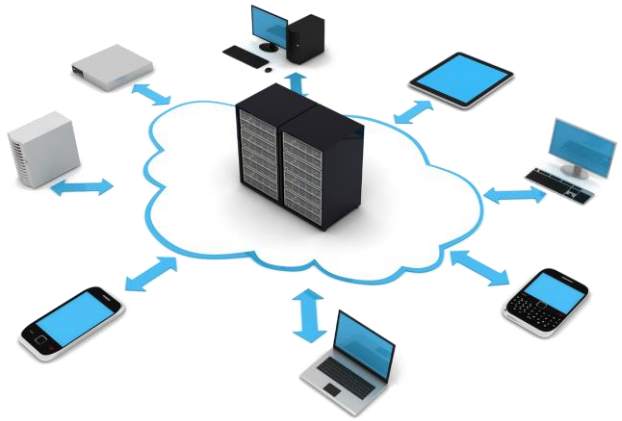


SLICES

Super Infrastructure for
Large-Scale Experimental Computer Science

Christian Perez
Inria

Convergence of Computation and Communication

Computation

1950/1990 - Mainframes

1975 -Personal Computers

ENIAC
1946

1950 - Batchmode
1960 - Interactive
1967 - First virtualisation attempt
1970 - Terminals (clients/server concepts)

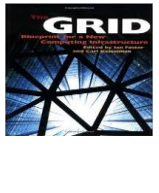
1999 - Salesforces
SaaS Concept

2002 - Virtualised Infrastructure

2010 - Cloud democratisation

2015
Fog / Edge
Software Defined XXX
5/6G

1999 - The Grid



2002- Amazon Initial
Compute/Storage services

2006 - Amazon EC2 (IaaS)

SmartPhones
2007

Transistor
1947

micro processor
1971

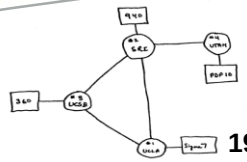
1995 - Commodity clusters

1838 - Telegraph

1876 - Telephone

1957 - satellite

1896 - Radio

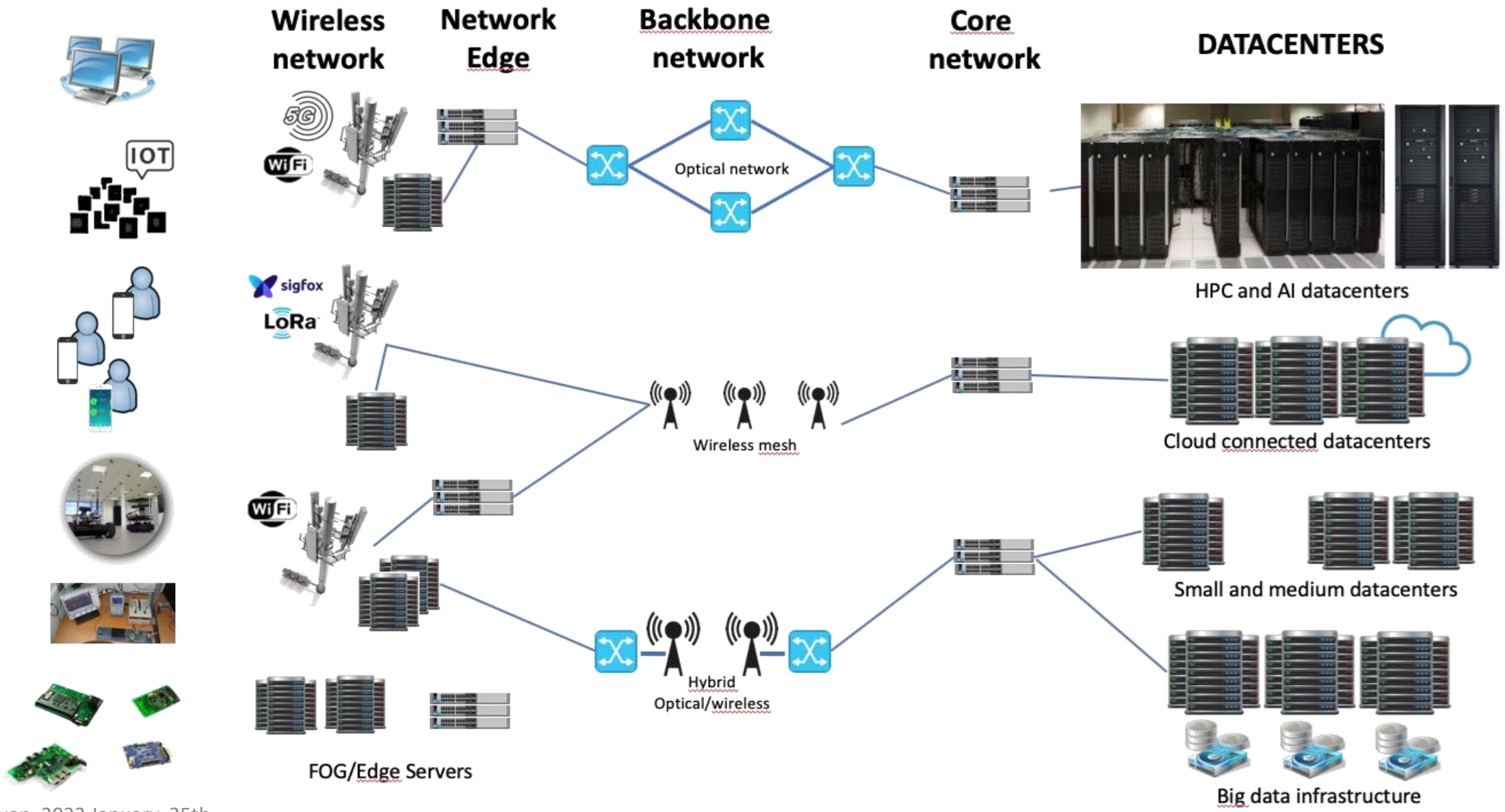


1985 - TCP/IP Adoption
1973 - Ethernet

1969 - ARPANET

Communication

Digital Environment



The Discipline of Computing: An Experimental Science

The reality of computer science

- Information
- Computers, networks, algorithms, programs, etc.

