Finanziato dall'Unione europea NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

terabit

The TeRABIT project

Terabit network for Research and Academic Big data in ITaly

Mauro Campanella
Principal Investigator

Assisi, 21 February 2024

ETIC Workshop

AGENDA

- TeRABIT in a nutshell
- the evolution of the 3 Research Infrastructures
- Project management
- Expected impact
- Synergy and impact for ET

TeRABIT in a nutshell

Applicant	: INFN (Istituto Nazionale di Fisica Nucleare)
Coapplicant	: OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS)
Unfunded participants	: Consortium GARR, CINECA
Principal Investigator INFN	: Mauro Campanella
Principal Investigator OGS	: Stefano Salon
Funding	: 41 ME
Personnel to be hired with fixed-term contracts	: INFN 23 persons + 1 infrastructure manager : OGS 4 persons + 10 PhD + 6 Masters
Unfunded effort	: 21 PM GARR, 25 PM CINECA
Start date	: 1 January 2023
Duration	: 30 month (end date 30 June 2025)

INFN Istituto Nazionale di Fisica Nucleare

OGS Istituto Nazionale di Oceanografia e di Geofisica Sperimentale

Consortium GARR

CINECA

Vision

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

The environment will leverage, federate and strengthen the three Research Infrastructures , existing and in operation GARR-T, PRACE-Italy and HPC-BD-AI (HPC – Big-Data – Artificial Intelligence. The tree RIs are in the list of the National Plan for RI (PNIR) and are are already connected to other national and European RIs (and data spaces) through GÉANT

Main objectives

1. Enable widespread data transfer, up to Terabits per second, and services on a national scale in Italy, with particular focus on its southern regions and islands, 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” and cloud interoperability

The Research Infrastructures involved (as of today)

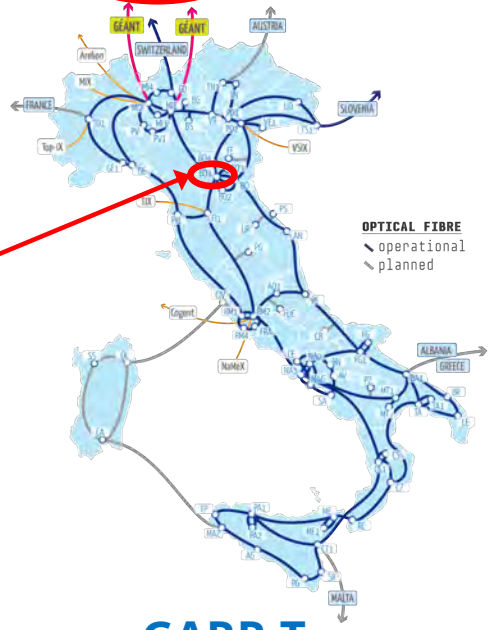
EuroHPC Joint Undertaking

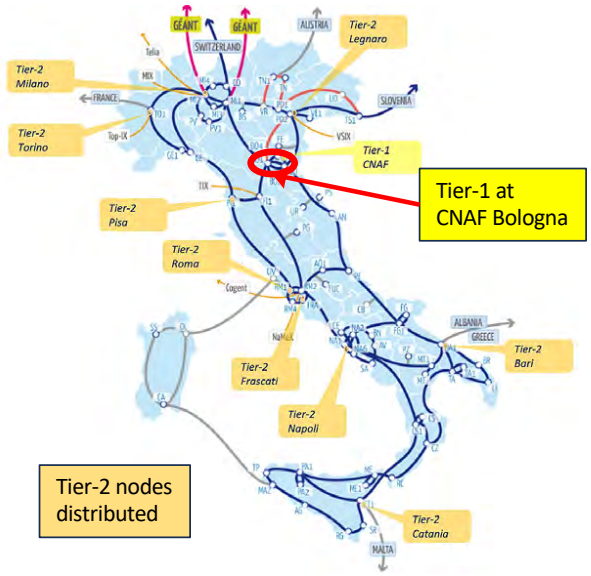
PRACE PARTNERSHIP FOR ADVANCED COMPUTING IN EUROPE

GÉANT

WLCG Worldwide LHC Computing Grid

Galileo100 - HPC, Hosted by CINECA - Bologna





Tier-1 at CNAF Bologna

Tier-2 nodes distributed

PRACE-Italy **GARR-T** **HPC-BD-AI**

Use of PRACE-Italy

Geographic distribution of institutions

67% of the total number of users works for an Italian institution, clustered in the Emilia Romagna region (19%), Lombardia region (18%), and Lazio (16%). While going to city level, Milan, Rome, Bologna and Trieste, in the order, have a user's pergentage going from 15% to 11%.

On the international side, the higher concentration of users is in Europe: the more represented foreign countries are Germany with 5% and the United Kingdom, France and Spain with 3% each, mainly working for universities and public or non-profit organizations.

