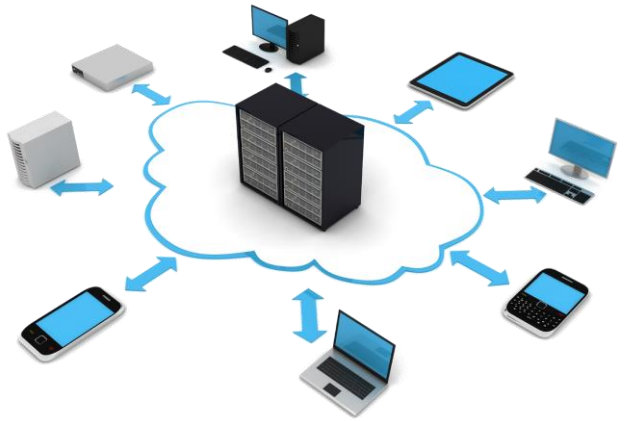
slices RI



# SLICES

*Super Infrastructure for*
*Large-Scale Experimental Computer Science*

Grid'5000

FIT FUTURE INTERNET TESTING FACILITY

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

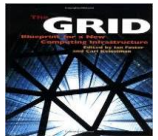
1970 - Terminals (clients/server concepts)

1999 - Salesforces SaaS Concept

2002 - Virtualised Infrastructure

2010 - Cloud democratisation

1999 - The Grid





2002- Amazon Initial Compute/Storage services

2006 - Amazon EC2 (IaaS)

2015
Fog / Edge
Software Defined XXX
5/6G

Transistor
1947

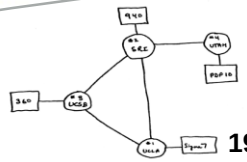
micro processor
1971

1838 - Telegraph

1876 - Telephone

1957 - satellite

1896 - Radio



1985 - TCP/IP Adoption
1973 - Ethernet

1969 - ARPANET

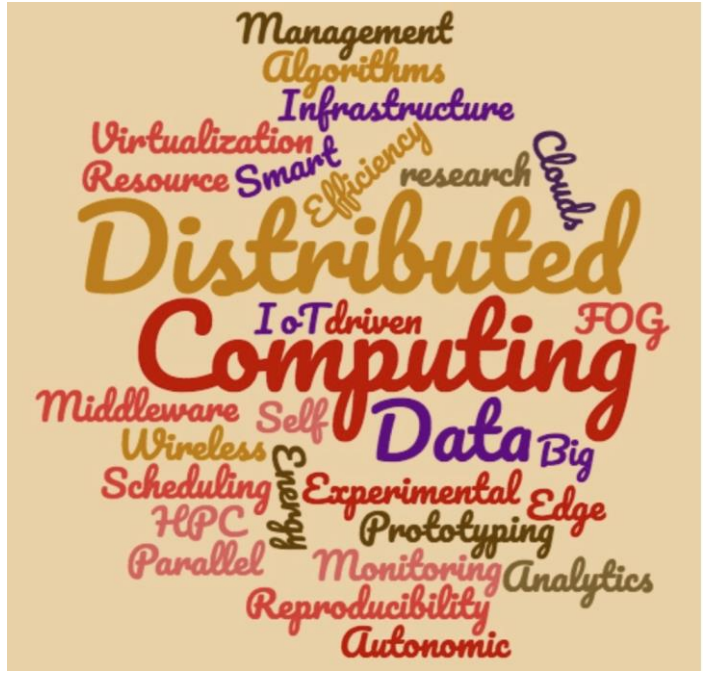
1995 - Commodity clusters

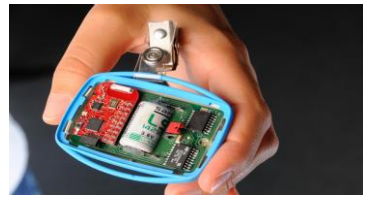
SmartPhones
2007

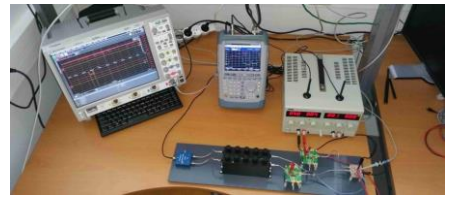
Communication

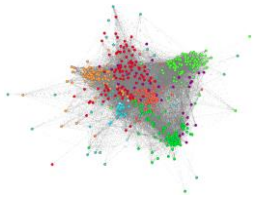
# Motivation

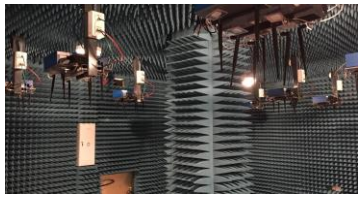
- Exponential improvement of
  - Electronics (energy consumption, size, cost)
  - Capacity of networks (WAN, wireless, new technologies)
- Exponential growth of applications near users
  - Smartphones, tablets, connected devices, sensors, …
  - Large variety of applications and large community
- Large number of Cloud facilities to cope with generated data
  - Many platforms and infrastructures available around the world
  - Several offers for IaaS, PaaS,  and SaaS platforms
  - Public, private, community, and hybrid clouds
  - Going toward distributed Clouds (Fog, Edge, extreme Edge)



