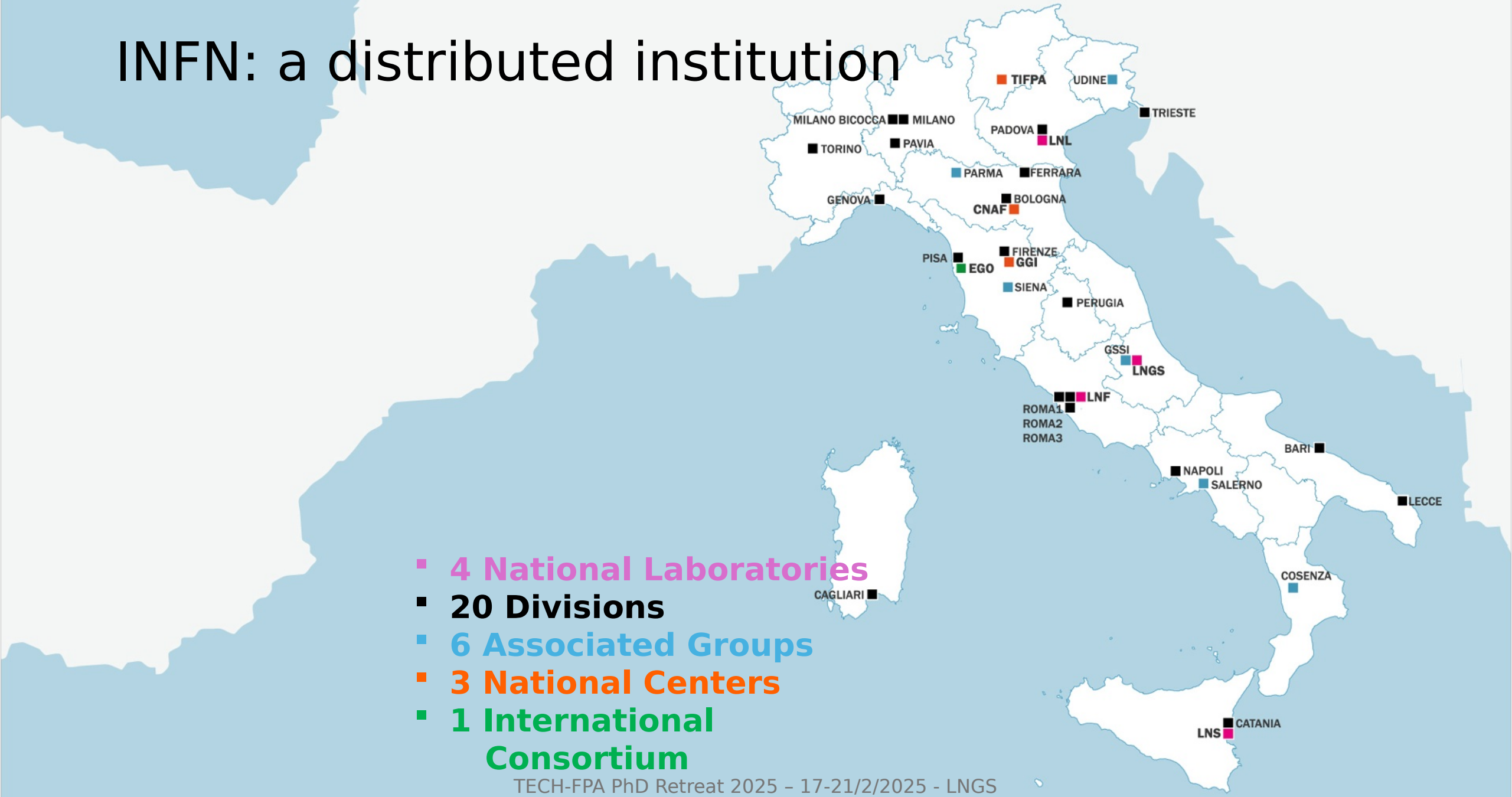
Computing in a national research Institution: the INFN case

Alessandro Brunengo, M.M.

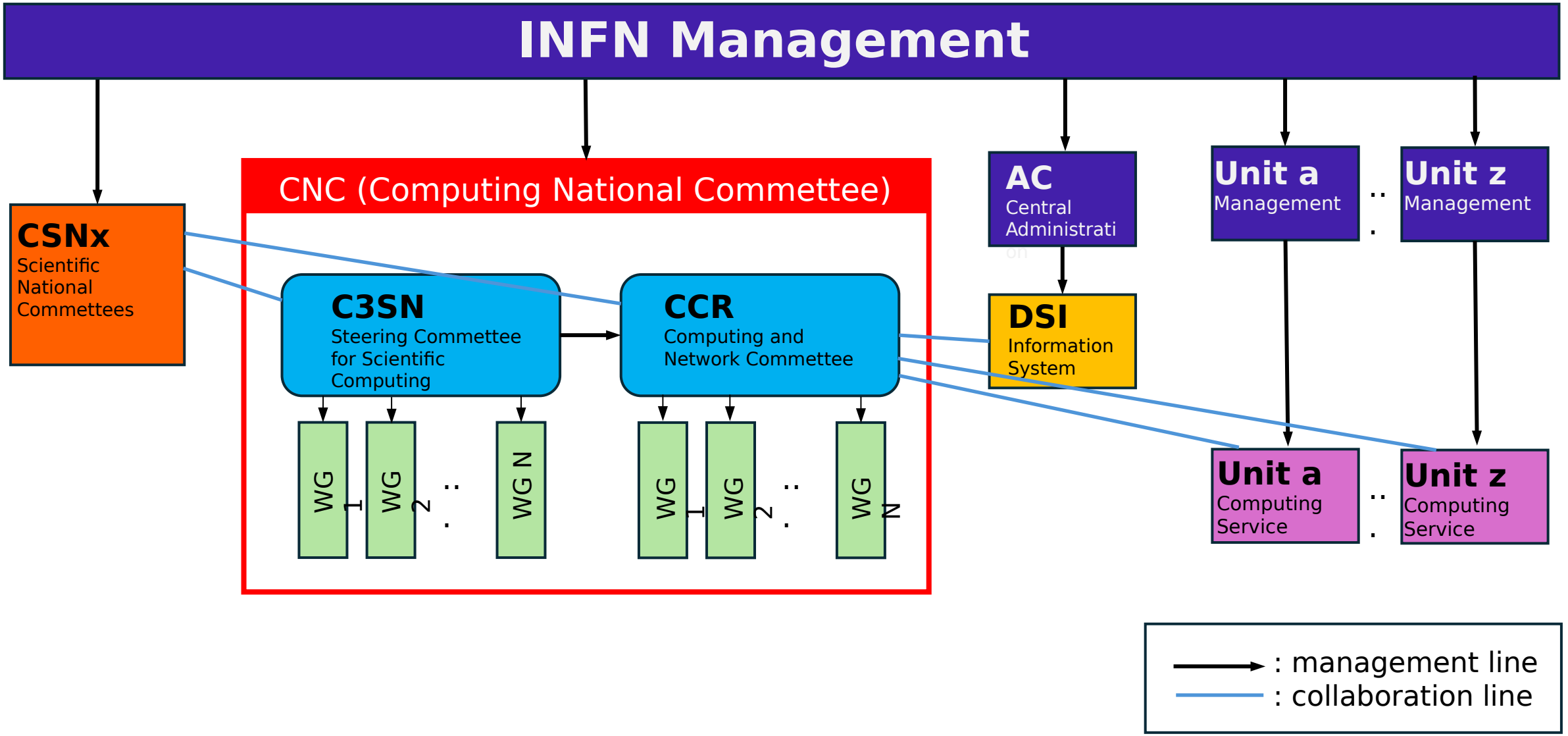
TECH-FPA PhD Retreat 2025 – 17-21/2/2025 - LNGS

