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Ministero  
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PIANO NAZIONALE  
DI RIPRESA E RESILIENZA



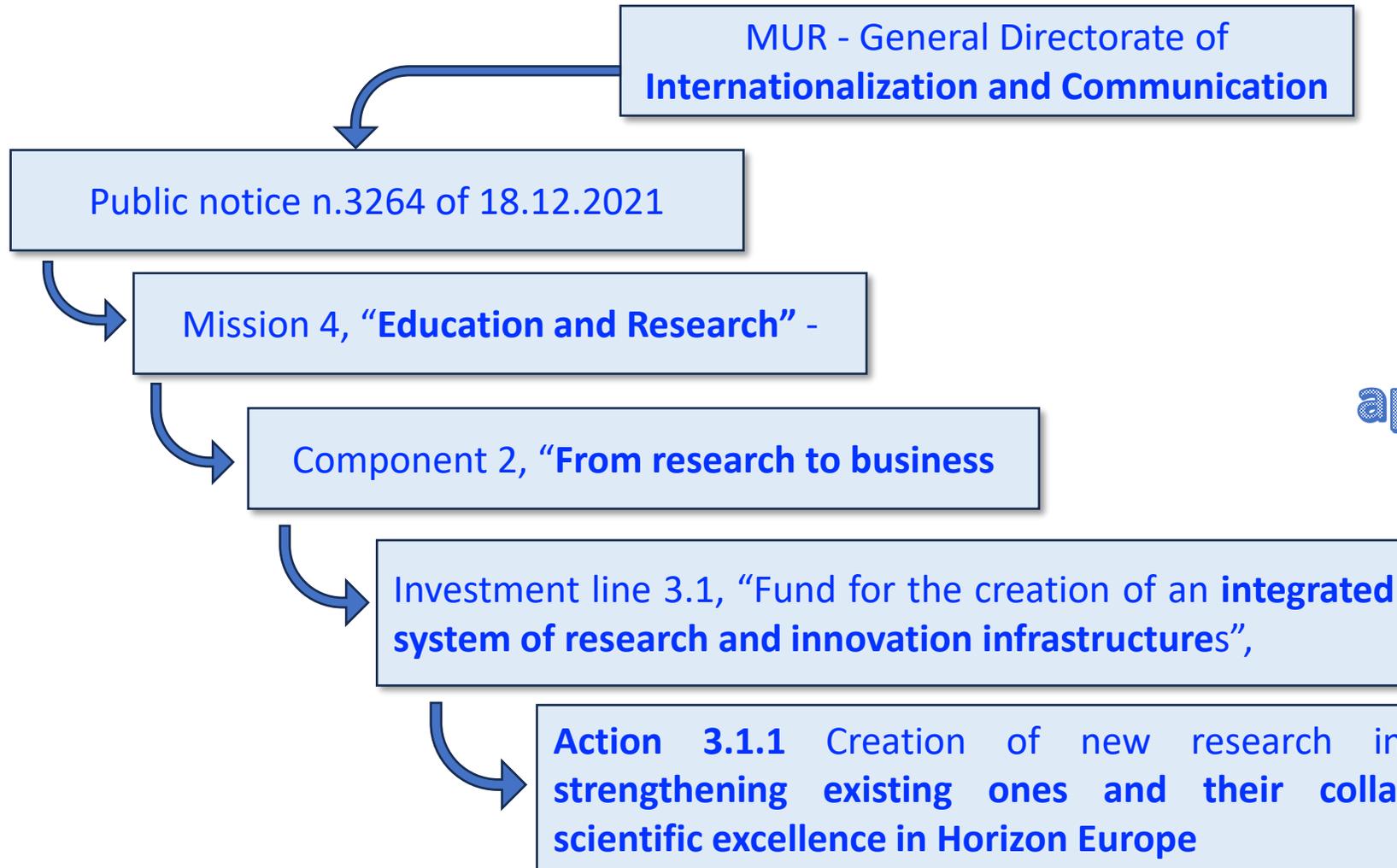
# The TeRABIT project

## Terabit network for Research and Academic Big data in Italy

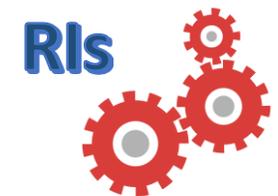
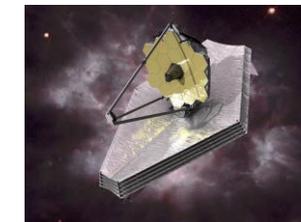
Mauro Campanella  
Principal Investigator