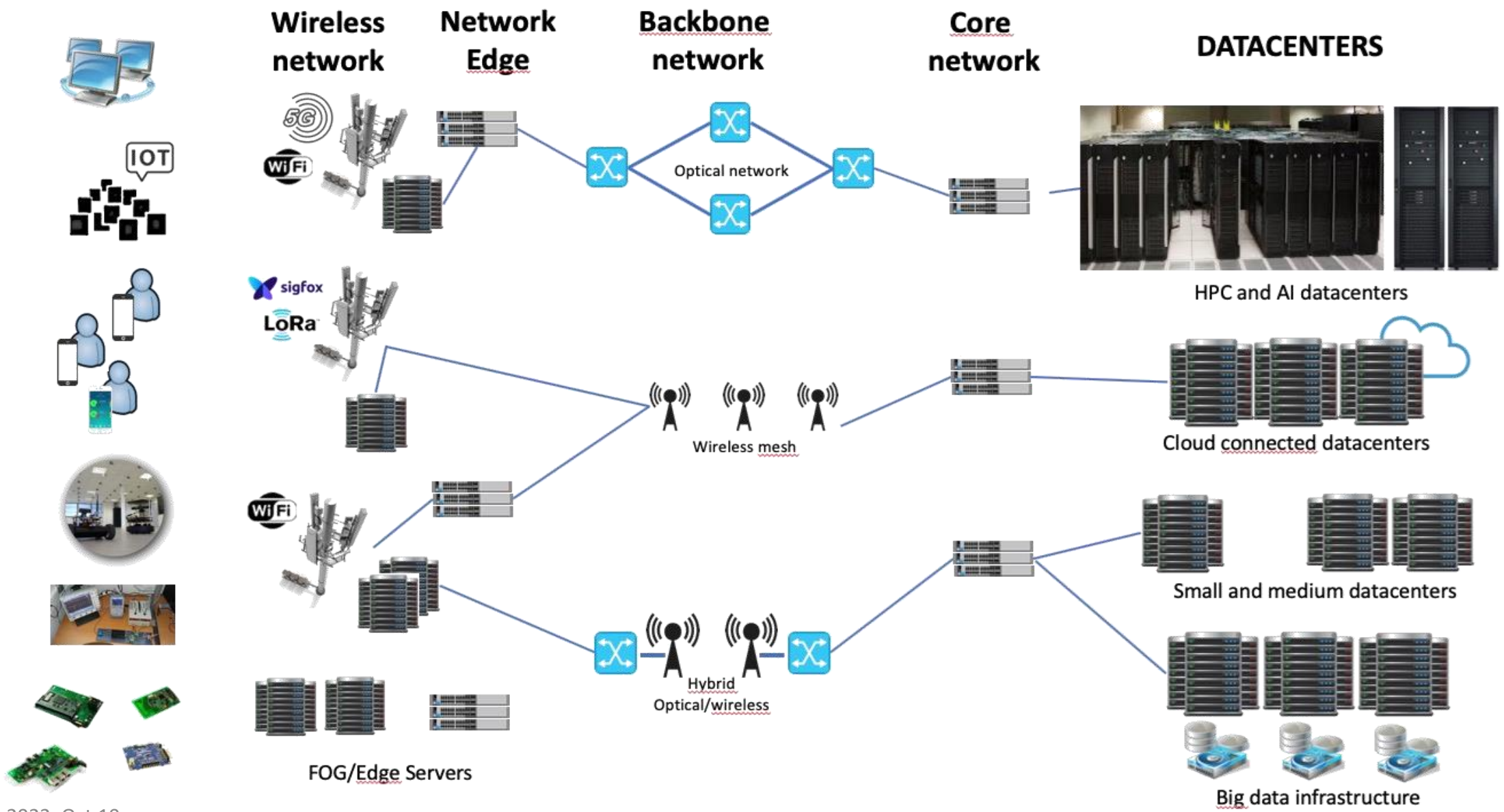









# Digital Environment



# 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

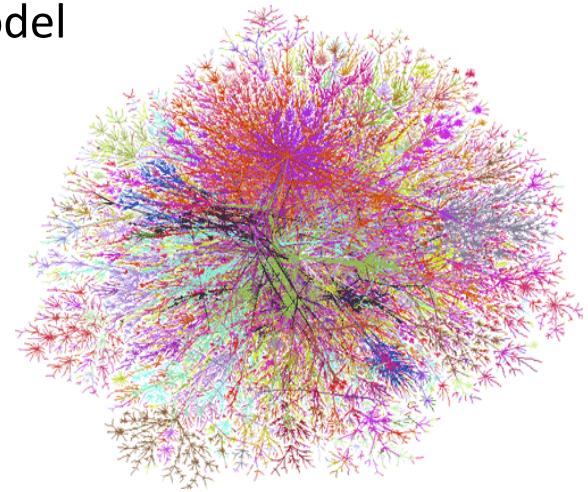
- Hardware, Systems, Networks, Programs, Protocols, Data, Algorithms, **…**

## 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



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

# Experimental testbeds

## Need of specific platforms to experiment

- To monitor how programs behave and not only of the results they produce
- To (dynamically) change the execution environment (up to generate real faults)
- Tier 0,1,2 only enable to execute « *safe* » programs

