Introduction to Grid'5000 (G5k)

Overview & First Steps

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Why do experiments[1] ?

"Beware of bugs in the above code;
I have only proved it correct, not tried it"
(Donald Knuth)

"In theory there is no difference between theory and practice. In practice there is."
(Yogi Berra)

[1] *Extract from a talk at NSFCloud in 2014 by Kate Keahey (Argonne Nat. Lab.)*

Why ?

IT Resources for Research

Carrying out "experiments" is essential in computer science today and “good experiments”[1] should fulfill the following properties.

- **Reproducibility** : same result with same input
- **Extensibility** : target comparaisons with other works
- **Applicability** : define realistic params (easy calibration, ..)
- **“Revisability”** : help to identity the reasons (object of study)

[1] *Inspired from a talk at SILECS School in 2018 given by F. Desprez (INRIA)*

Why ?

IT Landscape for Experimentation

Where ?

On his personal computer or lab/team machine, enabling virtualization or containerization

→ Insufficient (material) resources for large-scale deployment

On a datacenter or supercomputering facility (state) or a “mesocentre” (local/region)

→ Sometimes unsuitable for your needs

→ Generally a unique architecture and a limited network bandwidth

→ Lack of flexibility in terms of configuration, security (access, system with no root rights), support limited, etc.

In a cloud infrastructure

→ Virtualization and container vs. Physical hardware (bare-metal)

→ Public (AWS, Azure, GCP, etc.) 😕 No information/guarantees on placement, multi-tenancy, etc.

→ Private (Shared Observable Infra) 🙂 Monitoring & Measurement 😕 No control over infra settings.

→ Bare-metal as a service, a fully reconfigurable infra. 🙂 Control/alter all layers (virtualization, OS, networking)

Mutualization? *equipments, tools, support & training, good practices, etc.*

What ?

Grid'5000 | Overview

- A national scientific intrument with a reconfigurable testbed infrastructure for experimental research on computer science targeting and tackling large-scale domains

  Big Compute (parallel and distributed systems – Cloud, HTC, HPC), Big Data, Datacenters, High Performance Networking.

- But it's not a grid but "Bare Metal as a servce"
- GIS created in 2012 but 15 years already...
  - a very active community (researchers, engineers, techs)
  - ±600 active users and ~120 publications per year
  - ±60 millions core hours used in 2019

MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR, DE LA RECHERCHE ET DE L'INNOVATION
Liberté Égalité Fraternité

cnrs
dépasser les frontières

Inria
INVENTEURS DU MONDE NUMÉRIQUE

RENATER
CONNECTEUR DE SAVOIRS

cat.opidor.fr/index.php/Grid%275000

What ?

Grid'5000 | Some results[1] from G5k Users

- Portable Online Prediction of Network Utilization (Inria Bdx + US)
- Energy proportionality on hybrid architectures (LIP/IRISA/Inria)
- Maximally Informative Itemset Mining (Miki) (LIRM/Inria)
- Damaris (Inria)
- BeBida: Mixing HPC and BigData Workloads (LIG)
- HPC: In Situ Analytics (LIG/Inria)
- Addressing the HPC/Big-Data/IA Convergence
- An Orchestration Syst. for IoT Applications in Fog Environment (LIG/Inria)
- Toward a resource management system for Fog/Edge infrastructures
- Distributed Storage for Fog/Edge infrastructures (LINA)
- From Network Traffic Measurements to QoE for Internet Video (Inria)

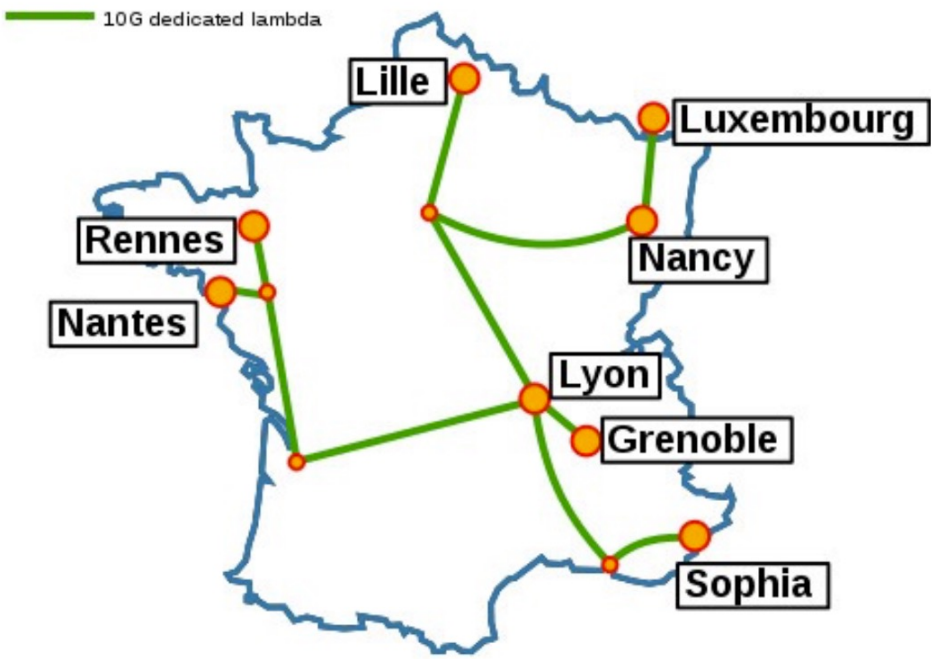
Lists of publications by Grid'5000 users are available on HAL OpenAccess Platform
https://hal.inria.fr/GRID5000