Bologna, 25 June 2024

TeRABIT Conference



apply research to production



## TeRABIT in a nutshell

Applicant	: <b>INFN</b> (Istituto Nazionale di Fisica Nucleare)
Coapplicant	: <b>OGS</b> (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS)
Other participants	: Consortium GARR, CINECA
Principal Investigator INFN	: Mauro Campanella (Milano)
Principal Investigator OGS	: Stefano Salon (Trieste)
Infrastructure Manager INFN	: Silvia Calegari (CNAF)
Funding	: <b>41 ME</b> (34.5 assets, 4.1 personnel, 2.4 other)
Personnel hired with fixed-term contracts or grants	: INFN 25 persons + 1 infrastructure manager : OGS 8 persons + 11 PhD + 4 master HPC
Unfunded effort	: 21 PM GARR, 25 PM CINECA
Start date	: <b>1 January 2023</b>
Duration	: 30 month (end date <b>30 June 2025</b> )





## Vision

Create a **distributed, hyper-connected, hybrid HPC-Cloud environment** that offers services designed to meet the evolving needs of research and innovation.

The environment will federate and strengthen the three **existing research infrastructures GARR-T, PRACE-Italy and HPC-BD-AI (HPC-Big Data-Artificial Intelligence)**, leveraging their existing of **connections to other national and European research infrastructures** and data spaces through the GÉANT backbone.

## Main objectives

1. Enable widespread **data transfer, up to Terabits per second**, and services on a national scale in Italy, with particular focus on southern and island regions, all connected to Europe
2. **Innovate the central HPC node of PRACE-Italy**, maintaining the Tier-1 level.
3. **Innovate the HPC services** offered to researchers, beyond the centralized calculation model, adding distributed **“HPC-Bubbles”**



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# The Research Infrastructures involved (snapshot of 2023)