## Currently in production

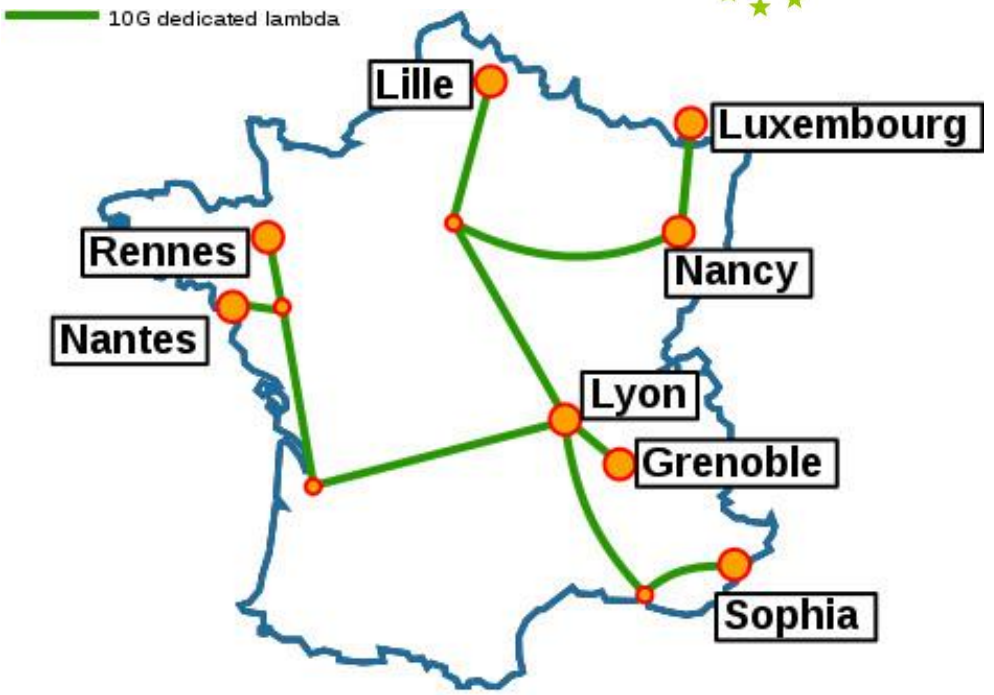
- Grid'5000
- FIT

## Next generation

- European level: SLICES
- French level: SLICES-FR (was SILECS)
  - On the f*euille de route nationale des Infrastructures de recherche* since 2018
    - https://www.enseignementsup-recherche.gouv.fr/pid25366/acces-thematique.html?theme=317&subtheme=318

