Grid’5000
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Grid’5000

Lucas Nussbaum
Grid’5000 Technical Director

2018-04-03
The Grid’5000 testbed

- A large-scale testbed for distributed computing
  - 8 sites, 30 clusters, 840 nodes, 8490 cores
  - Dedicated 10-Gbps backbone network
  - 600 users and 100 publications per year
The Grid’5000 testbed

- **A large-scale testbed for distributed computing**
  - 8 sites, 30 clusters, 840 nodes, 8490 cores
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- **A meta-grid, meta-cloud, meta-cluster, meta-data-center:**
  - Used by CS researchers in HPC / Clouds / Big Data / Networking
  - To experiment in a fully controllable and observable environment
  - Similar problem space as Chameleon and Cloudlab (US)
  - Design goals:
    - Support high-quality, reproducible experiments
    - On a large-scale, shared infrastructure
Organization and governance

- **Director** – Frédéric Desprez

- **Bureau** (6 members: FD, LN, Christian Perez, Adrien Lebre, Laurent Lefevre, David Margery)

- **Comité des responsables de sites**

- **Technical Director** – Lucas Nussbaum
  - Technical team: 9 full-time engineers

- **Architects committee** (6 membres)

- **Conseil de groupement**
  - Inria, CNRS, RENATER, CEA, CPU, CDEFI, Mines-Telecom

- **Conseil scientifique**
  - 10 members
Landscape – cloud & experimentation

- **Public cloud infrastructures** (AWS, Azure, Google Cloud Platform, etc.)
  - 😞 No information/guarantees on placement, multi-tenancy, real performance

- **Private clouds**: Shared observable infrastructures
  - 😏 Monitoring & measurement
  - 😞 No control over infrastructure settings
  - ~ Ability to understand experiment results

- **Bare-metal as a service, fully reconfigurable infrastructure** (Grid’5000)
  - 😏 Control/alter all layers (virtualization technology, OS, networking)
  - ~ *In vitro* Cloud

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1 Inspired from a slide by Kate Keahey
Landscape – cloud & experimentation

- **Public cloud infrastructures** (AWS, Azure, Google Cloud Platform, etc.)
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- **Private clouds**: Shared observable infrastructures
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- **Bare-metal as a service, fully reconfigurable infrastructure** (Grid’5000)
  - 😃 Control/alter all layers (virtualization technology, OS, networking)
  - ➾ *In vitro* Cloud

And the same applies to all other environments (e.g. HPC)

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1 Inspired from a slide by Kate Keahey
Some results from Grid’5000 users
HPC: In Situ Analytics

Goal: improve organization of simulation and data analysis phases

- Simulate on a cluster; move data; post-mortem analysis
  - Unsuitable for Exascale (data volume, time)
- Solution: analyze on nodes, during simulation
  - Between or during simulation phases? dedicated core? node?

Grid’5000 used for development and test, because control:

- Of the software environment (MPI stacks)
- Of CPU performance settings (Hyperthreading)
- Of networking settings (Infiniband QoS)

Then evaluation at a larger scale on the Froggy supercomputer (CIMENT center, Grenoble)

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Cloud: DISCOVERY project

Goal: design a distributed IaaS cloud, based on OpenStack

- Move services as close as possible to users
  - Legal reasons, network latency
- Leverage regional data centers
- Increase resillience (no SPOF)
- P2P and self-* approaches

Grid’5000 as a testbed already provides:

- Start and control your own OpenStack
- Possibly modified
- Running at large scale

Collaborations:

- Inria, RENATER, Orange, Mines Nantes

http://beyondtheclouds.github.io/
Big Data: smart power meters

- Goal: which big data solution for Linky smart meters data?
- Collaboration with ERDF
- 4 Big Data solutions installed and compared on Grid’5000
  - Postgres-XL, Hadoop, Spark, Cassandra
  - Up to 140 nodes
  - 1.7 TB of data (≈ 5 million meters, 1 mes/h, 1 year)

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3Houssem Chihoub and Christine Collet. “A scalability comparison study of smart meter data management approaches”. In: Grid’5000 Winter School. 2016.
Other usage areas

- Deep learning
- OS research
- Networking
- Reproducible research
An experiment’s outline

1. Discovering resources from their description
2. Reconfiguring the testbed to meet experimental needs
3. Monitoring experiments, extracting and analyzing data
4. Controlling experiments: API
Discovering resources from their description

