



Running Interactive analysis on INFN Cloud Platform

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On behalf of the [INFNCloud team](#)

Outline

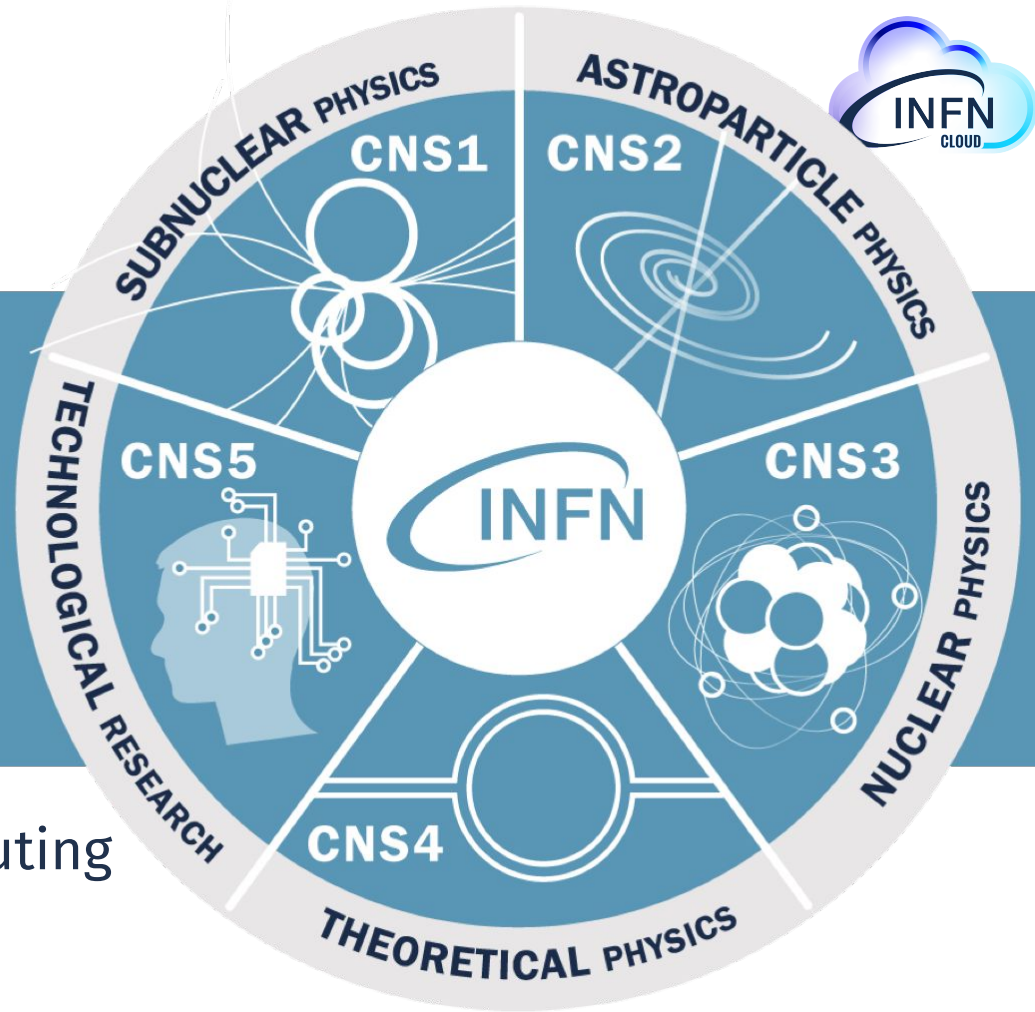


- What is INFN Cloud?
- An on-demand ecosystem for interactive analysis
- Implementations

Italian Institute for Nuclear Physics INFN



The 5 research lines and the INFN National Scientific Committees



And we learnt early that computing
is a transversal need....

The INFN Facilities

- 4 National Laboratories
- 20 Divisions
- 6 Associated groups
- 3 National Centres and Schools
- 1 International consortia



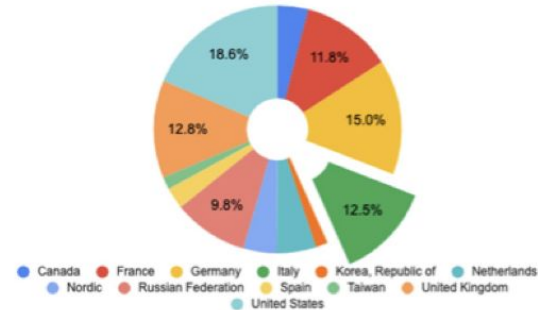
Not only LHC...