Studied objects are more and more complex

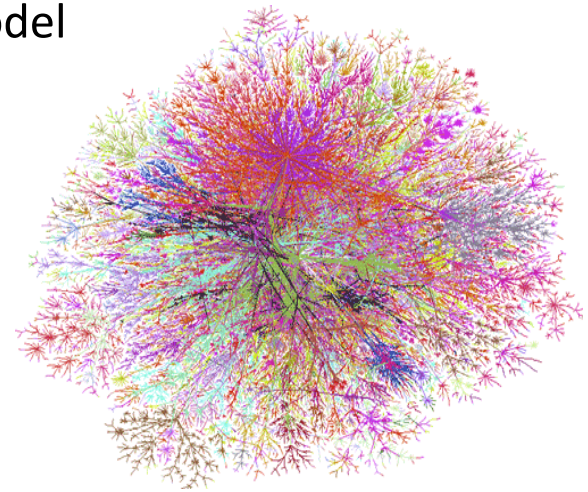
- Hardware, Systems, Networks, Programs, Protocols, Data, Algorithms, **…**

Experimental Validation: A good alternative to analytical validation

- Provides a comparison between algorithms and programs
- Provides a validation of the model or helps to define the validity domain of the model

Several methodologies

- Simulation (SimGrid, NS, …)
- Emulation (MicroGrid, Distem, …)
- Benchmarking (NAS, SPEC, LINPACK, ….)
- Real-scale (Grid’5000, FIT, FED4Fire, Chameleon, OpenCirrus, PlanetLab, …)



Good Experiments

A **good experiment** should fulfill the following properties

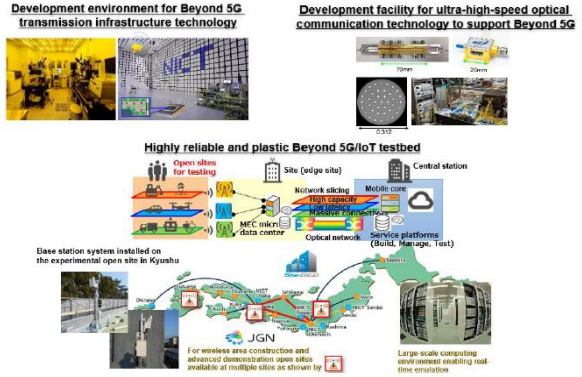
- **Reproducibility**: *must* give the same result with the same input
- **Extensibility:** *must* target possible comparisons with other works and extensions (more/other processors, larger data sets, different architectures)
- **Applicability:** *must* define realistic parameters and *must* allow for an easy calibration
- **"*Revisability*":** when an implementation does not perform as expected, *must* help to identify the reasons

ACM Artifact Review and Badging

Association for Computing Machinery

https://www.acm.org/publications/policies/artifact-review-and-badging-current

Third generation Mid-Scale (~100M$) Test Platforms



USA NSF PAWR (Platforms for Advanced Wireless Research): NSF + Industry, 100M€, 2017-2022

NSF Fabric: NSF, 20 M€, 2019-2023

Colosseum: NSF-DARPA, 20+7,5M$, 2017-2025.

Chameleon: NSF, 10M€, 2020-2023

EU Horizon Europe
ICT 17-19-52, 2018-2022
205 M€
SNS Stream C, first call, 2022-2025, 25M€

Japan NICT R&D
Shared Open Platform
200 M$

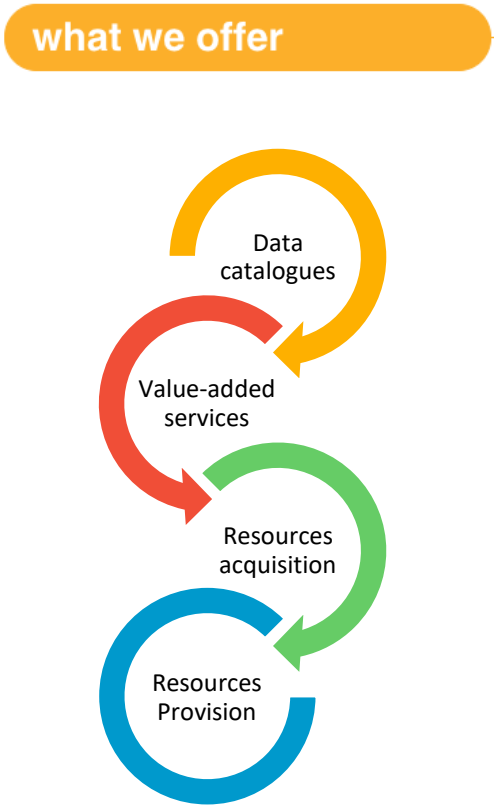
China CENI
Chinese Experimental National Infrastructure
2018-2022
190 M€

SLICES Research Infrastructure

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

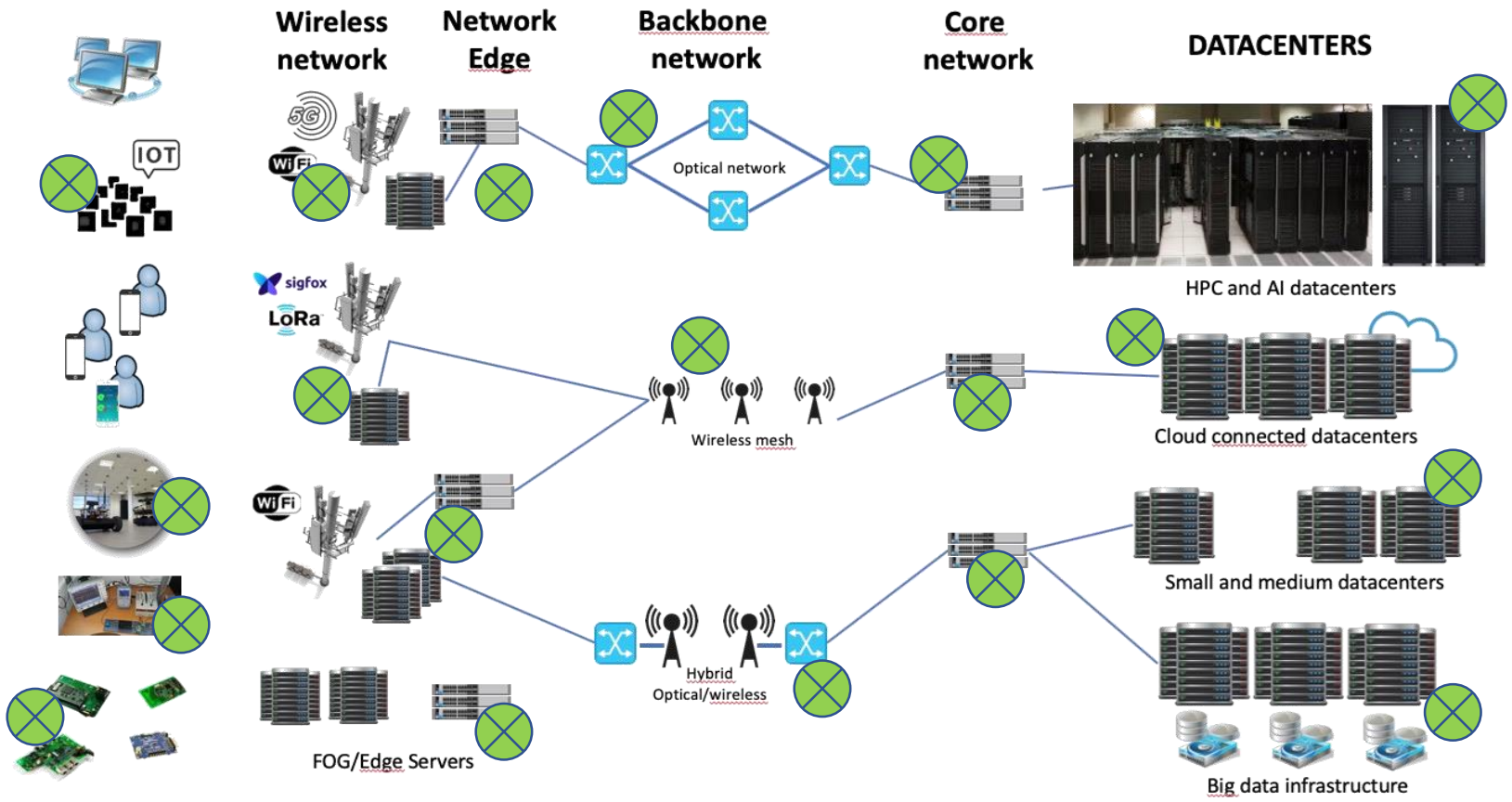
- **SLICES-RI** is a ***distributed RI*** aiming at deploying at Fully Open Controllable, programmable Virtualized Digital Infrastructure test Platform
- ***Gathering many scientific domains***: networking protocols, radio technologies, services, data collection, parallel and distributed computing, cloud and edge-based computing architectures and services

