SILECS
Super Infrastructure for Large-scale Experimental Computer Science

F. Desprez - INRIA
**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, …

- **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)

- **Prediction of 50 billions of connected devices by 2020** (CISCO)
Cloud Evolution

- Not only mega data centres!
“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 infrastructures

- **FIT**
  - Proving 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 (including a PLE access), 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, service nodes, > 8000 cores, with a large variety of network connectivity and storage access, dedicated interconnection network granted and managed by RENATER gathered around a GIS (CNRS, CEA, Inria, CPU, RENATER, Institut Mines-Telecom, CDEFI)

- Software stacks dedicated to experimentation
- Monitoring tools, resource reservation, data collection and storage
SILECS: Super Infrastructure for Large-scale Experimental Computer Science

- Having a large scale infrastructure to experiment IoT/Edge cloud applications and software stacks
  - Scaling factor
  - Exascale platforms
  - Virtualized, Programmable
  - FOG and Mobile Edge Computing

- **Features**
  - **Manageability**
    - Agility (SDN, NFV)
    - Self adaptability
    - Global orchestration
  - **Complexity**
    - Resources
    - Energy
  - **Data Flow** Management
    - Data deluge processing
New services brought by SILECS

- New applications with polymorphic IoT
- City-scale wireless experimentations
- New mobility models
- Device heterogeneity
- Customized devices
- IoT devices to Edge/Cloud controllable testbed
SILECS Design Objectives

• **Deploy a large set of digital resources from sensors to data centers**
  – Open, remotely accessible, virtualized infrastructure
  – Provide rich, diverse and advanced tools: test, measurement, benchmarking, reproducibility, data repository, …
  – Typically a « mid-scale » infrastructure

• **Mobilize the scientific community in the domain of digital sciences**
  – Articulate the French and European efforts in this domain
  – International attractivity and visibility (unique today at the international level)

• **Several challenges**
  – Heterogeneity of the resulting infrastructures
  – Different communities and different software stacks
  – Keep reproducibility at its highest level
  – Keep the infrastructure up-to-date
  – *Connect* the infrastructure to other platforms in Europe and elsewhere
Dream Architecture

- Domestic network
- Enterprise network
- Hybrid network
- Extreme Edge Frontier
- Inter Micro DCs latency
- Cloud Latency LCloud > 100ms
- Edge to Fog latency LFog [10-100ms]
- Micro/Nano DC
- Wired link
- Wireless link
Short Term View of the Architecture

- Lille
- Nancy
- Strasbourg
- Switzerland
- Grenoble
- Sophia
- Greece
- Rennes
- Nantes
- Paris

Nodes:
- Storage
- Datacenter
- NOC
- Wireless devices & robots
- Node

Networks:
- Renater NREN
- GEANT
Data Center Portfolio

Targets

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

Hardware

- Servers: x86, ARM64, POWER (with 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
- Integrated monitoring (energy, temperature, network traffic)
Wireless Portfolio

Targets
- Performance, security, safety and privacy-preservation in sensing complex environment,
- Performance understanding and enhancement in wireless networking,
- Targeted 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
- Large-scale deployment (both in terms of densities and network diameter)
- Different topologies with indoor/outdoor locations
- Mobility-enabled with customized trajectories
- Anechoic chamber
- Bare-metal reconfiguration
- Integrated monitoring (power consumption, radio signal, network traffic)
Outdoor IoT testbed

- IoT is not limited to smart objects or indoor wireless sensors (smart building, industry 4.0, ....)

- Smart cities need outdoor IoT solutions:
  - outdoor smart metering
  - outdoor metering at the scale of a neighborhood (air, noise smart sensing, ....)
  - citizens and local authorities are more and more interested by outdoor metering

- IoT wireless technologies are not adequate for outdoor environments
  - ISM Band and short range are not the good solutions

- Long Range or middle range offer new solutions
  - 5G, SigFox, LoRa, 802.15.4G,

- Need of combo solutions to address Smart Cities challenges
  - Polymorphic IoT: support of multiple IoT technologies in the same time on a large scale testbed
Outdoor IoT testbed, contd.

- Deployment of a polymorphic (long, middle and short range IoT wireless solutions) IoT testbed
  - Size and range of the testbed (city scale) impossible to spread by 1 only industrial company
  - R&D cost reduction to test and evaluate scenarios at city scale
  - Controlled outdoor testbed (re-use of FIT success and tools)
- Reproducible polymorphic IoT outdoor testbed, integrated in SILECS global testbed
  - Deployment in Strasbourg city (500000 citizens, 384 km2), Lyon campus
  - Agreement and support of local authorities
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
  - Control a large number of nodes
- **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
Services & Software Stack

Built from already functional solutions
# European Dimension

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| NRENs     | ![RENATER](image) | ![GÉANT](image) |

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Conclusions

• New infrastructure based on two existing instruments (FIT and Grid’5000)

• **Keep the aim of previous platforms** (their core scientific issues addressed)
  – IoT, wireless networks, future Internet for FIT
  – HPC, Big Data, Clouds, Virtualization, … for Grid’5000

• **Address new challenges**
  – IoT and Clouds
  – New generation Cloud platforms and software stacks (Edge, FOG)
  – Data streaming applications
  – Locality aware resource management
  – …

• **Financial sustainability**
  • Submitted to ESFRI in August (INRIA, S. Fdida, F. Desprez)
  • PIA-3, …
Thanks
Any questions ?