollo.iit@pec.cnr.it

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Thank you

On behalf of SLICES consortium

www.slices-ri.eu

For more information, please contact:
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slices — February 22, 2022

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