The VirtualData Cloud

or the demystification of what cloud means

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Hello

Who am I?

- Joined IJCLab/CNRS (engineer) after PhD/postdoc in cosmology.
- Mainly work in the big data ecosystem nowadays.
- Co-lead Rubin broker Fink: responsible for algorithms and infrastructures.
- Helped built various software pipelines in astronomy/cosmology.
- Also heavily involved in teaching activities.

I am primarily a cloud user, but I have the chance to touch the internals!

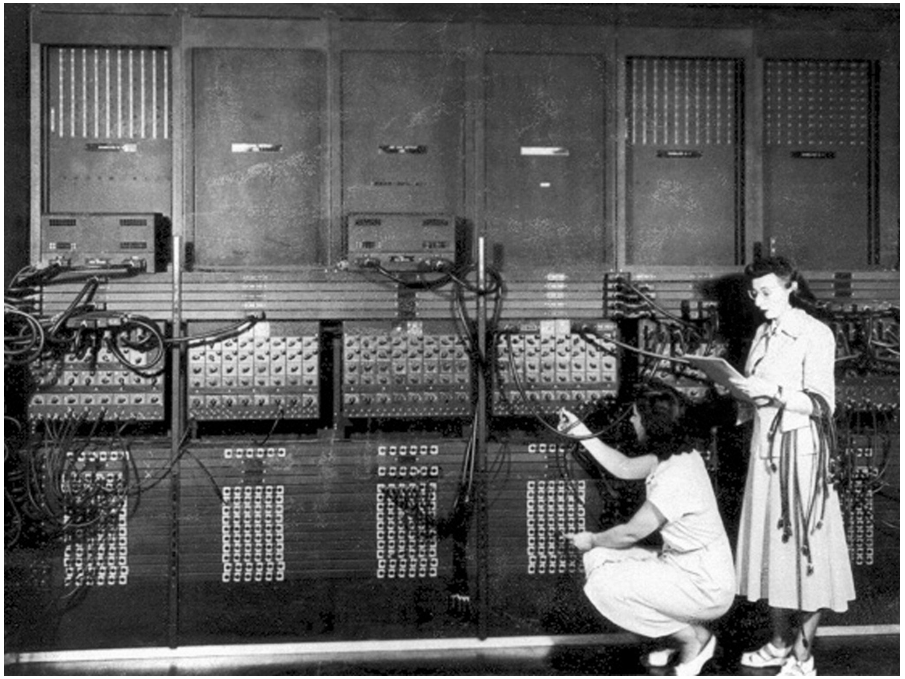
- We will probe the concept of *DevOps…*

Scientific computing

Computers used to be only for science :-)

Nowadays computers are used everywhere for (almost) everything

In our labs, it goes from smaller scale: *integrated circuit, desktop, laptop, mobile*; to bigger scale: *machines room, data center, computing center, supercomputer, grid, and…* ***cloud!***



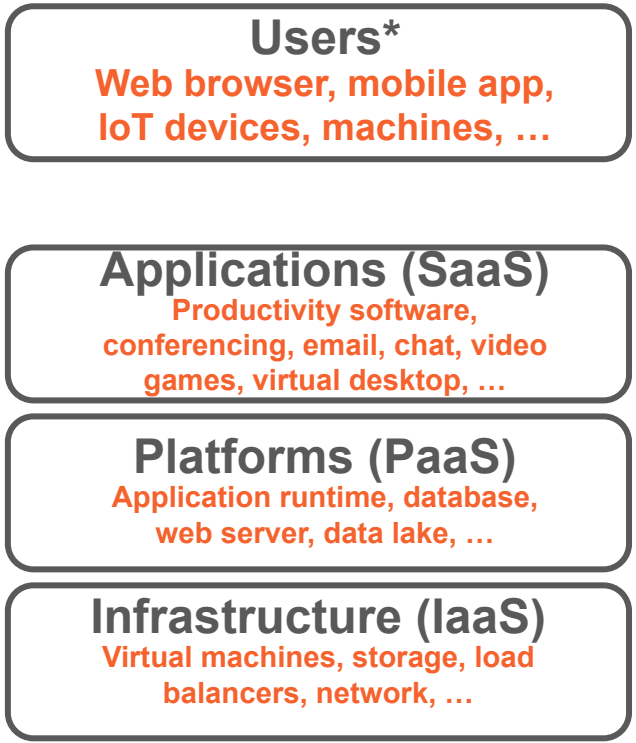
Cloud Computing

Cloud computing: group of networked elements providing services that do not need to be addressed or managed individually by users.