www.slices-ri.eu



SLICES

Fully Controllable and Programmable Digital Infrastructure Test Platform



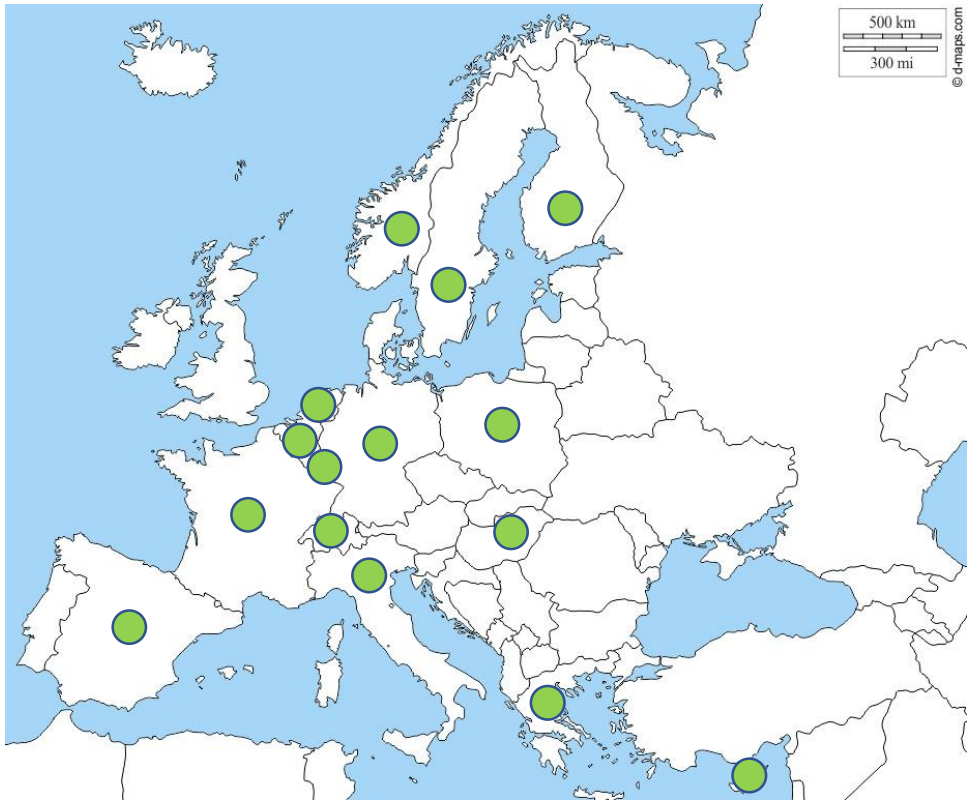
https://slices-ri.eu

Controllable, Programmable, Monitorable Element

SLICES – ESFRI Project since 2021

25 Participants from 15 countries

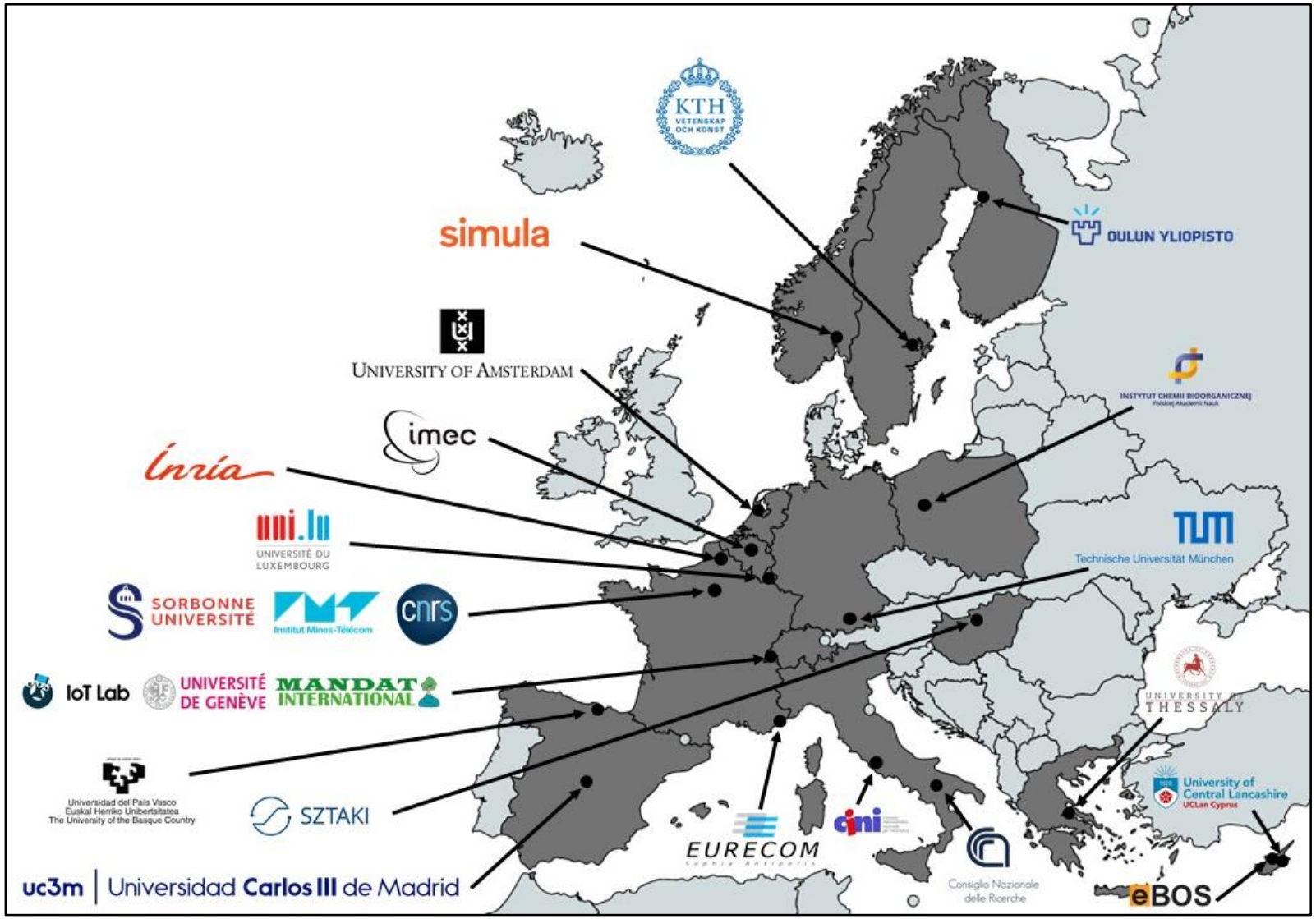
- Belgium