INFN: a distributed institution

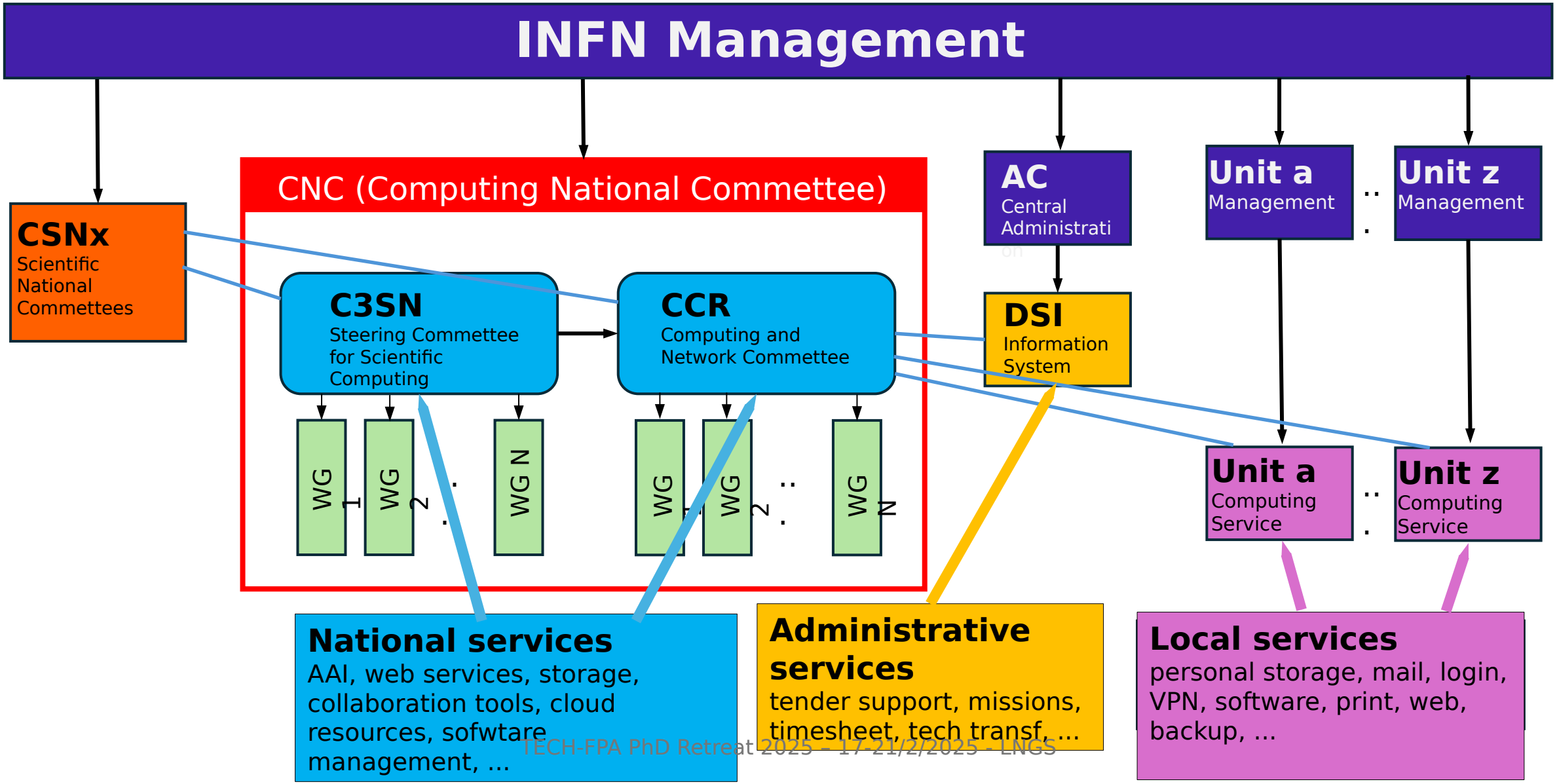


- 4 National Laboratories
- 20 Divisions
- 6 Associated Groups
- 3 National Centers
- 1 International Consortium

Computing governance



Computing INFN organization



Computing centers and networking

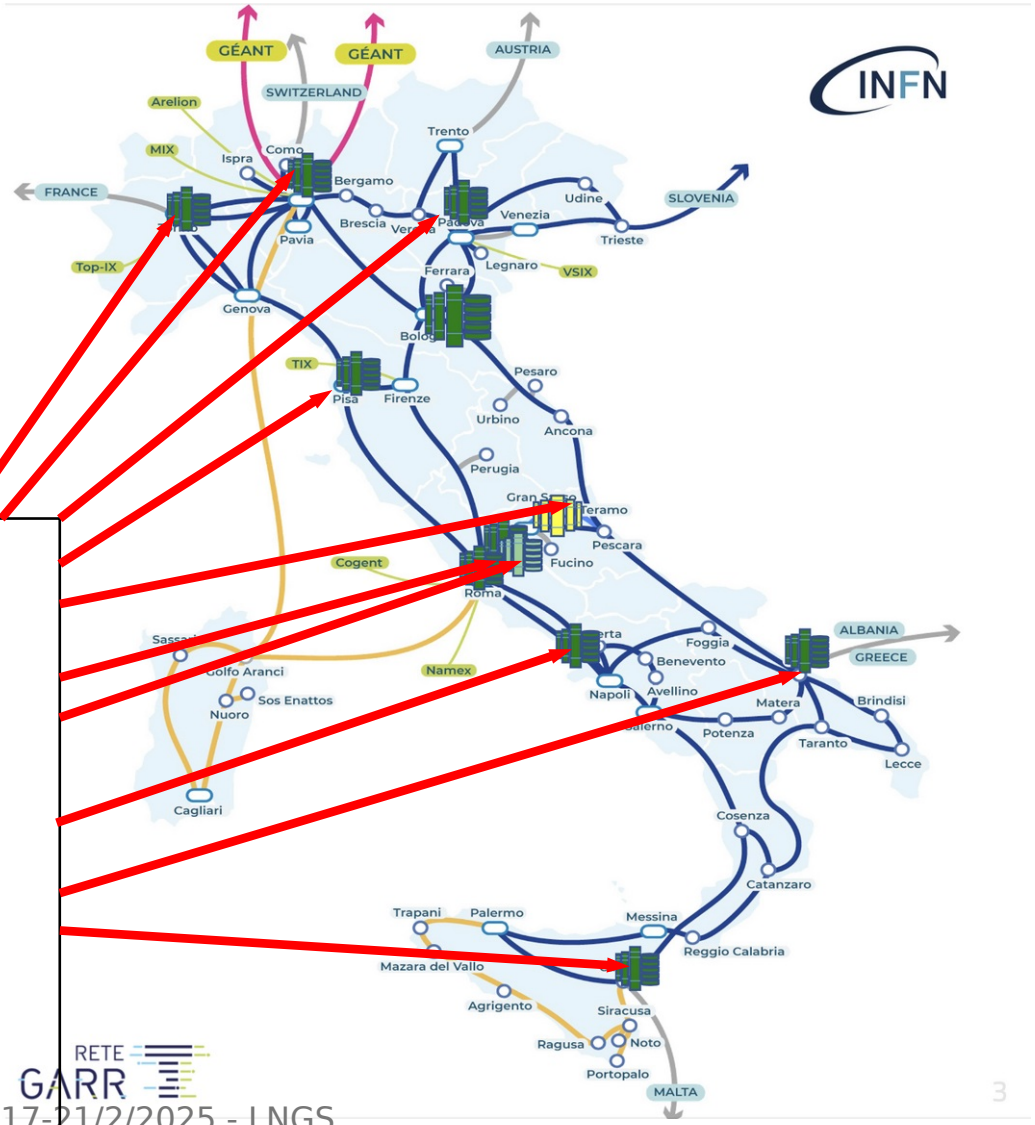
1 Tier1 (INFN CNAF)