**EuroHPC**  
Joint Undertaking



**PRACE**  
PARTNERSHIP FOR ADVANCED COMPUTING IN EUROPE

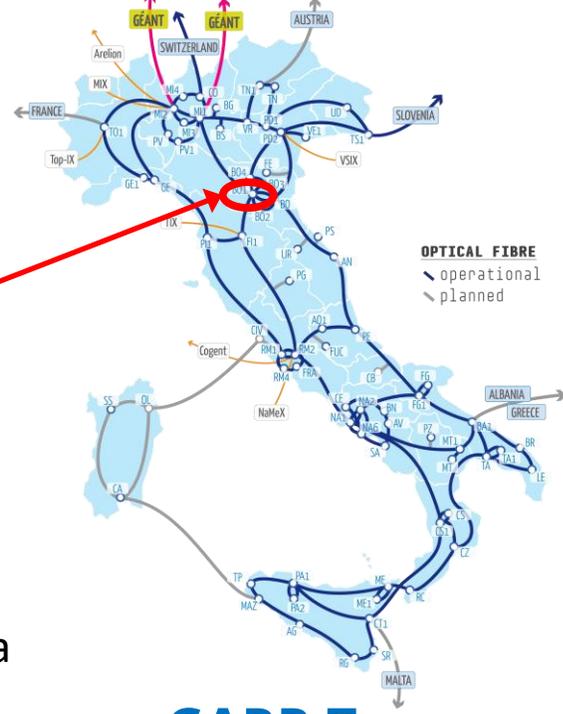


**WLCG**  
Worldwide LHC Computing Grid

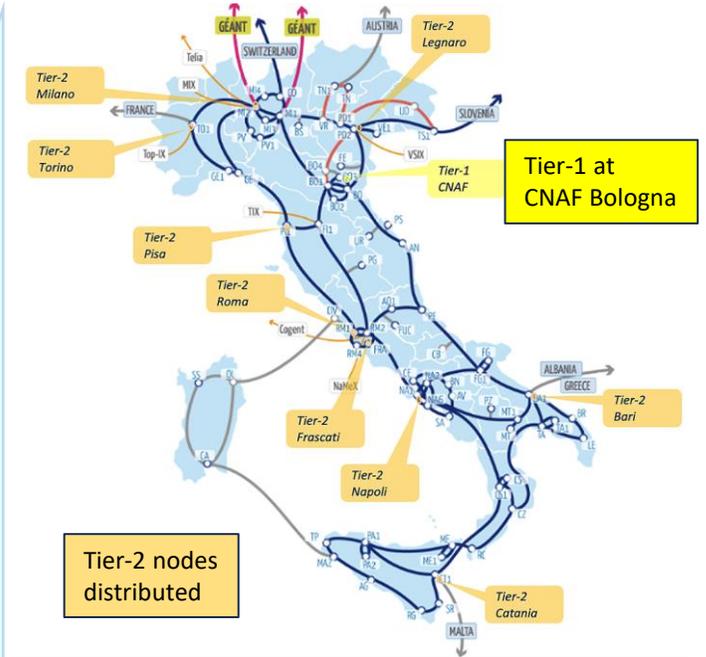


Galileo100 - HPC, Hosted by CINECA - Bologna

**PRACE-Italy**



**GARR-T**



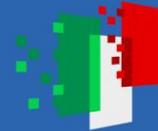
**HPC-BD-AI**



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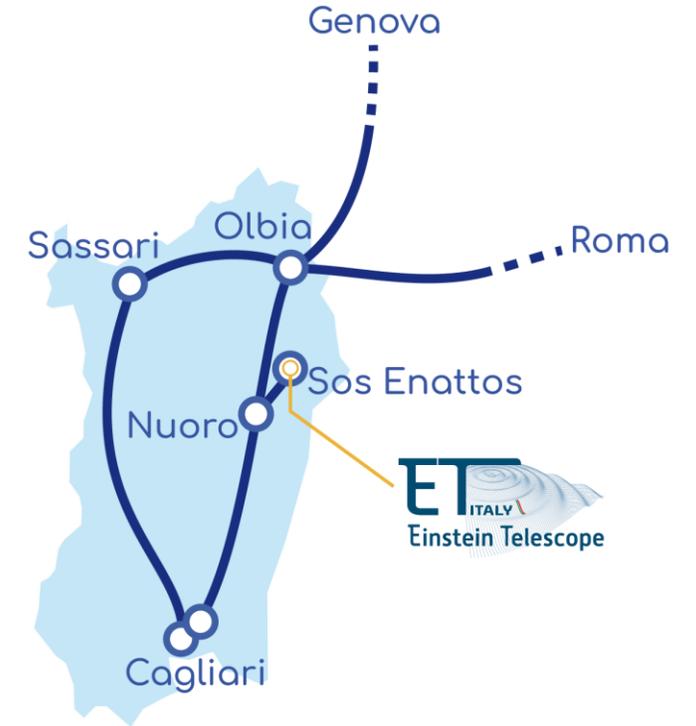
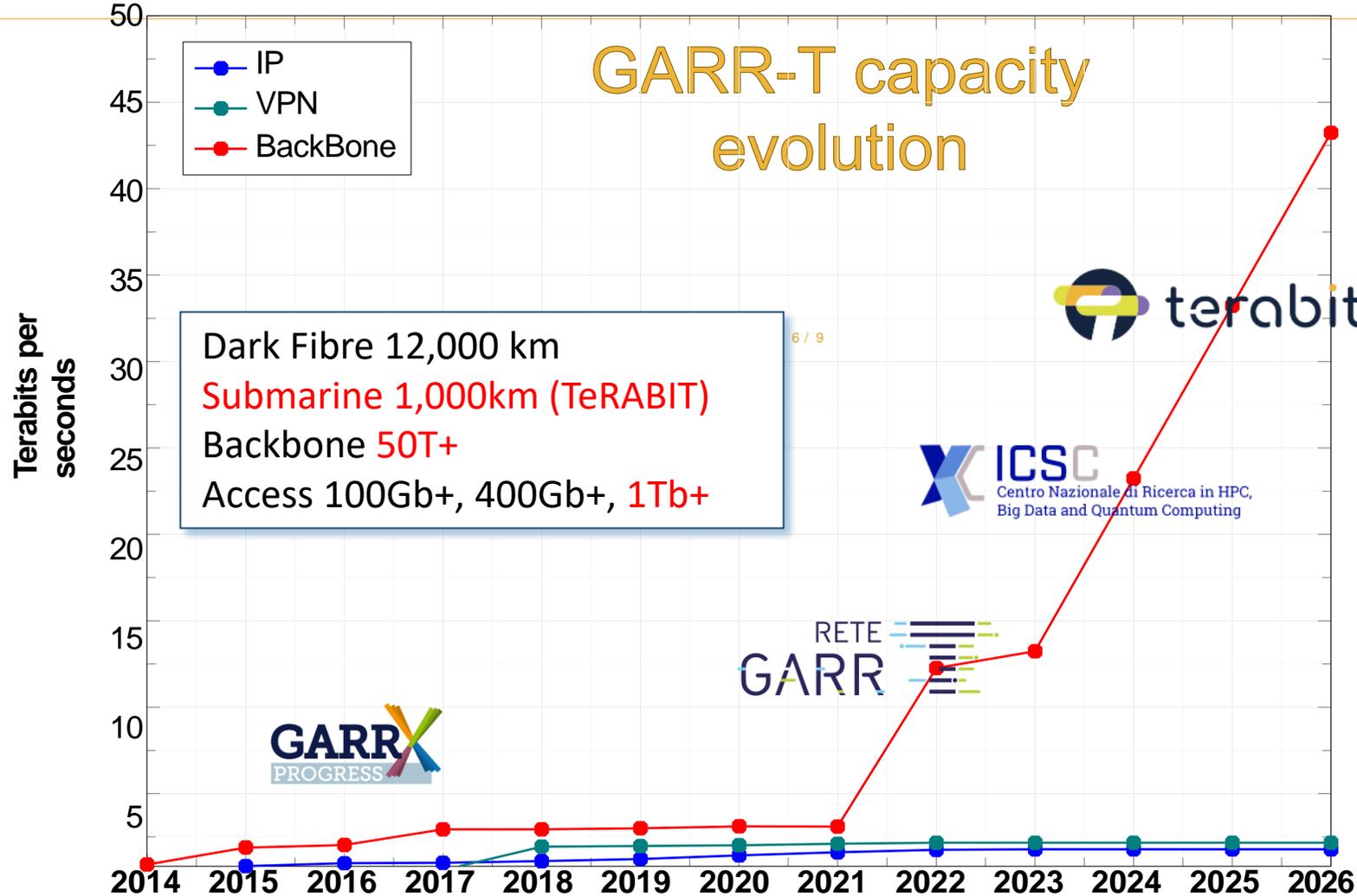
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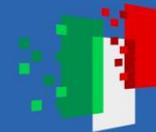