- Decoupling the usage from the rest

In practice, several layers of interaction

- SaaS: *Software* as a service
- PaaS: *Platform* as a service
- IaaS: *Infrastructure* as a service



*aka *clients* for the business world

Public clouds

Public term is misleading – pay-as-you-go model!

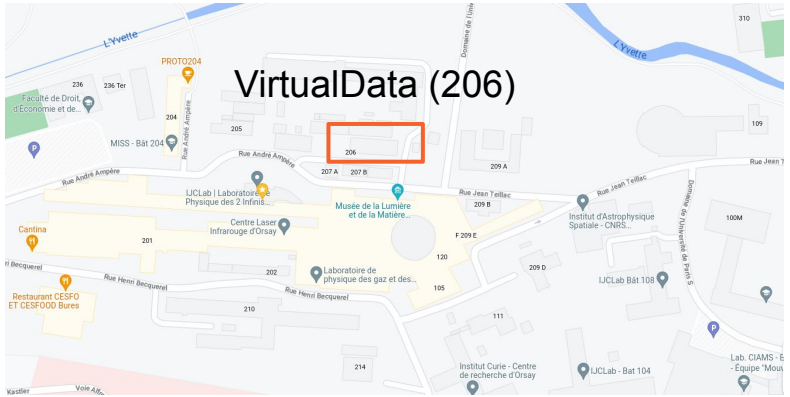
@PSaclay: early phase

Initially an initiative from P2IO labs in 2011

- 5 ex-labs of IJCLab + IAS
- Objective: build a *datacenter* focusing on energy efficiency to host the all the computer science (*informatique*) needs.

In operation since 2013

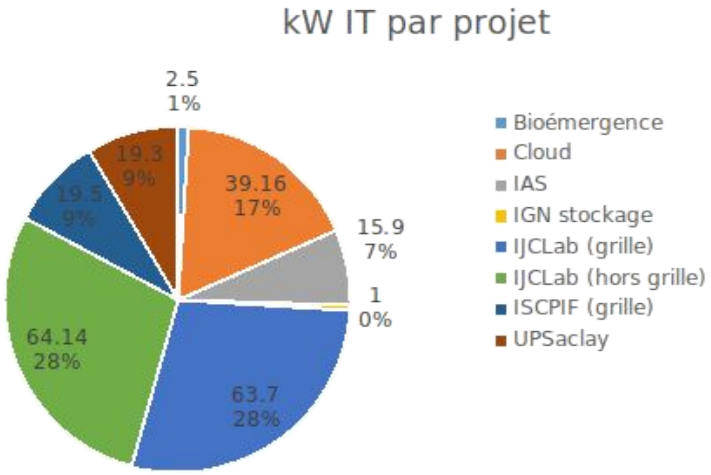
- Modular infrastructure with 51 racks (90 max) and 600 kW IT
- Double power source (300 kW), plus an emergency engine-generator (80kW)



Current hosting

The datacenter hosts shared & specific resources

- All computing from IJCLab + part of IAS
- DSI Paris-Saclay, AgroParisTech, CentraleSupelec
- EGI/WLCG grid node (LHC + Institut des Systemes Complexes)
- Cloud for scientific computing



1 kWh: 100 gCO2 (ADEME)
PUE ~1.25 → 1 kW IT = 1.25 kW real

VirtualData cloud

Mutualised resource for scientific computing of Paris-Saclay, piloted by IJCLab

- Started in 2016 (UPSud) & based on OpenStack
- 12,000 cores and 1 PB storage (w/ replication)
  - ⅔ less than 2 years old.
  - Servers with 256 cores/512 GB RAM, AMD processors 7702 @ 2 GHz.
  - 4 servers with 40 GB RAM per core (1.7 TB RAM aggregated).
  - No (yet) GPUs.