- CPU: ~ 550 nodi, 60 kcore, 1.2 MHS06
- Disk storage: ~ 85 PB
- Tape storage: ~ 195 PB

9 Tier2
(Ba,Ct,LNF,LNL/PD,Mi,Na,Pi,Rm1,To)
1 HPC centre LNGS

Aggregated resources:

- CPU: ~ 0.85 MHS06
- GPU: ~ 100
- Disk storage: ~ 65 PB



The INFN Cloud approach

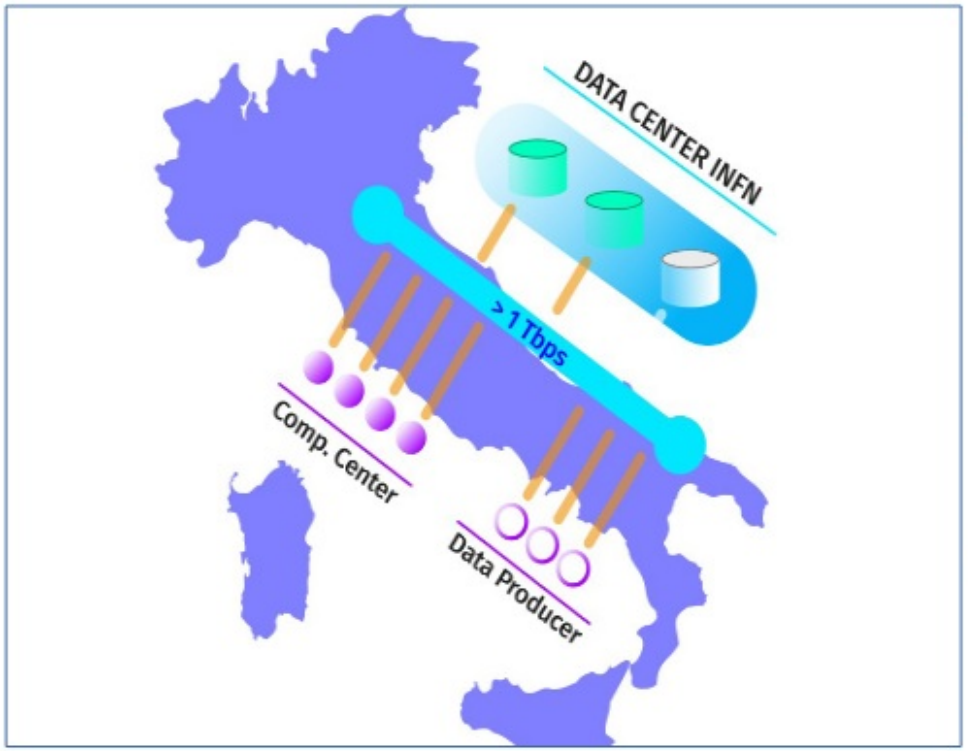
- To support and evolve use cases that could not easily exploit the Grid paradigm, for many years several INFN sites have been investing in Cloud computing infrastructures
  - heterogeneous in hardware, software and cloud middleware.

Cloud at CNAF
Cloud at Bari
CloudVeneto
Cloud at Torino...

- To optimize the use of available resources and expertise, INFN decided to implement a national Cloud infrastructure for research
  - as a federation of existing distributed infrastructures extending them if necessary in a transparent way to private and commercial providers;
  - as an "user-centric" infrastructure making available to the final users a dynamic set of services tailored on specific use cases;
  - leveraging the outcomes of several national and European cloud projects where INFN actively participated.
- INFN Cloud was officially made available to users in March 2021.

Federation of data, resources and knowledge

INFN federated cloud implementation



- The infrastructure is based on a core backbone connecting the large data centers of CNAF and Bari and on a set of loosely coupled distributed and federated sites connected to the backbone
  - backbone's sites are high speed connected and host the INFN Cloud core services.
- A site can join the INFN Cloud infrastructure accepting the Rules of Participation and after the approval of the INFN Cloud project management board.
  - Rules define access to resources and policies, according to INFN national and European laws.
- INFN Cloud's distributed organization provides support and management of both infrastructure and services.

INFN federated cloud features

- Open source, vendor neutral architecture
- Dynamic orchestration of federated resources
- Consistent AA technologies and policies
- Architecture makes it possible to help researchers in exploiting the computing resources in a flexible way
- Services can be deployed by users via an easy-to-use dashboard

Portal: https://mycloud.infn.it

INFN Cloud

Global resources:
- 3900 cores
- 16 TB RAM
- 380 TB disk storage

- Iaas, PaaS and SaaS services
- Based on INFN resources
- Implemented using OpenSource software
- Federated architecture
    - Backbone: CNAF – Bari
        - infrastructural services, redundant
    - RECAS Bari Cloud
    - CloudVeneto
    - Cloud Catania
    - Cloud@CNAF T1
    - Cloud Ibisco Napoli
- Access based on Indigo IAM
    - federated access, support for INFN AAI
- Detailed info in https://www.cloud.infn.it

INFN Cloud: portfolio

Virtual Machine
Launch a compute node getting the IP and SSH credentials to access via ssh

Docker-compose
Run a docker compose file fetched from the specified URL

Kubernetes cluster
Deploy a single master Kubernetes 1.24 cluster

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

Working Station for CYGNO experiment
Run a single VM with all the CYGNO envirnoment exposing both ssh access and Jupyter

Sync&Share aaS
The INFN Cloud Sync & Share as a Service is based on the popular ownCloud or NextCloud storage solutions.

Object Storage
The INFN Cloud Object Storage as a Service.

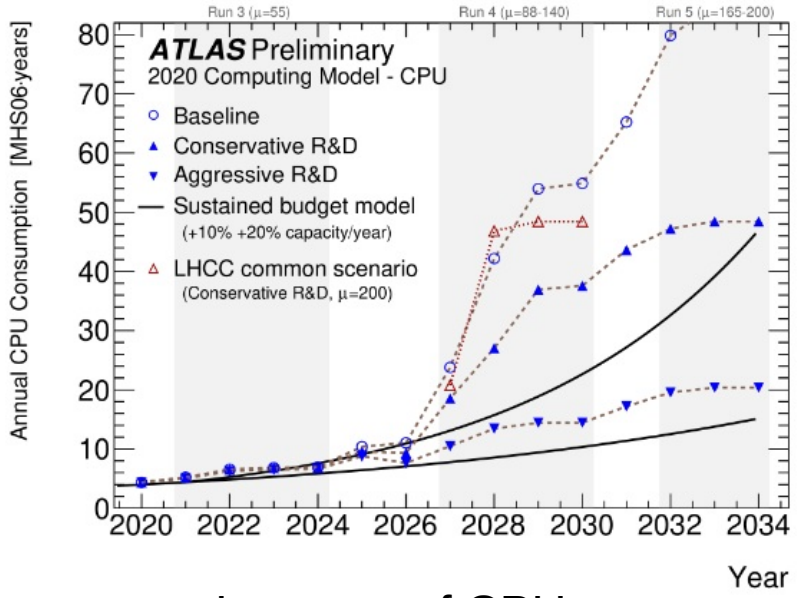
Image **RStudio**
RStudio is an integrated development environment (IDE) for R.