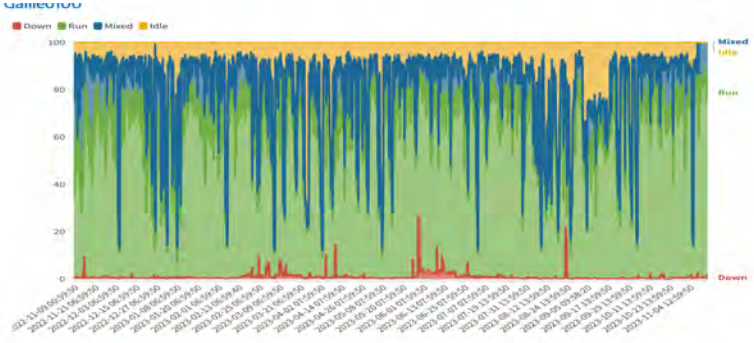
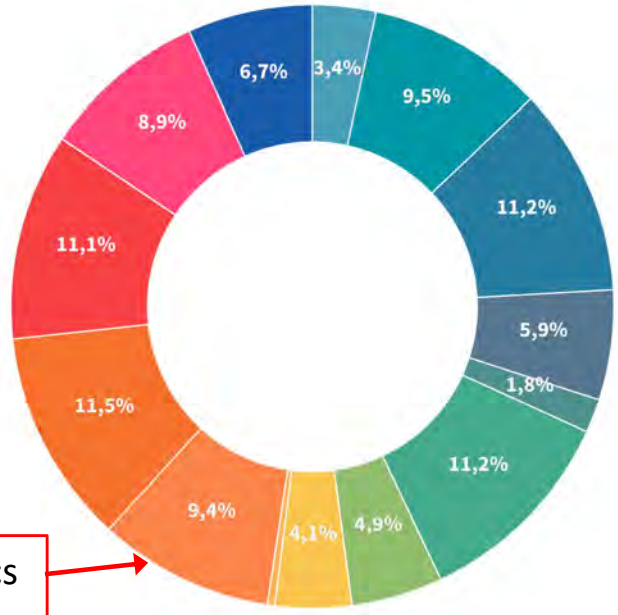


Figure 1: Galileo100utilization from November 2022 until November 2023.

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 about11% each, followed by Nuclear Fusion (10%), nal Engineering, Astrophysics, and Plasma Physics with more than 9% each.



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

Astrophysics and Plasma

PRACE-Italy capacity **at TeRABIT end (2025)**

Cloud	HPC	Storage
OpenStack Cloud partition	564 computing nodes (CPU/GPU, 0.5 to 2TB SSD)	Ceph Block, Object
7000 vCPUs	28.000 CPUs	22PB

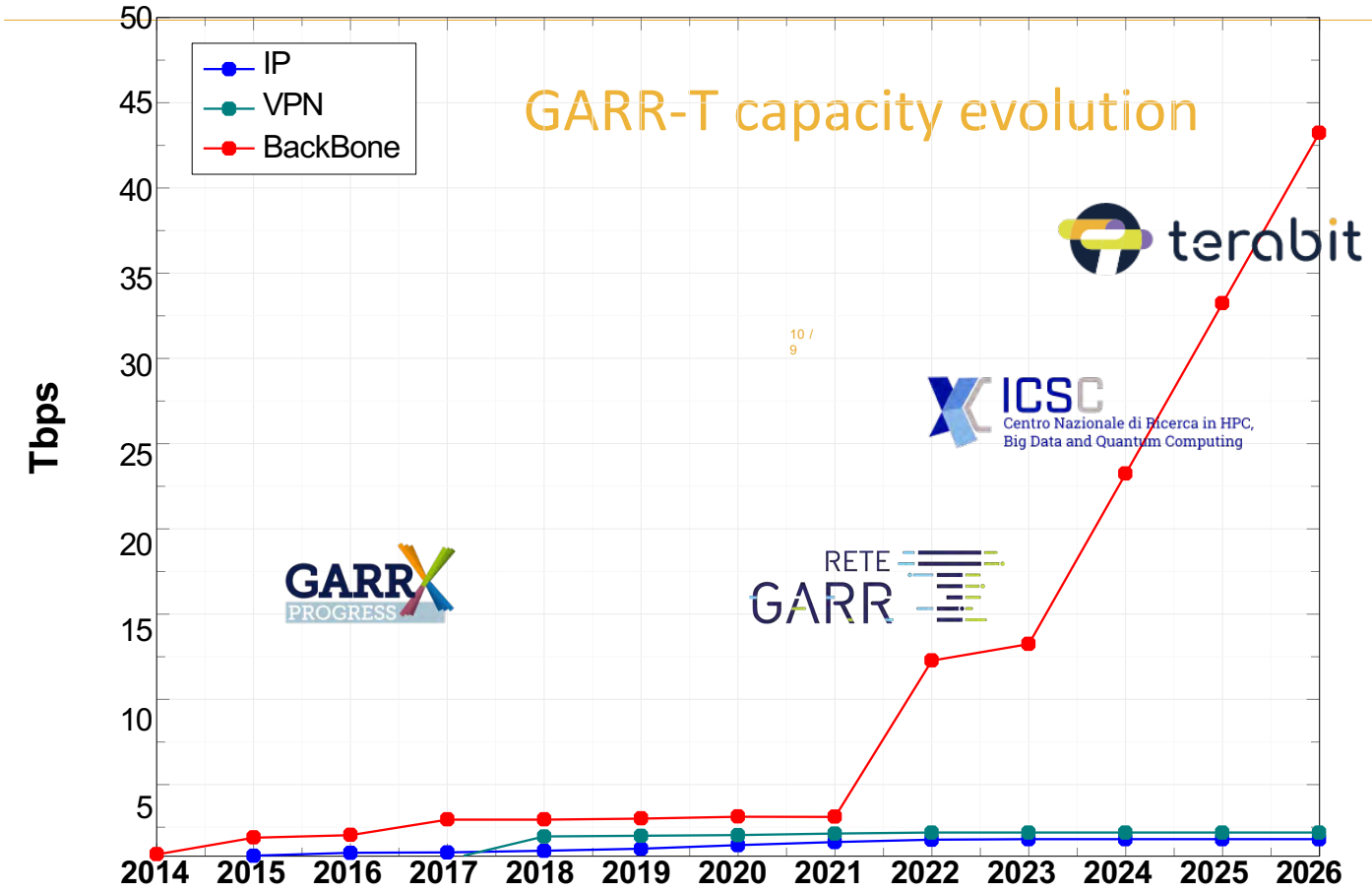
	NET INCREASE
Capacity	x 4.0
Storage	x 2.5