# 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



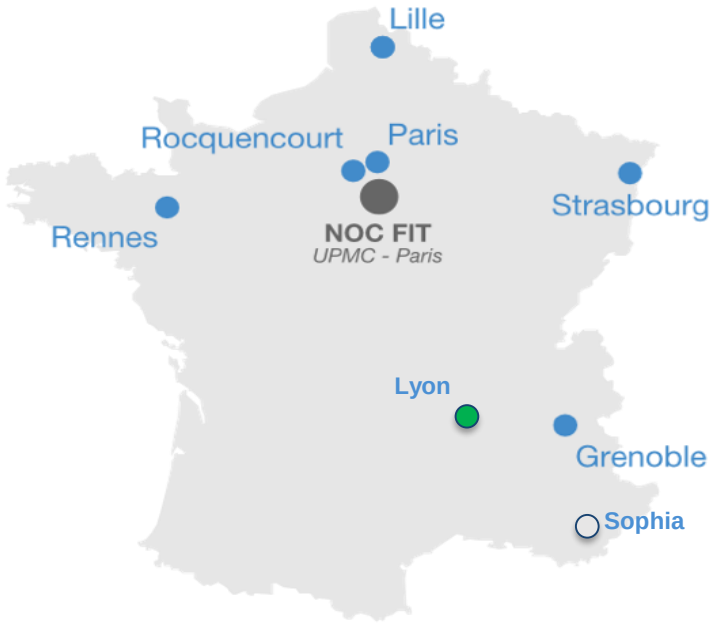


https://www.grid5000.fr/

# 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)



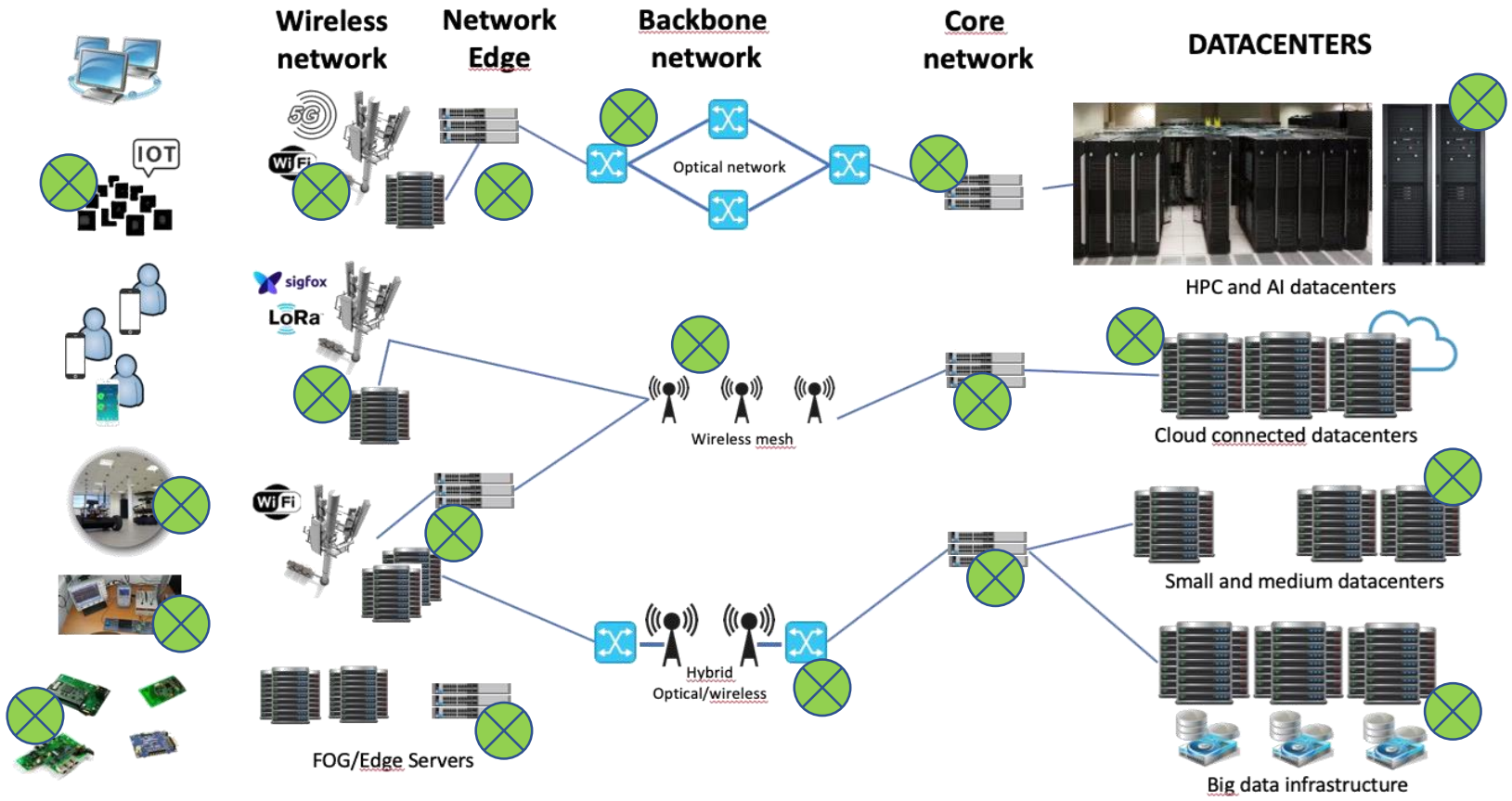

- **FIT-IoT-LAB**
  - 2700 wireless sensor nodes spread across six different sites in France
  - Nodes are either fixed or mobile and can be allocated in various topologies throughout all sites

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

https://fit-equipex.fr/

# SLICES

## Fully Controllable and Programmable Digital Infrastructure Test Platform



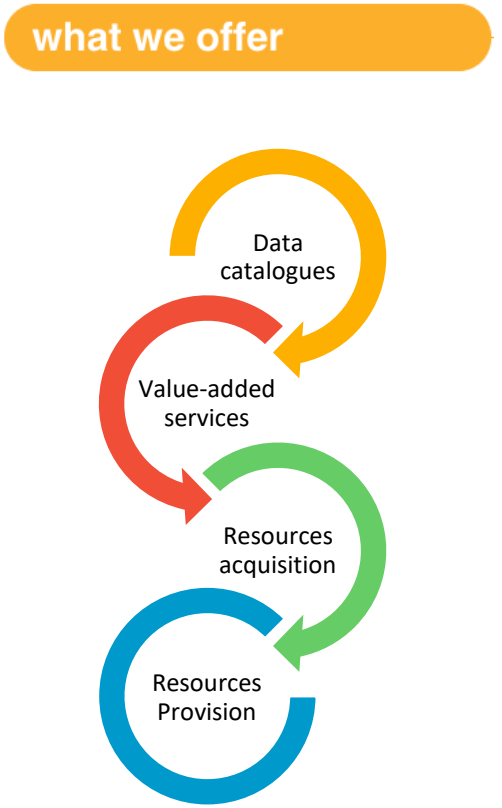

*Controllable, Programmable, Monitorable Element*

# SLICES in a nutshell

**SLICES** aims to support

- the **academic and industrial research community** that will design, develop and deploy the **Next Generation** of **Digital Infrastructures**

- **large-scale, experimental** research focused on
  - networking protocols
  - radio technologies
  - Services
  - data collection
  - parallel and distributed computing
  - cloud and edge-based computing architectures and services.