Jupyter with persistence for Notebooks
Run Jupyter on a single VM enabling Notebooks persistence

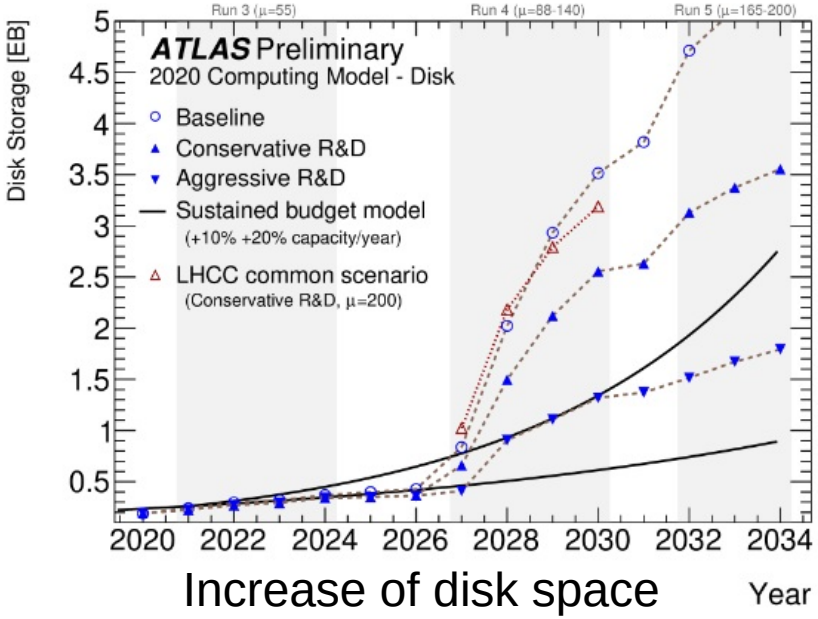
Working Station for Machine Learning INFN (ML_INFN)
Run a single VM with all the ML-INFN environment exposing both ssh access and Jupyter

Towards the future

- The main driver for the growth of INFN computing resources are the LHC experiments
- The computing needs are expected to increase significantly with the Hi-Lumi LHC
- In the last two years INFN has had the opportunities to promote and participate to projects in the field of infrastructure innovation and technology transfer, with the aim to improve its infrastructure and services
  - the Bologna Technopole: new very large facility hosting the main Italian scientific computing centers (ECMWF-CC, CINECA-Leonardo, INFN-CNAF)
  - a new National Research Center for HPC, Big Data and Quantum Computing (ICSC) funded with €320 M
    - 25 Univ., 12 Res. Inst., 14 companies
  - a new "Terabit network for Research and Academic Big data in Italy" project funded with €41 M
    - integration of HPC and Cloud resources



Increase of CPU



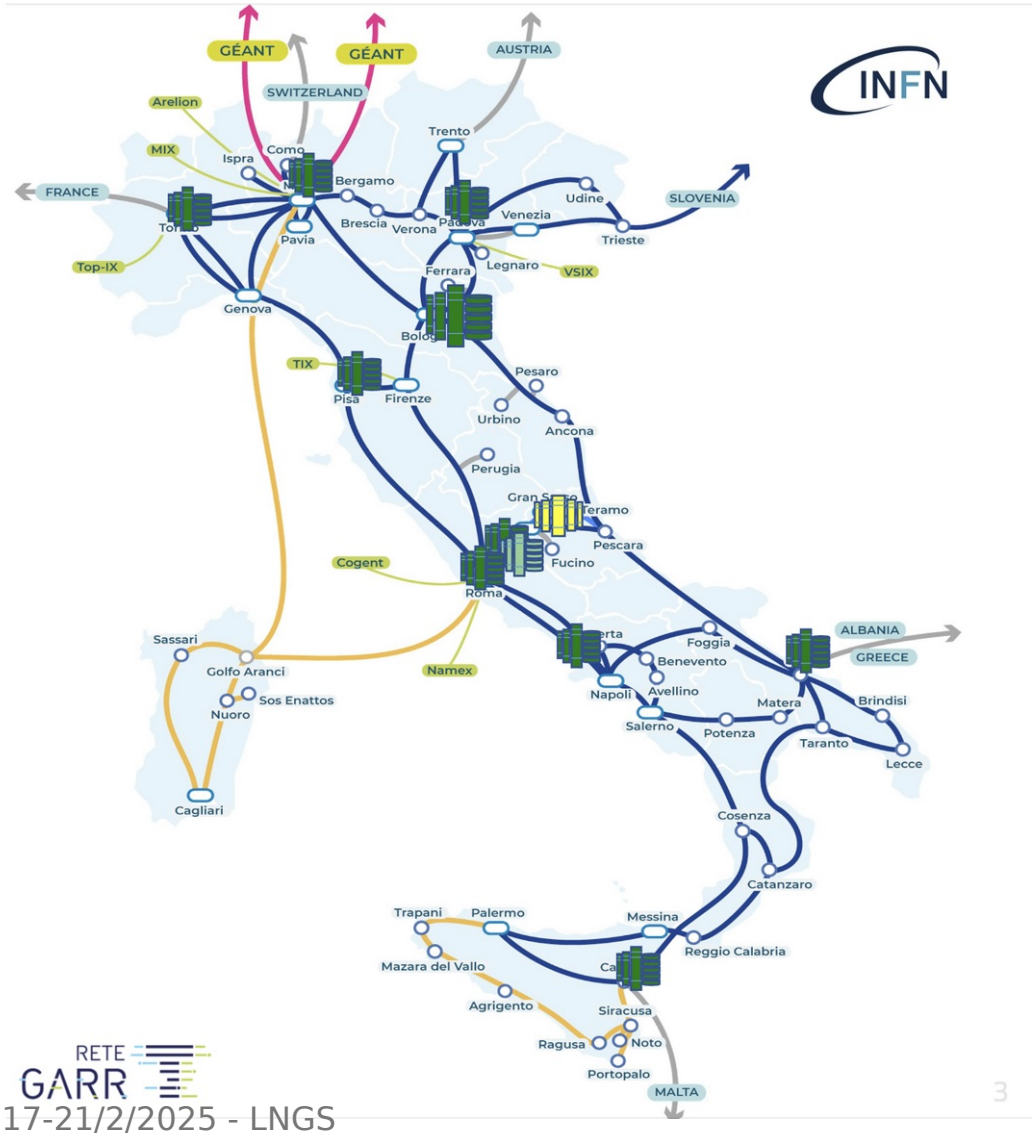
Increase of disk space

Computing centers and networking

Network connection through GARR (Italian Research Network)

- GARR backbone: 400-800 Gbps
  - increasing

- INFN bandwidth
  - CNAF: n*100/400 Gbps
  - Tier2s: 100/200 Gbps
  - Other sites: 10/20 Gbps