Cloud	Storage
OpenStack Cloud partition • HPC – CPU partition: 280+ comp. nodes, 70000+ cores, 3+ PFlops • Cloud – GPU partition: 70+ comp. nodes, 20000+ cores, GPU HBM: 20+ GB/GPU, DDR: 2x aggregated HBM	Ceph Block, Object
100.000 vCPUs	34 PB

Integrated in TeRABIT infrastructure, access to federated services

Community advantages:

- New user communities => expected increase of users benefitting
- TeRABIT user exploitation and use cases (e.g. sensors *to* HPC-Bubbles *to* G100++ *to* ICSC)
- Synergy within TeRABIT consortium for user training and support
- Move HTC workloads from HPC to Cloud, reducing pressure on HPC queues



Dark Fibre 12,000 km

Submarine 1,000km (TeRABIT)

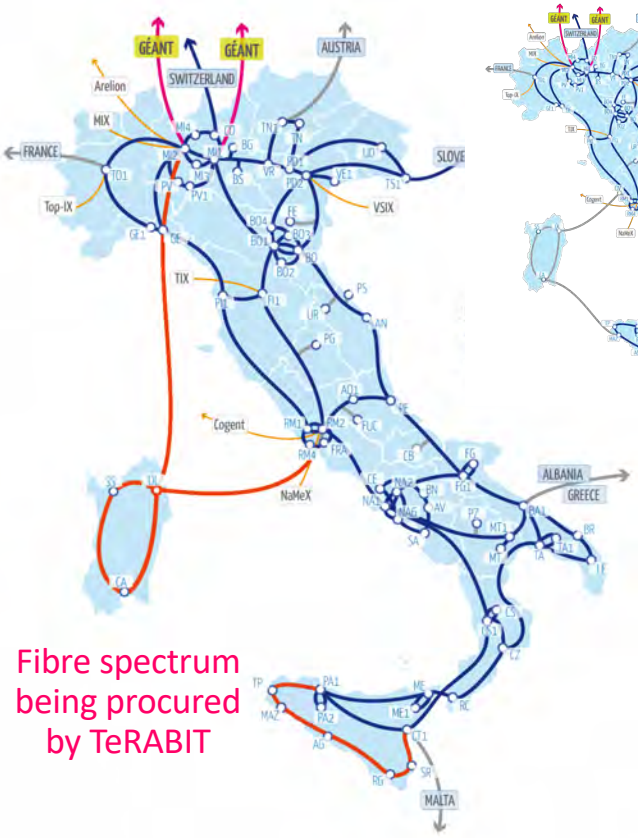
Backbone 30T, 50T+

Access 100G+, 400G+, 1T+