- Cyprus
- Finland
- **France (leader)**
  - **CNRS, Eurecom, INRIA, IMT, SU**
- Germany
- Greece
- Hungary
- Italy
- Luxembourg
- The Netherlands
- Norway
- Poland
- Spain
- Sweden
- Switzerland



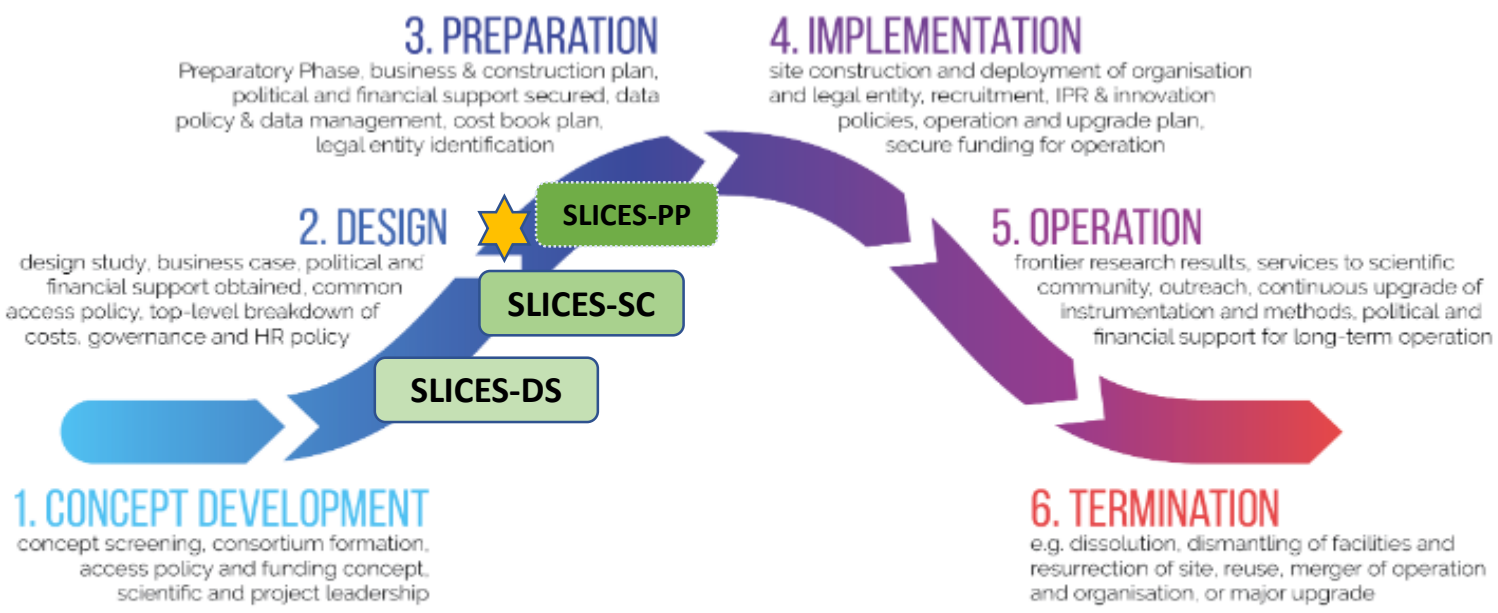
In cooperation with GIANT and national NRENs
Strong integration into the EOSC ecosystem