Regardless, a long time experience

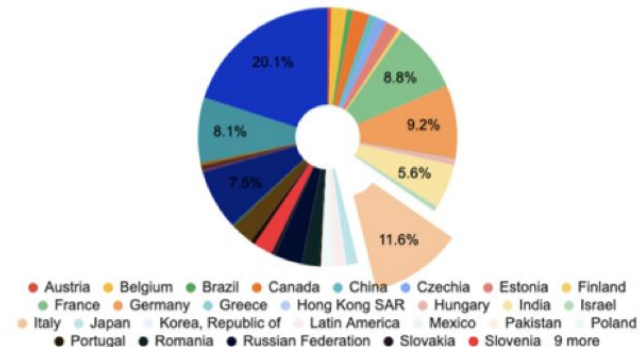


- INFN Distributed Computing federation delivers the LHC experiments O(7-20)% of their computing budgets
- "non LHC" (VIRGO, Astro, Nuclear, ...) is ~ 10-20% of the total
- Sites are of top quality among their peers, and have worked uninterruptedly for the last ~15 years
- In many cases, the infrastructures are close to those deployed in 2005 or slightly after
 - They could be bigger (CNAF uses ~1 MW, more recent centers are leaning towards ~10 MW)
 - They could be "greener"
 - Free cooling, direct cooling, ...
 - They could use more recent technologies, hardware and software
 - Go towards a national cloud, implement a data lake model for storage, ...

Share of Tier-1 CPU



Share of Tier-2 CPU



An ever growing asset

- Gradually shifting from “driven by in-home communities” to interdisciplinary projects
- One main goal: explore and adopt the most effective tools for our users to work with

Of course, at this point, cloud computing could not be left behind.



“Preparing the GRID”

“Preparing the Cloud”

“Expanding beyond HEP”

And then, the challenge



Extrapolations for High-Luminosity LHC

- A 20% yearly increase in performance from 2021 to ~2028 gives us a speed-up factor from technology advancements of $(1.2)^7 \sim 3.6x$.
- Back-of-the-envelope linear estimates foresee increased needs for computing at High-Luminosity LHC of **~75x** (box on the right).
- Therefore, **we miss a factor 20x!**
- How can we cope with this?
 - Get 20x more money from the Funding Agencies (unrealistic, the ballpark figure would be $\gg 1$ BEur/y)
 - Find ways to reduce the needs...

1 LHC Experiment ~2020:
~200.000 CPU Cores; ~200 PB
disk; ~350 PB tape



Using the same
computing
model

1 HL-LHC Experiment ~2028:
~15M CPU Cores; ~15 EB disk;
~26 EB tape

And then, the challenge(s)



Extrapolations for High-Luminosity LHC



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- **DUNE:** ProtoDUNE in 2019 collected 3 GB/s (same as CMS at the same time); real DUNE expected 80x at the end of the 2020s.
 - **SKA:** up to 2 PB/day (CMS ~ 3), to be collected and processed at “complex” locations.
 - **Genomics:** a single genome ~ 100 GB. Any population study ($>1M$ people) over 100 PB.
 - **CTA:** ~ 10 PB/y in 2025+.
 - **Virgo:** $\sim 10\%$ of a LHC experiment.
 - **ET** aiming at being $\sim 10\%$ of a HL-LHC experiment.



One umbrella to collect the answers....



INFN Cloud, <https://www.cloud.infn.it/>

- In **production** since March 2021.
- The **initial seed** of a National Datalake for research and beyond, building on (existing|renewed|new) e-Infrastructures.
- The **base of the evolution** of the INFN Distributed Computing vision.
- Built on a **thin middleware layer** running on top of *federated clouds*, decoupling physical and logical views via a **service composition** mechanism.
- The **INFN foundation** for the NRRP computing-related initiatives

What is INFN Cloud

A production-quality set of resources and solutions providing:

- A **core backbone**, with ancillary and special-purpose services.
- A **multi-site, federated Cloud infrastructure**.
 - INFN Cloud can transparently federate INFN sites as well as public or private Clouds (e.g.: AWS, Google Compute Cloud, Microsoft Azure, and others)
- A **customizable portfolio of services** accessible via web interfaces, terminal or API.
- A **fully distributed organization for the support and management** of both infrastructure and services.
- A set of **rules that define access resources and policies**, according to INFN, national and European laws.