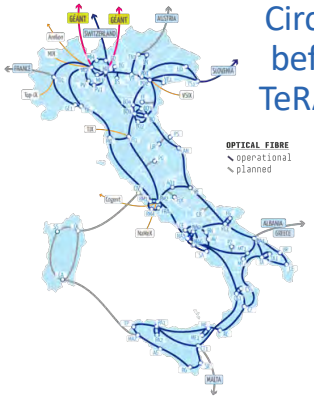
Global Connectivity

Experimental Infrastructure

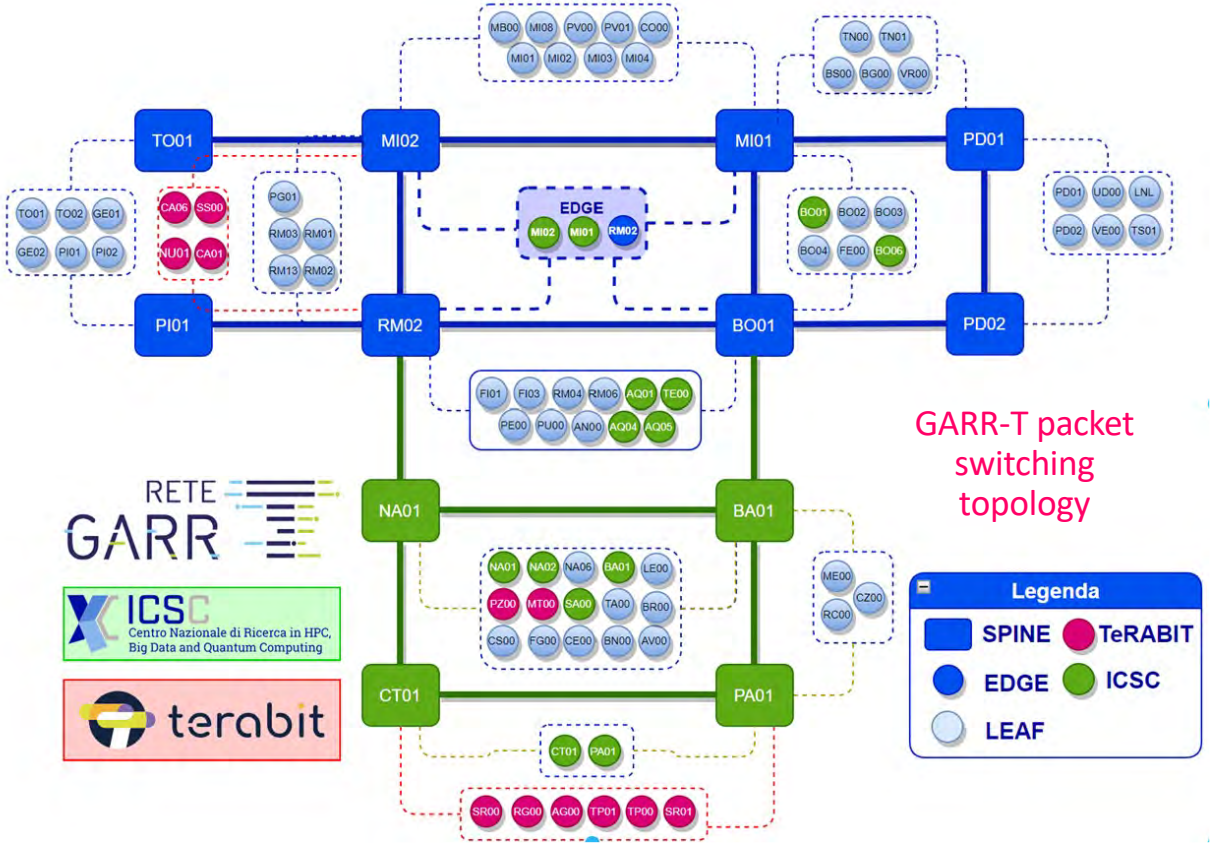
GARR-T Infrastructure evolution



Fibre spectrum being procured by TeRABIT

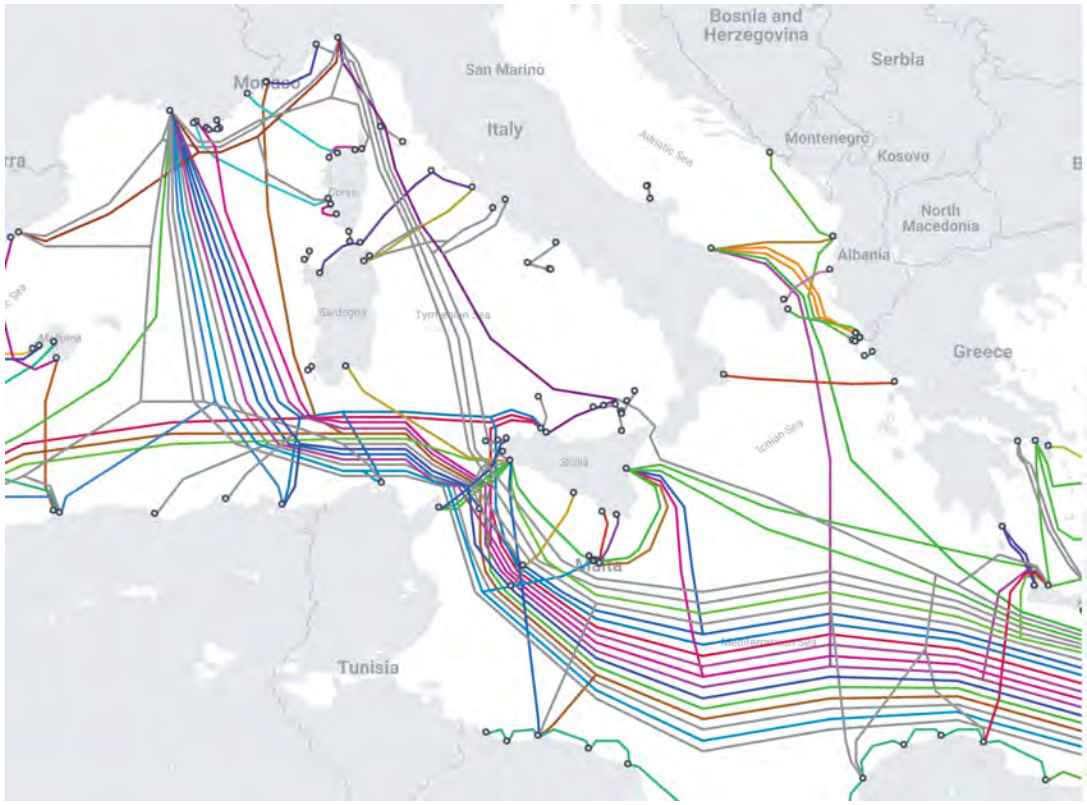


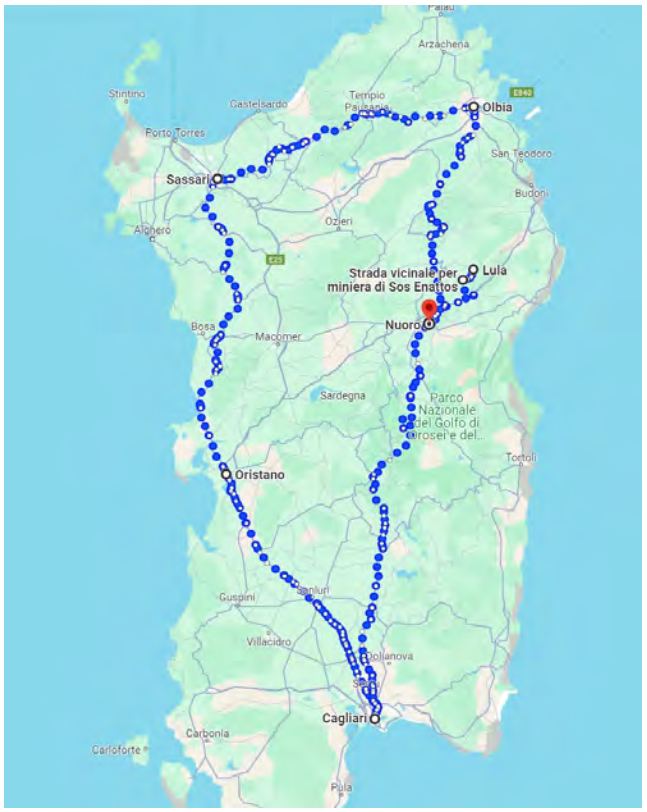
Circuits before TeRABIT



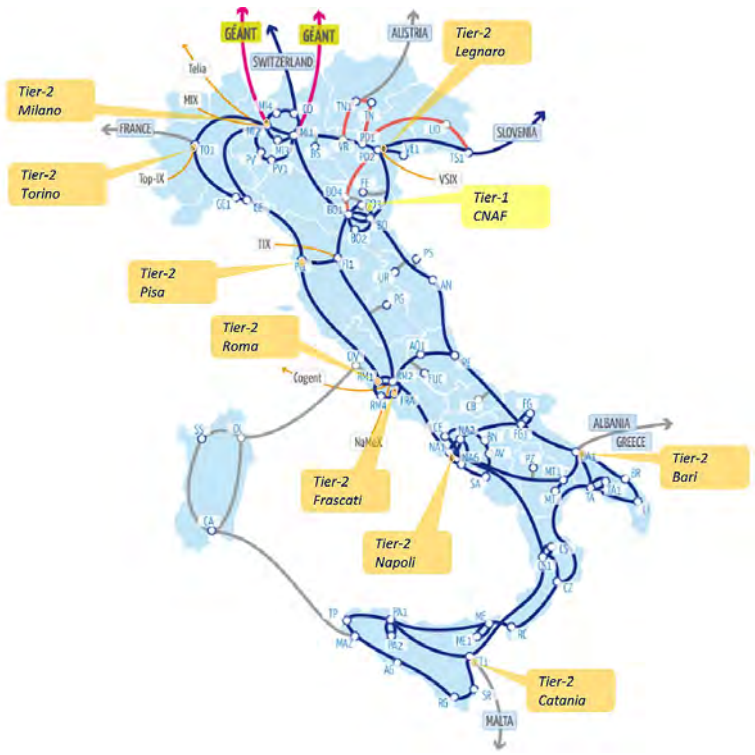
GARR-T packet switching topology