ESFRI: European Strategy Forum on Research Infrastructures

SLICES-PP: Consortium



Lifecycle of an ESFRI Research Infrastructure



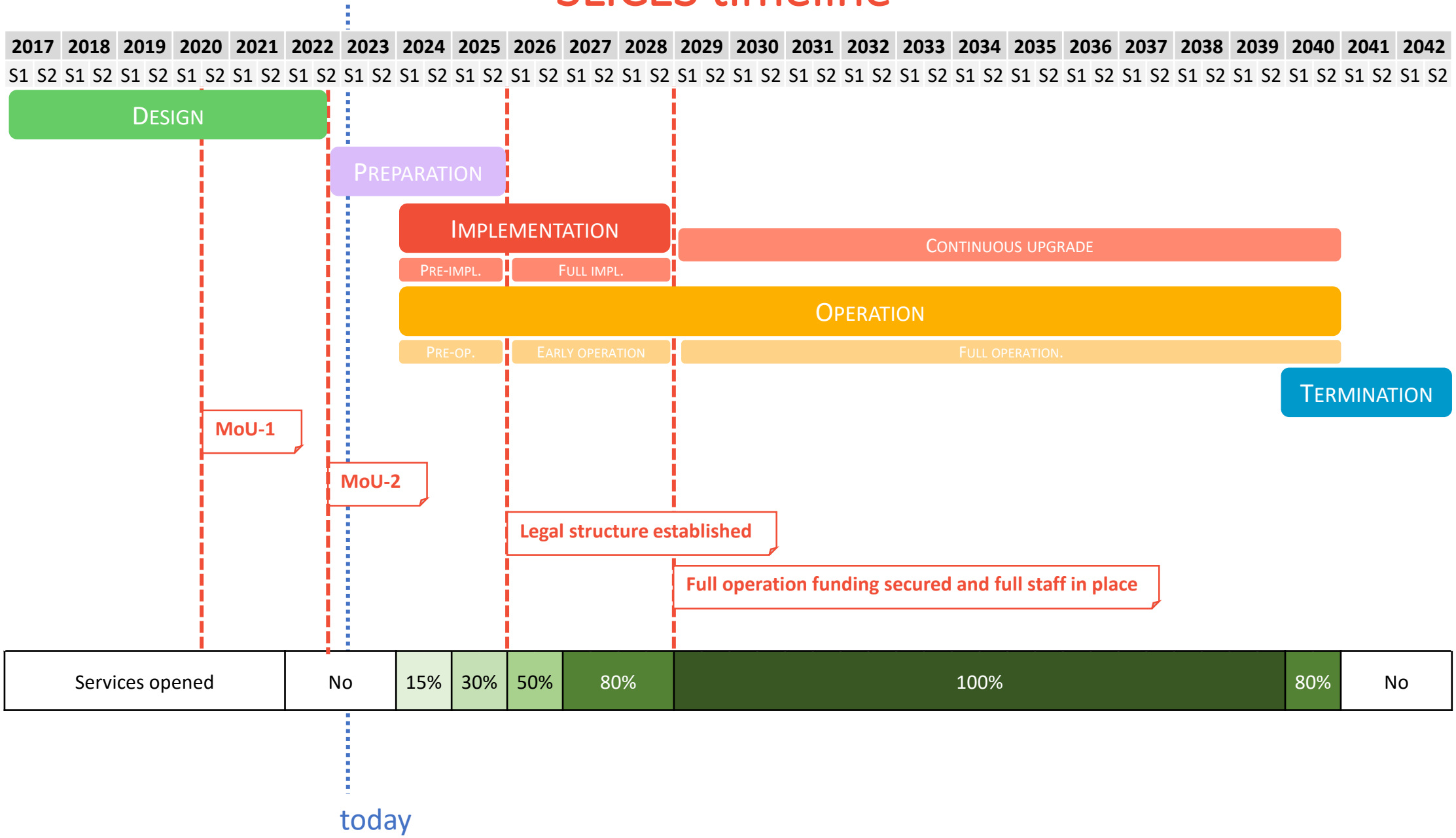
Supported by 2 projects started in 2020

- Slices Design Study (SLICES-DS)
  - Completed
- Slices Starting Community (SLICES-SC)

Preparation phase started in Sep. 2022

- Slices Preparatory Phase (SLICES-PP)
  - Duration: 40 months

SLICES timeline



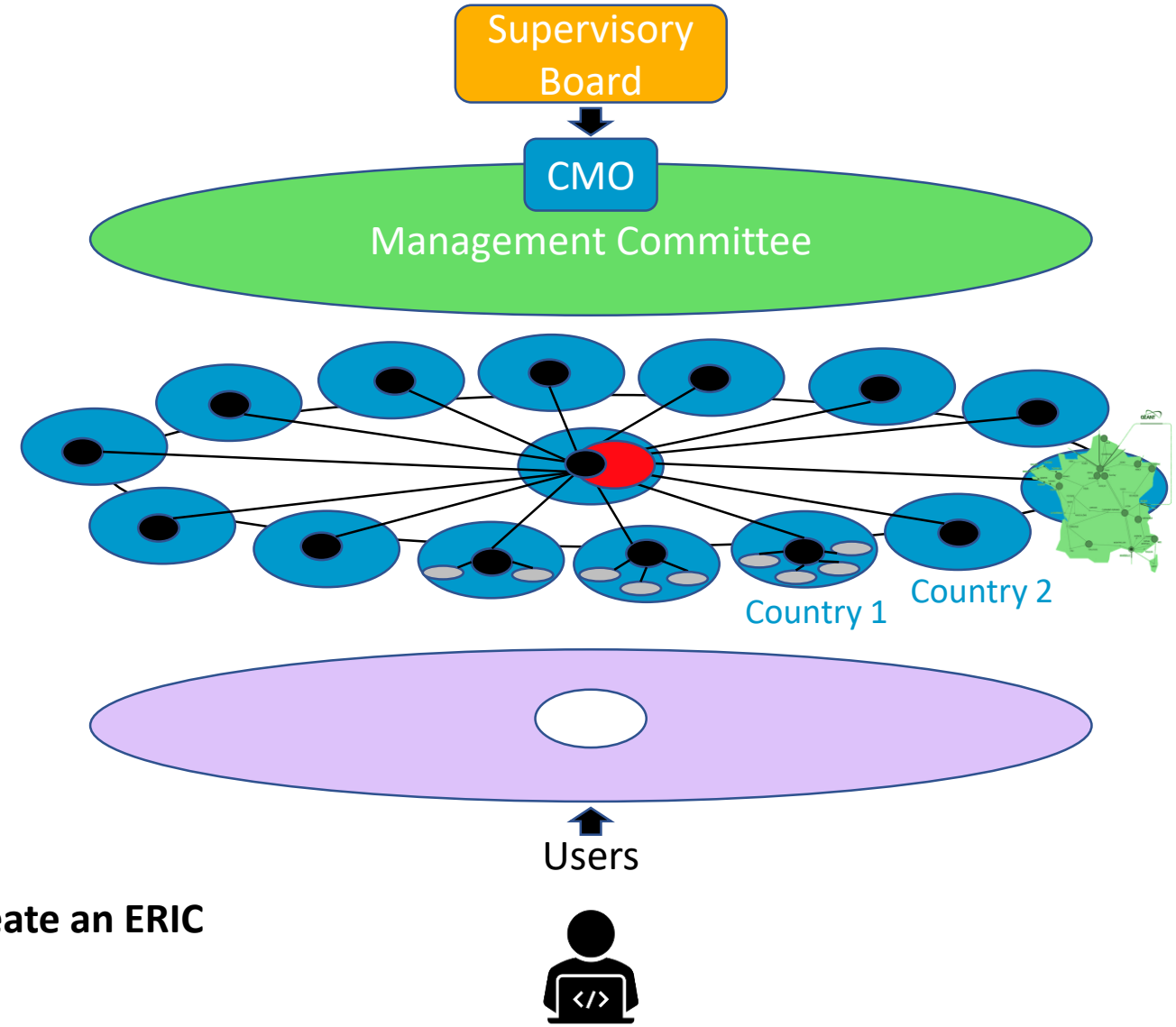
SLICES: A Distributed Research Infrastructure

