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PIANO NAZIONALE DI RIPRESA E RESILIENZA

ICSC
Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

ICSC
Centro Nazionale di Ricerca in HPC,
Big Data and Quantum Computing

ANNUAL MEETING

Del Centro Nazionale di Ricerca in HPC, BIG DATA AND QUANTUM COMPUTING

ISOLA D'ELBA – LA BIODOLA, 5 - 8 OTTOBRE 2025

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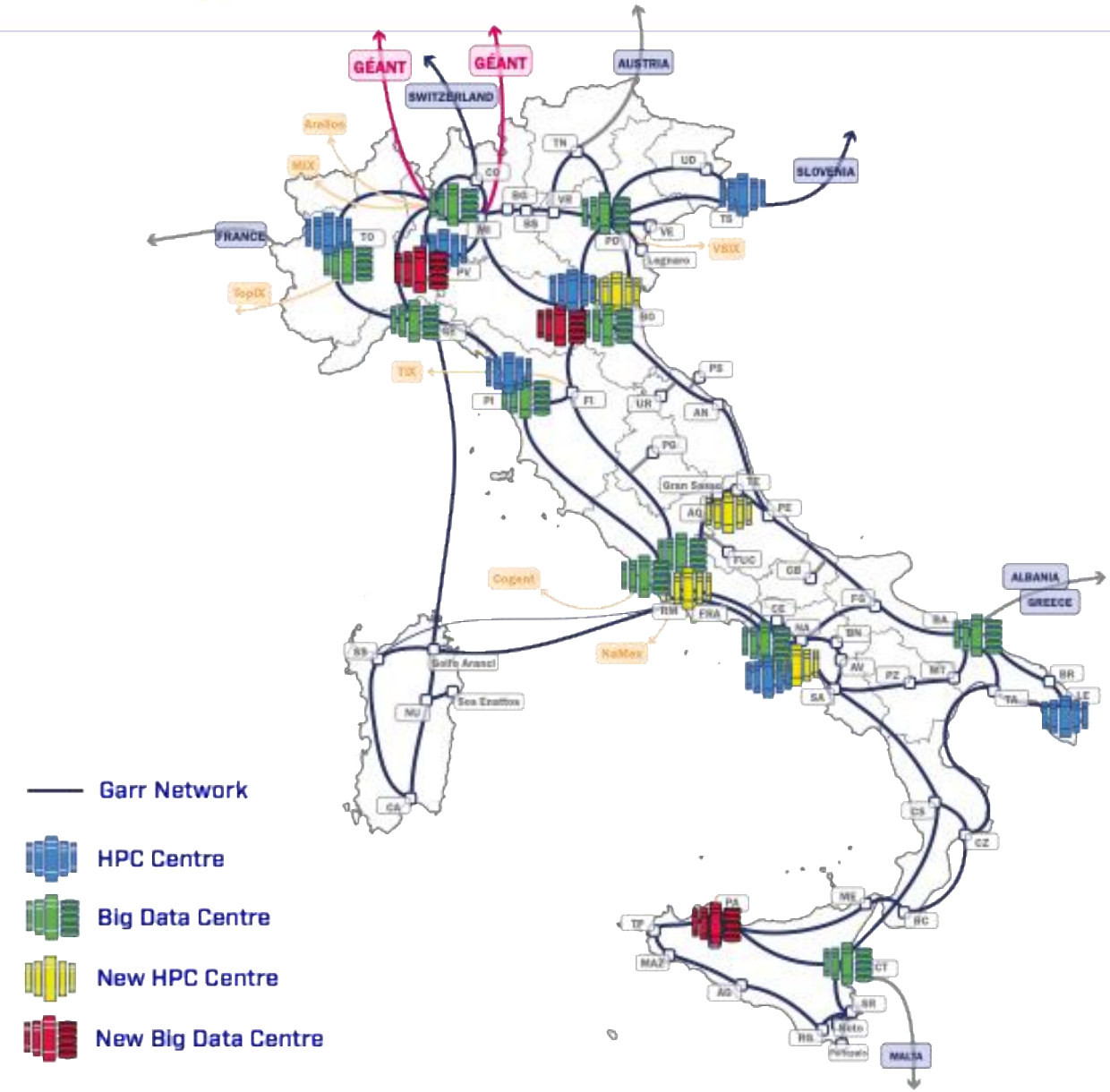
L'infrastruttura del Centro Nazionale ICSC: competitività e prospettive

Sanzio Bassini (CINECA), Massimo Carboni (GARR), Claudio Grandi (INFN)


GÉANT
GÉANT
SWITZERLAND
AUSTRIA
SLOVENIA
FRANCE
ALBANIA
GREECE
MALTA
Garr Network
HPC Centre
Big Data Centre
New HPC Centre
New Big Data Centre

Disclaimer

The infrastructure is built with components acquired following the financial mobilization resulting from the ICSC initiative, but also from TeRABIT and, to a lesser extent, from other similar initiatives funded under Mission 4 Education and Research of the PNRR.

In some cases, some partners used their own funds.

Finally, significant co-financing comes from specific European Commission initiatives.

In this context, it is difficult (and makes no sense) to disaggregate the components based on the funds used.

GARR

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GARR-T, ICSC, TeRABIT

GARR-T: PNRR projects (2023-2025)

RETE GARR

ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

terabit

Opportunity to develop GARR-T network:

- Reach new areas: **Sardinia** and **Abruzzo**
- Upgrade and integrate network in the South of Italy
- **Scale-up performance for HPC**
- **GARR-T** can reach the goal to become a **fully unified** and ***pervasive network*** for R&E community in the **whole country**

GARR: Procurements Procedures

Fibre Infrastructure 2301 - [20.7(*) M€] – 20y

- Optical Fibre + Open Line System
- [TeRABIT] Sardinia {submarine + terrestrial}
- [ICSC] Abruzzo {terrestrial}

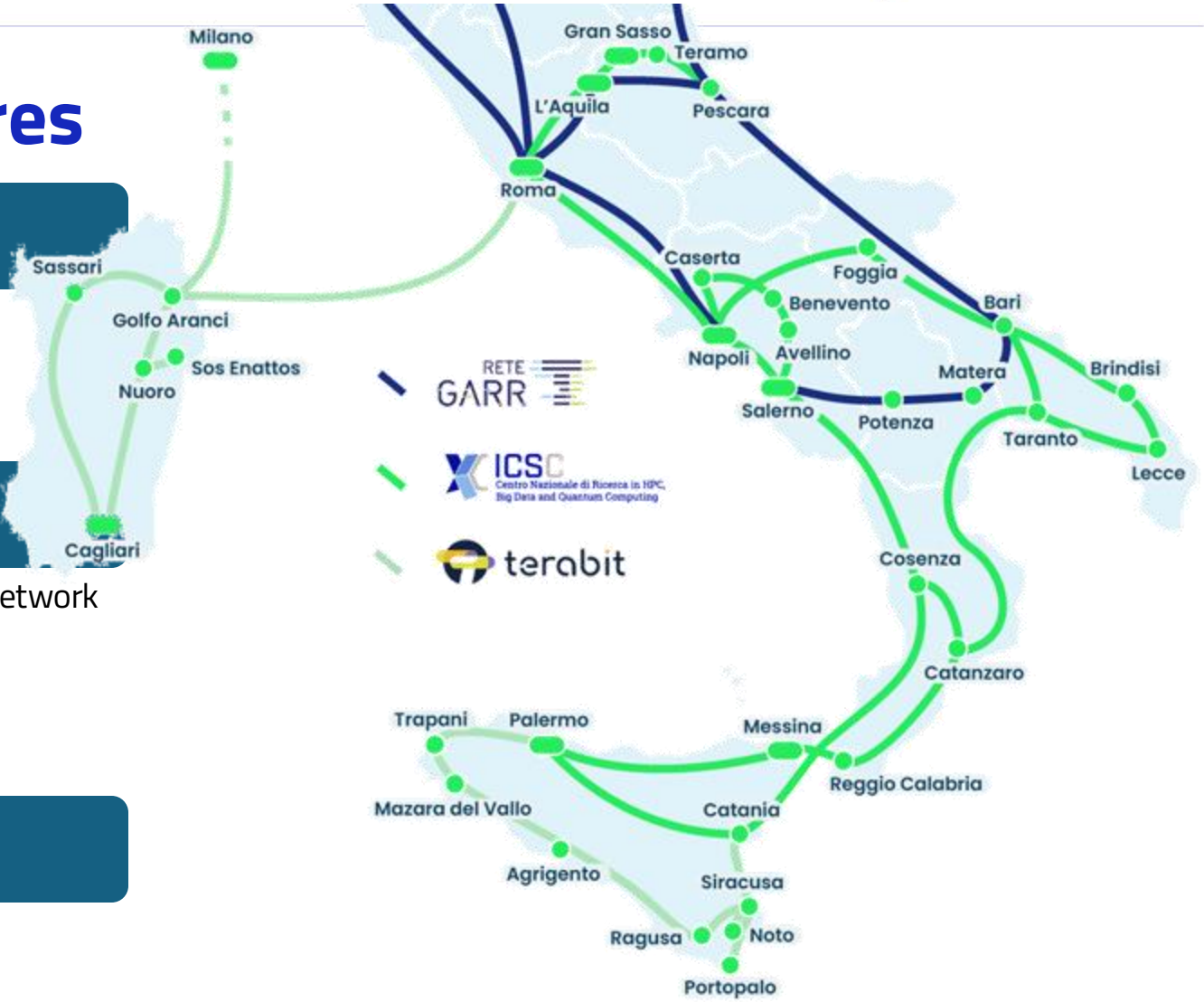
Optical Network 2302 - [15.0(*) M€] – 10y