▶ Describing resources → understand results
  ♦ Covering nodes, network equipment, topology
  ♦ Machine-parsable format (JSON) → scripts
  ♦ Archived (State of testbed 6 months ago?)
  ♦ Soon: better hardware description on the wiki

▶ Verifying the description
  ♦ Avoid inaccuracies/errors → wrong results
  ♦ Could happen frequently: maintenance, broken hardware (e.g. RAM)
  ♦ Our solution: g5k-checks
    ★ Runs at node boot (or manually by users)
    ★ Acquires info using OHAI, ethtool, etc.
    ★ Compares with Reference API

▶ Selecting resources
  ♦ OAR database filled from Reference API
    oarsub -p "wattmeter='YES' and gpu='YES'"
    oarsub -l "cluster='a'/nodes=1+cluster='b' and
    eth10g='Y'/nodes=2,walltime=2"
Reconfiguring the testbed

- Operating System reconfiguration with Kadeploy:
  - Provides a *Hardware-as-a-Service* cloud infrastructure
  - Enable users to deploy their own software stack & get *root* access
  - **Scalable, efficient, reliable and flexible:** 200 nodes deployed in ~5 minutes

- Customize networking environment with KaVLAN
  - Protect the testbed from experiments (Grid/Cloud middlewares)
  - Avoid network pollution
  - Create custom topologies
  - By reconfiguring VLANS \(\sim\) almost no overhead

**Kadeploy**

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Monitoring experiments

Goal: enable users to understand what happens during their experiment

- System-level probes (usage of CPU, memory, disk, with Ganglia)
- Infrastructure-level probes: Kwapi
  - Network, power consumption
  - Captured at high frequency ($\approx 1$ Hz)
  - Live visualization
  - REST API
  - Long-term storage
  - Should be fully operational again soon!
Controlling experiments: API

- Legacy way of performing experiments: shell commands
  - 😞 time-consuming
  - 😞 error-prone
  - 😞 details tend to be forgotten over time

- Promising solution: automation of experiments
  ➔ Executable description of experiments

- Support from the testbed: Grid’5000 RESTful API
  (Resource selection, reservation, deployment, monitoring)

- Several higher-level tools to help automate experiments
  Execo (Python), Ruby-cute (Ruby)
  https://www.grid5000.fr/w/Grid5000:Software
Recent and little-known features
Data management portfolio

- Storage5k: reservation of storage space on an NFS server
- Managed Ceph clusters in Rennes and Nantes
- OSIRIM: large storage space made available in Toulouse
- Reservation of disks on nodes
  ♦ To store large datasets between nodes reservations

**Missing:** long-term archival of experiment data
- Probably not a good idea to solve this on our own
- Feedback about CKAN-based servers (OpenAIRE / Zenodo), anyone?
Automated testing framework

Detect regressions before experimenters

23 tests, 1055 configurations

Still, does not cover everything please report problems!
Additional switch on the *grisou* cluster
  
  - 48 nodes with 4x 10G interfaces and 1x 1G interface
  - 1G interfaces are connected to an ONIE-supported switch

VPN to connect to Grid’5000

```bash
cd
```

```bash
sudo-g5k
```

OAR job extensions (*oarwalltime* command)

Persistent virtual machines

News on the website (also: Twitter @grid5000, RSS)
What to expect by mid 2018 (hopefully)

- New clusters in:
  - Nantes: 48 nodes (CPER SEDUCE)
  - Grenoble: 72 nodes + 4 nodes (HPCDA project, HPC/BigData convergence with NVMe)
  - Nancy: 64 nodes (+ 48 older nodes) (*production* queue)
  - Lille: 8 nodes with P100 GPUs (CPER DATA)

- Kwapi fully operational again

- Full rework of hardware & network pages

- Wrap-up of the work around Debian 9 images (inc. move to predictable network interface names, and new postinstalls)

- Many other behind-the-scenes changes
Grid’5000-related tutorials during the school

- Tue 4:30pm, Wed 2pm – Getting Started with Grid’5000
- Wed 2pm, 4:30pm – Benchmarking OpenStack with EnOS
- Thu 2pm – Monitoring energy consumption in Grid’5000 experiments
- Thu 2pm – BigData Experiments with Grid5000
- Fri 9am – Distributed systems and networking emulation with Distem
- Fri 9am – Open session – any Grid’5000 tutorial

Come talk to the Grid’5000 team about features you need!