This page collects all policies and procedures that have been validated by the INFN Cloud Project Management Board and that are currently in place across the INFN Cloud infrastructure.

Title	Applies To	Notes
INFN-Cloud Procedure to manage scheduled downtimes	Infrastructure/Users	v.1.0 02/02/2022
INFN-Cloud Rules of Participation	Infrastructure/Users	v.1.2 19/01/2022
INFN Cloud Security Recommendations	Infrastructure/Users	v.1.0 09/06/2021
User Community Operation Level Agreement	Users	v.1.0 13/04/2021

Welcome to the INFN Cloud Use Cases Documentation

You'll find here useful information regarding the use-cases supported on the INFN Cloud infrastructure.

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- [Getting Started](#)
- [How To: Create VM with ssh access](#)
- [How To: Deploy Sync&Share aaS](#)
- [How To: Associate a FQDN to your VMs](#)
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- [How To: Deploy a Spark cluster + Jupyter notebook](#)
- [How To: Deploy Elasticsearch & Kibana](#)
- [How To: Deploy RStudio Server](#)
- [How To: Instantiate docker containers using custom docker-compose files](#)
- [How To: Instantiate docker containers using docker run](#)
- [How To: Access cloud storage from a scientific environment](#)
- [How To: Request the "nomination to be system administrator"](#)
- [How To: Request the "nomination to be system administrator" \(italian version\)](#)

INFN is offering to its users a comprehensive and integrated set of Cloud services through its dedicated **INFN Cloud infrastructure**.

The **INFN Cloud portfolio**, available via an **easy-to-use web interface** but also exploitable via command-line interfaces, is defined upon clear user requirements.

It is based on **composable, scalable, open-source** solutions and can be easily extended either by the INFN Cloud support team or directly by end users.

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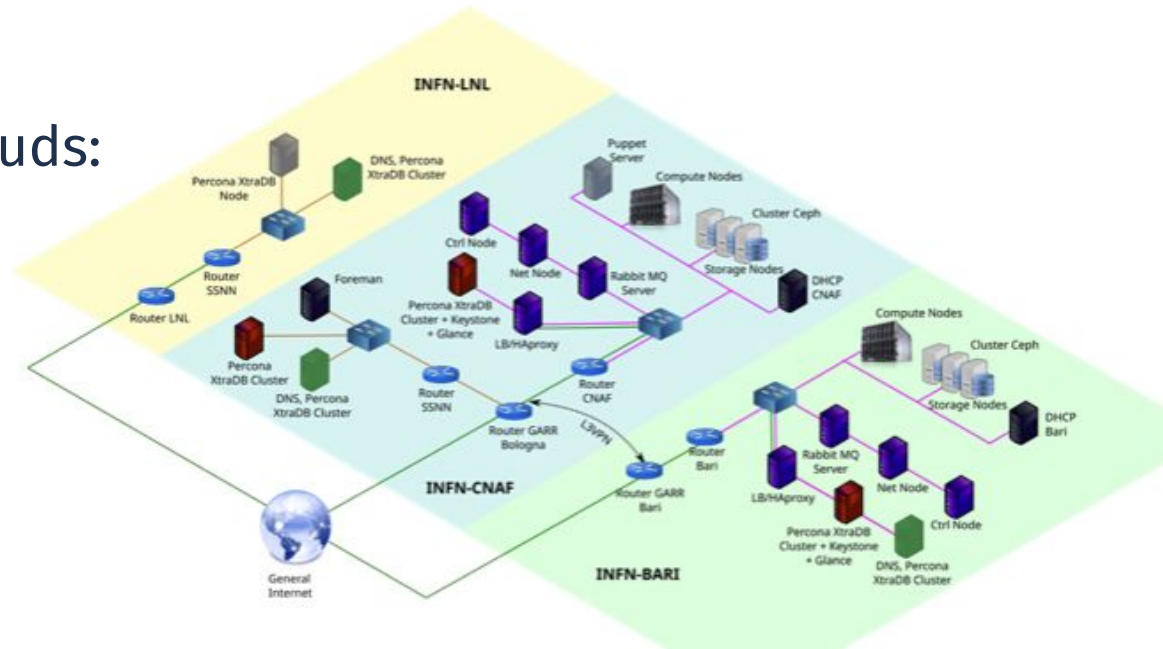
“A backbone to serve them all”