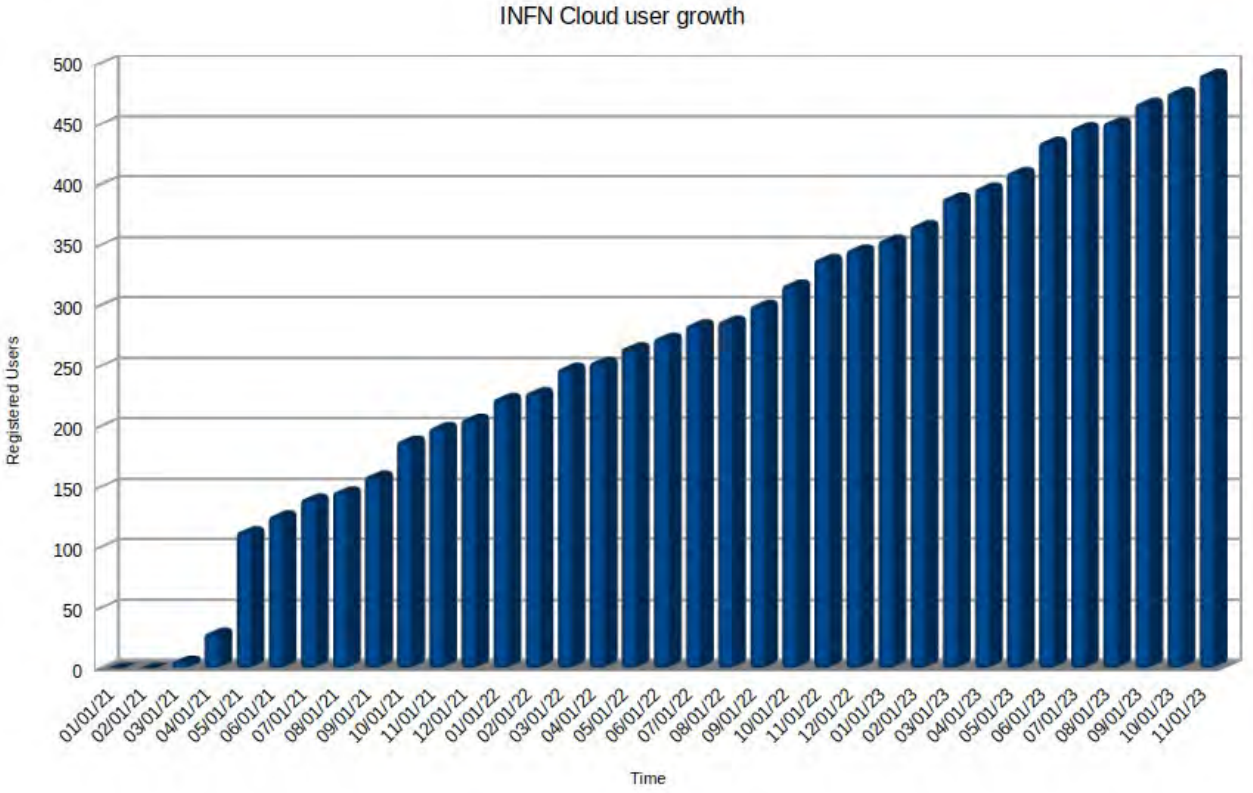
Sardinia submarine cable map and planned new GARR-T Topology





HPC-BD-AI user growth for cloud service from May 2021 to today





HPC-BD-AI evolution

HPC bubbles specification and locations

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

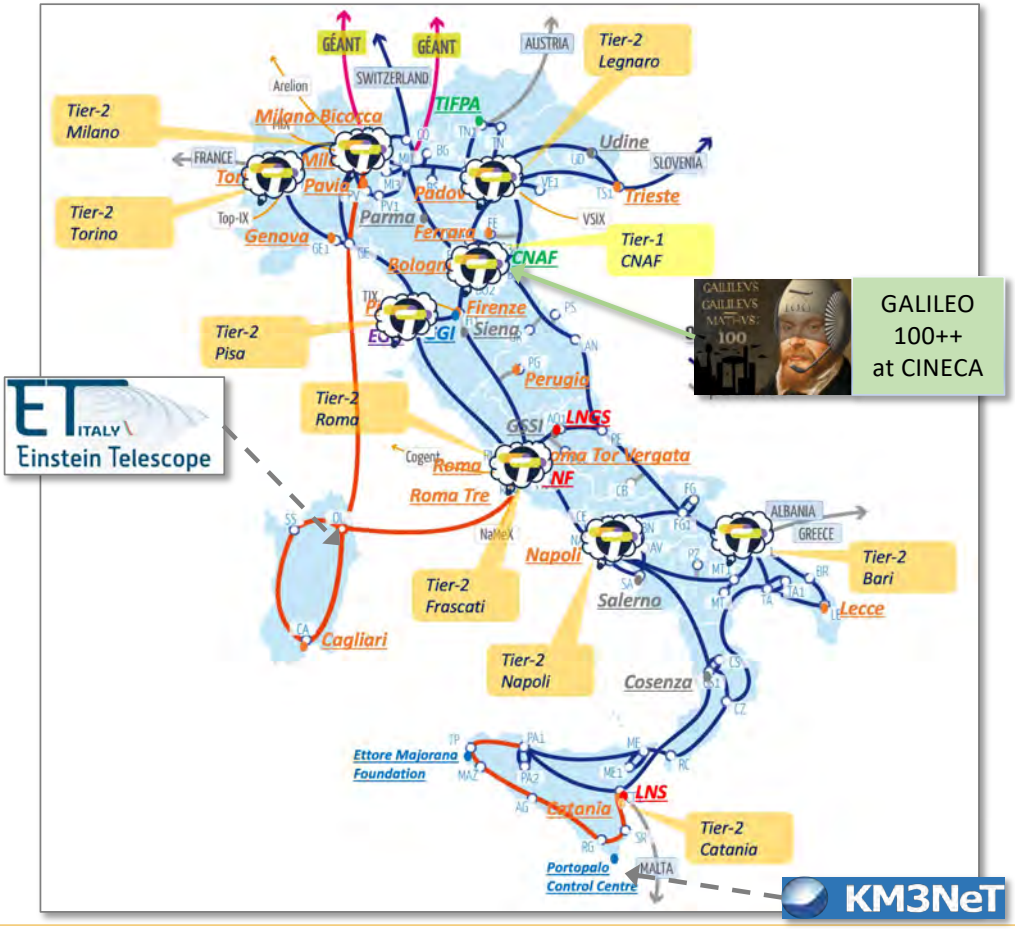
Sites: CNAF, Bari, Napoli, Roma 1, Pisa, Padova, Torino, Milano Bicocca