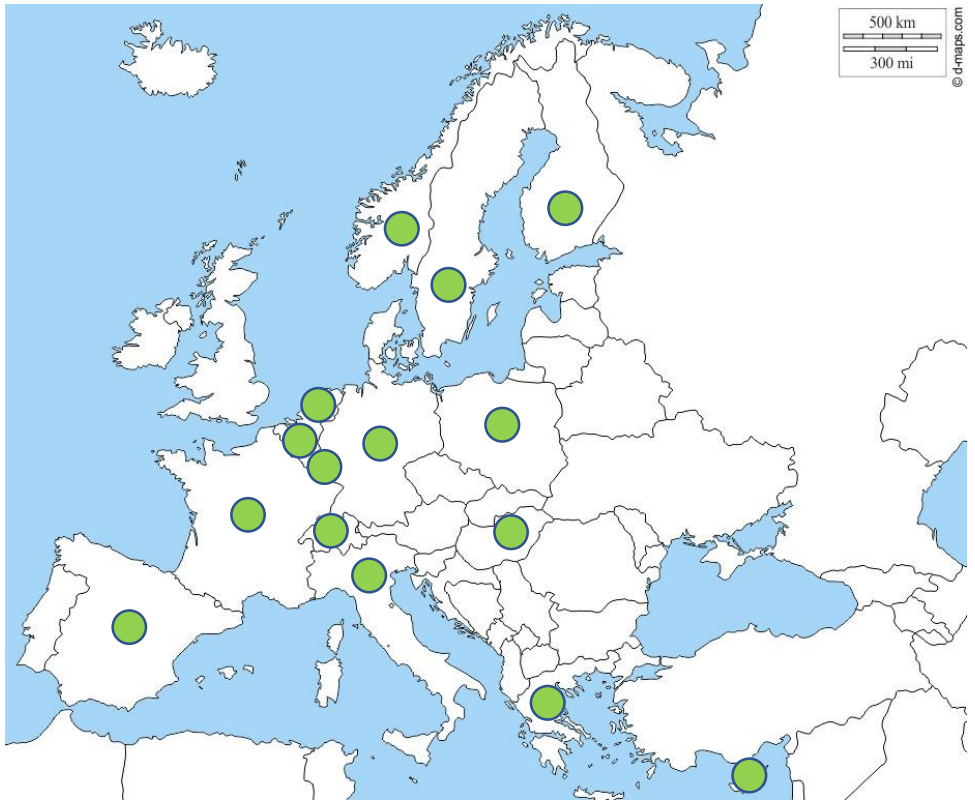



www.slices-ri.eu

# SLICES – ESFRI Project since 2021

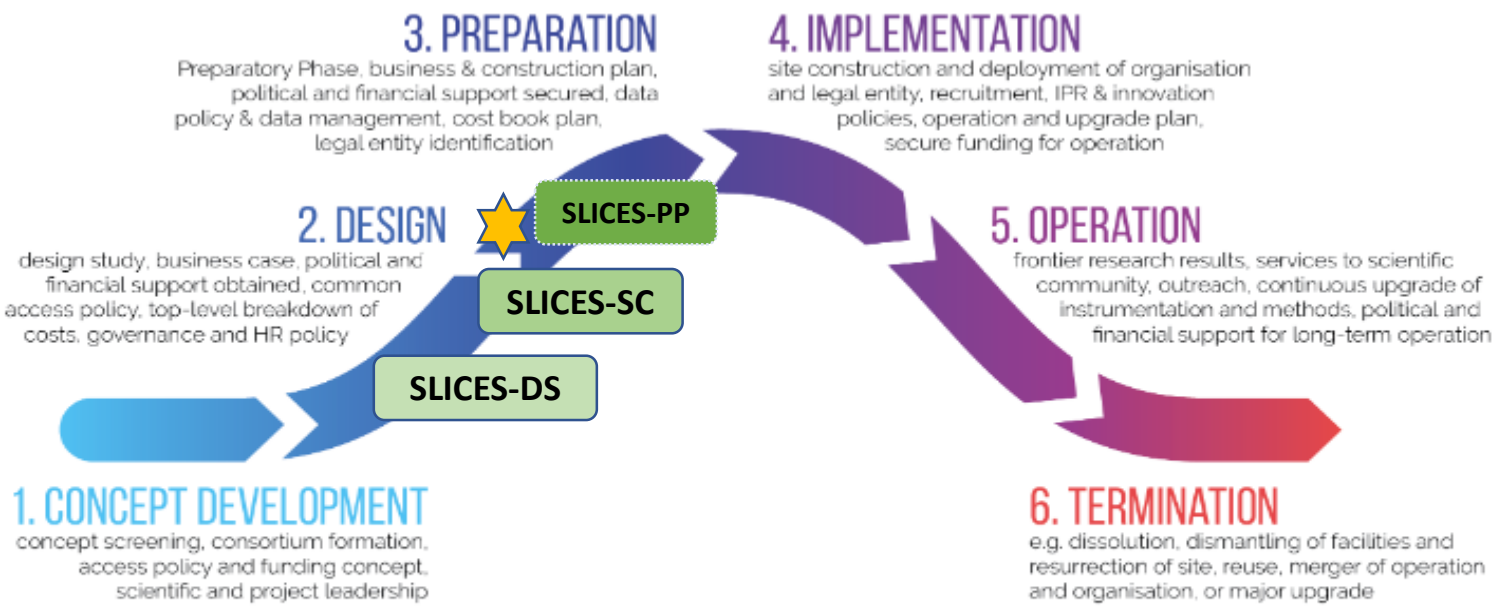
**25 Participants from 15 countries**

- Belgium
- Cyprus
- Finland
- **France (leader)**
- 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