A multi site cloud infrastructure to host the core services

- Geographical HA / failover
- Automation

The idea of federated clouds:

- Resource will be attached to the backbone and made available seamlessly

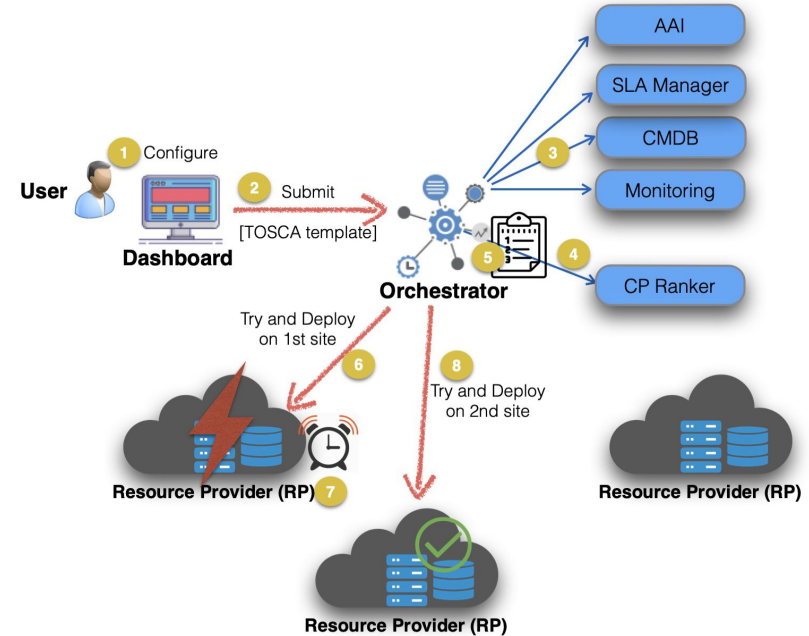


INDIGO PaaS

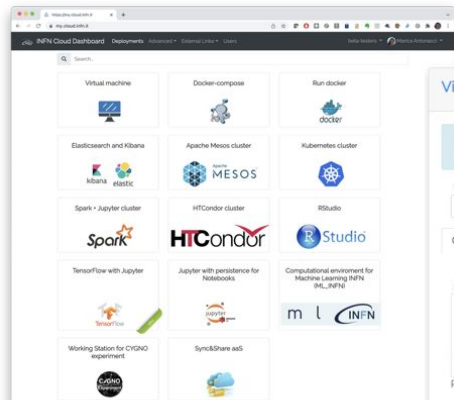


The INDIGO-DataCloud PaaS is rooted on:

- A distributed resource orchestration framework
- A standard-based federated solution for identity access management (INDIGO-IAM)