- Upgrade GARR-X Progress Optical Network → GARR-T unified optical network
- Network Transport Capacity over Open line system
- [Terabit] Sardinia, Southern Sicily
- [ICSC] Abruzzo, Campania, Puglia, Calabria, Sicilia

Upgrade Packet Network 2303 - [7.1(*) M€] - 5y

- [Terabit] Sardinia, Southern Sicily
- [ICSC] Abruzzo, Campania, Puglia, Calabria, Sicilia, Backbone and Edge Connectivity

(*) +VAT



TeRABIT: submarine Cable

Search by cable, landing, country, year ...

Show All Cables | Select Another Cable

Blue

Copy link

RFS
2023

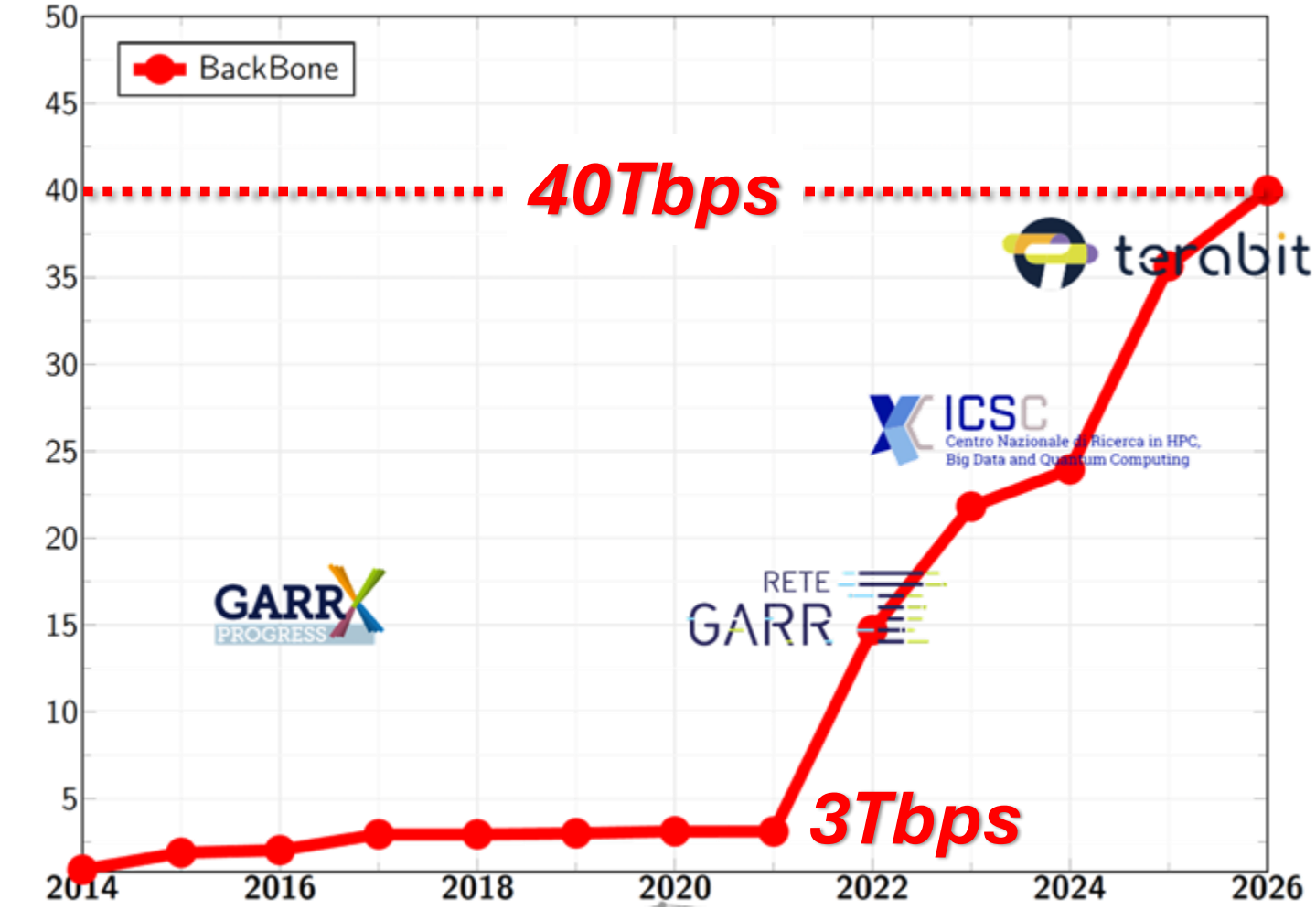
Cable Length
5,055 km

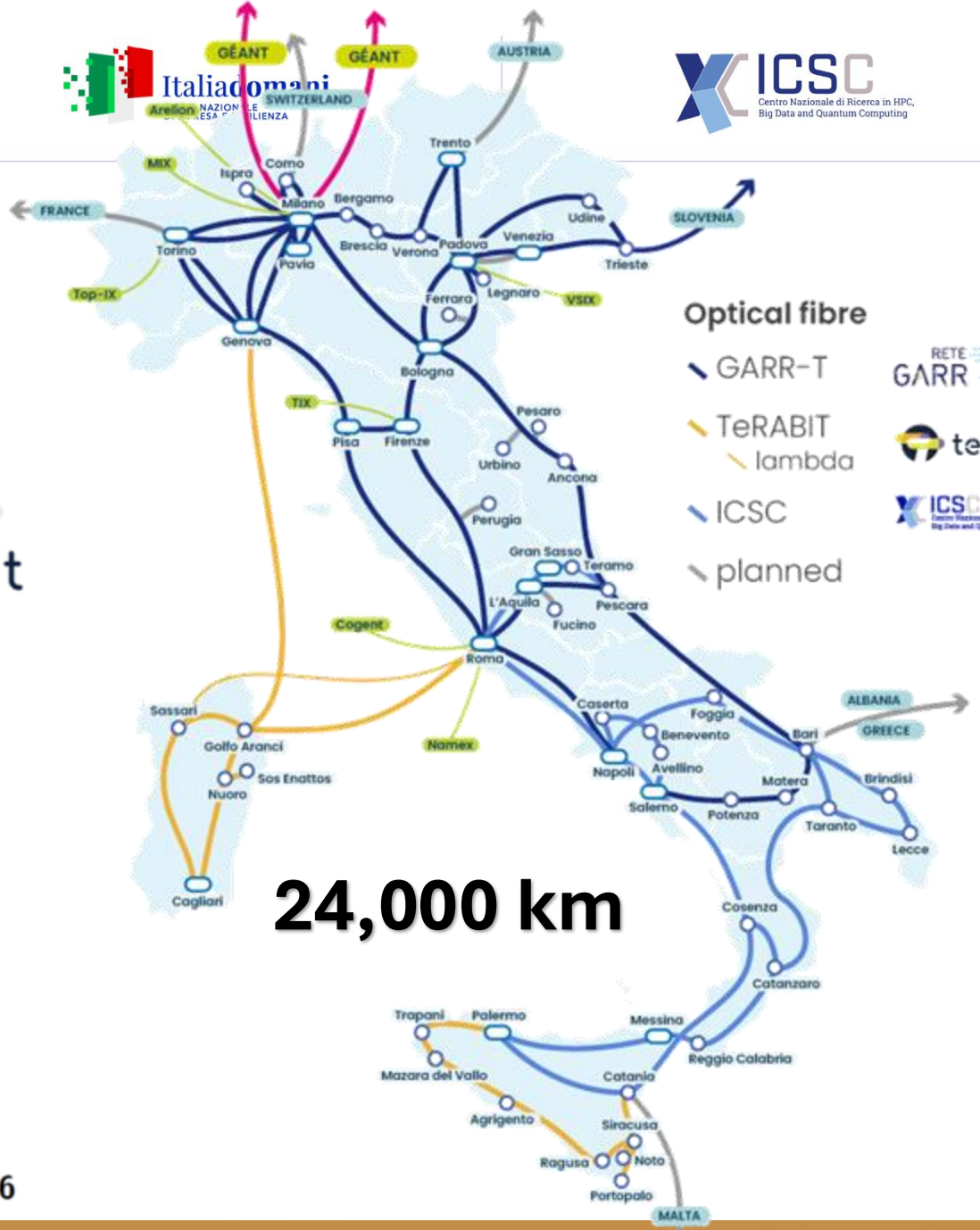
Owners
Google, Sparkle, Zain Omantel International