# Lifecycle of an ESFRI Research Infrastructure

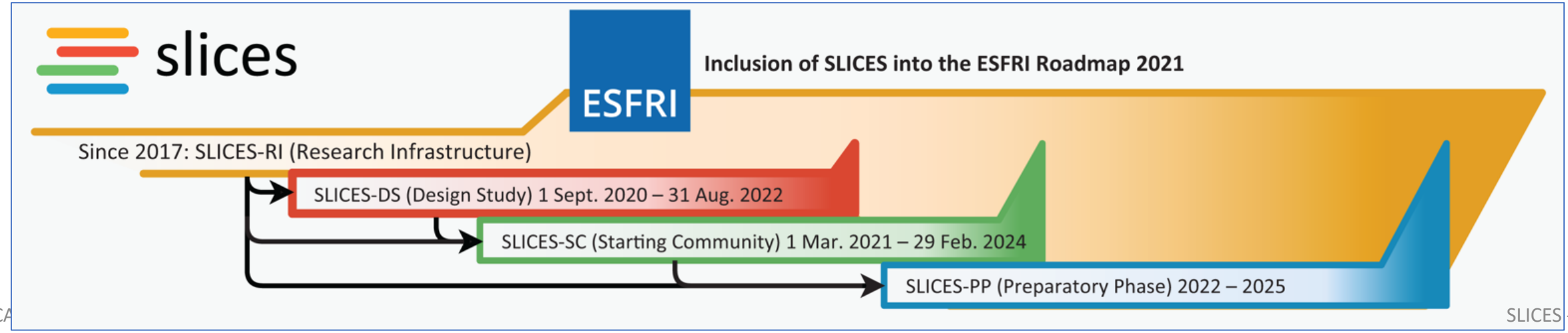



**Supported by 2 projects started in 2020**

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

**Preparation phase started in Sep. 2022**

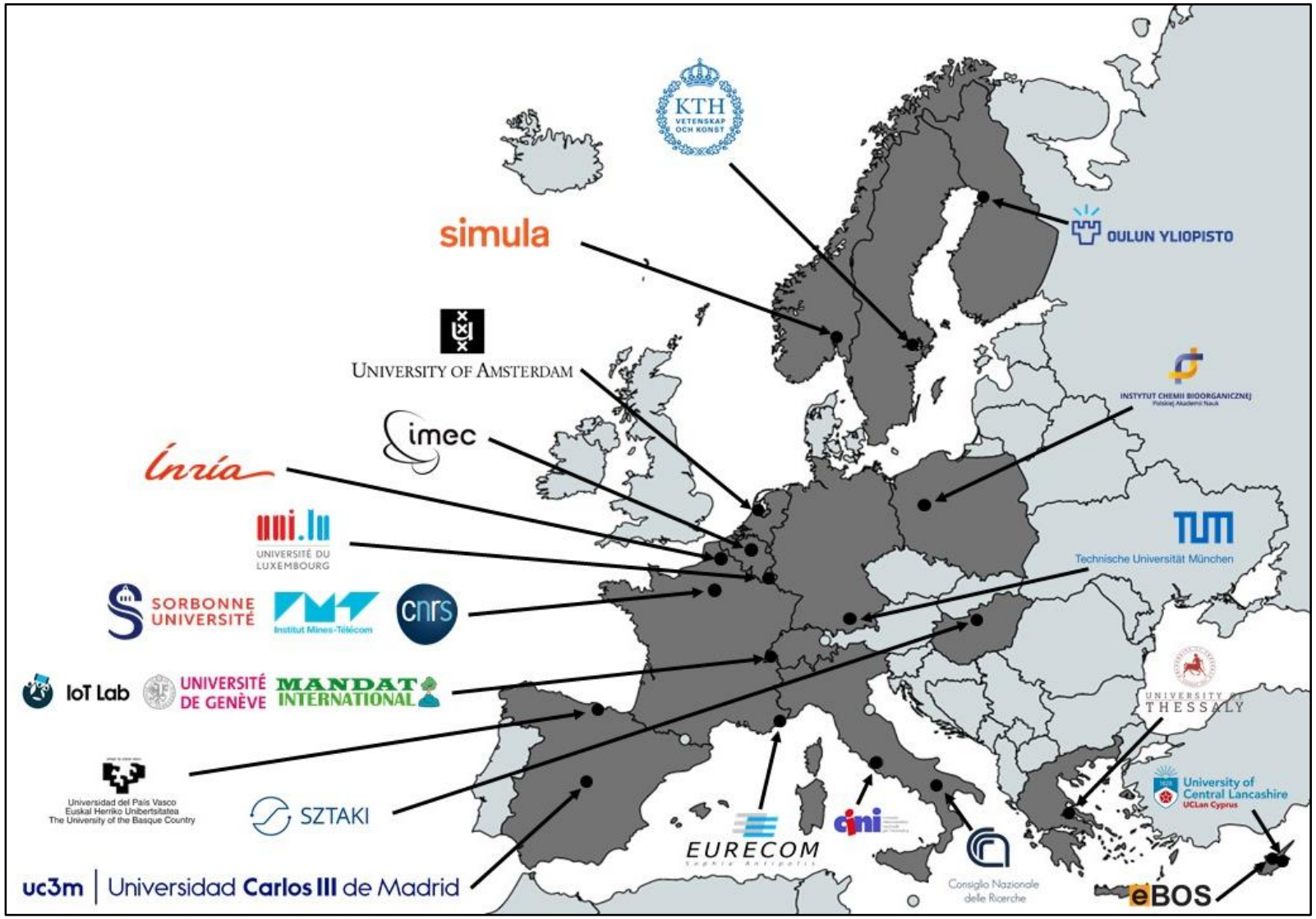
- Slices Preparatory Phase (SLICES-PP)
  - Duration: 40 months



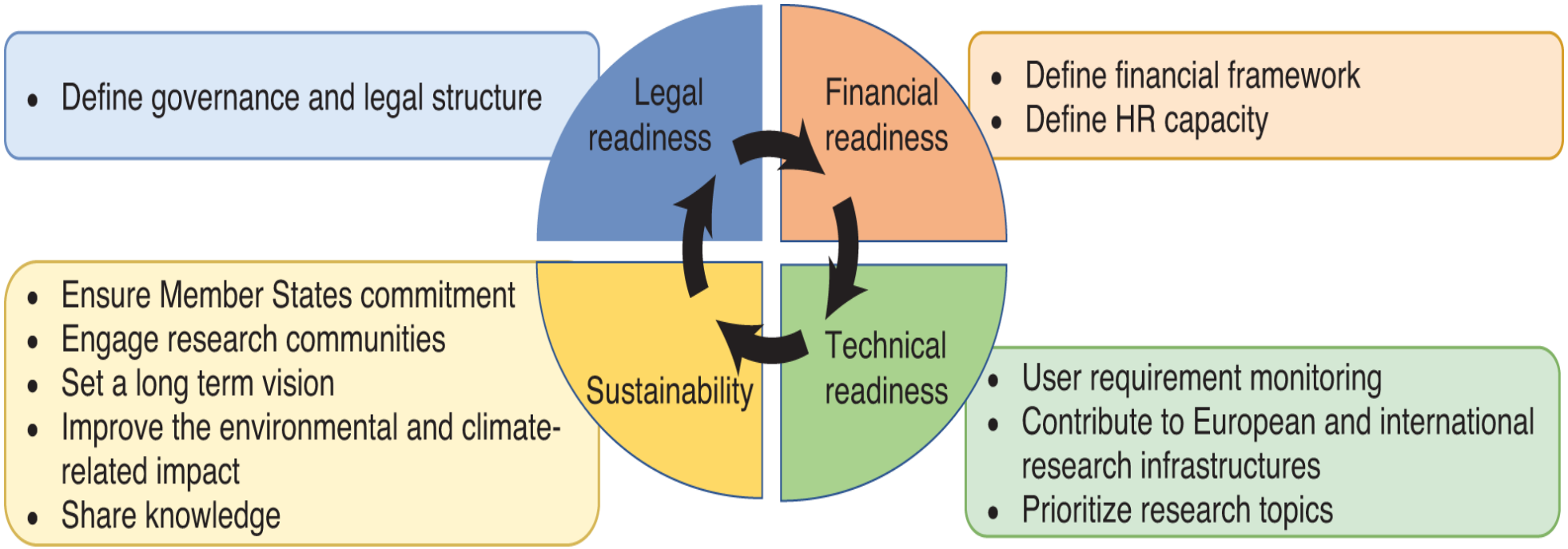
# SLICES-PP's overall objective

The overall objective of SLICES-PP is to
tackle all key questions concerning legal, financial and technical issues
leading to the establishment of the new SLICES research infrastructure
and ensuring commitment of Member States/Associated Countries to
its long-term operation and use in all fields of science.