Centralised governance

Distributed Infrastructure

Single entry point, single access policy

Decision to create an ERIC



Joint investment strategy

Decisions on new nodes

Decisions on core functions and data centre

Optimize the distribution of resources according to needs and competences

SLICES-FR: The French Node based on FIT and Grid'5000

Central Hub
Node
Partners

GIS SLICES-FR: Building the French node of SLICES

Goal of this GIS

- Coordinate the French participation and contribution to SLICES
- Operate the French node of SLICES-RI

16 potential members

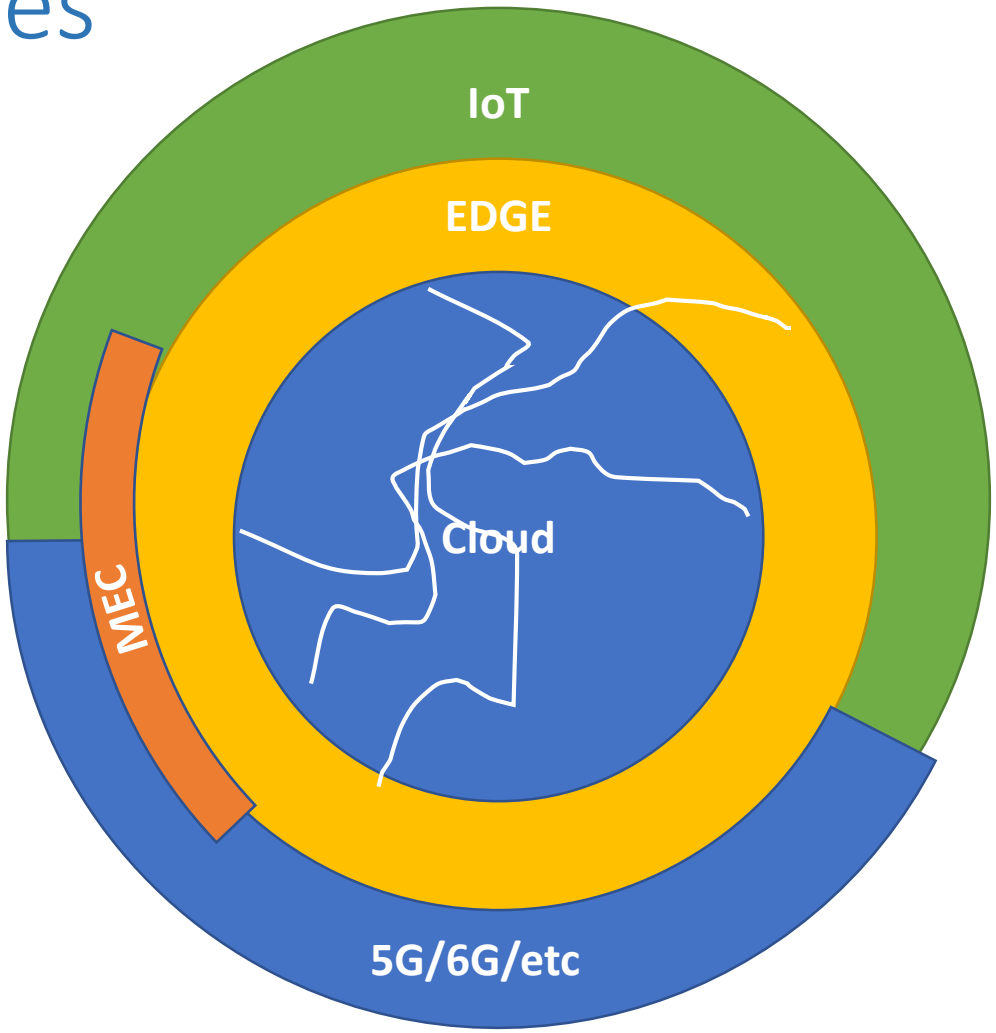
- Inria, CNRS, Institut Mines Télécom, Sorbonne Université, Université Fédérale de Toulouse Midi Pyrénées, Université Grenoble Alpes, Université de Lorraine, Université de Strasbourg, Université de Lille, ENS Lyon, INSA Lyon, EURECOM, RENATER, CEA, Nantes Université, Université de Rennes
- 3 types of membership
  - Core member, associated member, hosting member

SLICES-FR: 5 Year Goal

A unified platform

Platforms enabling new service incubation

SLICES-FR: Services



Un ensemble de nouveaux services sur toute la chaîne de la donnée.