Suppliers
ASN

Landing Points
Yeroskipos, Cyprus
Bastia, France
Marseille, France
Chania, Greece
Tel Aviv, Israel
Genoa, Italy
Golfo Aranci, Italy
Palermo, Italy
Rome, Italy

GARR-T Network numbers





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Federation Strategy

ICSC AAI: GARR's view

Requirements for the Italian EOSC Node AAI and ICSC HPC resource

- Be independent from GEANT and EGI identity layers (MyAccessID and EGI Check-in Service)
- Leverage existing service-oriented platforms and identity solutions developed by CINECA, CNR and INFN (for example D4Science and INDIGO-IAM)
- Leverage GARR services and expertise on metadata management (IDEM and eduGAIN metadata distribution and validation systems)
- Be directly connected to the Italian R&E Federation IDEM and, through IDEM, to eduGAIN
- Support REFEDS Assurance Framework and IDEM Assurance Profiles
- Define assurance requirements at least for:
  - Noncritical data access
  - Health and critical data access

ICSC AAI: GARR's VIEW on NEXT STEPS

- **Formally define the Architecture** and requirements for the **Italian EOSC Node AAI**
- Create a **24 months project** to implement the architecture:
  - Nominate a **project coordinator**
  - **Assign members**
  - Define an ***implementation roadmap***
  - **Implement the Architecture** (first 12 months)
  - **Operate the AAI** (next 12 Months)
  - **Work with ICSC Governance** to define the next **AAI operator**
- **Leverage *existing projects*** as funding sources (for example EOSC-INFRA-01-01, etc)
- Assign enough manpower (estimated effort at least 1 FTE/Year)

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EuroHPC & TeRABIT Access

EuroHPC Hyperconnectivity

The Digital Backbone

- **Headline Goal:** To create a secure, ultra-high-capacity, federated network infrastructure linking all European supercomputing, AI, and quantum resources.

What is "Hyper-connected"?

- The technical definition is connectivity for transferring data at 1 Terabit per second (1 Tbps) or beyond—the necessary speed to support modern exascale computing and big data workloads.

Key Components

1. **EuroHPC Supercomputers**: Connecting machines like LEONARDO/LISA (Italy), JUPITER (Germany) and MareNostrum5 (Spain).
2. **AI Factories & Quantum Facilities**: Integrating new, cutting-edge facilities across Europe.
3. **Research & Data Centers**: Linking national HPC centers and major data repositories.

Core Partner: **GÉANT** (and National Research and Education Networks - **NRENs**) is leveraging and upgrading its infrastructure to meet this massive demand.

EuroHPC Hyperconnectivity

Strategic Importance and User Benefits

Strategic Benefits

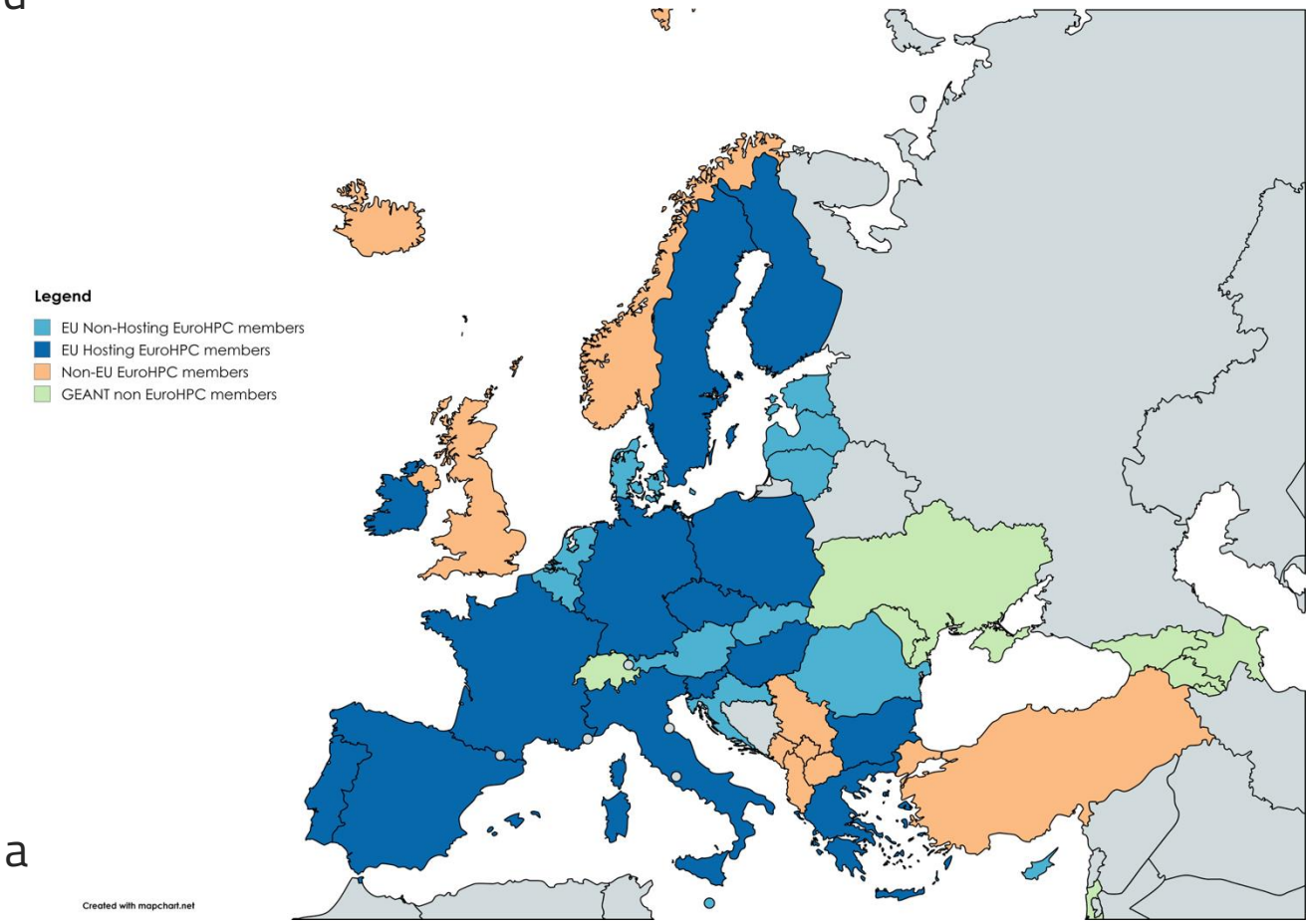
- **European Leadership:** Solidifies Europe's position in HPC, AI, and quantum research by enabling high-throughput data exchange.
- **Federation & Unification:** Creates a single, unified HPC ecosystem, making all resources accessible regardless of a user's physical location.
- **Future-Proofing:** Provides a flexible, adaptable platform to incorporate emerging technologies and future exascale and quantum systems.

Who Benefits?

- **Research Community**: Enables complex, pan-European scientific collaborations (e.g., climate modeling, drug discovery)
- **Public Sector**: Supports high-impact, data-driven applications for public good.
- **Industry & SMEs**: Provides industrial users with high-speed access to supercomputing power and AI services.

EuroHPC-JU HyperConnectivity Tender Requirements (NaaS)