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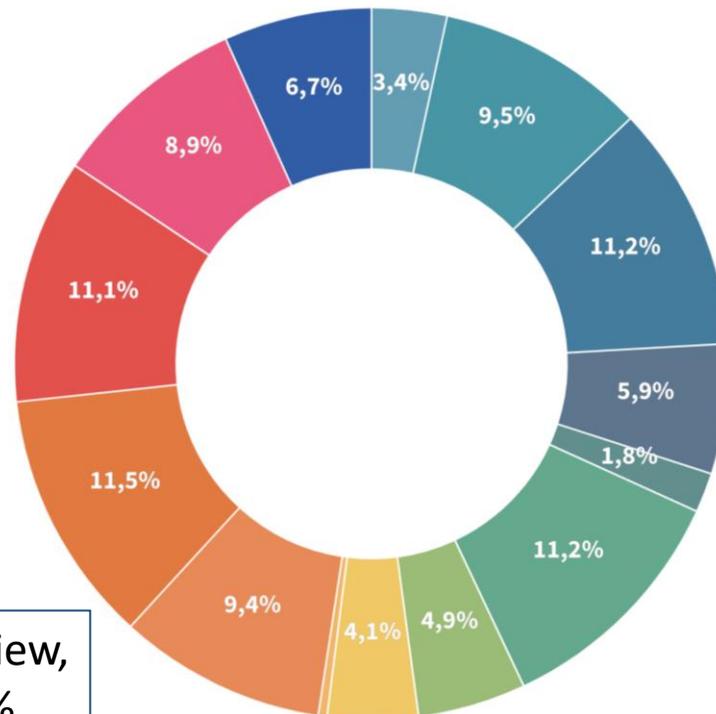
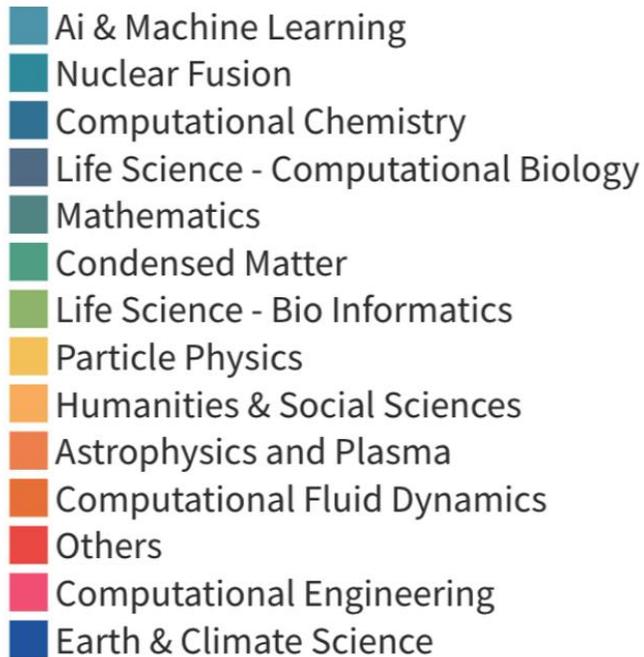
## GARR-T capacity evolution