Services de bout en bout de la transmission de la donnée

Mesure de consommation de ressource holistique

Traitement local vs traitement central

Reconfiguration à la volée

Personnalisation des communications

Reprogrammation dynamique cœur de réseau

Compatibilités

DL/ML/FL/SL distribué le long de la chaîne

…

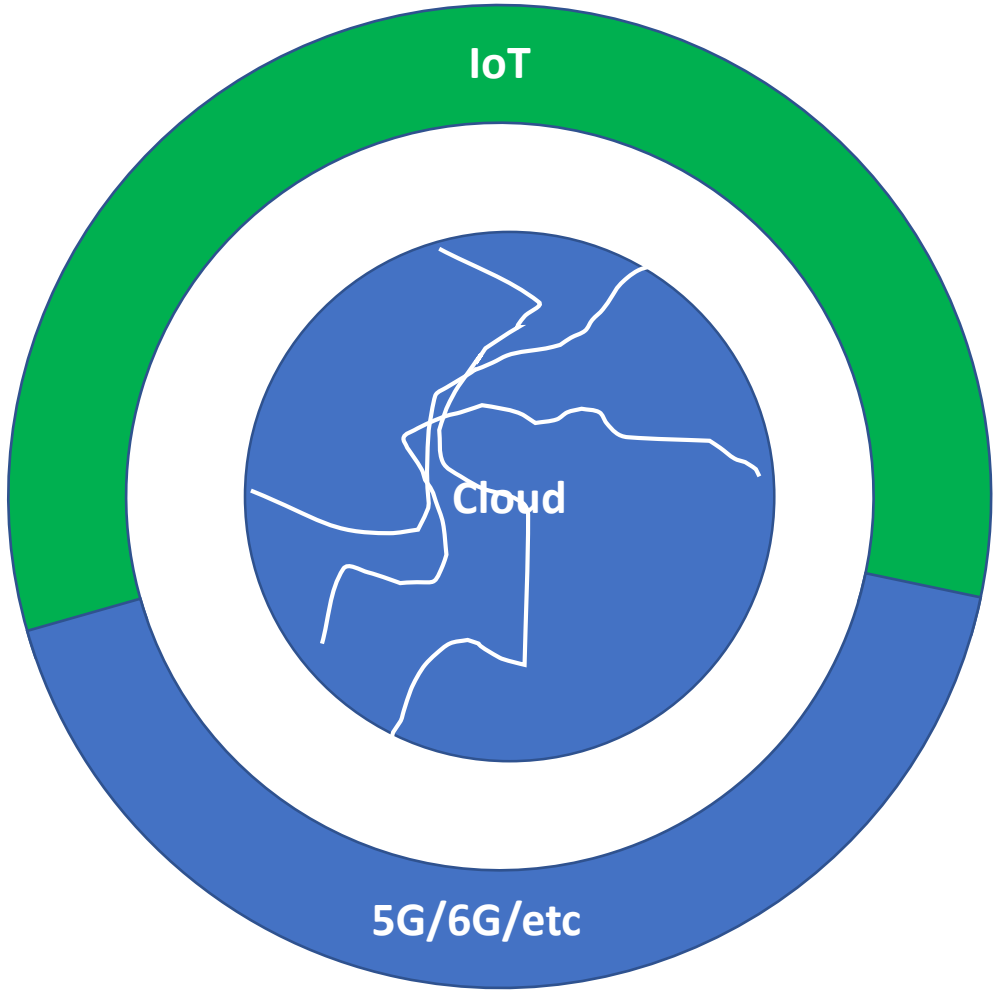
SLICES-FR: Services

Aspects clouds :

- HPC
- Storage
- Calcul distribué
- Allocation de ressources
- …
- Reconfiguration dynamique du réseau
- ……

Aussi bien globaux que très ciblés

SLICES-FR: Services

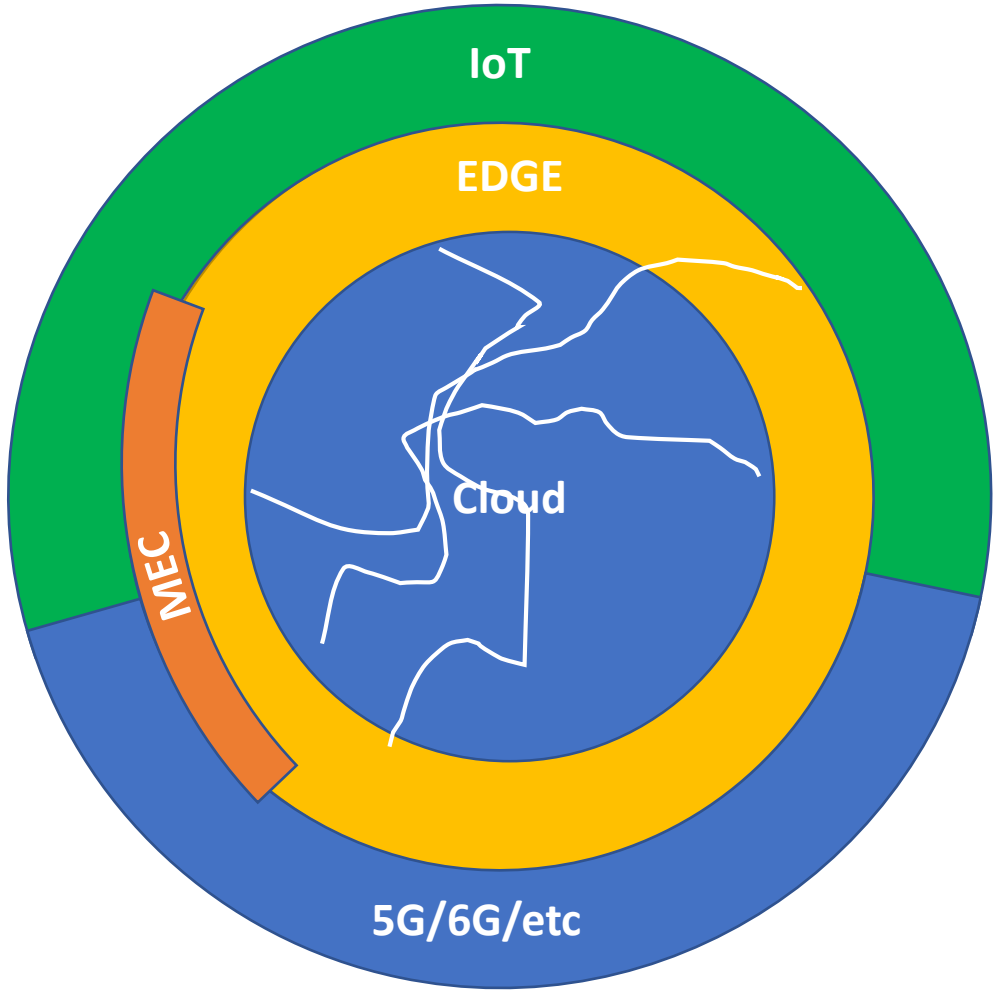


Aussi bien globaux que très ciblés

Aspects sans fil

- Routage
- MAC
- Services sur couche physique
- Coexistence
- Massive MIMO
- Node-G reconfigurable
- WuR
- VLC
- RIM
- GW reconfigurable
- …

SLICES-FR: Services



Aussi bien globaux que très ciblés

Aspects edge :

- Federated learning
- Allocation de ressources
- Déploiement dynamique
- ….