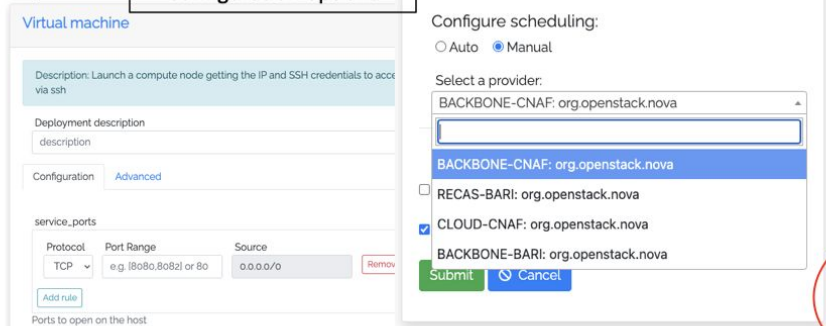


User interfaces first class citizens

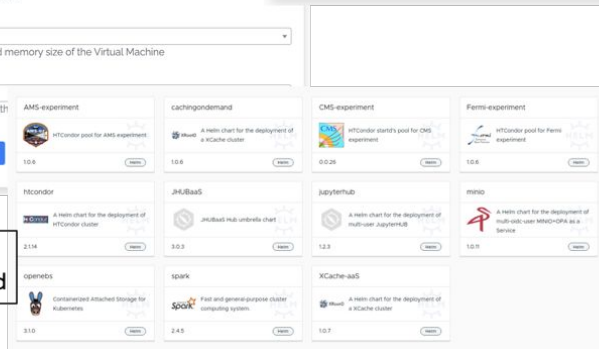


Per-user/per-group
View of the main dashboard

Basic/Advanced per-service
Configuration options



Kubeapp-level
Service dashboard



INFN Cloud Status

This page shows the high level status of the INFN Cloud services.

2022-03-25 -> 2022-03-28 - Power shutdown @ CLOUD-VENETO Maintenance due to start in about 17 hours

- INFN Cloud**
 - Object Storage Operational
 - Backbone - Cloud Compute (Bari) Operational
 - Backbone - Cloud Compute (CNAF) Operational
 - Authentication Operational
- Federated Cloud - CloudVeneto**
 - CloudVeneto - Cloud Compute Operational
- Federated Cloud - ReCaS-Bari**
 - RECAS-BARI - Cloud Compute Operational
- Federated Cloud - Cloud@CNAF**
 - Cloud@CNAF - Cloud Compute Operational
- PaaS services**
 - Infrastructure Manager Operational
 - Orchestrator Operational
 - CPR Operational
 - CMDB Operational
 - Dashboard Operational

What is a user looking for?

Currently two main use cases have been raised from many fronts:


1. Interactive and graphical analysis environment
 - a. colab-like, swan@cern like, in a word JupyterLab(++)
2. An easy to use storage system
 - a. for data analysis (e.g. input, config reading)
 - b. for sync&share (see dedicated [talk on this later](#))
 - c. Very often Posix-like access is an hard requirement

Different implementations


Slightly different needs



<https://www.cloud.infn.it/service-catalogue>

 **Compute Services**


A list of services that enable a specific cloud technology

 **Analytics**


A collection of ad-hoc solutions for analytic purpose

 **Machine Learning**

List of ready-to-use Machine Learning services

 **Data Services**

Data management and storage services

 **Scientific Community Customizations**

Customized environments

 **Elasticsearch and Kibana**


Deploy a virtual machine pre-configured with the Elasticsearch search and analytics engine and with Kibana for simple visualization

 **Spark + Jupyter cluster**

Deploy a complete Spark 3.0.1 + Jupyter Notebook on top of a Kubernetes (K8s) computing cluster


 **Jupyter with persistence for Notebooks**

Run Jupyter on a single VM enabling Notebooks persistence


 **Centralized Notebooks as a Service**

Use the INFN Cloud centrally managed Jupyter Notebooks as a Service Solution

Endpoint: <https://hub.cloud.infn.it>


 **Scientific Community Customizations**

Customized environments

 **Working Station for CYGNO experiment**

Run a single VM with all the CYGNO environment exposing both ssh access and Jupyter |

A collection of ad-hoc solutions for analytic purpose

 **Machine Learning**

List of ready-to-use Machine Learning services

 **Working Station for Machine Learning INFN (ML_INFNO**

Run a single VM with all the ML-INFNO environment exposing both ssh access and Jupyter

Deploy your service



Description	Deployment identifier	Status	Creation time	Deployed at	Actions
test_senza_iam	11ed3120-0a8e-5dcb-b185-0242a79ac9f5	CREATE_COMPLETE	2022-09-10 15:48:00	BACKBONE-CNAF	Details
test_jupy_fanzago	11ed3115-81ec-13f1-b185-0242a79ac9f5	CREATE_COMPLETE	2022-09-10 14:33:00	BACKBONE-CNAF	Details
jup_sologruppotraining	11ed2eee-199a-c181-b185-0242a79ac9f5	CREATE_COMPLETE	2022-09-07 20:46:00	BACKBONE-CNAF	Details
fede_prova_training	11ed2a15-341d-c7ad-b185-0242a79ac9f5	CREATE_COMPLETE	2022-09-01 16:43:00	BACKBONE-CNAF	Details