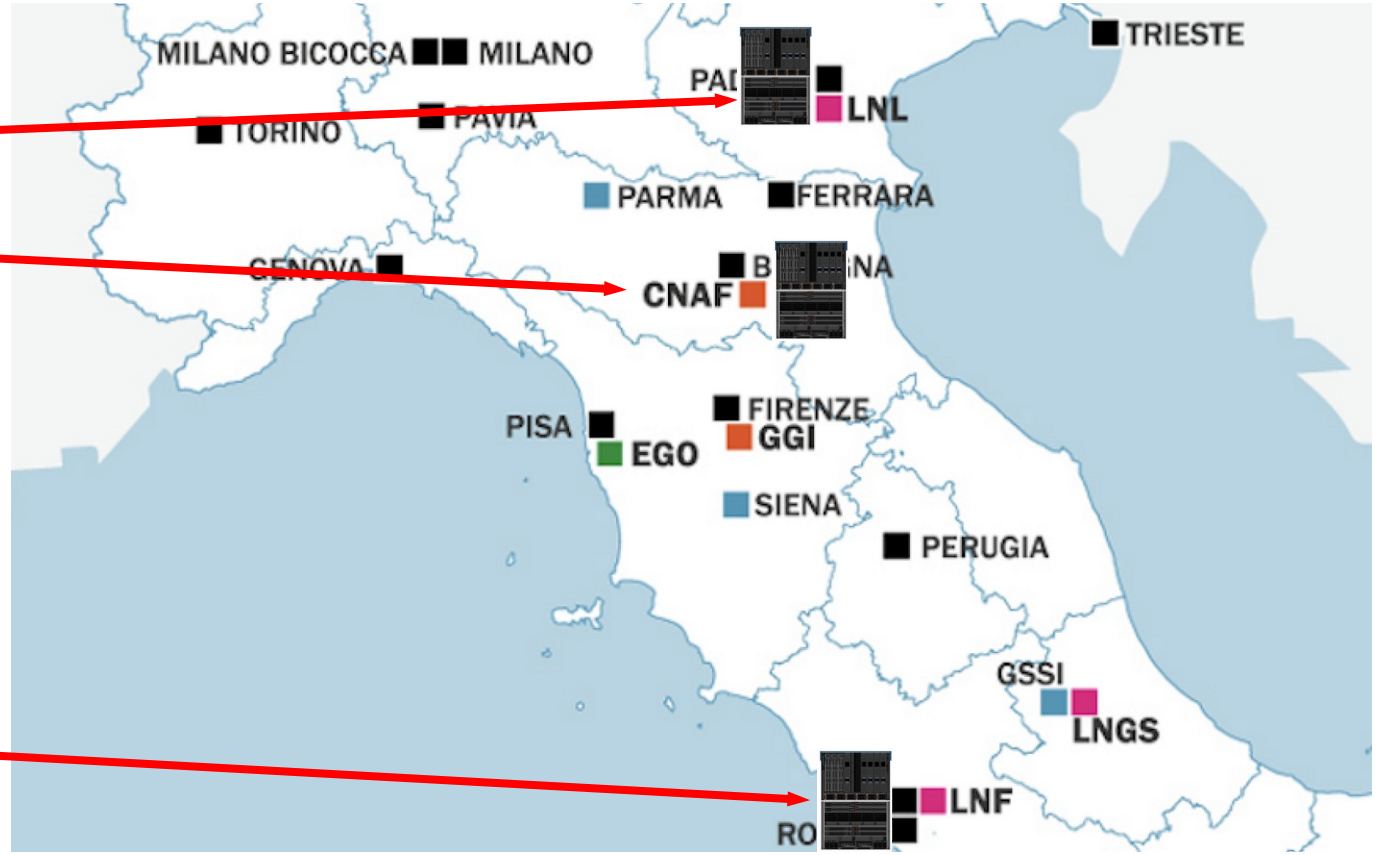
National services infrastructure

Business Continuity

site 2 (LNL)

site 1 (CNAF)

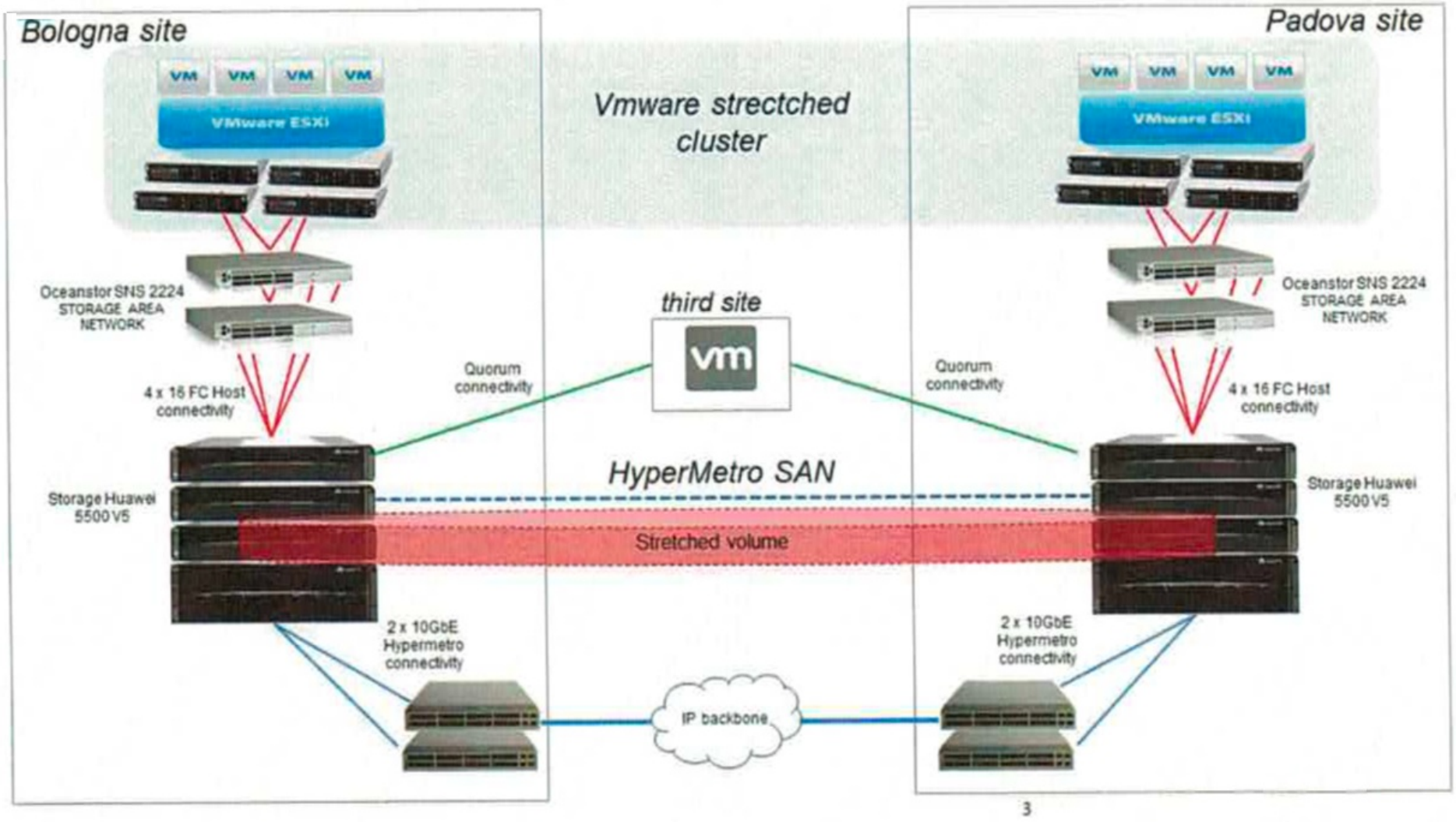
- CPU: 1500 core
- VM: 500 VM
- RAM: 14 TB
- Storage: 300 TB



Disaster Recovery (LNF)

