SILECS

Super Infrastructure for Large-scale Experimental Computer Science

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http://www.silecs.net/
Introduction

• 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, …
  – Prediction of 50 billions of connected devices by 2020 (CISCO)

• 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)
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
SILECS: based upon two existing infrastructures

- **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
  - 4 key technologies and a single control point: IoT-Lab (connected objects & sensors, mobility), CorteXlab (Cognitive Radio), wireless (anechoic chamber), Network Operations Center, Advanced Cloud technology including OpenStack
  - 9 sites (Paris (2), Evry, Rocquencourt, Lille, Strasbourg, Lyon, Grenoble, Sophia Antipolis)

- **Grid’5000**
  - A scientific instrument for experimental research on large future infrastructures: Clouds, datacenters, HPC Exascale, Big Data infrastructures, networks, etc.
  - 10 sites, > 8000 cores, with a large variety of network connectivity and storage access, dedicated interconnection network granted and managed by RENATER

- **Software stacks dedicated to experimentation**
  - Resource reservation, disk image deployment, monitoring tools, data collection and storage
FIT

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

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https://fit-equipex.fr/
GRID’5000

- **Testbed for research on distributed systems**
  - Born 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**
  - 10 sites, 29 clusters, 1060 nodes, 10474 cores, 10 Gbs network backbone
  - 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/
Silecs: Envisioned Architecture
Silecs: Short Term View of the Architecture

Diagram showing network connections between various locations with nodes and labels for different types of infrastructure and connections.

Legend:
- Storage
- Datacenter
- NOC
- Wireless devices & robots
- Node
- Renater NREN
- GEANT
Data Center Portfolio

Targets

- Performance, resilience, energy-efficiency, security in the context of data-center design, Big Data processing, Exascale computing, etc.

Hardware

- Servers: x86, ARM64, POWER, accelerators (GPU, FPGA)
- Networking: Ethernet (10G, 40G), HPC networks (InfiniBand, Omni-Path)
- Storage: HDD, SSD, NVMe, both in storage arrays and clusters of servers

Experimental support

- Bare-metal reconfiguration
- Large clusters
- Integrated monitoring (performance, energy, temperature, network traffic)
Wireless Portfolio

Targets
• Performance, security, safety and privacy-preservation in complex sensing environment,
• Performance understanding and enhancement in wireless networking,
• Target applications: smart cities/manufacturing, building automation, standard and interoperability, security, energy harvesting, health care.

Hardware
• Software Defined Radio (SDR), LTE-Advanced and 5G
• Wireless Sensor Network (WSN/IEEE 802.15.4), LoRa/LoRaWAN
• Wifi/WIMAX (IEEE 802.11/16)

Experimental support
• Bare-metal reconfiguration
• Large-scale deployment (both in terms of densities and network diameter)
• Different topologies with indoor/outdoor locations
• Mobility-enabled with customized trajectories
• Anechoic chamber
• Integrated monitoring (power consumption, radio signal, network traffic)
The GRAIL

**Experimental methodology:**
- experiment design & planning (workflow)
- description of scenarios, of experimental conditions
- definition of metrics
- laboratory journal
- analysis and visualization of results

**Orchestration of experiments:**
- organize the execution of complex and large-scale experiments (workflow)
- run experiments unattended and efficiently
- handles failures
- compose experiments

**Basic services:** common tools required by most experiments
- **Interact w/ testbed**
  - find, reserve and configure resources
- **Test resources before using them**
- **Manage the environment**
- **Manage data**
- **Change experimental conditions**
- **Instrument the application & the environment**
- **Monitor and collect data**

**Experimental testbed (e.g Grid’5000):**
- reconfigurable hardware and network
- isolation
- some instrumentation and monitoring
Plans for SILECS: Testbed Services

- **Provide a unified framework that (really) meets all needs**
  - Make it easier for experimenters to move for one testbed to another
  - Make it easy to create simultaneous reservations on several testbeds (for cross-testbeds experiments)
  - Make it easy to extend SILECS with additional kinds of resources
  - Notes
    - SFA is probably not a sufficient solution here, even if SFA-compatibility is required for international collaboration (e.g. European federation)
    - It should be designed carefully to ensure we do not add just another not-so-useful abstraction layer

- **Factor testbed services**
  - Services that can exist at a higher level, e.g. open data service, for storage and preservation of experiments data (in collaboration with Open Data repositories such as OpenAIRE/Zenodo)
  - Services that are required to operate such infrastructures, but add no scientific value
    - users management, usage tracking

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Built from already functional solutions
## European Dimension (ESFRI)

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Conclusions

• New infrastructure based on two existing instruments (FIT and Grid’5000)
• Design a software stack that will allow experiments mixing both kinds of resources while keeping reproducibility level high

**Keep the aim of previous platforms** (their core scientific issues addressed)
- Scalability issues, energy management, …
- IoT, wireless networks, future Internet for SILECS/FIT
- HPC, big data, clouds, virtualization, deep learning … for SILECS/Grid’5000

• **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
  - …
Thanks, any questions?

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