The evolution of INFN's Cloud Platform: improvements in Orchestration and User Experience

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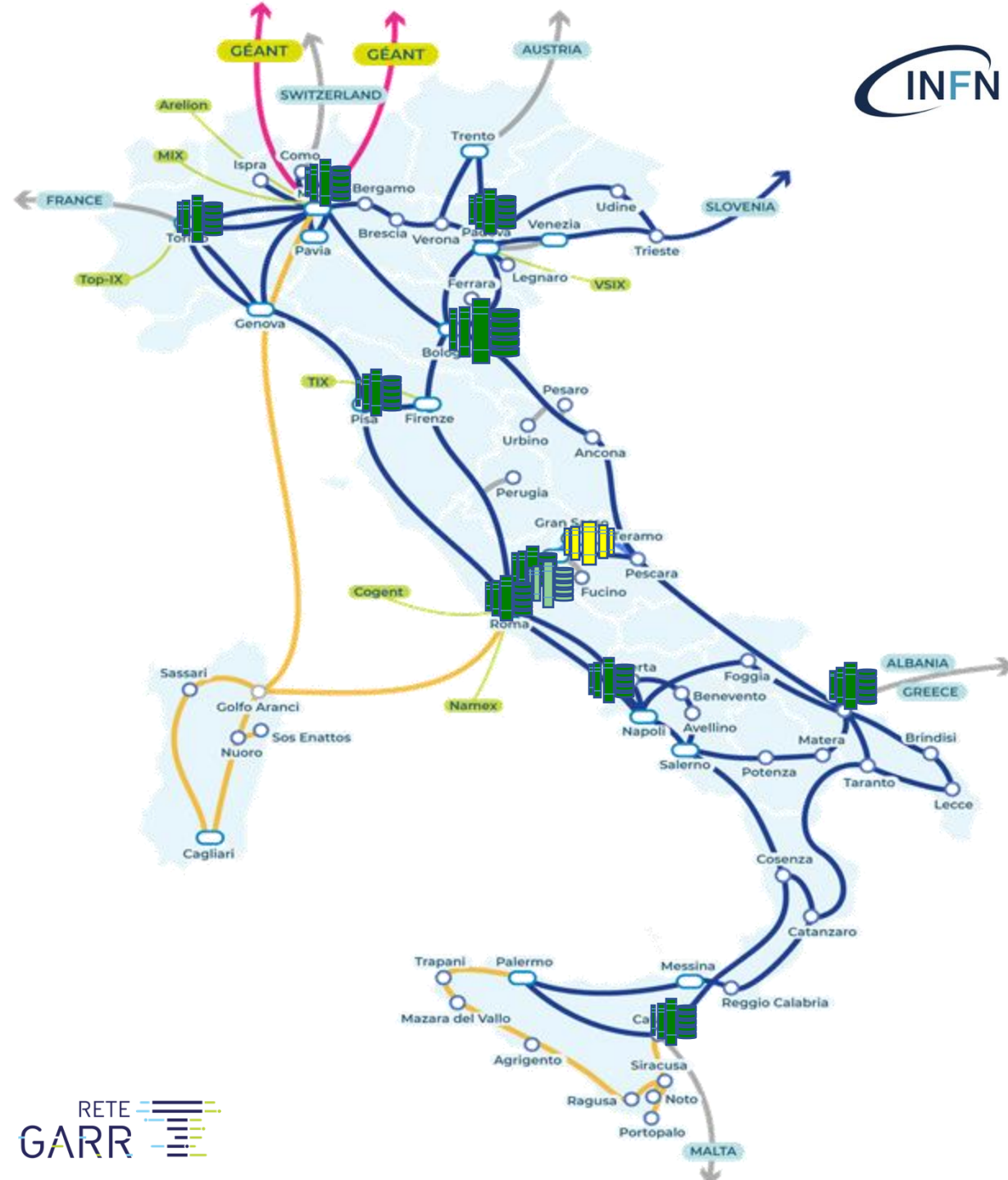October 19 - 25, 2024

CHEP 2024

DataCloud is the Infrastructure for INFN Scientific Computing

- Tier-1 (CNAF)
- Tier-2's (BA, CT, LNF, LNL/PD, NA, MI, PI, RM1, TO)
- INFN Cloud
  - Backbone and federated clouds
- HPC4DR (LNGS)
- (Tier-3)

DataCloud addresses the needs of INFN research projects

DataCloud is evolving into a Cloud Federation

Following the INFN Cloud model, resources are being made available through Cloud interfaces

- Inclusivity, through a lightweight federation model and the adoption of standards
- Ease of use, through the PaaS orchestrator and dashboard
- Flexibility, thanks to hybrid resource allocation mechanisms