# SLICES-PP: Consortium



# SLICES-PP: Methodology



# SLICES: A Distributed Research Infrastructure

**Centralised governance**

Supervisory Board

CMO

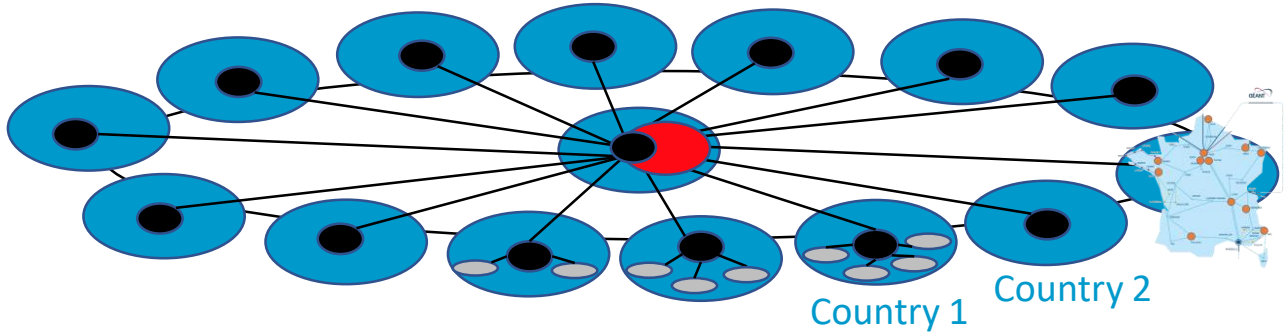
Management Committee

Joint investment strategy

Decisions on new nodes

Decisions on core functions and data centre

**Distributed Infrastructure**




Optimize the distribution of resources according to needs and competences

**Single entry point, single access policy**

Users

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

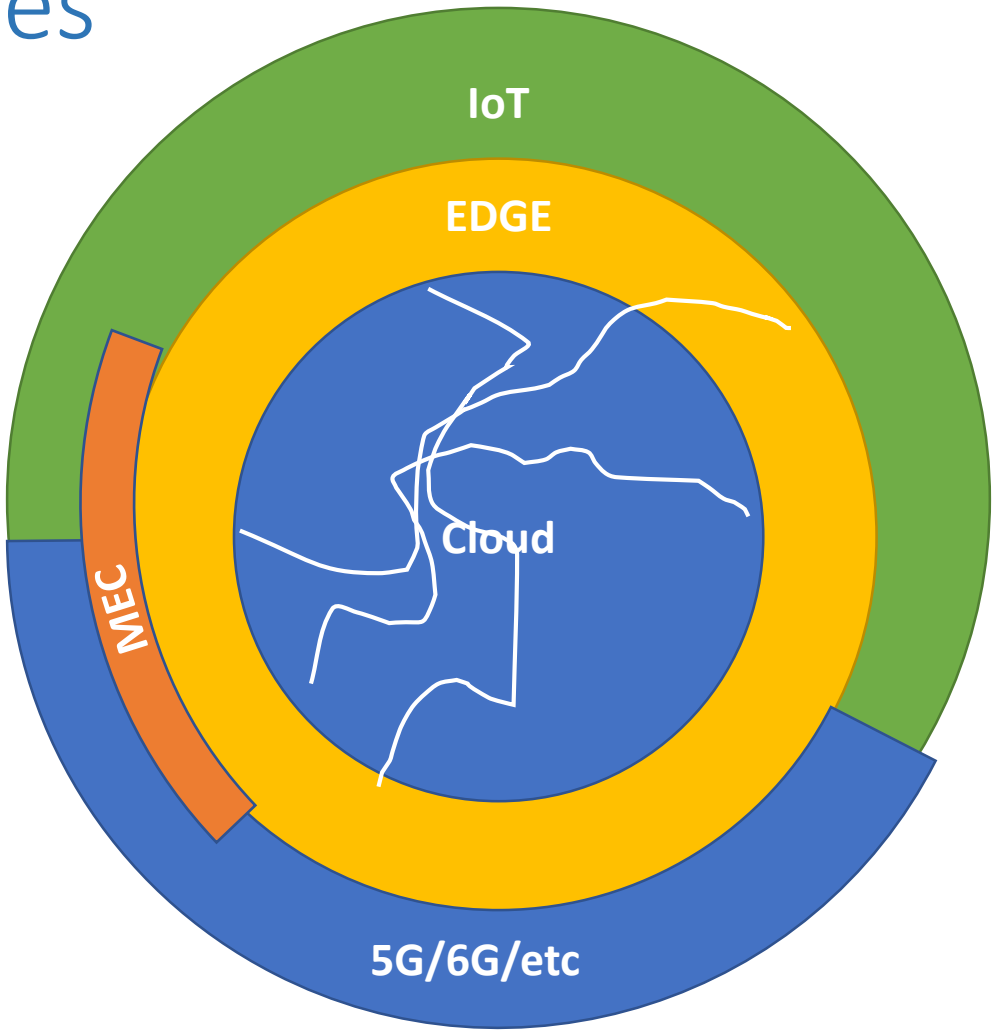
- Inria,  CNRS, Institut Mines Télécom, Sorbonne Université, Université Fédérale de Toulouse Midi Pyrénées, Université Grenoble Alpes, Université de Lorraine, Université de Strasbourg, Université de Lille, ENS Lyon, INSA Lyon, EURECOM, RENATER, CEA, Nantes Université, Université de Rennes
- 3 types of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