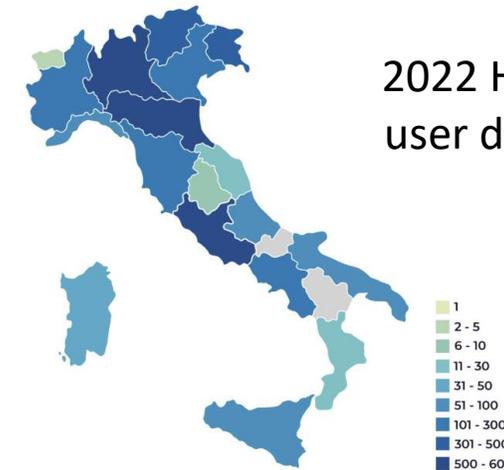
## Scientific domains

Scientists use Cineca computational resources within all scientific disciplines. The most represented three are Computational Chemistry, Condensed Matter Physics and Computational Fluid Dynamics, with about 11% each, followed by Nuclear Fusion (10%), Computational Engineering, Astrophysics, and Plasma Physics with more than 9% each.

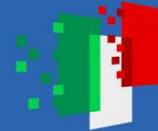


In 2022, following a strict peer review, the resource allocated were 109,3%

## Use and upgrade of PRACE-Italy



TeRABIT upgrade	NET INCREASE
Capacity	~ x 5.0
Storage	~ x 2.5



# HPC-BD-AI evolution

HPC bubbles  specification and locations

HPC nodes HW: Type 1 : CPU only  
Type 2 : CPU + GPU,  
Type 3 : CPU + FPGA

Sites: CNAF, Bari, Napoli, Roma 1, Pisa, Padova, Torino, Milano Bicocca

Additional Storage:  
Mass storage : CNAF  
High performance storage : CNAF, Bari