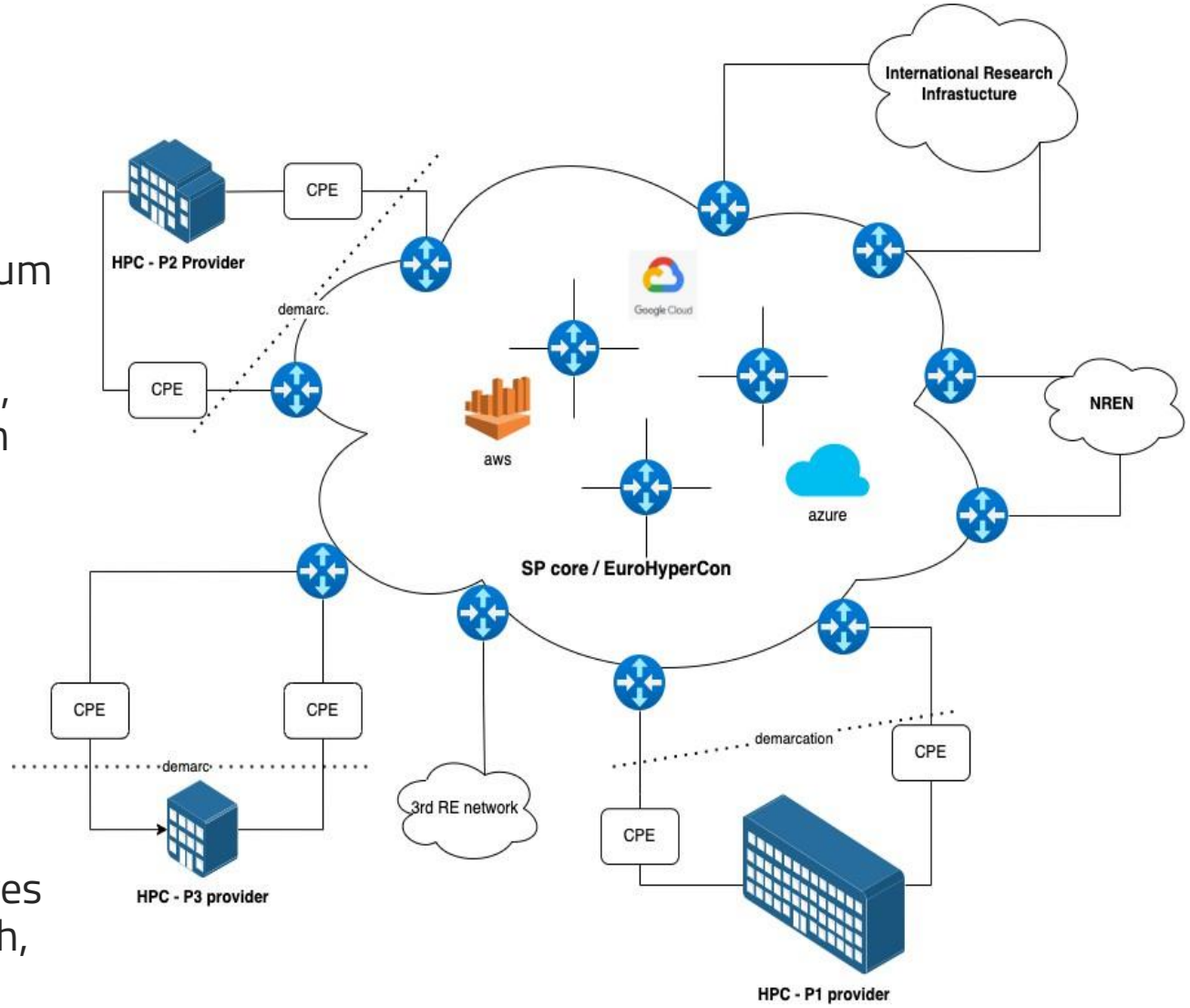
- **Ultra-High Bandwidth**: Network must achieve or exceed **Terabits per second (Tbps)** for massive data transfer.
- **Pan-European Coverage**: Connect multiple European countries, linking national and multinational HPC systems.
- **Technology Integration**: Provide an internetworking framework to unify HPC, AI, and Quantum Computing resources into one ecosystem.
- **Flexible Architecture**: Services must be adaptable to allow for different types of experimentation and the incorporation of new technologies.
- **Tailored Services**: Architectures and services must be custom-designed to meet the unique demands of scientific research and HPC applications.
- **Delivery Model**: The service is to be provided following a -**Network-as-aService (NaaS)** model.



EuroHPC Points of Interest

Sites to be Connected

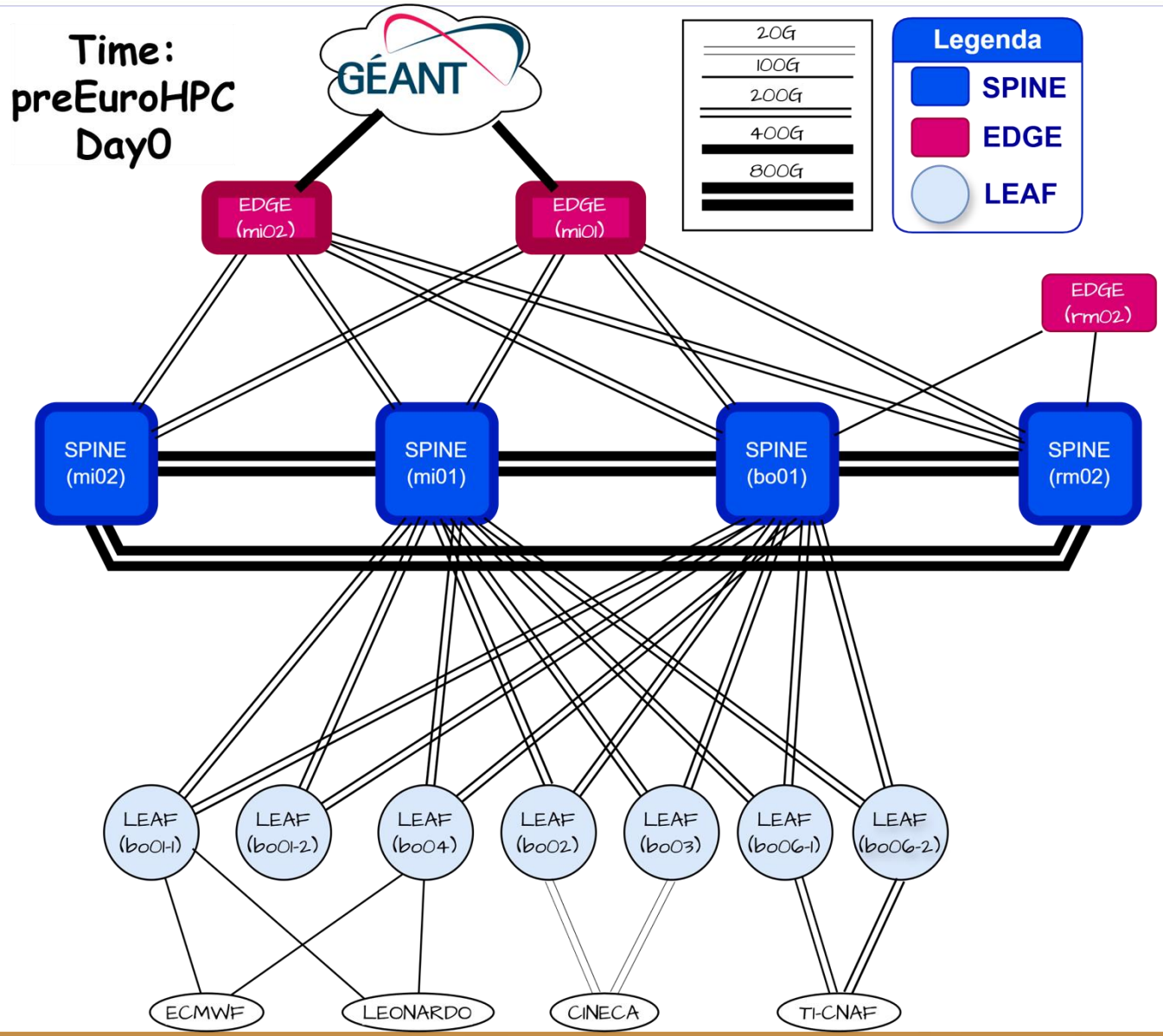
- **HPC/Quantum Sites**: EuroHPC-funded HPC or Quantum sites, plus other major HPC sites across Europe.
- **NRENs**: National Research and Educational Networks, which accommodate the vast majority of the research and academic user base.
- **Major European IXPs**: Internet Exchange Points that serve as entry points for the commercial sector (including SMEs).
- **Data Providers**: Major facilities that produce large volumes of scientific/engineering data, as well as commercial data sites (e.g., cloud storage).
- **Flagship Research Projects**: Key EU scientific initiatives that rely heavily on HPC access (e.g., Destination Earth, Battery 2030+).