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

TeRABIT final Infrastructures

The image shows the overlap of the expected final phyisical topologies of all three Reseach Infrastructures:

- GARR-T with (in red) the new fibres
- HPC-BD-AI with the HPC Bubbles locations
- PRACE-ITALY with the ugprated GALILEO 100 hosted at CINECA



Project management

General Assembly / Scientific Council
- Claudio Grandi INFN
- Cosimo Solidoro OGS

Principal Investigators
Infrastructure Manager

Financial Officer
- Martina Allegro INFN
- Paola Del Negro OGS

User Advisory Board
- Ivan Girotto ICTP
- Daniela Theis CRS4
- Sabrina Tomassini GARR
- Carmelo Pellegrino INFN
- Alessandro Lonardo INFN
- Susanna Corti CNR ISAC

EXECUTIVE BOARD

WP Leaders

WP1 - management
- Mauro Campanella INFN-GARR

WP2 –Terabit Network
- Massimo Carboni INFN

WP3 –Tier1 HPC system
- Giorgio Bolzon OGS

WP4 – Dist. HPC Cloud
- Giacinto Donvito INFN

WP5 –Training&dissemin.
- Stefano Salon OGS

Principal Investigators
- Mauro Campanella INFN
- Stefano Salon OGS

Infrastructure Manager
- Silvia Calegari INFN

Work Packages and activities

INFN	INFN	OGS	INFN	OGS
WP 1 Project management	**WP 2 Italian Terabit network**	**WP 3 PRACE Italy**	**WP 4 Distributed federated cloud**	**WP 5 Training and dissemination**
A1.1 Project Management	A2.1 Acquisition of Optical Fibre and Marine spectrum	A3.1 HPC infrastructure requirements and codesign	A4.1 Deployment of HPC bubble (North)	A5.1 Exploitation and training of TeRABIT integrated infrastructure.
A1.2 Scientific Management	A2.2 Transmission layer and Open Line system	A3.2 HPC infrastructure evolution and deployment	A4.2 Deployment of HPC bubble (South)	A5.2 Dissemination of TeRABIT integrated infrastructure
	A2.3 Packet Network and Network control		A4.3 Implementation of the PaaS orchestration layer	
	A2.4 Control and Services tailoring provision		A4.4 Deployment of flexible cache solutions	

Users: higher education and dissemination

Case studies

Enhancement of the HPC-TRES (HPC Training and Research for Earth Sciences) network coordinated by OGS and the participation of research groups (e.g., CNR, INGV, CMCC, Politecnico Torino, ICTP, etc.)

training of young technologists

- organization of **2 workshops** lessons on different computing technologies and hands-on sessions.
- organization of **1 hackathon** => the TeRABIT infrastructure services will be tested and demonstrated by use cases proposed by the participants.