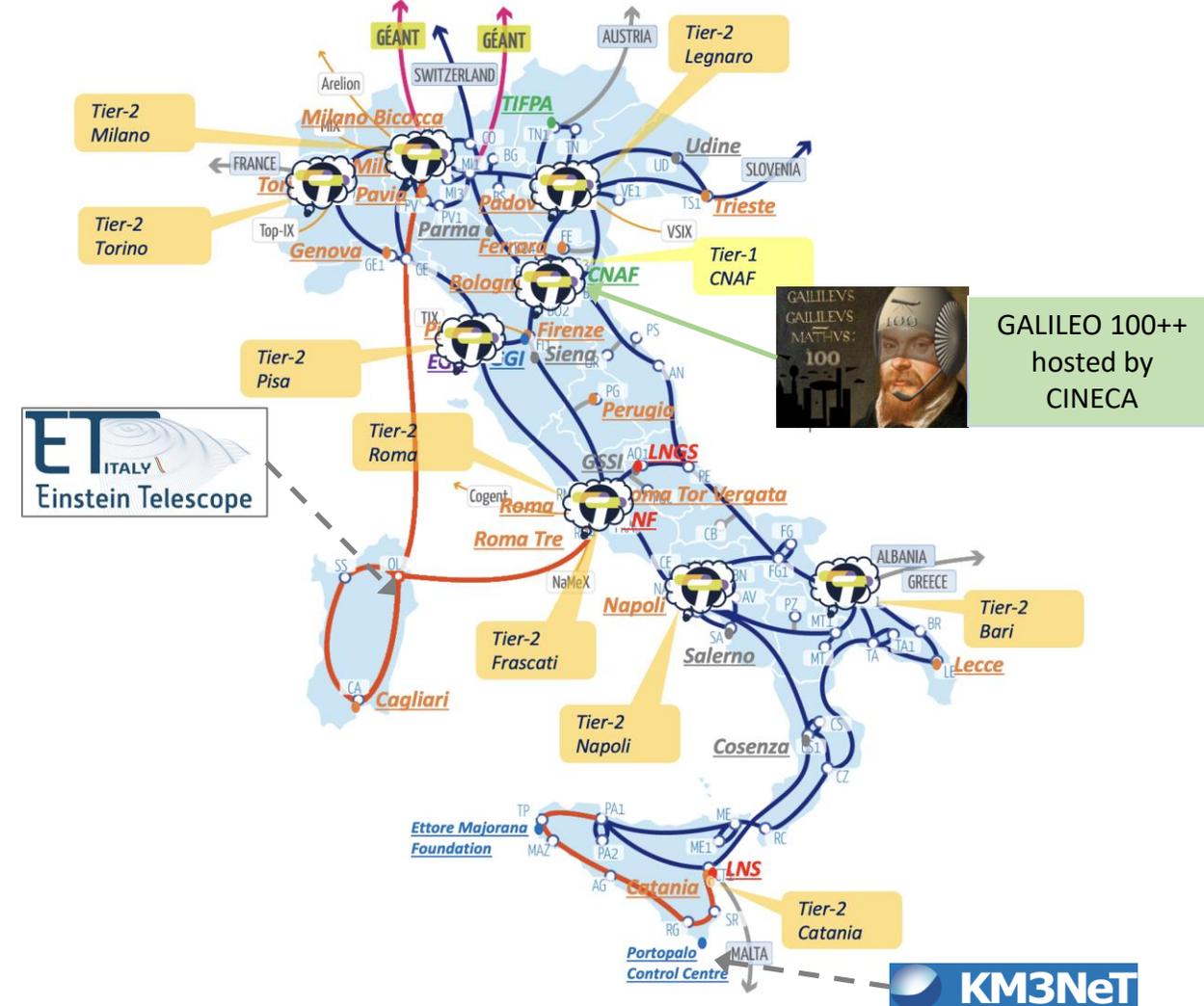




# TeRABIT final Infrastructures

The image shows the overlap of the expected combined final physical topologies of all three Research Infrastructures:

- GARR-T with (in red) the new fibres
- HPC-BD-AI with the HPC Bubbles locations
- PRACE-ITALY with the updated GALILEO100 hosted at CINECA



## Users: higher education and dissemination

Case studies



Enhancement of HPC Training and Research for Earth Sciences and the participation of other research areas experts

training of young technologists



- organization of **2 workshops**
- organization of **1 hackathon**

HPC Master and PhD



Doctoral and master HPC students

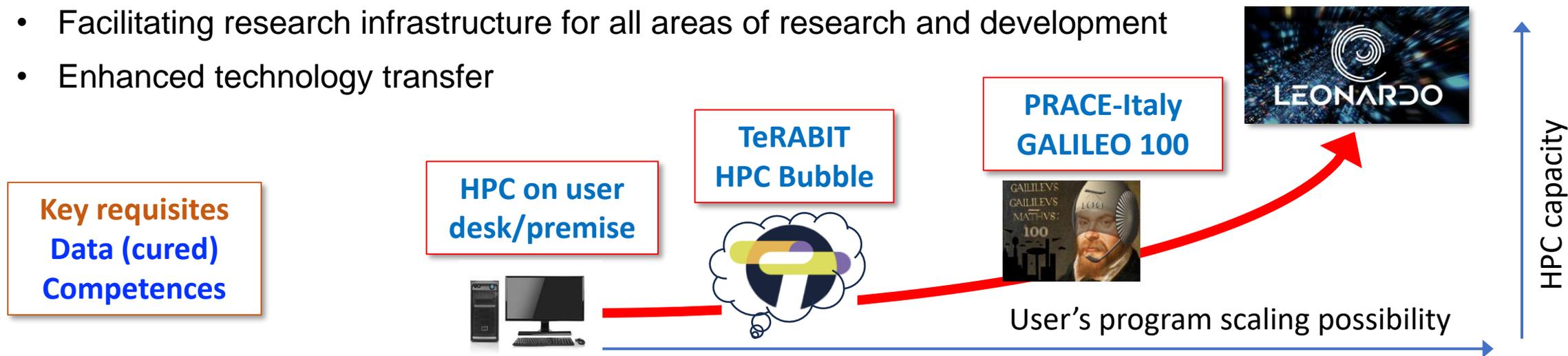
Students



- Sessions to present the TeRABIT project in High Schools distributed in Italy
  - ✓ Train young researchers and technologists of the future