Traditional (Grid and batch system) access remains as needed and when convenient

- E.g. through Virtual Kubelets, …
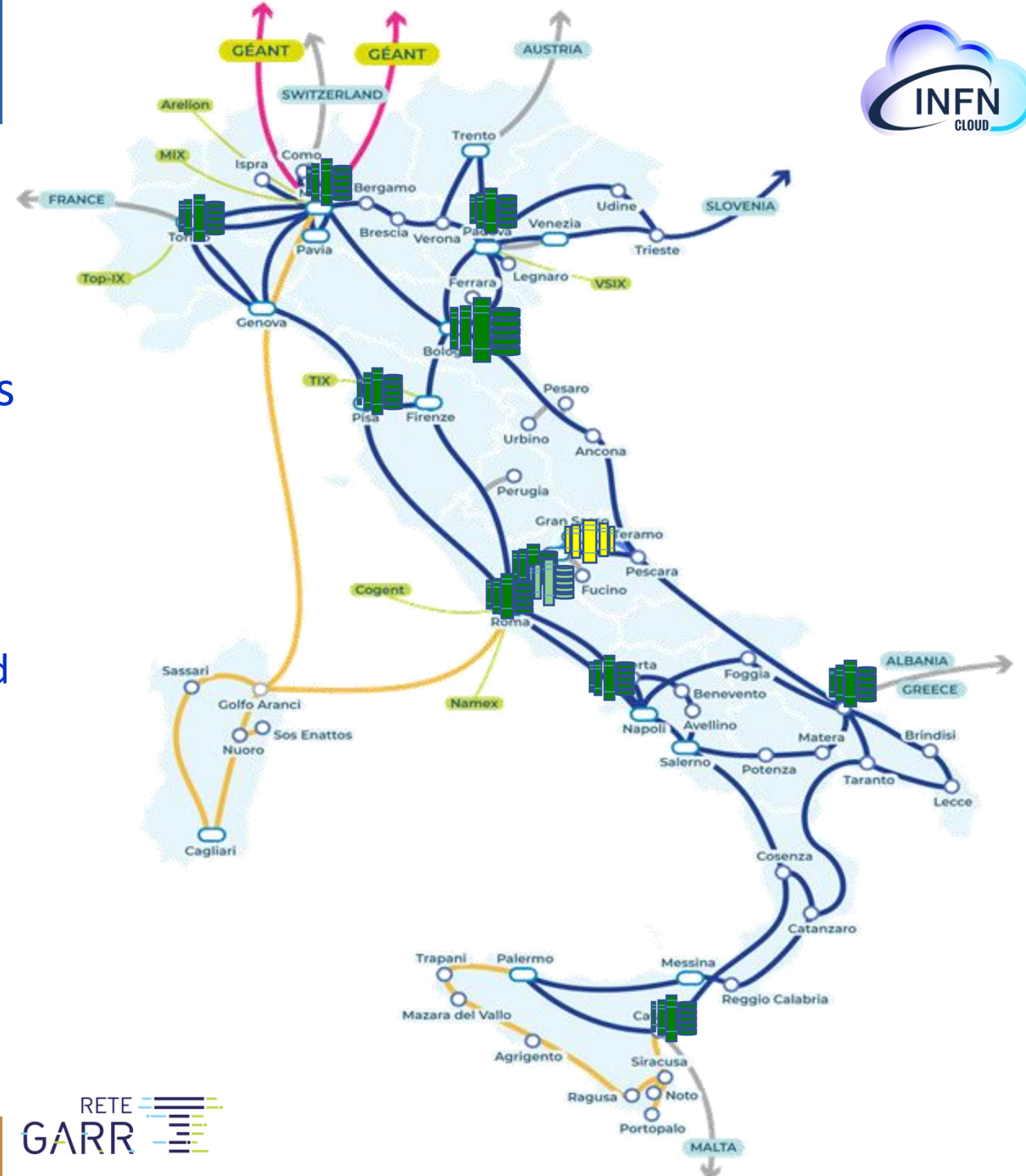
DataCloud is the basis for the Italian Cloud Federation

In the framework of the current Next Generation EU projects, in particular ICSC and TeRABIT, INFN has a leading role in the creation of the Italian Cloud Federation

The goal is to access all Italian scientific computing resources through uniform interfaces

Main players: INFN, CINECA, GARR

Inclusivity

The federation will include data centres that are already in production, and part of international communities

The procedures for joining the federation must be non-intrusive

Standard must be used whenever possible, and developed when missing

The federation will serve users of several fields and organizations

The procedures for user's onboarding must be as simple as possible

E.g.: use of Identity Federations

INDIGO IAM

See: Enrico Vianello: Evolving INDIGO IAM towards the next challenges Track 4, Tuesday 17:27
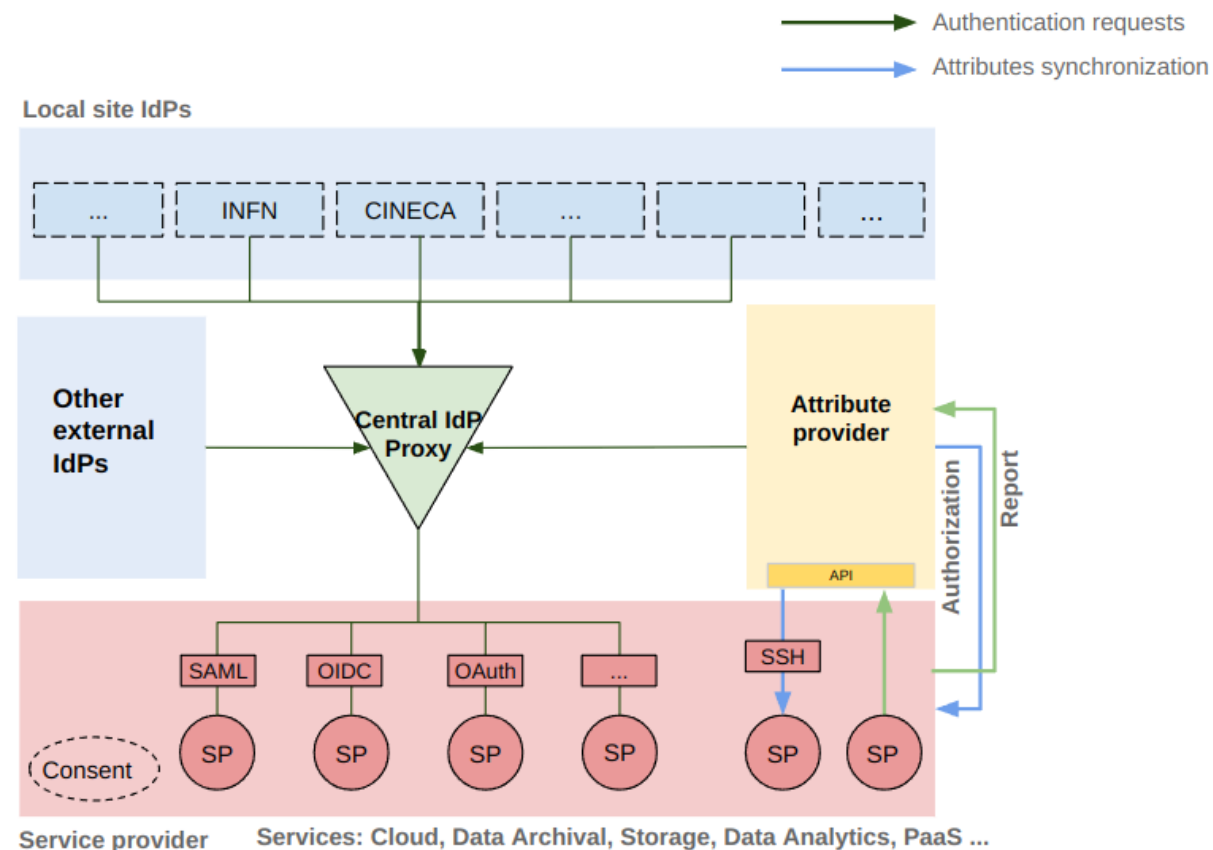
Ease of use