GARR-T: HTC sites

preEuroHPC access capacity (today)

- LEONARDO (100G+100G)
- INFN-TIER1 (200G+200G)
- CINECA (20G)
- ECMWF (100G+100G)



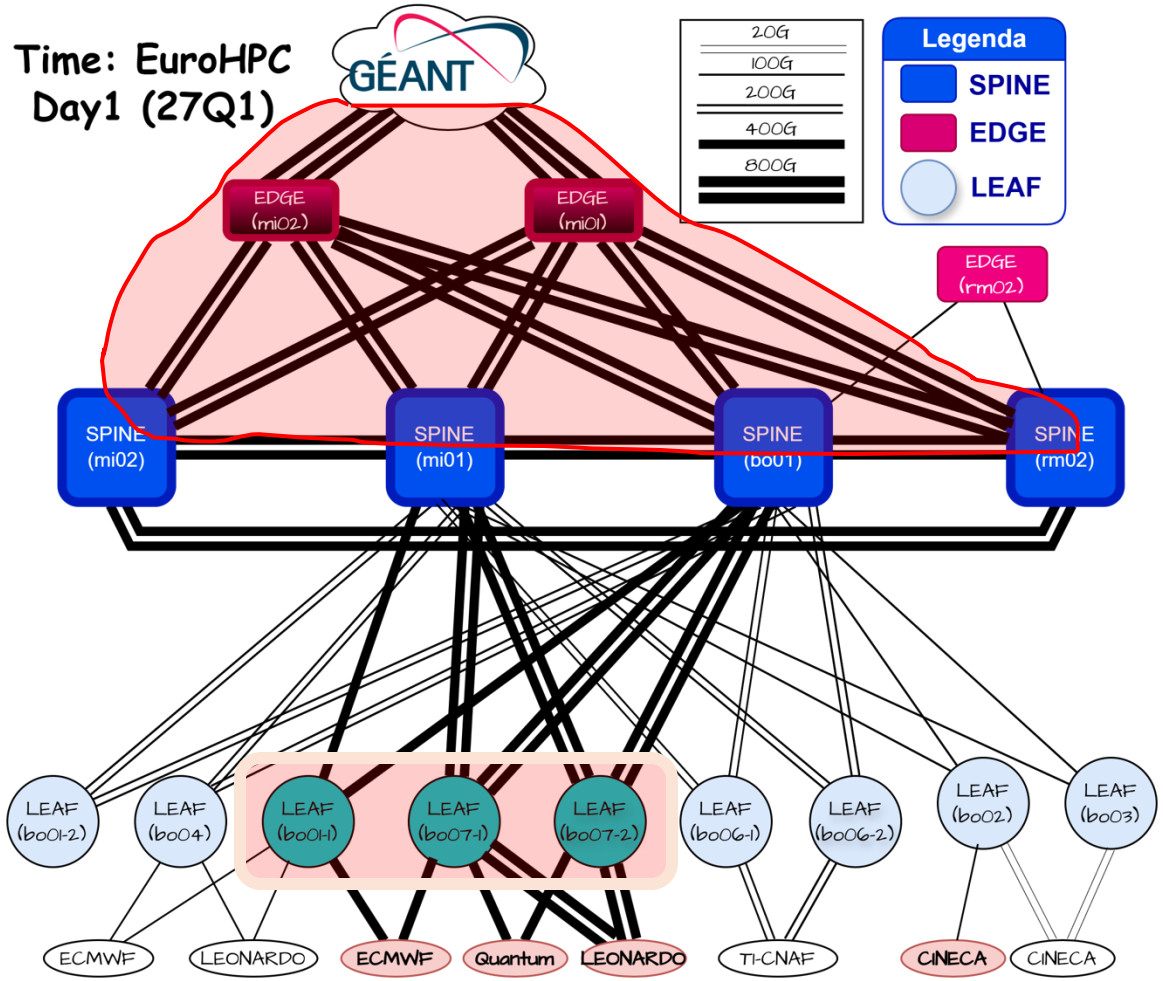
GARR-T upgrade to support EuroHPC-JU requirements

- LEONARDO (100G+100G)
- INFN-TIER1 (200G+200G)
- CINECA (20G)
- ECMWF (100G+100G)

EuroHPC Day1 (27Q1)

EXTRA HyperConnectivity

- **LEONARDO/LISA (800G+800G)**
- **INFN-TIER1 (200G+200G)**
- **Quantum (400G+400G)**
- **CINECA (100G)**
- **ECMWF (400G+400G)**



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INFN

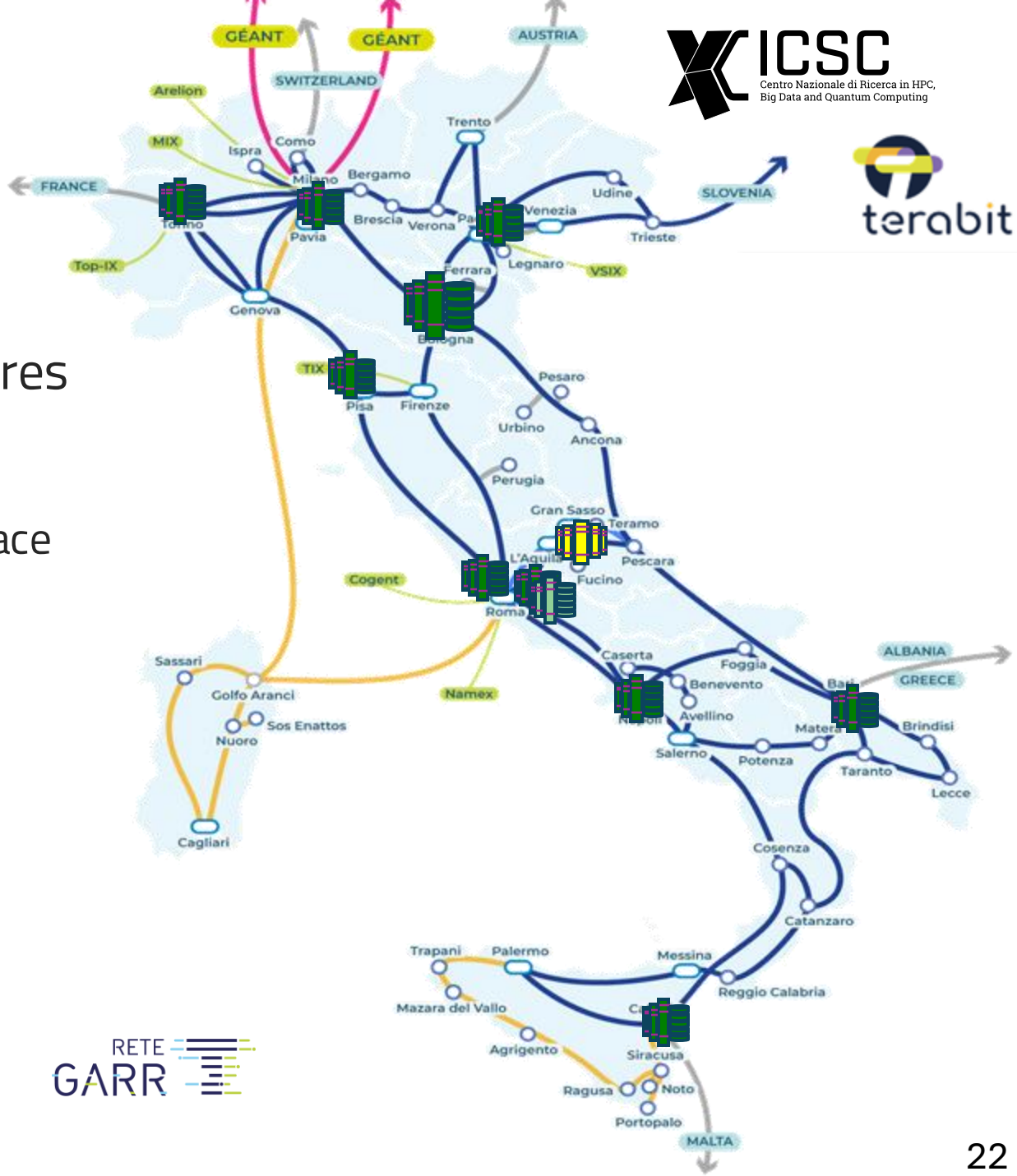
Upgrade of INFN computing centres

Expansion and modernization of data centres (spaces, power, cooling)

- Including the upgrade of the Gran Sasso Data Centre for Disaster Resilience and the new Space Economy Data Centre in Frascati

Resource acquisition: network, CPU, GPU, FPGA, storage, tape

- Local Data Centre's network
- CPU power for High Throughput Computing
- CPU power for High Performance Computing (together with TeRABIT)
- Disk storage (high capacity and cloud)
- Tape storage



INFN - Acquired IT resources

Commissioned HTC servers and storage (by ICSC):

- ~900 kHS06 (Tier-2)
  - ~55k CPU core
- ~80 (Tier1) + 40 (Tier-2) PBN
- Library + 143PB tapes

Being installed now:

- HPC Bubbles by TeRABIT, ICSC, DARE
  - 160 CPU nodes
  - 61 GPU nodes
  - 10 FPGA nodes
  - 118 storage nodes

Coming:

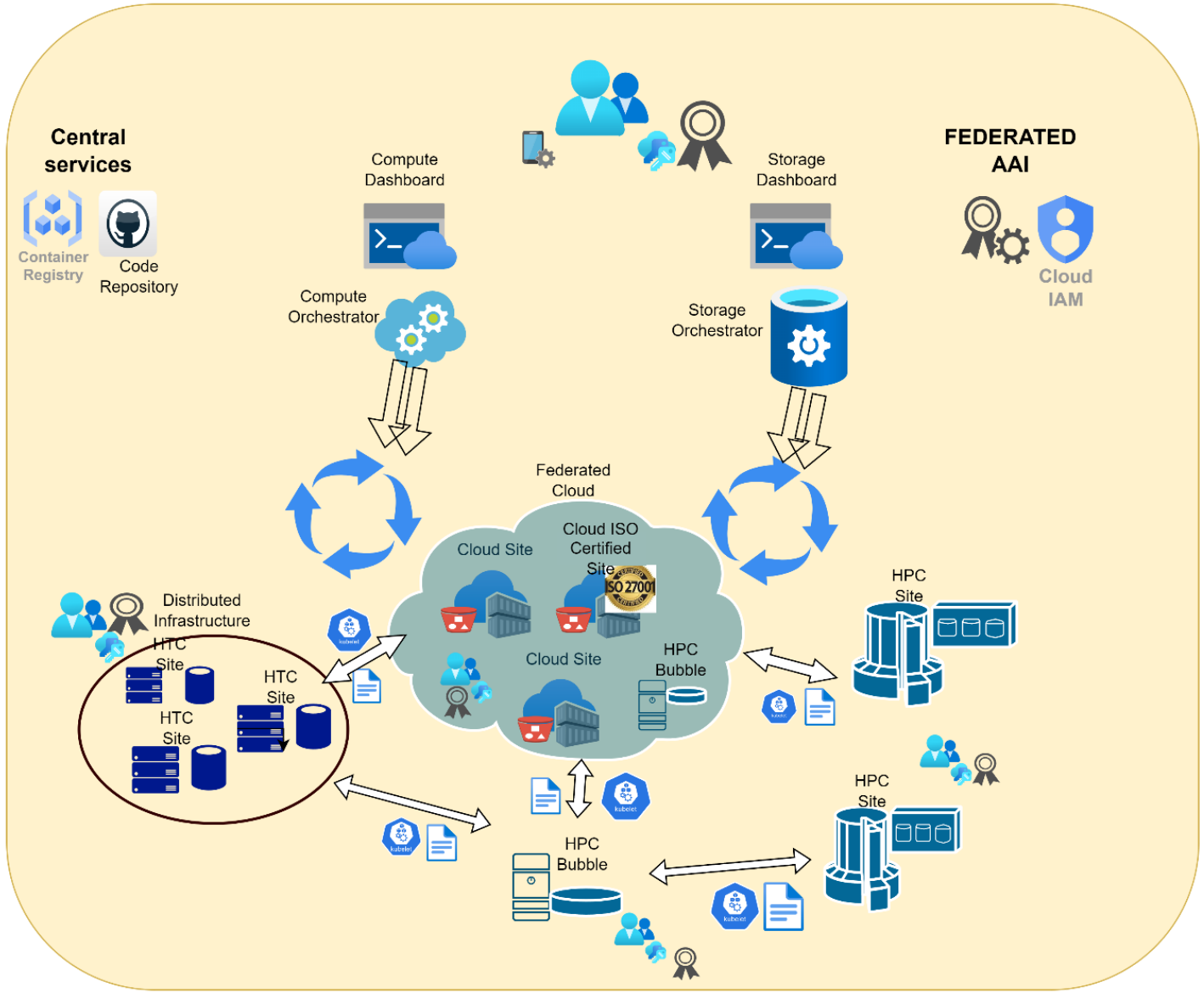
- ~50 PBN (Tier-2)

CPU node	192 physical cores 1.5TB RAM DDR5 IB NDR 400G 20TBL (SSD) + system disks
GPU node	As CPU + 4x NVIDIA H100 SXM5 with 80GB and HBM2e memory
FPGA node	32core RAM 768GB DDR5 IB NDR 440G 4 x XILINX U55C o 4 x TerasicP0701
Storage node (CEPH Bricks)	64 physical cores 1TB RAM DDR5 384 TBL HDD + 25.6 TBL NVMe
Accessories	Switch IB, Switch ETH cables IB, cables ETH Transceivers

INFN resource access

INFN are heterogenous by construction

- Cloud access via PaaS and IaaS (OpenStack, Kubernetes)
- Grid access
- Local access if nothing else works
- ISO certified partition for GDPR critical applications
- Optimized for High Throughput Computing
- HPC bubbles for small parallel workflows and prototypes
- Offloading to external systems
  - e.g. Leonardo and other HPC systems



National Federated Cloud

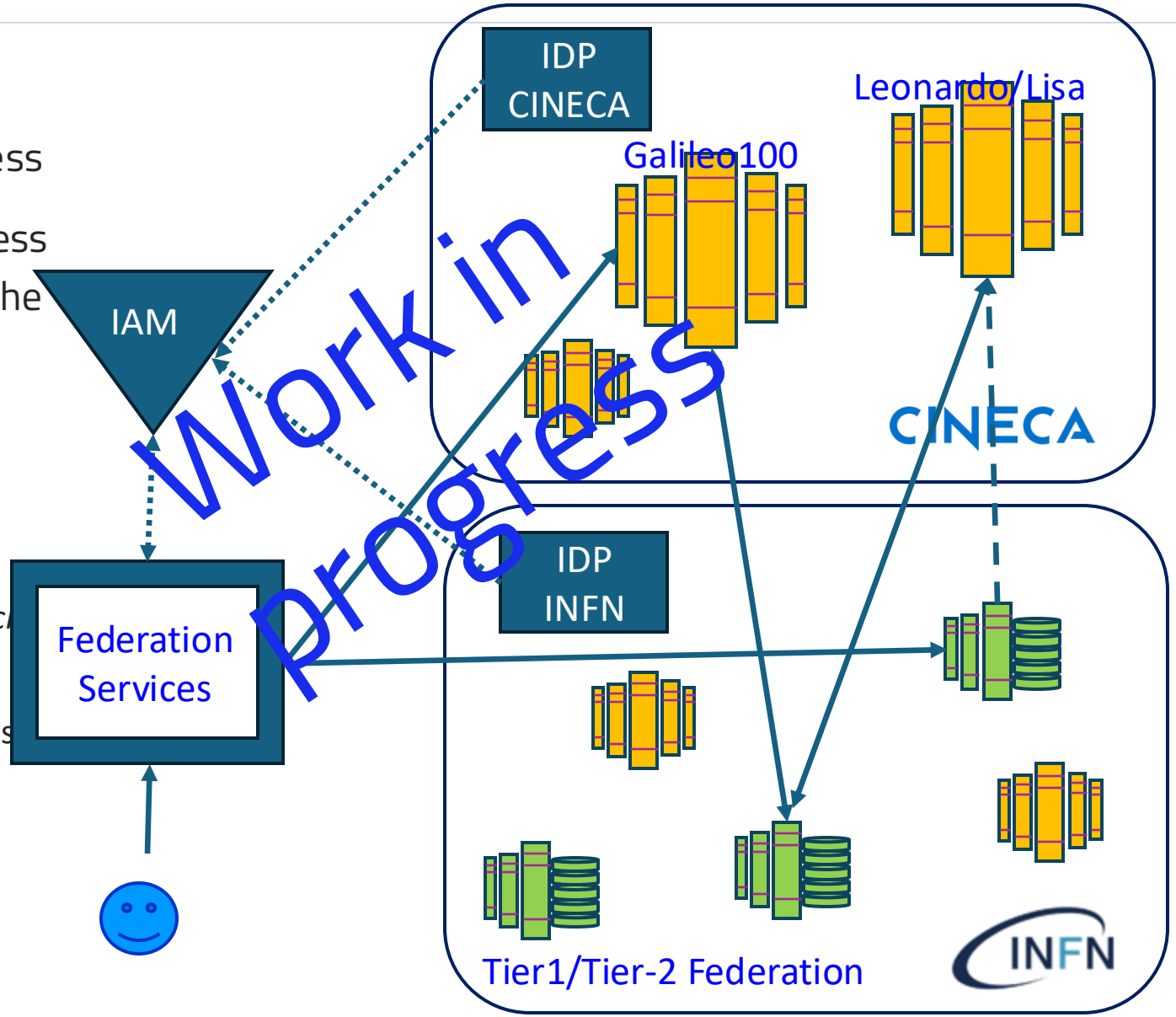
INFN Cloud for CINECA (and others) resources access

Main difficulties on AAI policies (and in turn on access via PaaS). Work started but not completed within the project. Will be addressed in the future

First **Proof of Concept**

- *(INDIGO IAM for INFN and CINECA identity federation)*
- *(INDIGO PaaS Orchestrator for access to OpenStac based resources)*
- InterLink offloading to reach CINECA HPC resources
- RUCIO for INFN and CINECA storage system federation

