Grid’5000
Lucas Nussbaum

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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
  ♦ Dedicated 10-Gbps backbone network
  ♦ 600 users and 100 publications per year

▷ 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

institutional and scientific steering

technical steering

advisory and evaluation bodies
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.)
  - 😞 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

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)

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/
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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3 Houssem 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 to understand results
  - Covering nodes, network equipment, topology
  - Machine-parsable format (JSON) to scripts
  - Archived (State of testbed 6 months ago?)
  - Soon: better hardware description on the wiki

- Verifying the description
  - Avoid inaccuracies/errors to 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 ̃ almost no overhead
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!

![Graphs showing data monitoring](image)
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!
Other random stuff

- 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
- `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!