The federation will serve users with different computing competences

Complexity of the underlying infrastructure hidden to the end user

Support field experts in developing platforms that enable the effective exploitation of the infrastructure through composition of services and resources
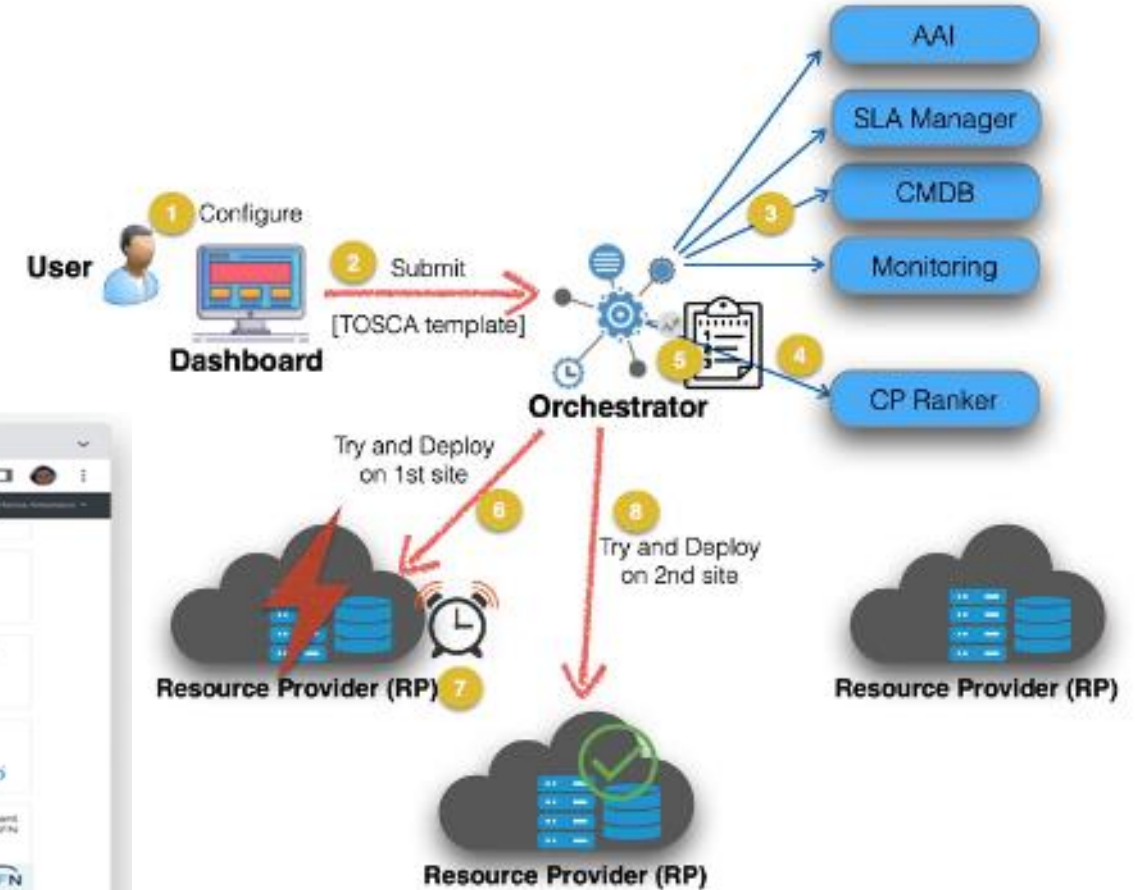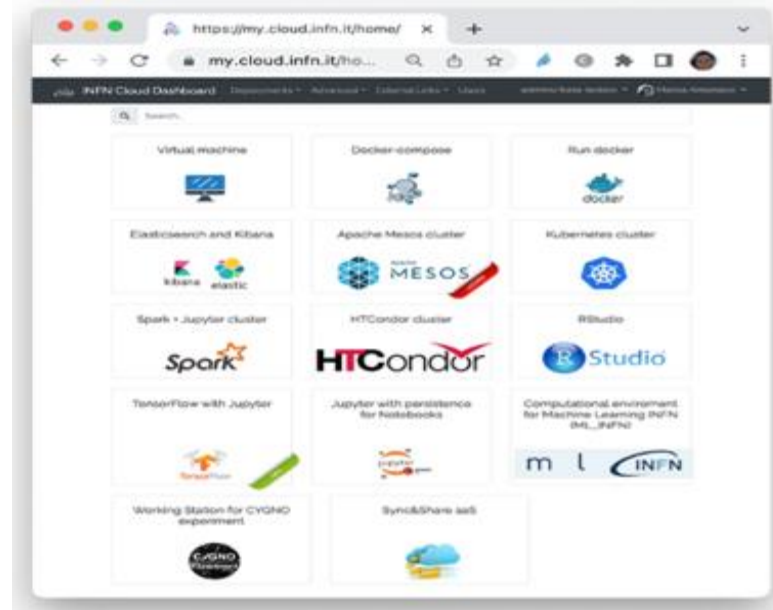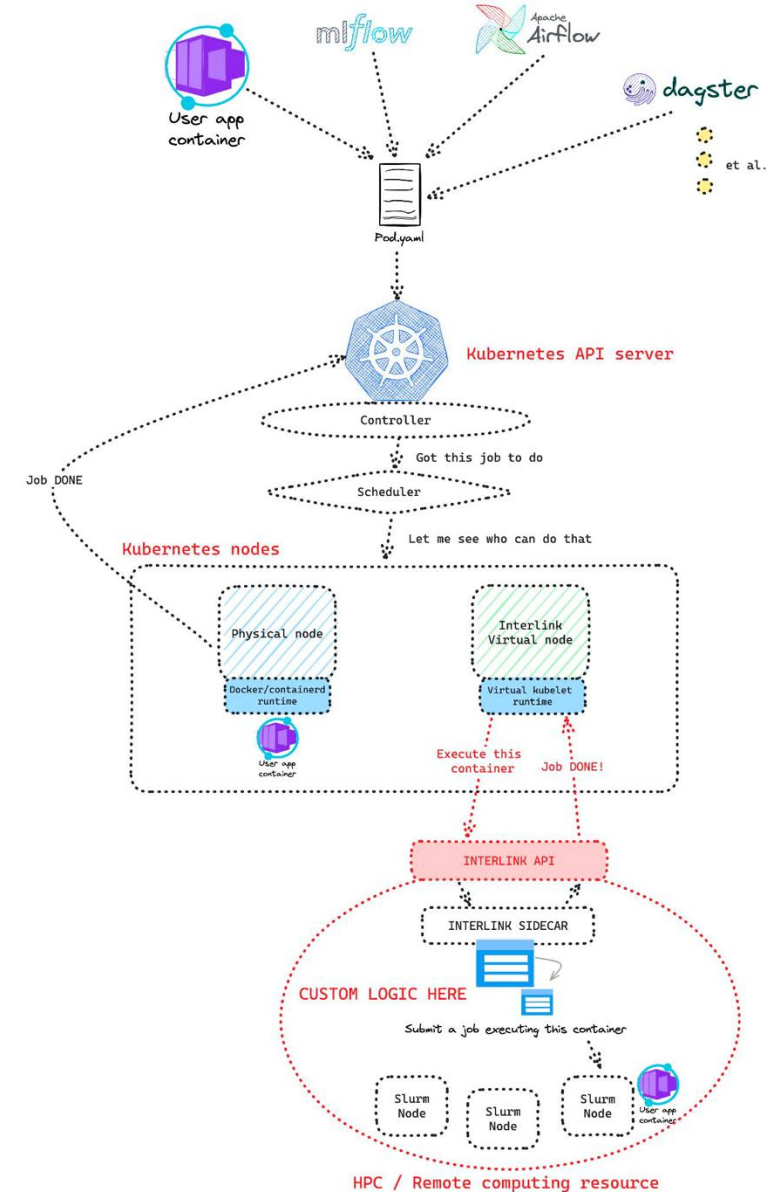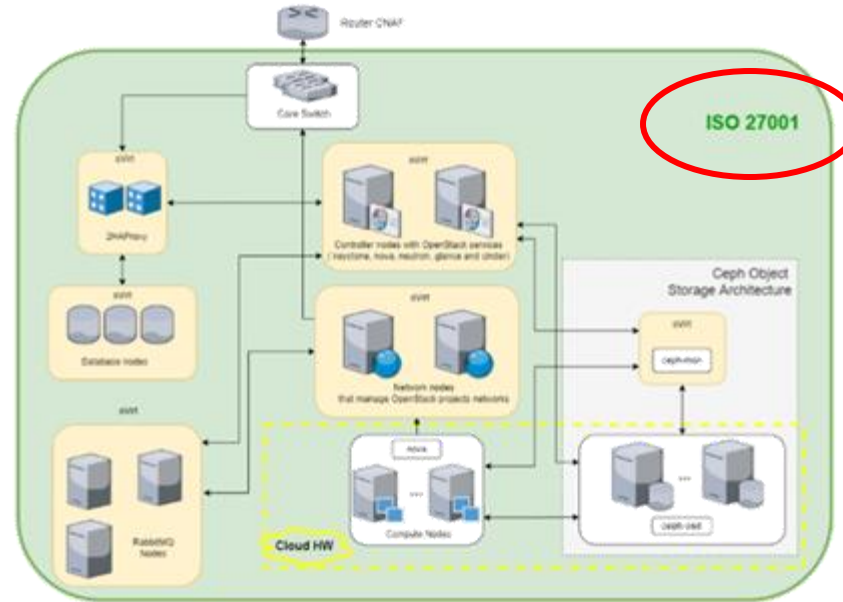

INDIGO PaaS orchestrator

Flexibility

Support multiple access methods to the resources, oriented to:

a. Transparency and ease of use
b. Efficiency and effectiveness

See: Diego Ciangottini Unlocking the compute continuum: scaling out from cloud to HPC and HTC resources Track 7, Tuesday 16:51

Support application-specific requirements

E.g. enhanced privacy

First Proof of Concept of the Italian Federation
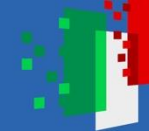
INDIGO IAM to federate CINECA and INFN IdPs

INDIGO PaaS Orchestrator to transparently access CINECA and INFN OpenStack-based resources ⟹