## Planned impact of the project

- Infrastructures strengthening to answer scaling requirement of research
- Tighter integration between network, data and HPC services with common, federated services
- Innovative HPC services (bubbles), modular and increasing HPC/ML capacity between the "edge", where the users and its data are, and PRACE-Italy, in synergy with ICSC (Leonardo)
- Federation and communication between HPC Infrastructures with close collaboration with the national and international HPC center (via GÉANT) as PRACE and EuroHPC centres
- Facilitating research infrastructure for all areas of research and development
- Enhanced technology transfer

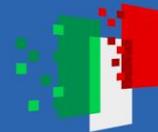




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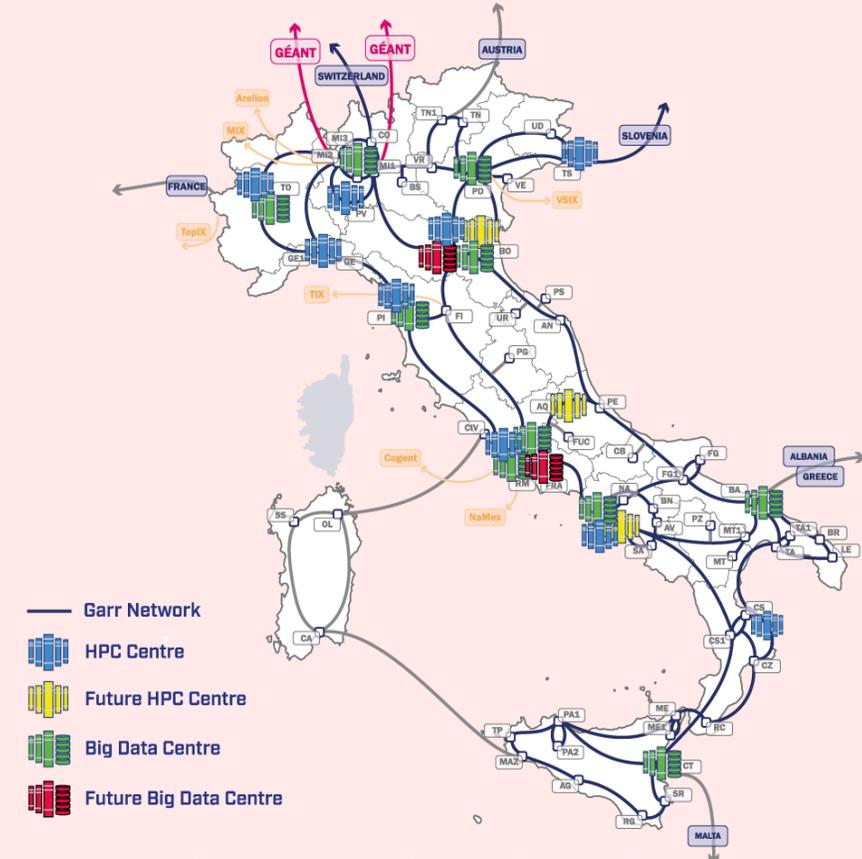
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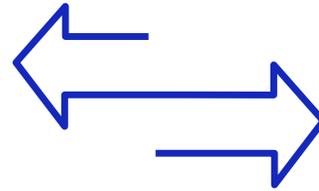
## 0 SUPERCOMPUTING CLOUD INFRASTRUCTURE



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



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



ICSC is made of  
10 thematic spokes  
1 spoke for the infrastructure

ISTRUZIONE E FORMAZIONE,  
IMPRENDITORIALITÀ, TRASFERIMENTO DI  
CONOSCENZE, POLICY, OUTREACH

<p><b>1</b></p> <p>FUTURE HPC &amp; BIG DATA</p>	<p><b>2</b></p> <p>FUNDAMENTAL RESEARCH &amp; SPACE ECONOMY</p>
<p><b>3</b></p> <p>ASTROPHYSICS &amp; COSMOS OBSERVATIONS</p>	<p><b>4</b></p> <p>EARTH &amp; CLIMATE</p>
<p><b>5</b></p> <p>ENVIRONMENT &amp; NATURAL DISASTERS</p>	<p><b>6</b></p> <p>MULTISCALE MODELING &amp; ENGINEERING APPLICATIONS</p>
<p><b>7</b></p> <p>MATERIALS &amp; MOLECULAR SCIENCES</p>	<p><b>8</b></p> <p>IN-SILICO MEDICINE &amp; OMICS DATA</p>
<p><b>9</b></p> <p>DIGITAL SOCIETY &amp; SMART CITIES</p>	<p><b>10</b></p> <p>QUANTUM COMPUTING</p>