HPC Master and PhDs

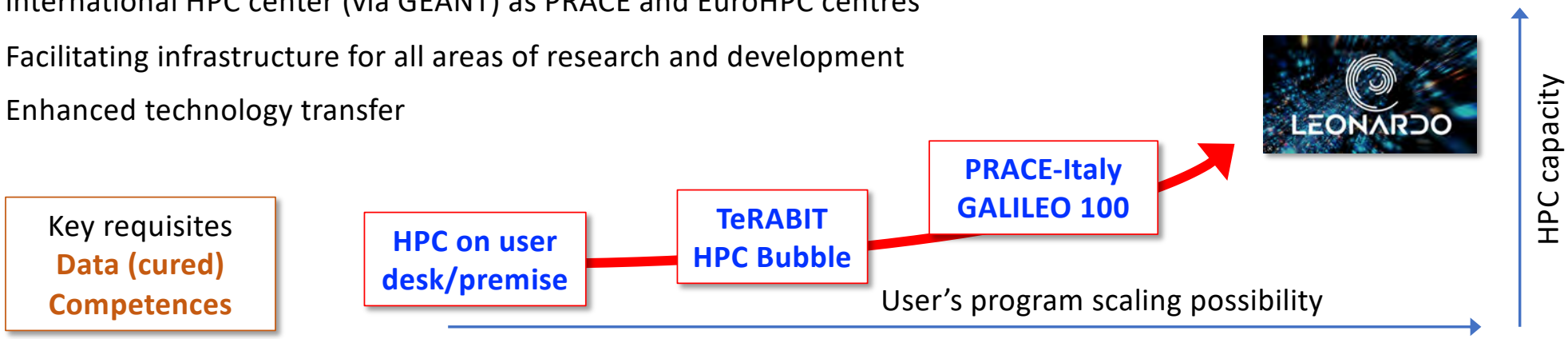
Higher education: doctoral and master HPC students who will use TeRABIT services

Students

- Planning of 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
- Tighter integration between network, data and HPC services with common 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 infrastructure for all areas of research and development
- Enhanced technology transfer



Synergies and impact on ET Research Infrastructure

- Connectivity
    - Dedicated optical fibre from GARR PoP to Sos Enattos
    - High capaciry packet services (Tens of Gbps up to Tbps) connected to Europe/World
    - Avaiability/feasibility of non IP services (spectrum, ultraprecise time distribition e.g.) and advanced expertise in optical transmission
- Unconstrained access to HPC community resources
    - from lab, to PRACE to Leonardo (EuroHPC)
    - testing cloud-HPC interaction
    - testing “mini” HPC centre (Bubble HPC)
- Dissemination

Thank you

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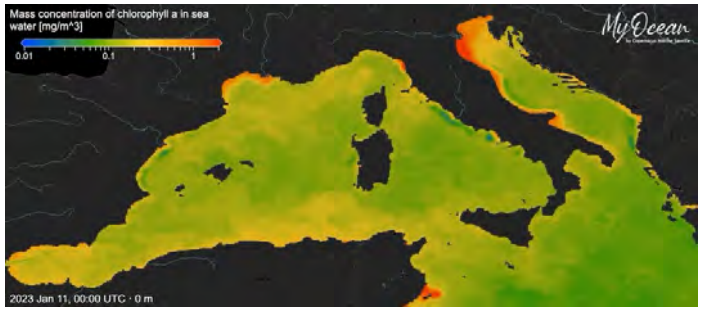
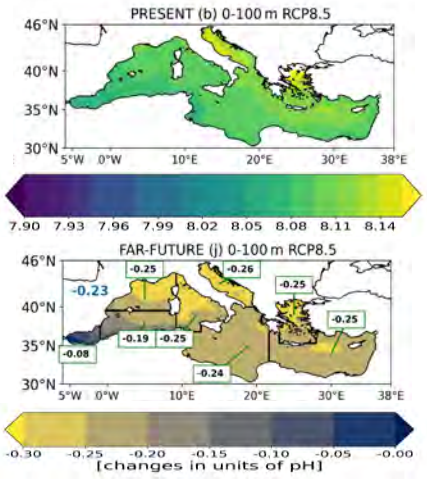
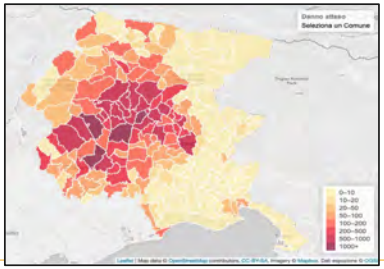
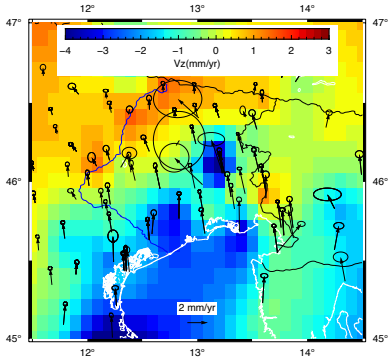
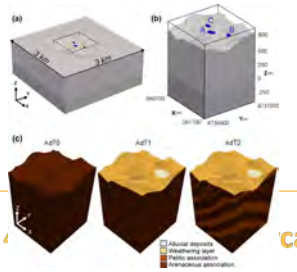
OGS as user of PRACE-Italy

- Operational oceanography and digital twins in the Mediterranean Sea and North Adriatic in the Copernicus context
- Climate change scenarios and multi-scale effects on marine, coastal and lagoon ecosystems
- Regional Earth System modelling for carbon cycle analysis
- Regional seismic monitoring (also through GNSS data processing), probabilistic risk assessment and production of damage scenarios
- 3D simulation of seismic wave propagation in complex geological structures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