InterLink offloading to reach CINECA's Leonardo Supercomputing

RUCIO to federate CINECA and INFN storage systems

IDP CINECA

Leonardo/Lisa

Galileo100

IAM

Work in progress

Federation Services

IDP INFN

CINECA

Tier1/Tier-2 Federation

INFN
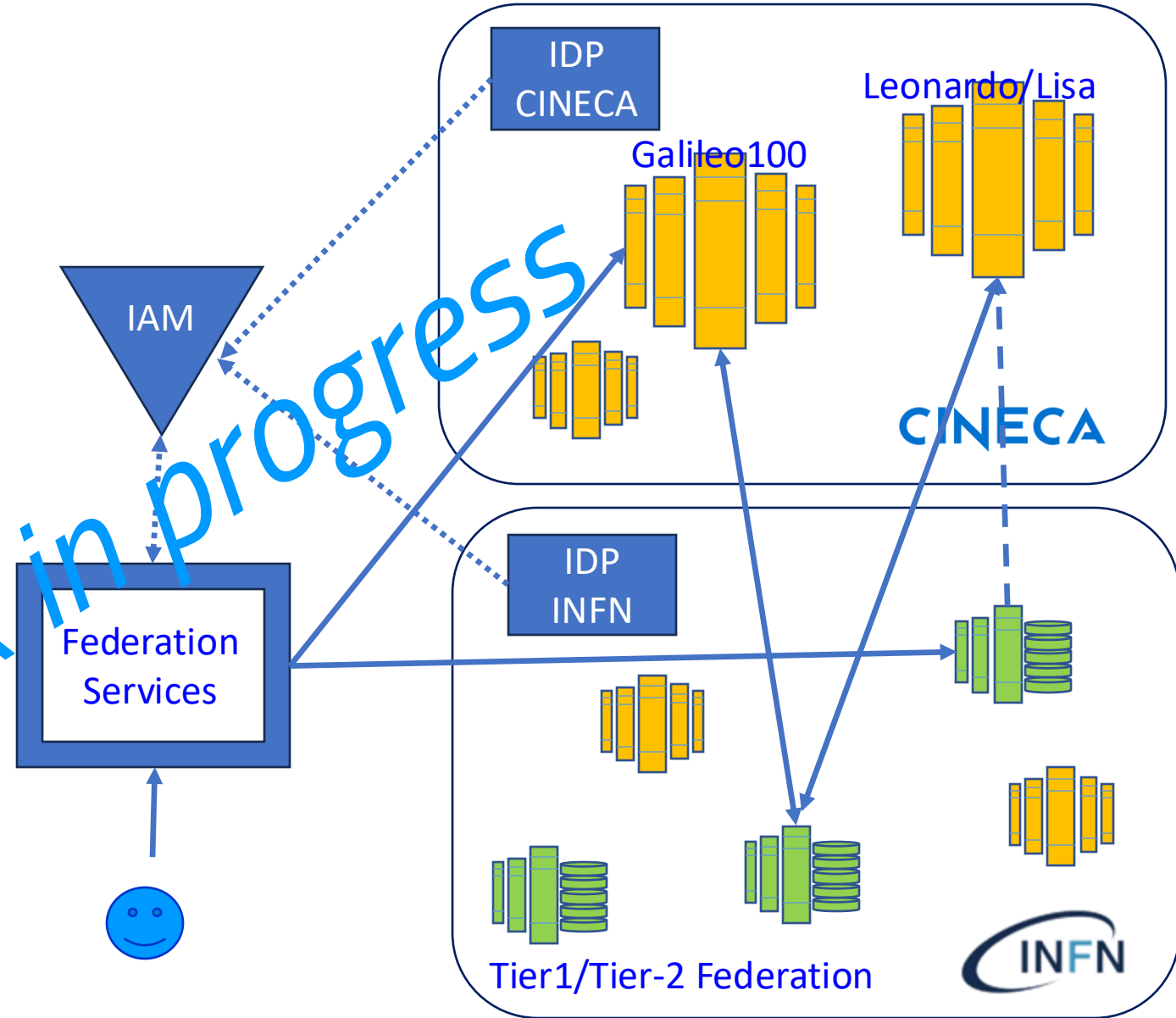
Evolution of the PaaS Orchestrator

Security

Replace obsolete and vulnerable software components to address emerging threats

Robustness and scalability

Exploit modern and robust components that can cope with heterogenous resources and scale with increasing number of users and services

User experience

Hide the complexity of the underlying system through a web dashboard

Refactoring

Main programming language: Java → python

flowable workflow engine → micro services + kafka RabbitMQ message broker

New Federation Registry micro service

All components use OpenID-Connect/Oauth2

New connectors for IM/ kubernetes and RUCIO

... and more

Leveraging AI

Master orchestration exploits AI-based techniques

  More dynamic and efficient choices
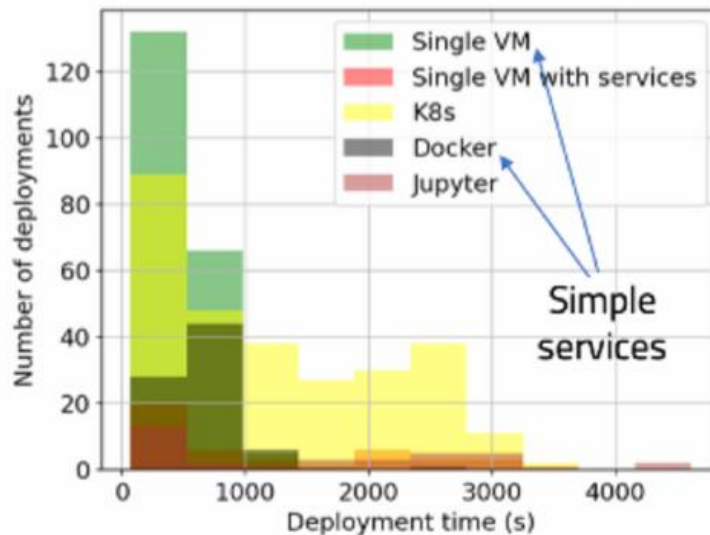
Preparatory work:

  Identified significant metrics and data sources

  Prepared datasets to analyze the problem
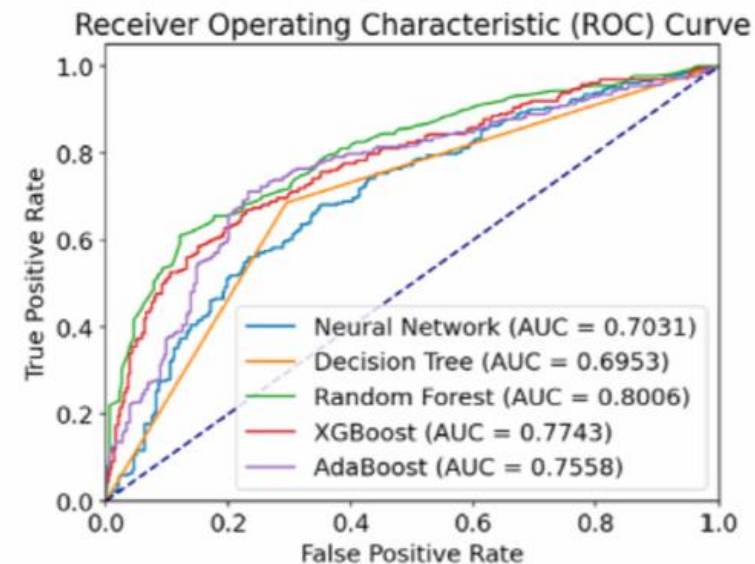
See: Enrico Vianello AI-based approach for provider selection in the INDIGO PaaS Orchestration System of INFN Cloud Poster session, Wednesday (#321)

Dashboard redesign

Users' entry point

Graphical representation of TOSCA templates

Conclusions

The INFN scientific computing infrastructure is evolving to become interdisciplinary and to cope with heterogenous needs and resources

Strong collaboration with national HPC centres

The PaaS Orchestrator and the web dashboard are key component to provide flexibility and ease of use

The orchestrator is undergoing a complete rewriting to provide sustainability and ability to address new needs

The dashboard scope and design is being extended to support workflows that do not necessarily go through the orchestrator

Backup slides

National Research Centre in HPC, Big Data and Quantum Computong

10 thematic spokes
1 infrastructure spoke
(CINECA, GARR, INFN)

25 universities
12 research institutes
14 strategic private companies

320 M€ budget

0 SUPERCOMPUTING CLOUD INFRASTRUCTURE

Garr Network
HPC Centre
Future HPC Centre
Big Data Centre
Future Big Data Centre

High-level teams of experts integrating
the Spokes working groups (mixed cross-sectional teams)

EDUCATION & TRAINING, ENTREPRENEURSHIP, KNOWLEDGE TRANSFER, POLICY, OUTREACH

1 FUTURE HPC & BIG DATA

2 FUNDAMENTAL RESEARCH & SPACE ECONOMY

3 ASTROPHYSICS & COSMOS OBSERVATIONS

4 EARTH & CLIMATE

5 ENVIRONMENT & NATURAL DISASTERS

6 MULTISCALE MODELING & ENGINEERING APPLICATIONS

7 MATERIALS & MOLECULAR SCIENCES

8 IN-SILICO MEDICINE & OMICS DATA

9 DIGITAL SOCIETY & SMART CITIES

10 QUANTUM COMPUTING

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terabit

https://www.terabit-project.it/

TeRABIT: Terabit Network for Research and Academic Big Data in ITaly
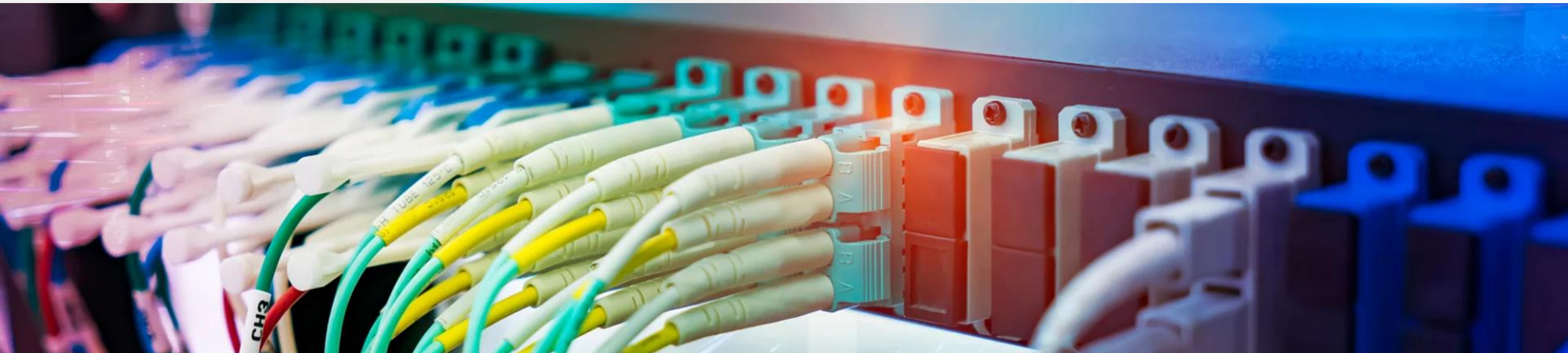
TeRABIT is a Research Infrastructure project synergic with ICSC

Partners are the same of the ICSC Spoke-0 (Supercomputing Cloud Infrastructure):