Showing 1 to 4 of 4 entries

Remember your ssh key to access the Vm

JupyterHub url

11ed3115-81ec-13f1-b185-0242a79ac9f5

Description: test_jupy_fanzago

Overview Input values Output values

node_ip: 192.135.24.189

jupyter_endpoint: <https://192.135.24.189:8888>

ssh_account: fanzago

AuthN/Z: OIDC leads the integration



The entry point is a customized JupyterHUB instance integrated with INDIGO IAM:

1. Authenticate the user and forward the identity to the spawning jupyterlab instance
2. Authorize different flavor of instances based on the group membership
 - a. E.g. different cpus/ram or GPU
 - b. Administration rights

The screenshot shows the JupyterHub interface. The top part displays the login page with the URL `https://192.135.24.195:8888/hub/login` and a "Sign in with OAuth 2.0" button. A callout box labeled "Authentication and authorization via IAM" points to the login area. The middle part shows the "Server Options" page where the user is identified as the "Hub admin". It features dropdown menus for "Select your desired image" (set to "dodasts/anj-base-lab-peris") and "Select your desired memory size" (set to "1GB"). A "Start" button is visible. A callout box explains: "Default image provided to start the JupyterLab server. You can use your private one built from the default one". The bottom part shows the "Admin" page with a table of users:

User	Admin	Last Activity	Running (0)
andreett	admin	21 hours ago	Start server Edit user Delete user
fanzago	admin	Never	Start server Edit user

Buttons for "Add Users", "Stop All", and "Shutdown Hub" are also present. A callout box on the right states: "Hub's admin can control users and notebooks".

Then we needed a shareable and scalable storage...