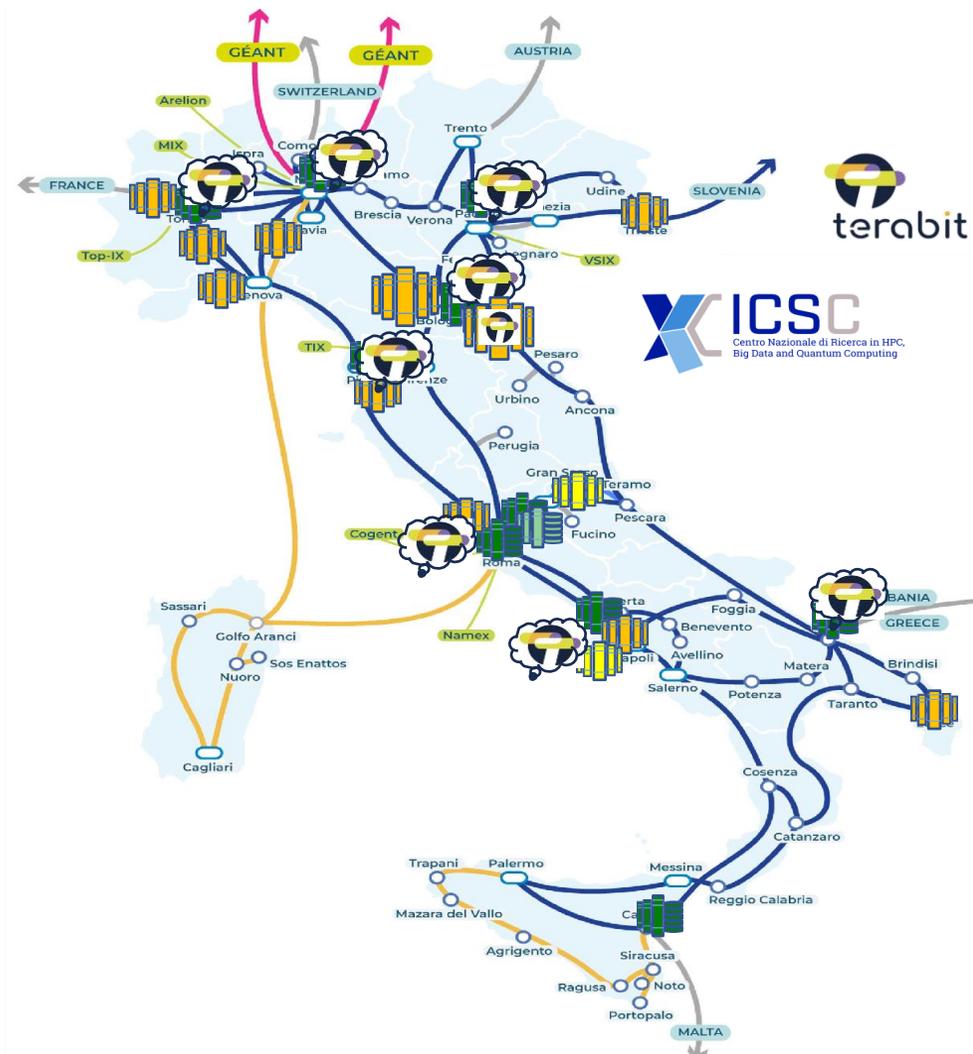
# National computing research infrastructure

ICSC e TeRABIT plan the creation of the national computing infrastructure for research

Access to resources should be transparent for the end-user

Main actor are: INFN, CINECA, GARR

And also: CMCC, ENEA, SISSA, IIT, Univ. TO, Univ. Roma Sapienza, ...





## Not technical challenges

Skills and permanent updating

Cost of operation (electrical power)

Cyber – Security

Digital Divide

Talent retention

Digital (big)-Data-centric evolution in research

Policies and Trust between RIs and Thematic infrastructures

## Technical challenges

Rapid ICT evolution lead by commercial players, e.g. Large Language Models

Federated authentication and authorization

Storage (data) access and data management

Upgrade and federate the IRs in production

Digital divide



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# Thank you

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