Activities to be carried on in the European context



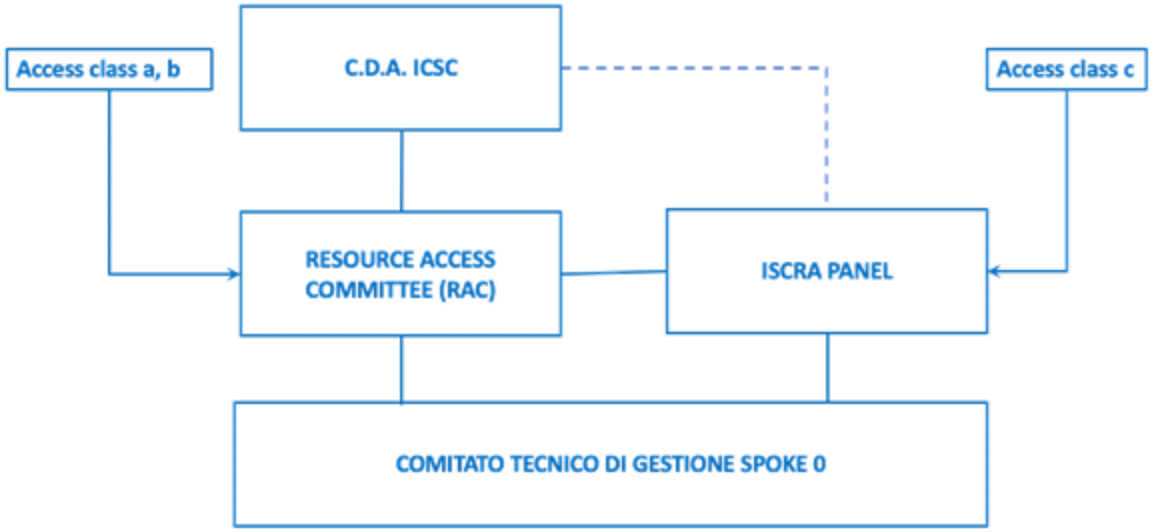
Resource allocation procedures

Scientific evaluation of the requests by the spokes, or by the CdA

Technical evaluation and prioritization by the Resource Access Committee

Feasibility evaluation by the Spoke 0 Technical Management Committee

Setup and allocation of resources by the Spoke 0 partner



175 projects evaluated by the RAC

All projects have resources allocated (or are going to...) on INFN and CINECA

Users need to be registered with the resource provider

Perspectives for resource access

The targets to use identity federations and centralized authorization have not been achieved within the project

- EuroHPC Federation Platform (EFP) initiative is overlapping with our activities

Due to this, the federation of OpenStack instances in the PoC could not be achieved

We expect fast advancements when the EFP initiative will provide the first middleware, or at least the architecture definition

- ICSC is partner of CSC (that is driving the EFP initiative) in the proposed EOSC-CONNECT project

Again, coordination at the European level may allow us to achieve the targets that we could not achieve in Italy

The most critical aspect is the definition of the policies

Perspectives for infrastructure and resources

With the completion of the ICSC and TeRABIT acquisitions, the capacity of the infrastructure and the amount of resources is unprecedented

The infrastructure will continue to evolve and expand

- GARR-T evolution, EuroHPC Hyperconnectivity
- CINECA AI factory, Gigafactory
- INFN planned increase of resources

The Italian infrastructure must me seen in connection with the European and in general the international infrastructure

- GEANT, EOSC, EuroHPC, ...

CINECA

Economic mobilization in millions of Euros

Ministry University and Research	180,00 €
Next Generation EU / PNRR	170,40 €
National research institutions and CINECA	117,38 €
National Agency for Cybersecurity	117,00 €
Emilia Romagna Regional Govern	20,00 €
ItaliaMeteo Agency	9,00 €
AI4I - the Italian institute of artificial intelligence for industry	5,00 €
Bruno Kessler Foundation	2,00 €
Slovenia + Austria	10,00 €
Total Cost of Ownership (for 5 years of production cycle 2024 - 2028/29)	1.022,08 €
of which	
Co-funded by European Commission: EuroHPC and EUROfusion	391,30 €
Co-funded by Italy	630,78 €
whose intended use	
CAPEX	763,38 €
OPEX	258,70 €

The commitment of CINECA in a few points

European EuroHPC Hosting Entity

HPC Service provider EUROFusion international nuclear fusion community

Eni Applications dev-ops and HPC System and Production mgmt.

The only civilian organization in the world that manages two HPC systems in the top 10 of the Top500: Eni HPC6 & EuroHPC LEONARDO

Leader of the spoke infrastructure (Research Network; HPC, Big Data and AI; QC) of the National HPC Center

Hosting and coordinating Entity of the AI Factory IT4LIA

THE MAIN ACTIONS

2022
Leonardo project € 290 Ml
Tecnopolo DAMA Bologna
Sistema HPC LEONARDO
Sistema HPTC INFN WLCG

2021
Evolution
The Data and AI
Factory Ecosystem

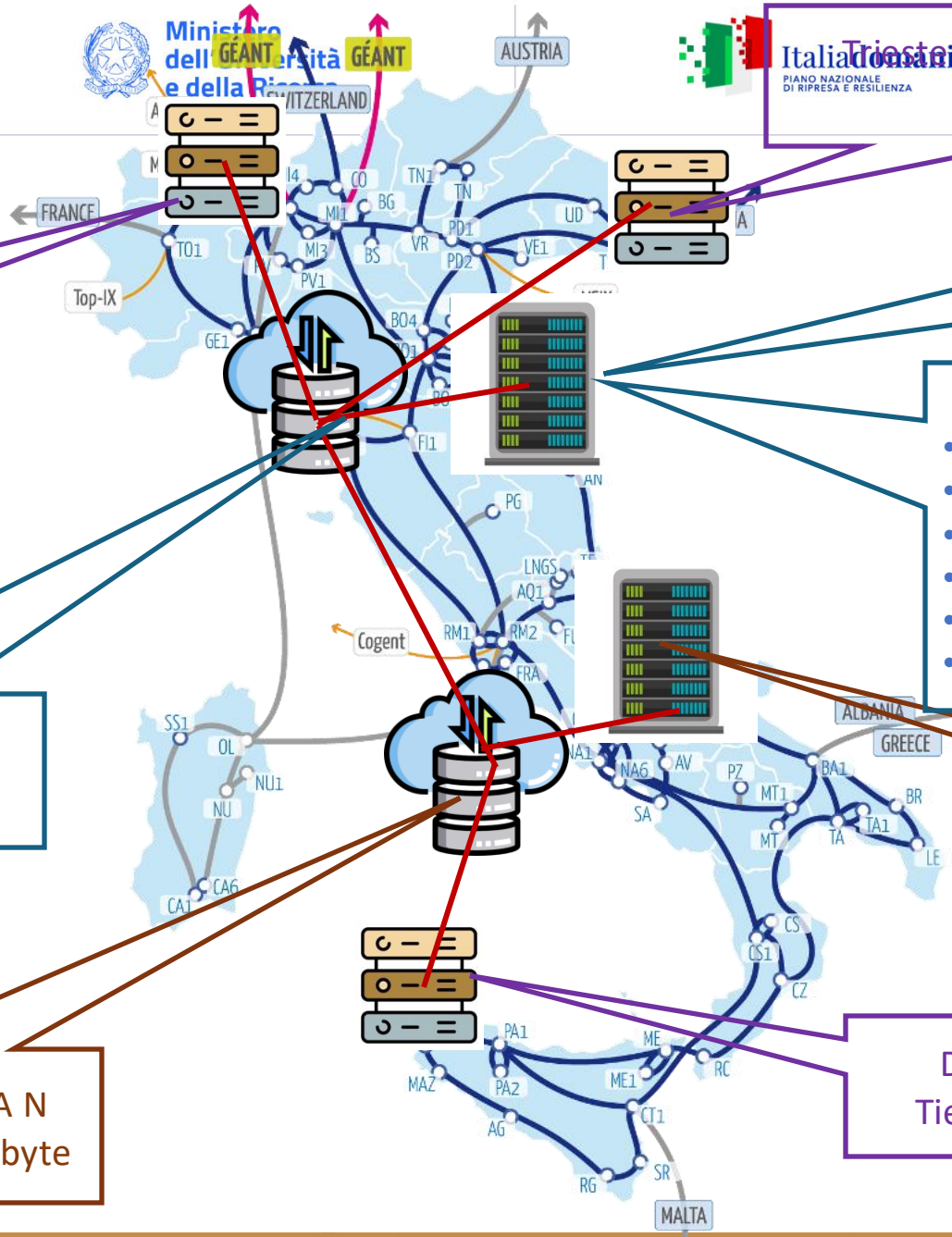
2023
PNRR € 260 Ml
Next GENEU – PNRR
ICSC National Ecosystem
EuroFusion
ACN