[1] *Extract list from F.Desprez and L.Nussbaum talk on SILECS/Datacenters, 2019*

Where ?

Grid'5000 | Key Features[1]

- 8 sites, 39 clusters, ±800 nodes,
- ±16000 CPU cores and ±300 GPU
- ±100 TiB RAM + 6 TiB PMEM
- R_{peak} 614.3 TFLOPS (excluding GPUs)
- 511 SSDs and 1004 HDDs on nodes (total: 1.44 PB)
- Dedicated 10-Gbps backbone network



[1] Source : https://www.grid5000.fr/w/Hardware

Where ?

Grid'5000 | Resources @ Nantes site[1]

Site	Cluster	Access Condition	Date of arrival	Nodes	CPU	Cores	Memory	Storage	Network
Sophia	uvb		2011-01-04	30	2 x Intel Xeon X5670	6 cores/CPU	96 GiB	**250 GB HDD**	1 Gbps (SR-IOV) + 40 Gbps InfiniBand
Rennes	paranoia		2014-02-21	8	2 x Intel Xeon E5-2660 v2	10 cores/CPU	128 GiB	**1 x 600 GB HDD** + 4 x 600 GB HDD	1 Gbps (SR-IOV) + 2 x 10 Gbps (SR-IOV)
Rennes	parapide		2010-01-25	17	2 x Intel Xeon X5570	4 cores/CPU	24 GiB	**500 GB HDD**	1 Gbps + 20 Gbps InfiniBand
Rennes	parapluie		2010-11-02	16	2 x AMD Opteron 6164 HE	12 cores/CPU	48 GiB	**250 GB HDD**	1 Gbps + 20 Gbps InfiniBand
Rennes	parasilo		2015-01-13	27	2 x Intel Xeon E5-2630 v3	8 cores/CPU	128 GiB	**600 GB HDD** + 4 x 600 GB HDD* + 200 GB SSD*	2 x 10 Gbps (SR-IOV)
Rennes	paravance		2015-01-13	72	2 x Intel Xeon E5-2630 v3	8 cores/CPU	128 GiB	**1 x 600 GB HDD** + 1 x 600 GB HDD	2 x 10 Gbps (SR-IOV)
Nantes	econome		2014-04-16	22	2 x Intel Xeon E5-2660	8 cores/CPU	64 GiB	**2.0 TB HDD**	10 Gbps (SR-IOV)
Nantes	ecotype		2017-10-16	48	2 x Intel Xeon E5-2630L v4	10 cores/CPU	128 GiB	**400 GB SSD**	2 x 10 Gbps (SR-IOV)
Nancy	graffiti	**production** queue	2019-06-07	13	2 x Intel Xeon Silver 4110	8 cores/CPU	128 GiB	**479 GB HDD**	10 Gbps

1312 cores
7.552 GiB Mem
±64 TB (dont 19TB SSD)

- `econome` {Dell PE C6220}
- `ecotype` {Dell PE R630}

Processors counts per families

Processor family	Grenoble	Lille	Luxembourg	Lyon	Nancy	Nantes	Rennes	Sophia	Processors total
AMD EPYC		16		10	14				**40**
AMD Opteron				28			32		**60**
Intel Xeon	88	62	28	92	612	140	248	60	**1330**
POWER8NVL	24								**24**
ThunderX2				8					**8**
Sites total	**112**	**78**	**28**	**138**	**626**	**140**	**280**	**60**	**1462**

Accelerator cores

Accelerator model
AMD Radeon Instinct MI50 32GB
Intel Xeon Phi 7120P
Nvidia A100-PCIE-40GB
Nvidia GeForce GTX 1080 Ti
Nvidia GeForce GTX 980
Nvidia GeForce RTX 2080 Ti
Nvidia Quadro RTX 6000
Nvidia Tesla K40m
Nvidia Tesla M2075
Nvidia Tesla P100-PCIE-16GB
Nvidia Tesla P100-SXM2-16GB
Nvidia Tesla T4
Nvidia Tesla V100-PCIE-32GB
Nvidia Tesla V100-SXM2-32GB

[1] *Source : https://www.grid5000.fr/w/Nantes:Hardware*

How ?