INFN, CINECA and GARR

Covers areas complementary to those of the ICSC infrastructure

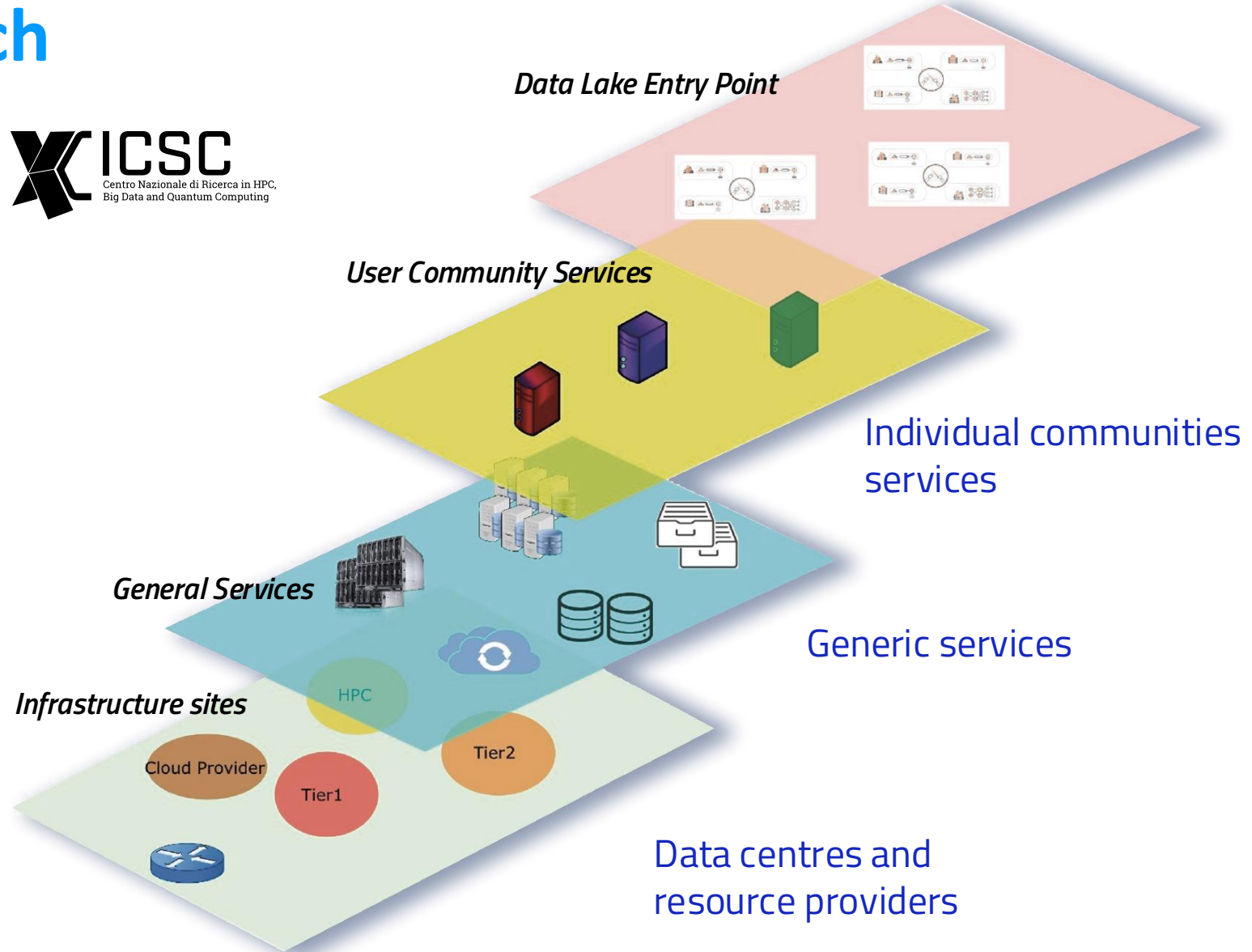41 M€ budget

A data lake for research

Existing infrastructures aggregation, upgraded and made available to scientific domains

A dynamic model, where infrastructures and domains can also be temporary

A clear separation between the physical and the logical levels

A high-speed network interconnection to hide the actual resource locations

A unified vision (when needed) of an Italian research data-lake

Data Lake Entry Point

User Community Services

Individual communities services

General Services

Generic services

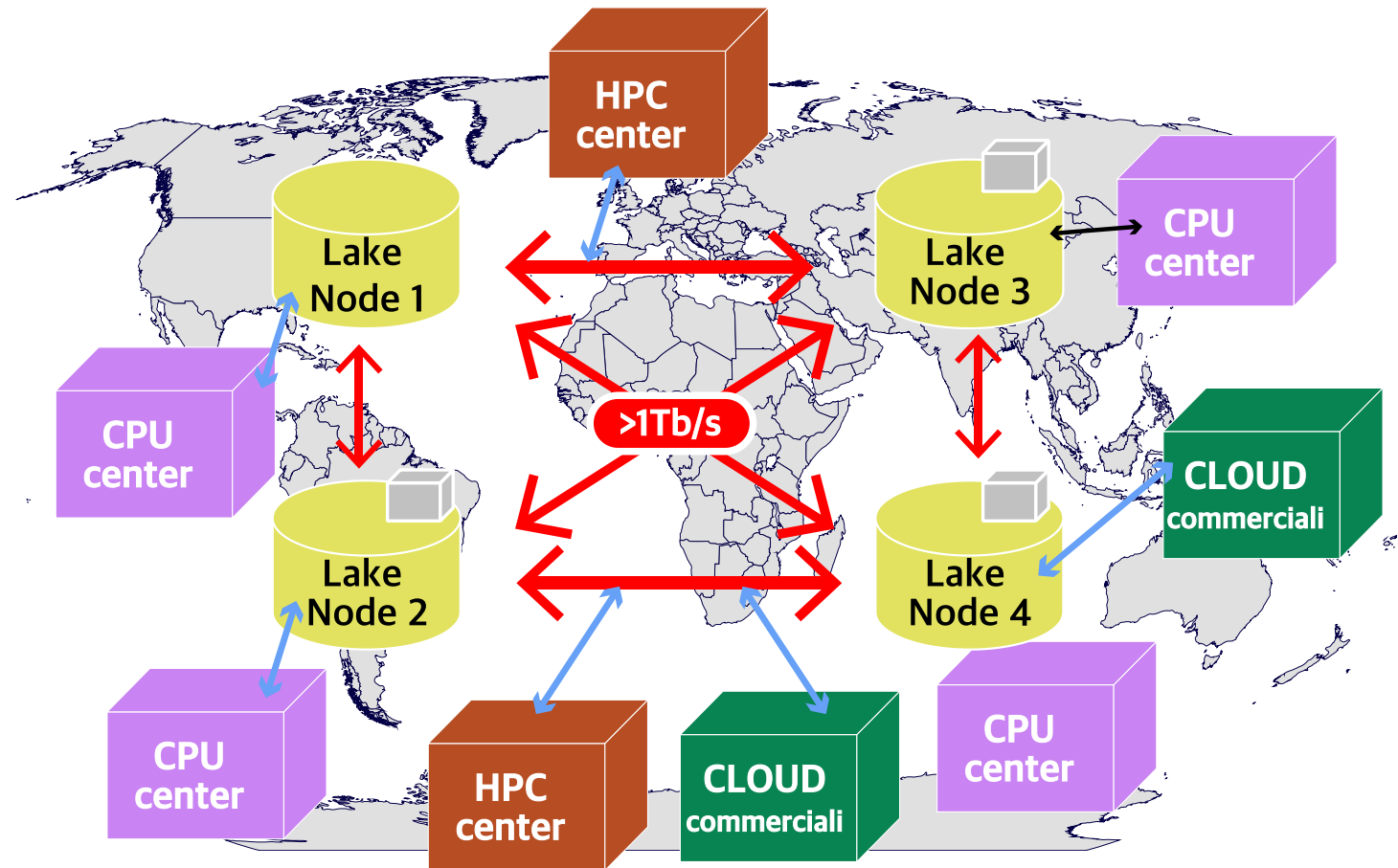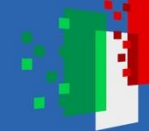*Infrastructure sites*