…

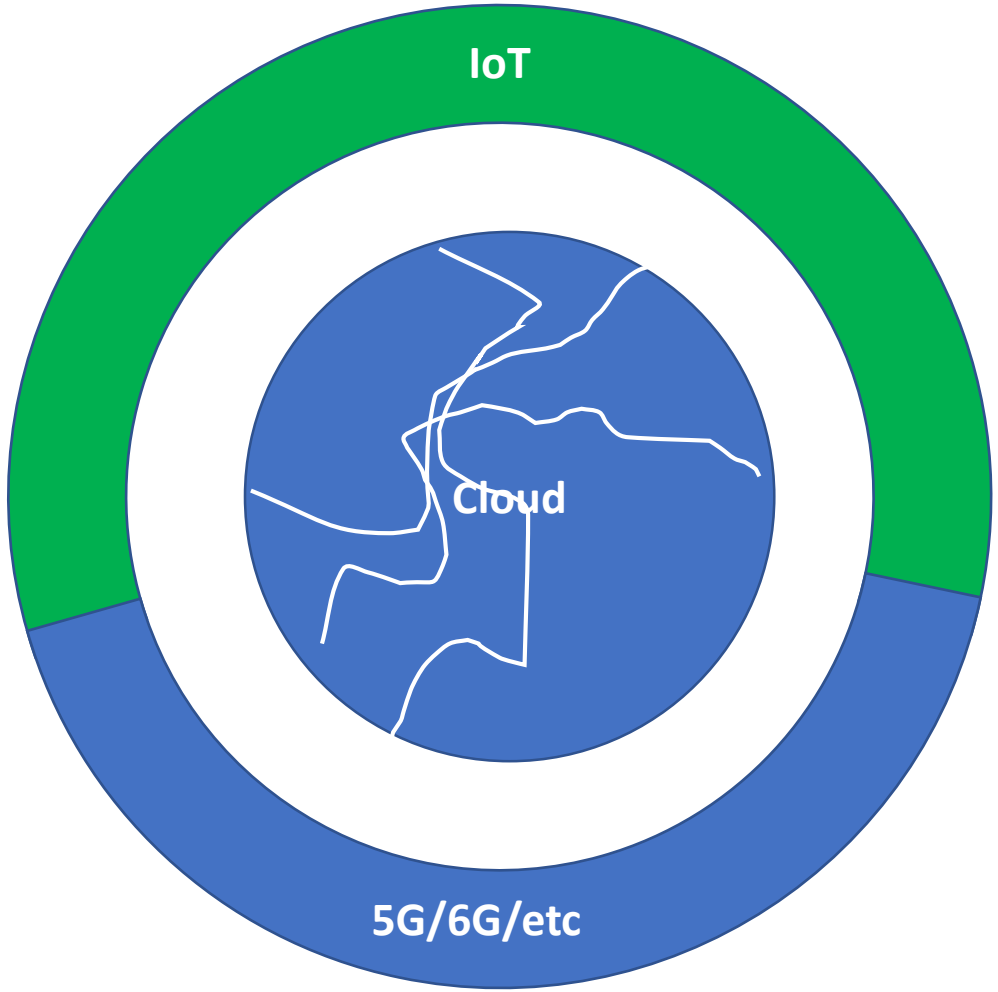
# SLICES-FR: Services


Aussi bien globaux que très ciblés

Aspects clouds :

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

# SLICES-FR: Services

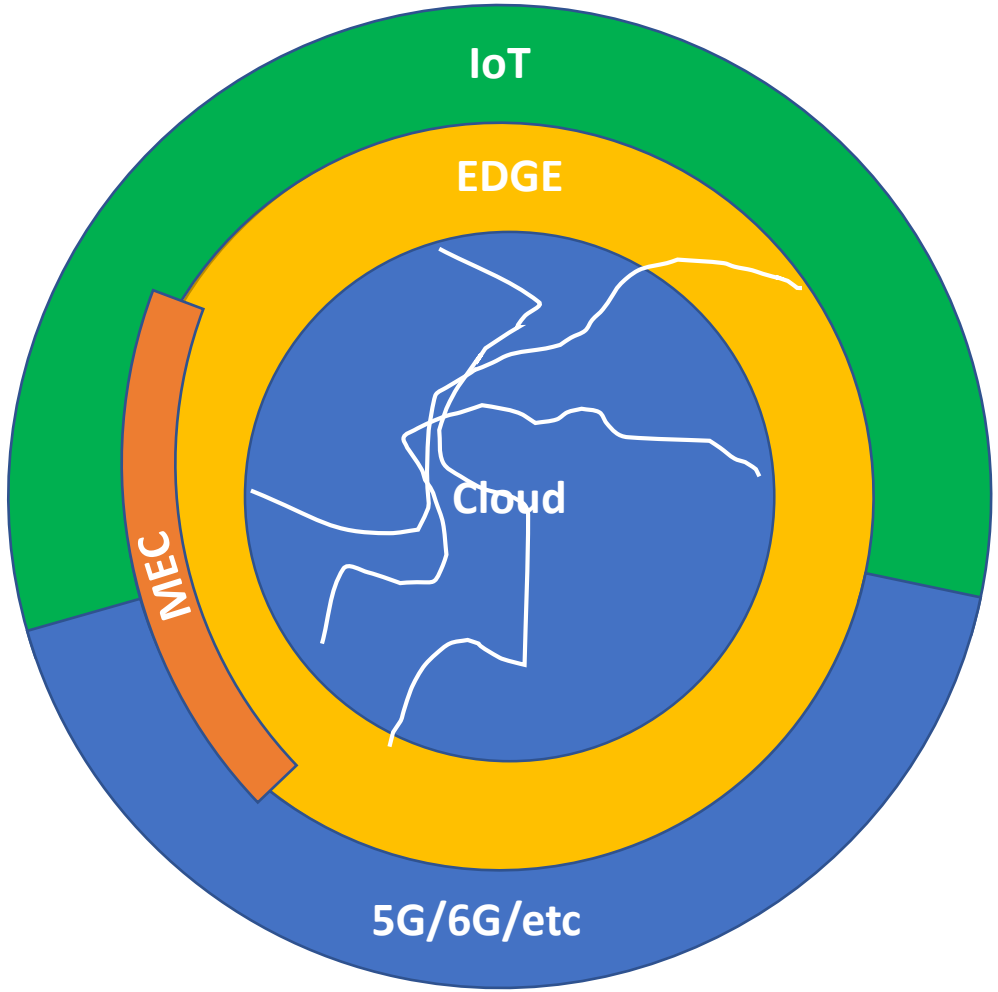



Aussi bien globaux que très ciblés

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 choosing their membership status
- Next step: Start the writing of the GIS between core members

## Architect committee

- Currently: analyzing how to build 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

- Being set up
- Next step: call for inputs to the community

# 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