2024
Innovation € 430 Ml
AI Factory
Progetto IT4LIA

2025
Exploitation!

- 2026-7
- Competitiveness € 3-4 Bn
AI Giga Factory
In progress

CINECA National distributed infrastructure



Milano ENI Green Data Center:
Tier2: University of Bicocca

Bologna Data Lake GARDA B
Multi protocol Multi Petabyte

Napoli Data Lake GARDA N
Multi protocol Multi Petabyte

Trieste - SISSA Data Center:
Tier2 SISSA

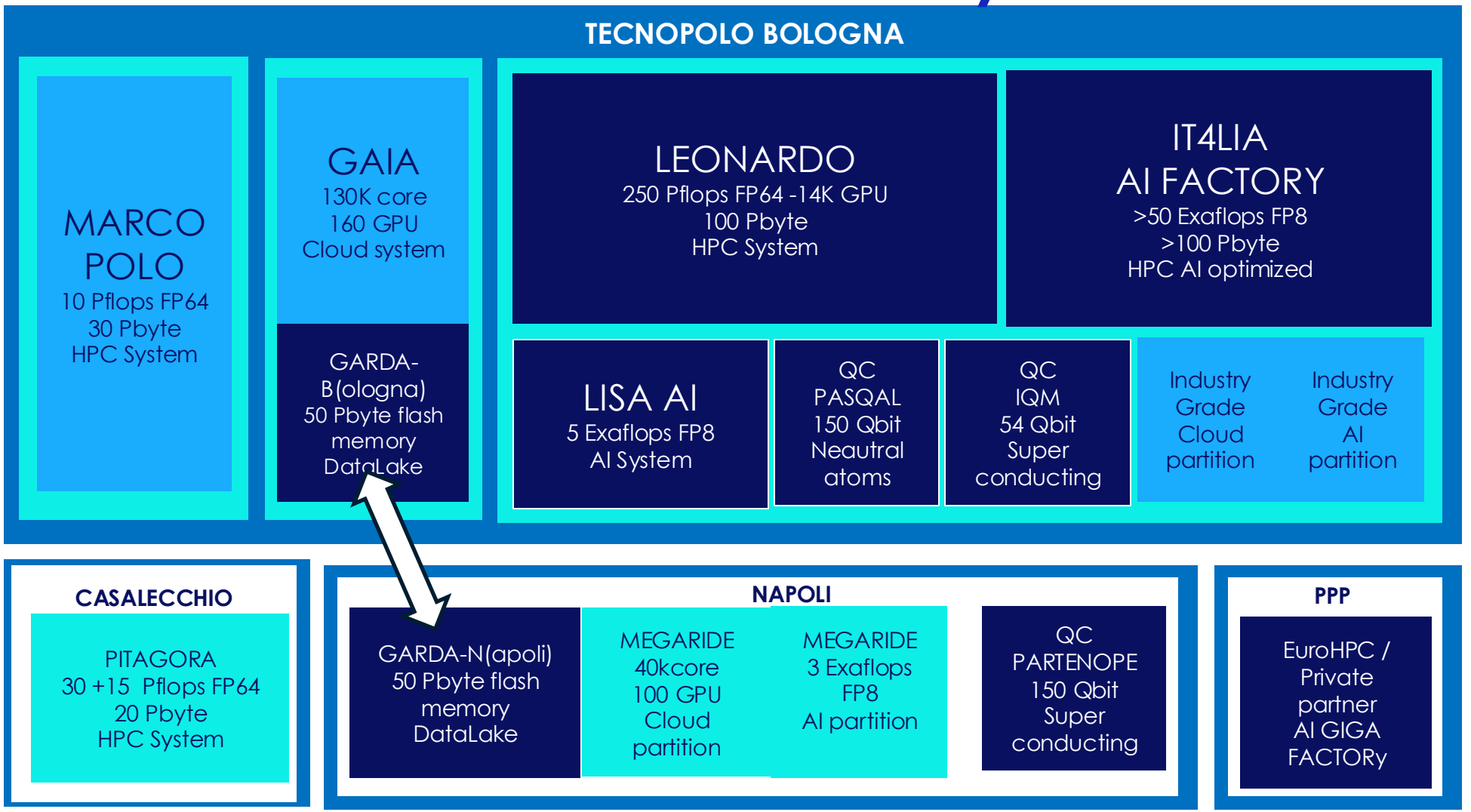
Bologna - Casalecchio Data Center:
Tier1 Eurofusion: **PITAGORA**

Bologna Tecnopolo Data Center
- Tier0: **LEONARDO + LISA**
- Tier1 **MARCOPOLO**: CNR / INAF / AIM
- Tier1 cloud: **GAIA**
- Tier1 **EuroHPC Industrial Grade**
- QC NA **Pasqal**
- QC Superconducting **IQM**

Napoli San Giovanni a T. Data Center
NAPOLI1: CNR / ACN

Data Center Uni Palermo
Tier2: University of Palermo

Towards AI Factory



Technical specifications	Tender publication	Contract	Implementation	Preproduction	Production		
						LEONARDO	2023
						PITAGORA	2024
					Nov. 2025	GAIA Cloud	2025
				Nov. 2025	Dec. 2025	MEGARIDE	
				Nov. 2025	Dec. 2025	QC IQM	
			Oct. 2025	Dec. 2025	Feb. 2026	MARCOPOLO	2026
			Oct. 2025	Dec. 2025	Feb. 2026	LISA	
			Dec. 2025	Apr. 2025	June. 2026	QC PASCAL	
		Nov. 2025	Jan. 26	Mar. 2026	May. 2026	TIER2	
		Jan. 2026	June 2026	Sept. 2026	Nov. 2026	AI FACTORY	
Oct. 2025	Nov. 2025	Feb. 2026	July 2026	Oct. 2026	Dec. 2026	INNOVATE	

Access policies

TCO coverage percentage						
	EU	MUR + EPR + CINECA	ICSC	Terabit	AIM	ACN
LEONARDO	50%	50%				
INFN HTC			81%	19%		
LISA	50%		50%			
GAIA Cloud		23%		77%		
MARCOPOLO		45%	24%		31%	
MEGARIDE		21%	26%			55%
PITAGORA	90%	10%				
PASQAL QC	50%	5%	45%			
IQM QC		22%	78%			
IT4LIA	50%	50%				
	EU Call	ISCRA + Pay per Use	ISCRA (?)	ISCRA (?)		

Perspective

- Favorable circumstances have been seized, allowing the creation of a national HPC, Big Data, AI, and QC infrastructure unparalleled in its power, value, and enabling potential.

- This infrastructure is integrated into the European system, where Italy plays a visible and leading role.

- To create the conditions for lasting development prospects, the challenge in the coming months is to ensure the exploitation of such infrastructure in terms of effective access, quality of service, and production resilience.

Immediate actions

- Create a single evaluation channel for access to computing resources, valid for different evaluation criteria and different user categories, applying the evaluation drivers by mean of an independent set of experts, trustable and transparently. In particularly:
    - scientific merit for the research community;
    - impact value for public administration;
    - level of technological innovation for industry and private organizations.

- Implement a single portal, supported by intelligent chatbot methods for interaction with a broad and heterogeneous audience, regarding access threats to HPC and AI infrastructures at various levels:
    - European: EuroHPC, EUROFusion, AI Factories, …
    - National: ISCRA, IT4LIA, …
    - Institutional: CINECA, INFN, AIM, Eni …
    - Pay per use and added value services
- Go beyond the concept of a federation of infrastructures and develop an enabling and persistent service strategy aimed at communities that perform a service role of public value, such as:
    - Medicine, healthcare, and life sciences communities
    - Weather, climate, and resilience to climate change
    - Environment, territory, hydrogeology, geophysics...
    - Cultural heritage, humanities, social sciences

Vision for digital infrastructure development

Actual state of the art.

- Three levels: Tier0; Tier1; Tier2. Below: Personal productivity and training.
- Two main sites.
- Tecnopolo Bologna.
  - HPC and Cloud AI at scale; Data lake repository. 30 MWatt IT (23/24 MWatt Enel D + 10/12 MWatt Fuell cells)
- San G. Teduccio Naples.
  - HPC and AI for cyber security; Data lake repository. 2 MWatt IT

- Network architecture primarily aimed at integrating geographical areas.

- There is still difficulty integrating data produced by scientific experimentation and observation activities.

- Integration with public administration systems remains challenging.

Vision for digital infrastructure development

Future trends

- Two main sites.
- Tecnopolo Bologna.
  - HPC - Post Leonardo: minimum 1 exaflop HPL post exascale (2028)
  - Large-Scale Cloud AI - Second Round of Integrated AI Factory Under AI Gigafactory Infrastructure
  - Data lake repository: 500 PB full flash
  - Towards 60 MWatt IT (30 MWatt Enel D / Terna + 30 MWatt Fuell cells)
- San G. Teduccio Naples.
  - HPC and AI for cybersecurity adequate to manage at least 500 PB of full flash memory
  - Data lake repository: 500 PB full flash
  - 10 MWatt IT Enel D

- Towards terabit second for the experimental data provider infrastructures: Sincrotone, Gran Sasso...

- European sovereignty:
  - Implement a system of adequate size that integrates only European technology.
  - Support the development, including by encouraging the creation of a related start-up, of the quantum computing project coordinated by the nanotechnology laboratory at Federico II University.
  - As a strategic guideline, favor exclusively solutions based on on-premise implementation and open-source software stacks.