Data centres and resource providers

Data-centric model

Decouple storage and CPU

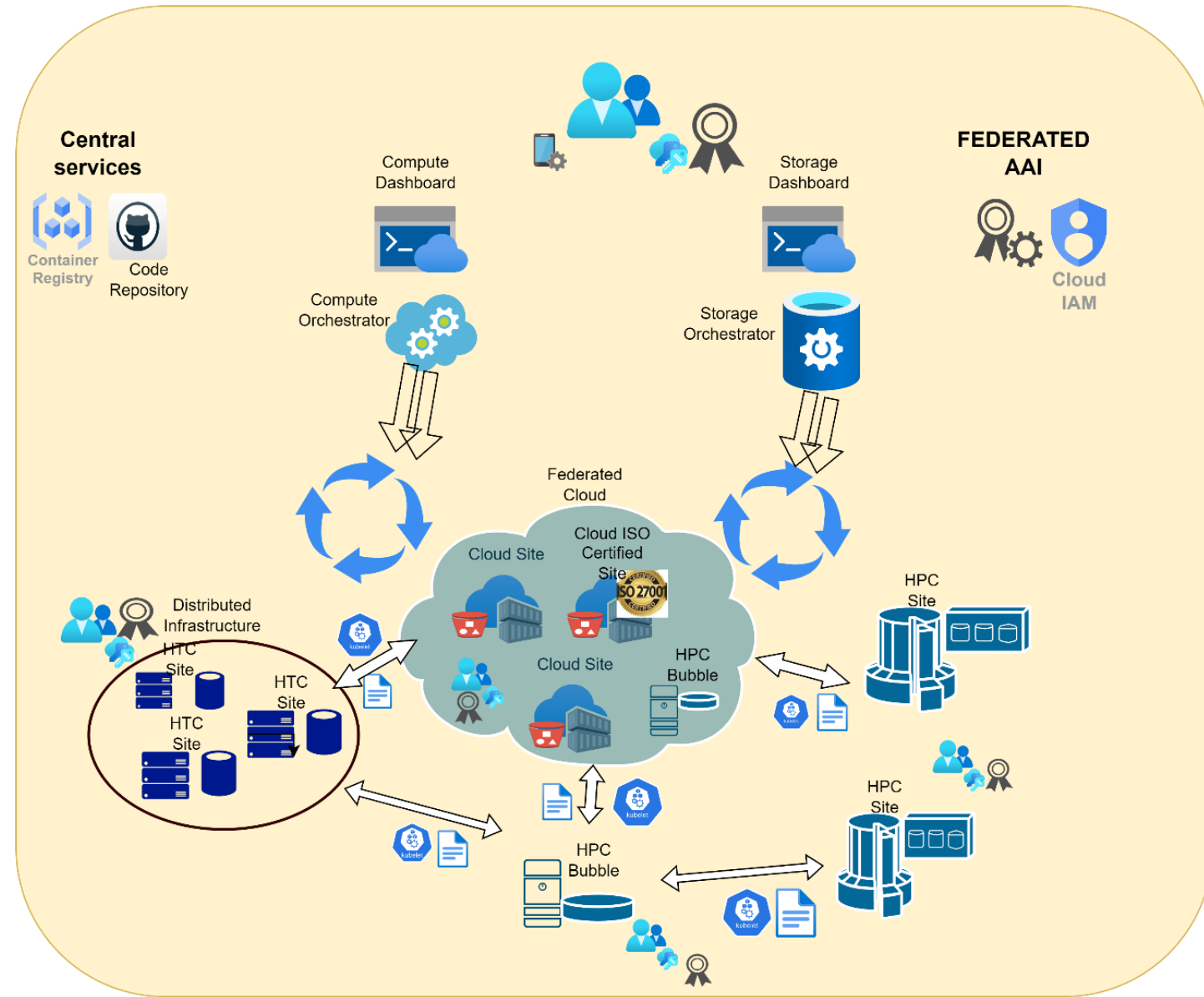Storage nodes interconnected with high bandwidth network

Heterogeneous computing nodes can access data wherever they are

Etherogeneity

Integration of a diverse set of resources, providers, and solutions

Current Orchestrator Architecture