Funding sources since 2016: labs/users, IdF region (DIM), Paris Sud/Saclay…

- Capability to increase the resources as needs grow and opportunities come.

VirtualData cloud

Computing infrastructure for various needs

- Users access dynamically needed resources (compute & storage) within a shared pool (under quotas).
- Storage & compute is decoupled.
- Users completely control the executing environment (OS, libraries, …).
- Possibility to orchestrate several virtual machines together.

Basic mode of use: creation/execution of a virtual machine (VM) for an application.

- Other use cases from advanced services
- Possibilities to deploy clusters of containers (Kubernetes, Swarm)
- VMs can last several months: users need to periodically confirm to extend the lease. Otherwise, resources go back to the shared pool.

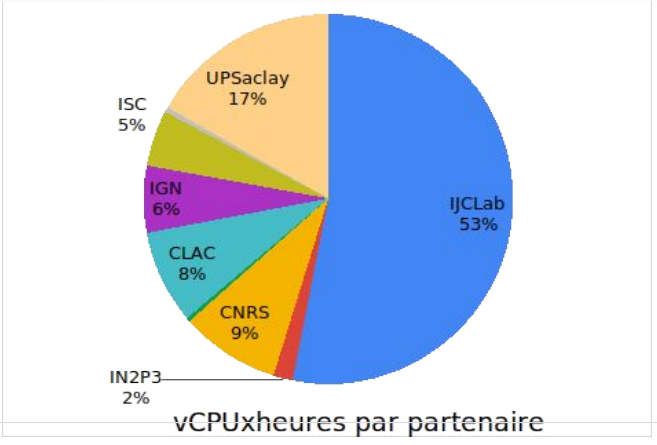
Compute

Mutualised resource in expansion

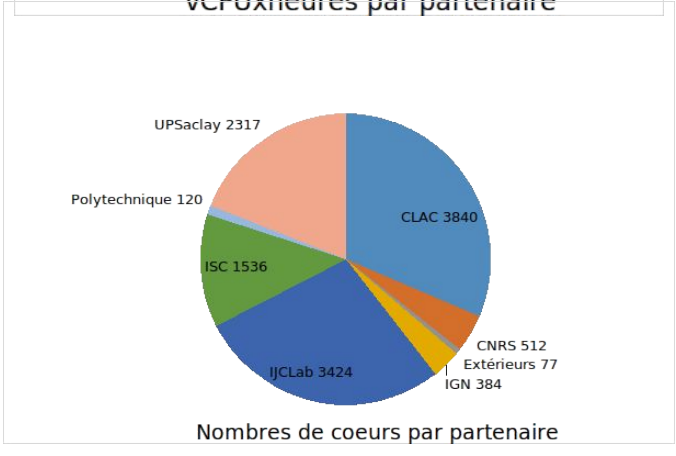
- 12,000 cores
- 2021: 43 MheuresxCPU delivered (~50% load, + 25% wrt 2020)
- 80 active « projects »

Some critical services

- CNRS BBB, Mathrice BBB, GRANDMA, SVOM…
- All hypervisors have a backup electricity supply (but no emergency line).



vCPUxheures par partenaire



Nombres de coeurs par partenaire

Storage

VirtualData storage platform based on Ceph (1 PB effective in 2023) :

- Storage cluster with high availability and high performance thanks to data replication and distribution.
- Various storage types: file system (~NFS), virtual disks (~iSCSI) or object storage (S3)

Mainly for cloud operations

- Main usage: non-volatile disks of virtual machines.
- Some usage of S3 for import/export of large volumes of data.
- No long-term archival, no back-up by default, …

Solution chosen for the future global storage platform of the PSaclay mesocentre.