- CPU: 500 core
- RAM: 4 TB
- Storage: 200 TB

Business Continuity infrastructure



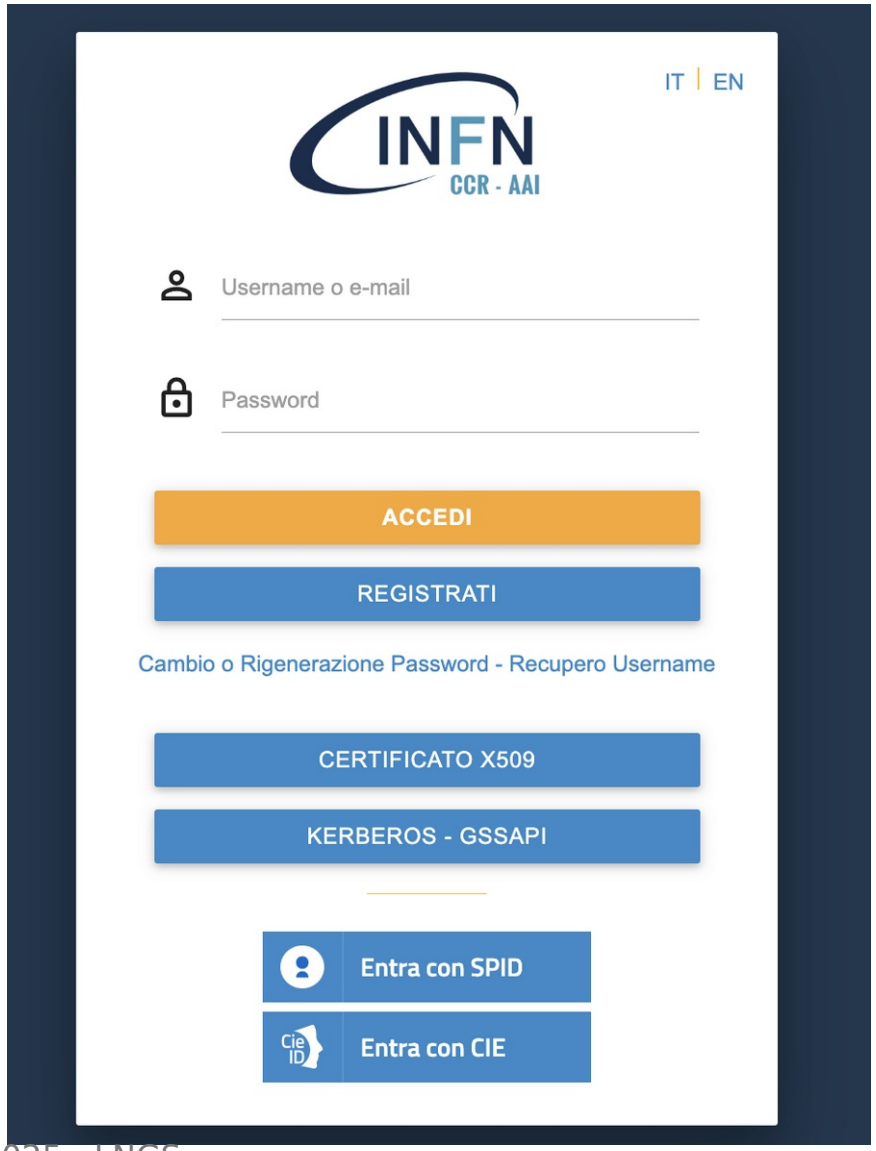
Training

- Using computing resources, tools and services in an effective way require a significant amount of training
- INFN provides several opportunities for personnel, young researchers and users
- Special school are regularly organized
- A good example is the ESC School: international advanced computing School held every year in Bertinoro, addressed mainly to PhD students and post-doc
  - next edition: 28/9-9/10 2025

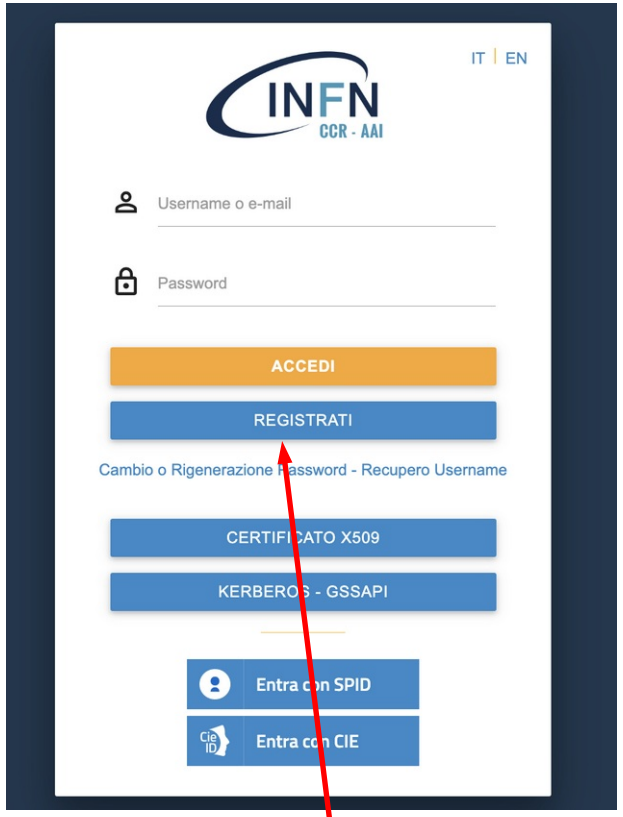
https://esc.infn.it

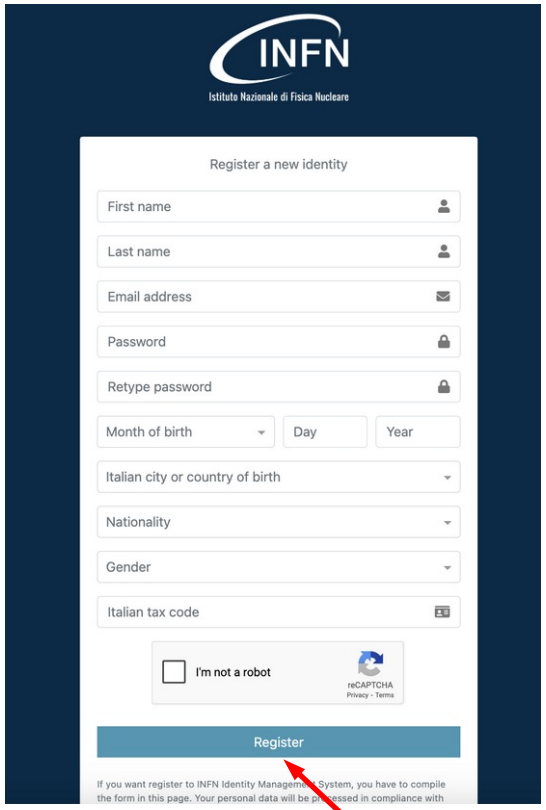
INFN Authentication/Authorization Infranstructure (AAI)

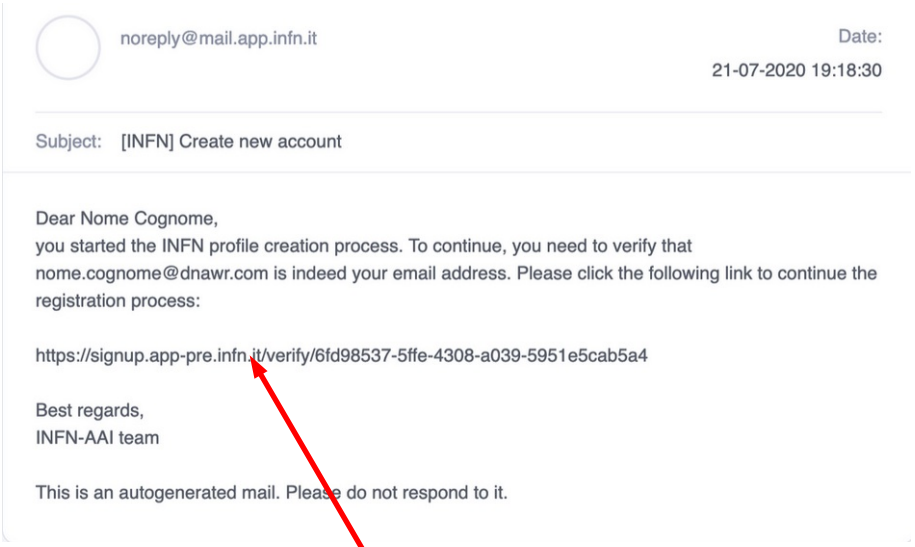
- **One digital identity for everybody in INFN**
- Open to inclusion of external collaborators/visitors
- Support for different level of assurance
- Support for **different auth method**
  - user/pwd, X.509 cert., KRB, SPID, CIE
- Support for **SSO (SAML, OIDC)**
  - web app, Oauth2 app
- Support for **2FA**
  - **available, will be mandatory soon**
- Integrated with LDAP interface
  - auth support for other app (ssh...)
- Integrated with federated services
  - **IDEM**: italian, managed by GARR
    - digital libraries, scientific journals, e-learning...
  - **EDUgain**: worlwide, managed by Geant
- Registration and proper authorization is needed to have access to all national services
  - and some local services