Et MEC

- Auto-deploiement de ressources mobiles
- Prédiction de trajectoires et mobilité

SLICES-FR: Current Status

Governance

- Current: Partners have chosen their desired membership status
- Next step: Start the writing of the GIS between core members

(Temporary) Architect committee

- Composition: Simon Delamare, Raymond Knopp, Lucas Nussbaum, Damien Saucez, Guillaume Schreiner
- Currently: analyzing how to build the French node (and not to design the French node)
  - Overall constraints, Envisioned hardware and services, Strategy for user management, Strategy for semi-permanent services (such as cloud and other high level services)

User Committee

- Chairs: Cedric Adjih, Laurent Lefevre
- Currently: Composing the committee (not too many people, good coverage of topics)
- Next step: call for inputs to the community

Funding

- Through the GIS, CPER, PEPR Cloud and 5G, …

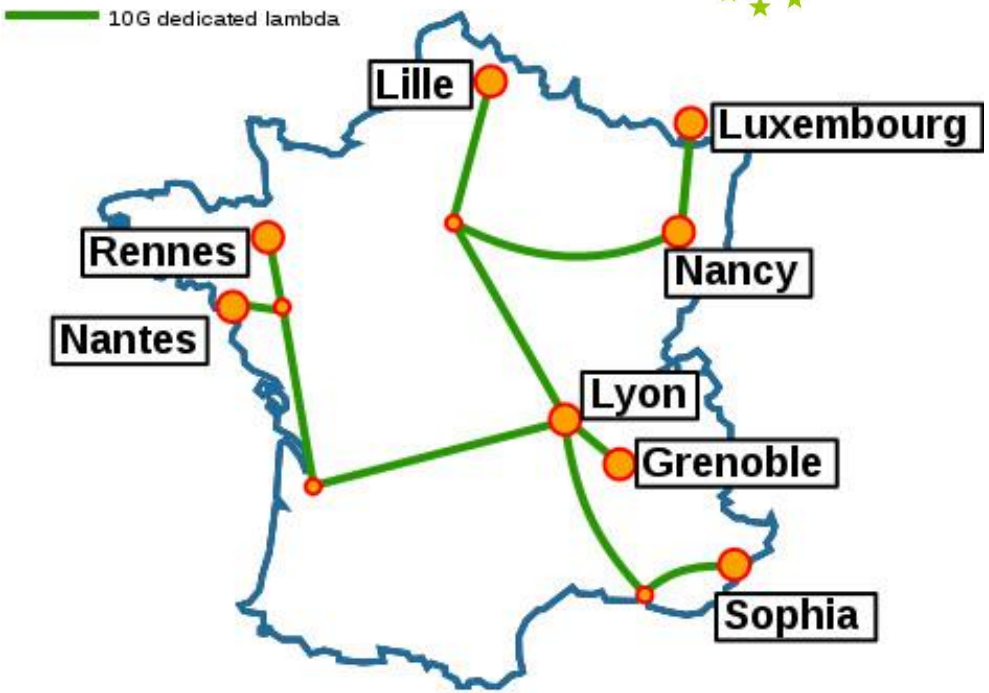
Conclusions

- **SLICES-RI**: ESFRI Research infrastructure for experimental computer science and future services in Europe
- **SLICES-FR**: Research infrastructure in France based on two existing instruments (FIT and Grid'5000)
- **Challenges**
  - Enable experiments mixing both kinds of resources while keeping reproducibility level high
  - Keep the existing infrastructures up while designing and deploying the new one
- **Keep the aim of previous platforms** (their core scientific issues addressed)
  - Scalability issues, energy management, …
  - IoT, wireless networks, future Internet
  - HPC, big data, clouds, virtualization, deep learning, ...
- **Address new challenges**
  - IoT and Clouds
  - New generation Cloud platforms and software stacks (Edge, FOG)
  - Data streaming applications
  - Big data management and analysis from sensors to the (distributed) cloud
  - Mobility
  - 5G/6G
  - Next generation wireless
  - …
- **Next steps**
  - SLICES-PP: establishment of the new SLICES research infrastructure
  - SLICES-FR: establishment of the GIS

BACKUP SLIDES

GRID’5000

- **Testbed for research on distributed systems**
  - Born in 2003 from the observation that we need a better and larger testbed
  - HPC, Grids, P2P, and now Cloud computing, and BigData systems
  - A complete access to the nodes’ hardware in an exclusive mode (from one node to the whole infrastructure)
  - Dedicated network (RENATER)
  - Reconfigurable: nodes with Kadeploy and network with KaVLAN
- **Current status**
  - 8 sites, 38 clusters, 763 nodes, 15852 CPU cores, 335 GPU
    - Memory: ~100 TiB RAM + 6.0 TiB PMEM
    - Storage: 1.42 PB (1515 SSDs and 953 HDDs on nodes)
    - 617.0 TFLOPS (excluding GPUs)
  - Diverse technologies/resources (Intel, AMD, Myrinet, Infiniband, two GPU clusters, energy probes)
- **Some Experiments examples**
  - In Situ analytics
  - Big Data Management
  - HPC Programming approaches
  - Network modeling and simulation
  - Energy consumption evaluation
  - Batch scheduler optimization
  - Large virtual machines deployments

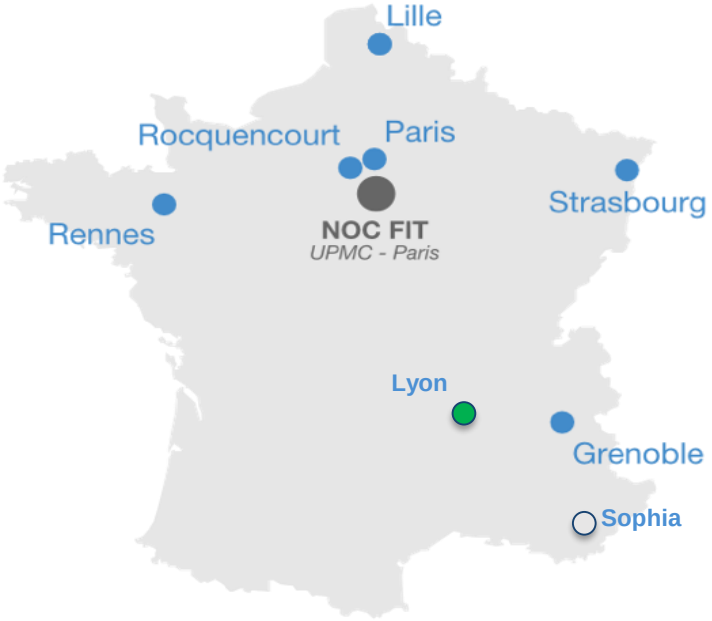


https://www.grid5000.fr/

FIT

Providing Internet players access to a variety of fixed and mobile technologies and services, thus accelerating the design of advanced technologies for the Future Internet

- **FIT-R2Lab:** WiFi mesh testbed (DIANA)
- **FIT-CorteXlab:** Cognitive Radio Testbed 40 Software Defined Radio Nodes (SOCRATE)



https://www.iot-lab.info/hardware/

- **FIT-IoT-LAB**
  - 2700 wireless sensor nodes spread across six different sites in France
  - Nodes are either fixed or mobile and can be allocated in various topologies throughout all sites

https://fit-equipex.fr/