Openstack (core services)

- Dashboard (Horizon)
- Identity (Keystone)
- Networking (Neutron)
- Block Storage (Cinder)
- Compute (Nova)
- Shared File Systems (Manila)
- Image (Glance)
- Object Storage (Swift)
- Telemetry (Ceilometer)
- Load balancing (Octavia)
- Orchestration (Heat)
- Secrets Service (Barbican)
- Bare metal provisioning (Ironic)
- Database as a Service (Trove)
- DNS service (Designate)
- Container orchestration (Magnum)
- …

Advanced services

In addition to its IaaS aspect, VD exposes a number of advanced services:

- Apache Spark
- JupyterHub (https://jupyterhub.ijclab.in2p3.fr)
- Batch system (HTCondor)

JupyterHub

Service (JupyterHub & JupyterLab) for executing and sharing Jupyter notebooks:

- Notebook : mixing code/text/graphics.
- Highly used in the data analysis world and for teaching.
- Several kernels available: Python, R, C++ (from C++ 11 to C++ 20)
- Authentication with eduGAIN but need to contact first info-scientifique.di@unviersite-paris-saclay.fr

Actual configuration: 1 VM with 256 cores / 512 GB RAM

- Current work to dynamically (on-demand) provision workers within a cluster of containers

Regarding teaching: 20 UE, ~50 teachers, O(10,000) students in 2021-22

Apache Spark

Service to process and analyse large volumes of data in parallel (MapReduce).

- High scalability by adding resources (horizontal scaling).
- Based on the Apache Spark framework, highly used in the big data world.

Service potentially open to user groups.

- Heavily used in Astronomy/cosmology, especially for the Vera Rubin Observatory. See e.g. https://fink-broker.org
- Used to be use for Genomics projects.

Dynamical management of workers is possible (connection with Kubernetes).

Batch system

Used to launch applications in a non-interactive mode but without maintaining the infrastructure (e.g. like a supercomputer).

- Like a traditional computing center/supercomputer.
- Solution based on HTCondor deployed in VD.
- 1 private instance for IJCLab connected to the local spaces of users.
- 1 instance for external users of IJCLab requiring import/export of data.

Still in its infancy: we need your feedback if you are using it to better design the service. Planned evolutions:

- Dynamical provision of resources as a function of the job load.
- Deployment of the CVMFS service to easily distribute and deploy software independently of the job submission.

Support

IJCLab administrates the cloud, the storage, and all advanced services: ~4 FTE

Dedicated Helpdesk: https://cloud-support.ijclab.in2p3.fr

No support for user-based applications/services.

- The expertise needs to exist in the laboratory or community using the resources. IJCLab/mésocentre promote expertise networking.

How to get an account to access the cloud? https://registration.lal.in2p3.fr

- Self-registration (no validation), and then contact the helpdesk to be added in a project, or create a new one.

Economical model

Cloud opens to all PSaclay members, without guarantee of resources.

- After a phase of PoC, users need to contribute to be granted a defined level of resources.
- Contribution model centered on *machines* and not computing hours: users are allocating machines as opposed to job submission mechanisms.

Buying the cores that one would like to be guaranteed (IJCLab prescriptor – standard configuration exists), and then possibility to use more if/when available. On the other side, use by others if/when available.

Need to fund hosting costs of machines during the usage period (~5-7 years).

For storage: no mutualisation (of course!)

Let’s play!

We will see a series of example on how to interact and use the cloud. Here is the playlist:

- Intro [beginners]: requesting resources
- Example 1 [beginners]: Web application
- Example 2 [beginners]: REST API
- Example 3 [experts]: Continuous integration service
- Example 4 [beginners]: Streaming service
- Outro [experts]: Creating and managing clusters

hands-on

Go to https://github.com/virtualdata-cloud-i2i

To conclude

Do not be a simple client – inspect what is inside, how things are implemented.

Be careful about bullshitting and marketing.

But I strongly believe that the use of cloud will only grow!