INFN AAI: auto registration process





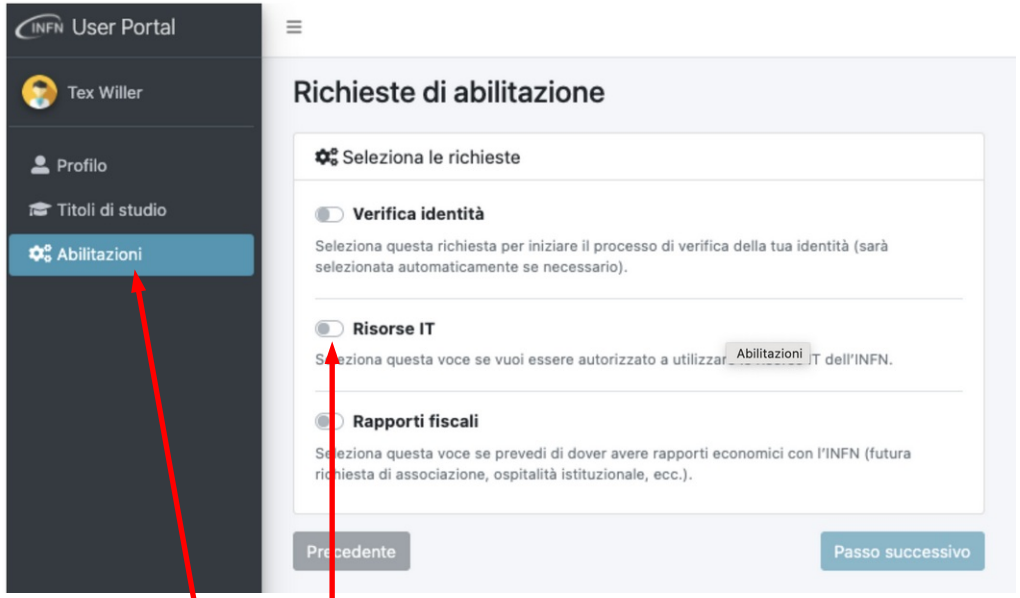


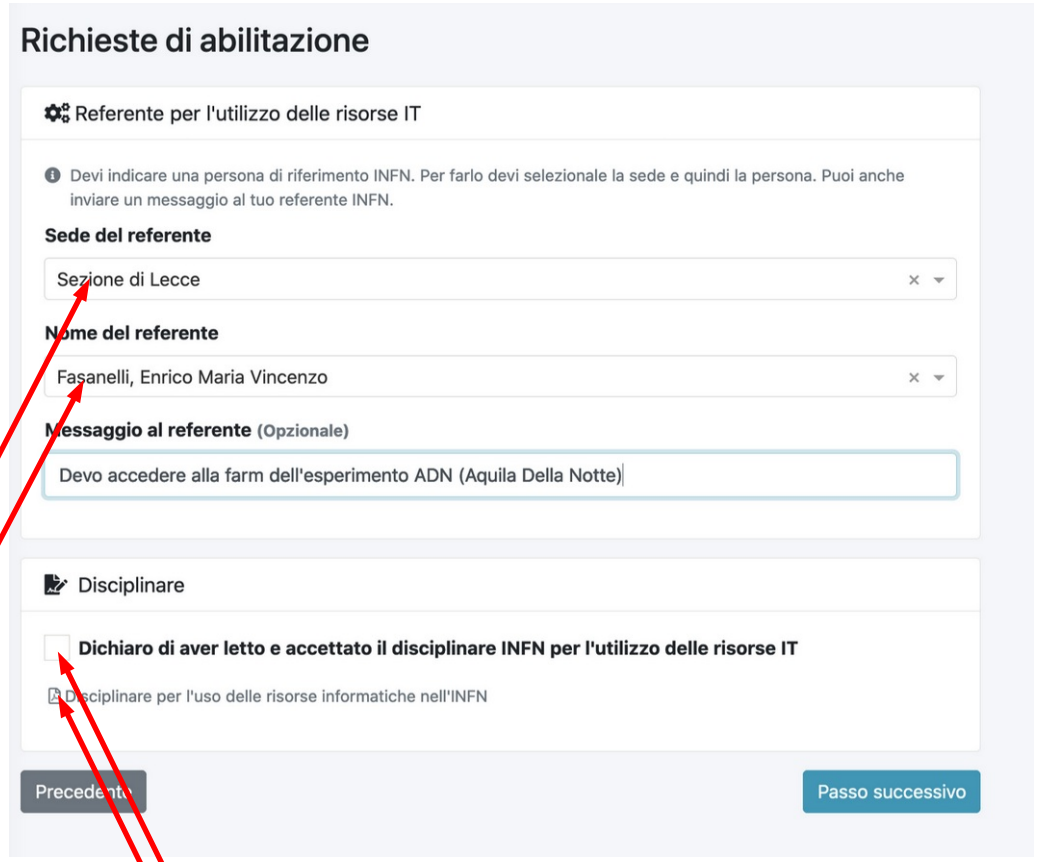
Step 1:
- Go to https://userportal.app.infn.it
- Select “Register”

Step 2:
- Fill the form, choose a password and click on “Register”

Step 3:
- Click on the link sent you by email to confirm your registration

INFN AAI: request to access IT resources





Step 1:

- Go to https://userportal.app.infn.it
- Select “Enabling Requests”
- Select “IT Resources”

Step 2

- Select the INFN Division and the name of your INFN referent
- Read and accept the “Regulation for the use of INFN IT resources

National services

National services portal: https://servizinazionali.infn.it

Document management

Alfresco
Enterprise Content Management
Document sharing, workflow

Pydio/Cells
Cloud storage
Sync and share

Office365
Sharepoint
Onedrive

Organizational tools

Indico
Event management.
Web site, agenda, registration, contributes, abstract, fees,...

SoGo
Manage personal and shared calendars

LimeSurvey
Create surveys, market research, user feedback

Dress
E-voting (even official)

Web services

Url Shortening
Get (short) URL alias in infn.it domain

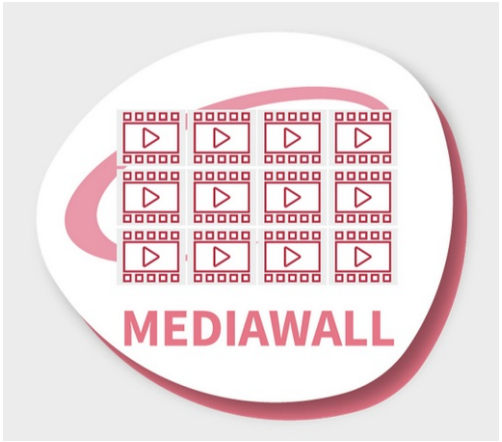
Matomo Analytics
Web site statistics report: visitors, origin, keywords, most visited pages, etc.