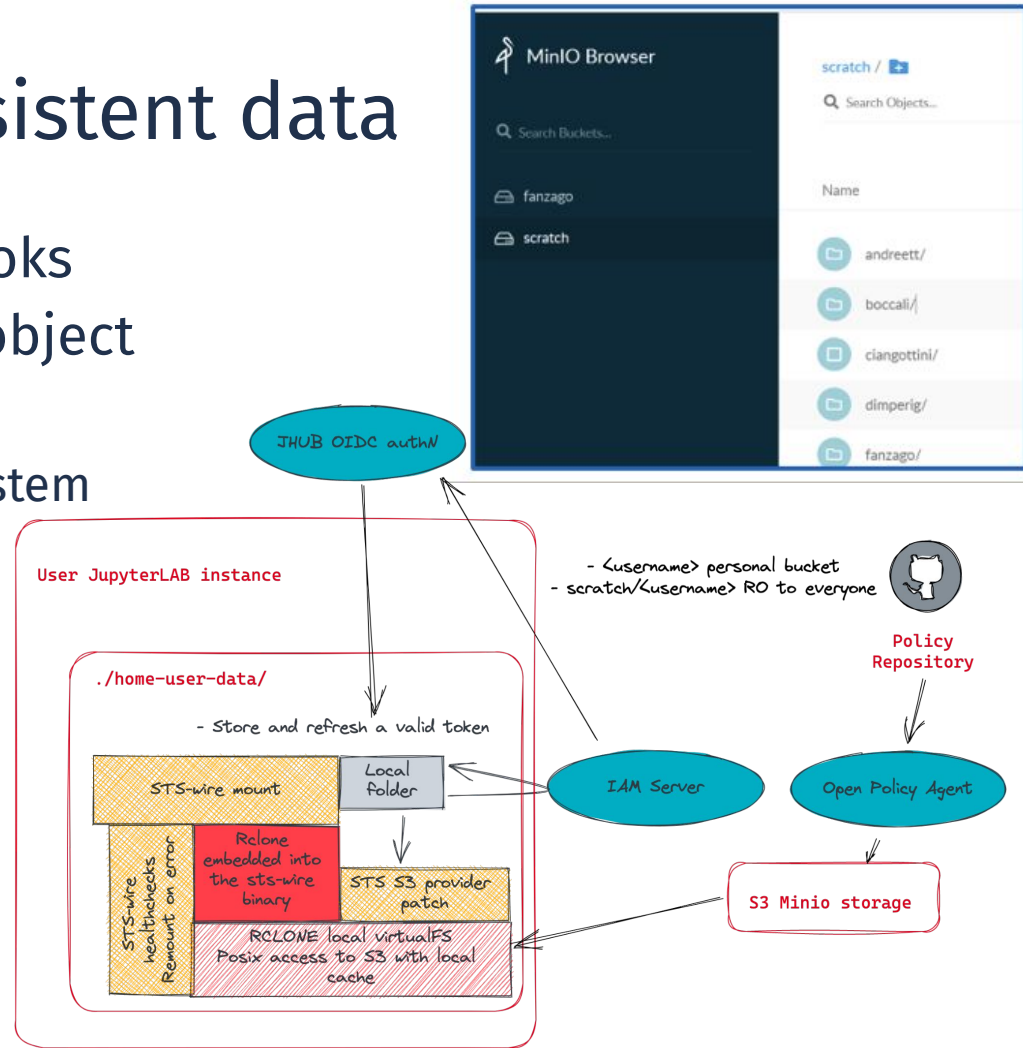


INFN Cloud provides object storage based on Openstack Swift, as centrally managed service.

- The object storage is replicated in the two sites of backbone, Bari and CNAF
 - It guarantees the redundancy of data
- INFN Cloud is using the Minio-gateway software on Swift
 - Indigo-IAM OIDC authentication has been integrated and authorization policies are currently managed via OpenPolicyAgent
 - Ceph migration is under evaluation
 - Difficult to find good alternatives for Minio's WebUI tough
- Service URL <https://minio.cloud.infn.it>

Store JupyterLab persistent data

- All the services running notebooks mount user areas store on the object storage backend
 - E.g. they are visible in the file system as posix directories.
 - [STS-wire](#): rclone mount+oidc shim library as been developed for the purpose



All in all, this is what you get

You login with your credentials, select your docker image and...



The image shows a JupyterLab interface with several callouts:

- Shared area among users of authorized group:** Points to a file browser view showing a shared directory with subdirectories 'andreett' and 'fanzago'.
- Inside Lab container:** Points to a terminal window showing the output of the 'df' command, displaying disk usage for various filesystems and mounts.

File Browser (Shared Area):

Name	Last Modified
/ shared /	
andreett	a day ago
fanzago	seconds ago

Terminal (Inside Lab container):

```
root@518f931c05e4: /jupyter X
# bash
root@518f931c05e4:/jupyter-workspace# df
Filesystem      1K-blocks    Used   Available Use% Mounted on
overlay         20134592 11121996    8996212   56% /
tmpfs           65536      0         65536    0% /dev
tmpfs          2013020    0       2013020    0% /sys/fs/cgroup
shm            65536      0         65536    0% /dev/shm
/dev/vda1      20134592 11121996    8996212   56% /shared
fanzago:fanzago 1099511627776 0 1099511627776 0% /s3/fanzago
scratch:scratch 1099511627776 0 1099511627776 0% /s3/scratch
root@518f931c05e4:/jupyter-workspace#
```




Not only on-demand...

Also a SaaS managed service available for every INFN Cloud user.

Hosted on the INFN Cloud Backbone (HA/failover on the two sites)

Enabling a quick evaluation for new use cases



Server Options

You are logged in as default user. If you want to enhance your quota please contact us at ...

Select your desired image:

Select your desired number of cores:

Select your desired memory size:

Start

Conclusions



- INFN Cloud focus is on enabling users to perform their analysis work in a intuitive and easy to use fashion
- If you want to do data-science like experience with JupyterLab you can now:
 - Instantiate your own JupyterHub instance to share with your collaborators
 - Get access to the SaaS-level, for a ready to use environment
- At all the implementation you will be able to store and access data on the same object storage backend

More is yet to come:

- Swift to Ceph migration for S3-compatible object storage backend
- Managing data at different sites
 - data-lake approach, RUCIO-FTS under study
- Exploiting ML specific setups for the whole pipeline
 - A first functional setup already available under ML-INFN project activity
 - Preprocessing, training, inference...
 - putting it all together in a cloud-native way is the main challenge now