Grid'5000 | An experiment's outline

- Discovering resources, selecting resources and submitting jobs
- Reconfiguring the resources to meet experimental needs
- Monitoring experiments by extracting and analyzing data
- Controlling experiments, automation, reproducible research

How ?

Grid'5000 | Software Stack[1]

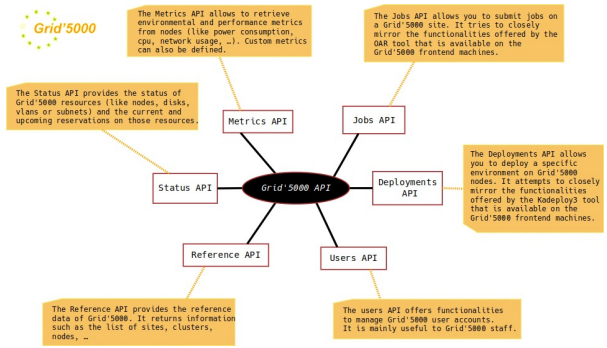
- Isolated network, access using **SSH**

- Tasks/Resources Management: **OAR**
- System Reconfiguration: **Kadeploy**
- Network Configuration: **Kavlan**
- Monitoring: **Kaspied, Kwapi, Kwollect (grafana), OAR/{Monika,DrawGantt}** …

- All in One: **Grid'5000 API**

oar.imag.fr

kadeploy.gitlabpages.inria.fr



[1] Source: https://www.grid5000.fr/w/Getting_Started

How ?

Grid'5000 | Usage Policy[1] & Conditions of use[2]

"reserve your physical resource on-fly"

- Limited access during workdays (9h – 19h) for smaller-scale experiments and priority to large-scale jobs during nights and holidays/week-ends.
- Limitation per cluster → max 2 hours on all the cores of the cluster.
- If your intended usage does not fit within the detailed rules presented in the Usage Policy, you can request a special permission to the executive committee.
- Reserved resources are force-removed once the reservation is done

[1] https://www.grid5000.fr/w/Grid5000:UsagePolicy
[2] https://www.grid5000.fr/w/Grid5000:General_Conditions_of_Use

How ?

Grid'5000 | Request an account

- Justify of a use of Grid'5000 for its intended purposes.
  E.g. *"I am a PhD student working on AI and networking and will use Grid'5000 for simulating network performance for the XXX experimental project"*
- Go to the request a new account page, fill up informations
  - **SSH Public Keys**
  - Group Granting Access = **LS2N**
  - Inria Research Center = **Not Affiliated to INRIA**
  - **Project & Team**
  - Motivation & **Intended Usage**
- The account manager will be notified and validate your request.

How ?

Grid'5000 | Demo time[1] !

github.com/randria/talks/tree/main/20210923-ls2n-csi-g5k_demo

1. First connection with SSH
2. Discovering and visualizing resources
3. Allocating and accessing resources
4. Reconfiguring and deploying resources

[1] Source: *https://www.grid5000.fr/w/Getting_Started*

Help ?

Grid'5000 | On your bookmarks

grid5000.fr

grid5000.fr/w/Nantes

Who ?

Grid'5000 | LS2N Contact & Support

- Richard **RANDRIATOAMANANA**,
  - Reseach Support Team and main lab tech contact for infra/g5k
  - By email: randria@ls2n.fr or soutien-ia@ls2n.fr
- Adrien **LEBRE** (Team leader)
  - Team LS2N/STACK
  - Account manager G5k-Nantes
  - G5k Scientific Site Committee Member
- Jean-Marc **MENAUD** (Samurai)
  - Team LS2N/STACK
  - CPER project Leader
  - G5k Scientific Site Committee Member
- Remous-Aris **KOUTSIAMANIS** and Rémy **POTTIER** (*until end of Oct.*)
  - Team LS2N/STACK
  - Support and technical contacts

Credits & Thank you!

- https://www.grid5000.fr
- **Formation Groupe Calcul** “Utilisation de Grid’5000 pour la réalisation de benchmarks”, *S. Delamare / A. Cadiou / L. Pouillloux, Oct. 2020* *https://calcul.math.cnrs.fr/2020-04-formation-g5k.html*
- **OCIF Talk** “Using Grid’5000” de *Remous-Aris Koutsiamanis (IMTA), 2019*
- “The data-centers facet of SILECS (a.k.a G5k)” de *Frédéric Desprez et Lucas Nussbaum, 2019, https://www.grid5000.fr/mediawiki/images/Grid5000.pdf*
- **TP Inria Lille** “Premiers pas avec G5k” de *Simon Delamare (LIP Lyon), 2014* *https://www.grid5000.fr/w/User:Sdelamare/Lille_Tutorial*