SLICES

Super Infrastructure for Large-Scale Experimental Computer Science

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Convergence of Computation and Communication

Computation

- ENIAC 1946
- Transistor 1947
- Microprocessor 1971
- 1950 - Batchmode
- 1960 - Interactive
- 1967 - First virtualisation attempt
- 1970 - Terminals (clients/server concepts)
- 1975 - Personal Computers
- 1999 - Salesforce SaaS Concept
- 1999 - The Grid
- 2002 - Virtualised Infrastructure
- 2010 - Cloud democratisation
- 2015 - Fog/Edge Software Defined XXX 5/6G

Communication

- 1838 - Telegraph
- 1876 - Telephone
- 1896 - Radio
- 1957 - Satellite
- 1969 - ARPANET
- 1973 - Ethernet
- 1985 - TCP/IP Adoption
- 1995 - Commodity clusters
- 2002 - Amazon Initial Compute/Storage services
- 2006 - Amazon EC2 (IaaS)
- 2010 - Cloud democratisation
- 2015 - Fog/Edge Software Defined XXX 5/6G

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Digital Environment

Wireless network  Network Edge  Backbone network  Core network  DATACENTERS

- HPC and AI datacenters
- Cloud connected datacenters
- Small and medium datacenters
- Big data infrastructure
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
Third generation Mid-Scale (~100M$) Test Platforms


**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€
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
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
SLICES-PP: Consortium
Lifecycle of an ESFRI Research Infrastructure

3. PREPARATION
Preparatory Phase, business & construction plan, political and financial support secured; data policy & data management, code book plan, legal entity identification

2. DESIGN
design study, business case, political and financial support obtained, common access policy, top-level breakdown of costs, governance and HR policy

1. CONCEPT DEVELOPMENT
concept screening, consortium formation, access policy and funding concept, scientific and project leadership

4. IMPLEMENTATION
site construction and deployment of organisation and legal entity, recruitment, IFRI & innovation policies, operation and upgrade plan, secure funding for operation

SLICES-PP

SLICES-SC

SLICES-DS

5. OPERATION
Transfer research results, services to scientific community, outreach, continuous upgrade of instrumentation and methods, political and financial support for long-term operation

6. TERMINATION
e.g. dissolution, dismantling of facilities and resurrection of site, reuse, merger of operation and organisation, or major upgrade

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

- **2017 to 2022**: Design
- **2023**: Preparation
- **2024 to 2025**: Implementation
  - Pre-impl.
  - Full impl.
- **2026 to 2029**: Continuous upgrade
- **2030 to 2033**: Operation
  - Pre-op.
  - Early operation
  - Full operation
- **2034 to 2037**: Termination

- **MoU-1**
- **MoU-2**
- **Legal structure established**
- **Full operation funding secured and full staff in place**
- **Services opened**
  - No
  - 15%
  - 30%
  - 50%
  - 80%
  - 100%
  - 80%
  - No

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SLICES: A Distributed Research Infrastructure

- **Centralised governance**
- **Distributed Infrastructure**
- **Single entry point, single access policy**
- **Decision to create an ERIC**

Central Hub

Node

Partners

Supervisory Board

CMO

Management Committee

Country 1

Country 2

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

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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
A unified platform

Platforms enabling new service incubation
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
Aspects sans fil

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

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

Aussi bien globaux que très ciblés
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
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-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

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

https://fit-equipex.fr/
https://www.iot-lab.info/hardware/