Wiki
Get your wiki site based on dokuwiki

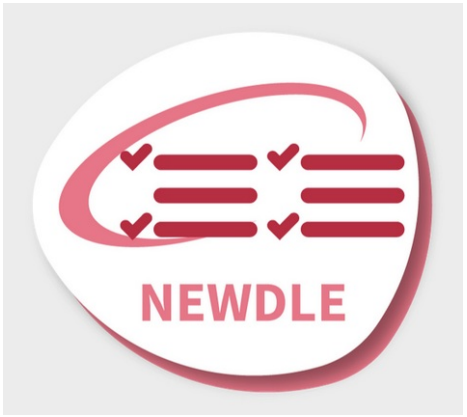
WebSite
Managed service to create WP/Joomla! web sites

Web services (cont.)

Vault
INFN credential manager



Mediawall
Open source service for collecting and managing multimedia content



Newdle
Open source meeting organizer

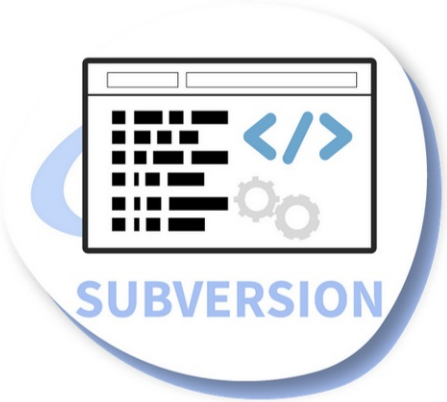
Development collaborative platforms

Jira Software
Collaborative platform from the Atlassian suite designed to facilitate and make team project development more effective

Jira Service Management
Ticketing system and asset management from the Atlassian suite

Confluence
Atlassian suite collaborative wiki for project and development documentation

Development collaborative platforms (cont.)



Subversion
software development version manager, based on Subversion VCS

Baltig
software development version manager, based on Gitlab VCS

Other services

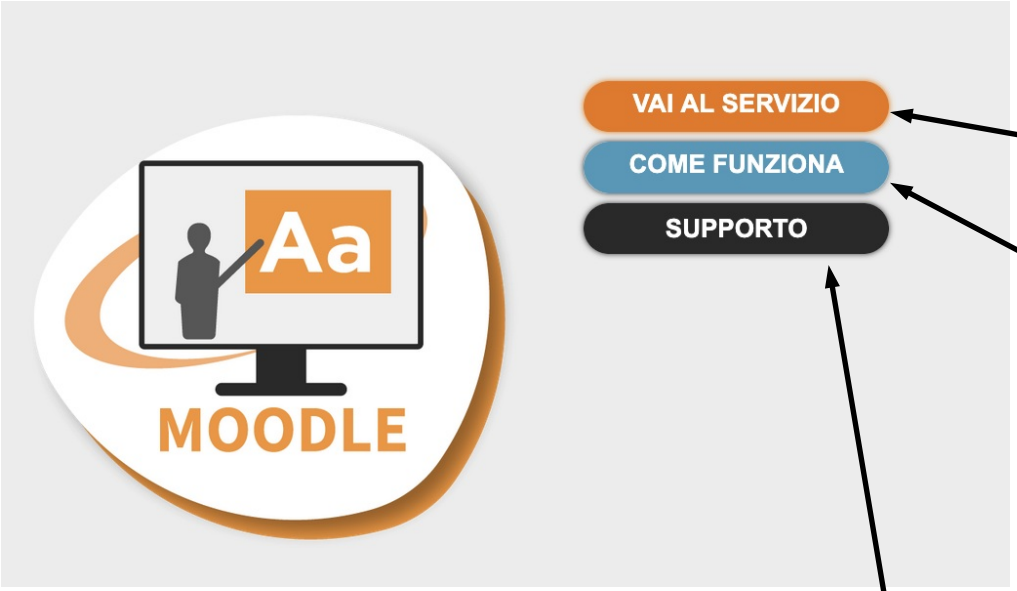
X.509 Certificate Service

Personal and server SSL certificate request

Moodle

INFN e-learning service asynchronous online training

Get info, use the service, ask for support



Link to the service

How does it work

- Brief info
- Technical documentation
- Demo slides and training pills

Ask for support

Submit a ticket.
You will be redirected to the right place:

- local support
- national support

Local ICT services

Division Computing Service

- Network connectivity
  - wired and wireless access
  - eduroam is availiable in all INFN sites
- Interactive access
  - unix and farm login server
  - unix/windows remote desktop
- Remote VPN access
- Mail services
  - local mailbox, mail alias, mailing list
- Storage services
  - Unix, Windows, local cloud sync and share
- Web services
  - CMS web sites, webmail, wiki, ...
- Other local services
  - backup, print service, ...

Administrative IT services

- Administrative services
- Tools for research support (collaboration, timesheet)
- Found management services and authorization workflows
- Purchase and tender procedures workflow
- Utilities for third mission (technology transfer, outreach)
- Tools: BI, legal digital signing, ...
- Get support

https://
portale.dsi.infn.it

Software platforms available at INFN (I/II)

Adobe Acrobat Pro

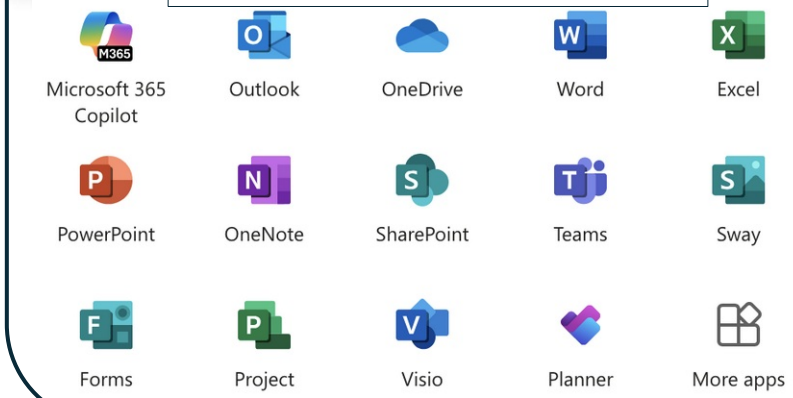
Adobe Creative Cloud

Atlassian Confluence

Atlassian Jira Software

Atlassian JSM

Microsoft 365 products



Zoom Pro
Large 500/1000
Webinar 500/1000

Overleaf

Software platforms available at INFN (II/II)

Simulation

CDF, **EM**, **HFSS**, **Lumerical**, **Granta**, **Zemax** fluid, em, multiphysics, optical

COMSOL multiphysics numerical sim

MRADSIM® Radiation sim

Dassault Opera (em 2d/3d)
Dassauilt CST (em fields 3d)

Computation and data analysis

National Instruments

Wolfram Mathematica

PTC Mathcad

MathWorks Matlab

Electronic and Mechanical Design

Altium cadence SYNOPSYS® Mentor® A Siemens Business

FPGA design: AMD XILINX altera An Intel Company

Autodesk PDM coll., AEC coll., Autocad, Inventor, Fusion

PTC Creo

SIEMENSNX

Dassault SolidWorks

Dassault Catia

Software licensing

- All commercial platforms require a valid license
- Different licensing model:
    - individual, shared, campus (with or without limits)
    - perpetual (pay for maintenance), subscription (usually yearly)
- Different license coverage:
    - educational, research, commercial
    - educational eligibility is not always available for INFN
        - it can depend on the usage (i.e. research vs industry collaborations)
- **Usage of unlicensed sofwtare is strictly forbidden on INFN devices or on personal devices connected to the INFN network**
    - please always check EULAs carefully
    - info in https://web/infn.it/CCR

Thanks !