

Finanziato dall'Unione europea NextGenerationEU







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

National Research Centre in HPC, Big Data & Quantum Computing Claudio Grandi - INFN



ICSC Italian Research Center on High-Performance Computing, Big Data and Quantum Computing









The Scenario Why a National research Center on HPC, BD & QC?

With the current Data a splosion...

- An unprecedented amount of data is going to be produced
- The real competitiveness challenge is extracting value from data
- Supercomputing, simulation, AI, high-performance data analytics and Big Data are essential for innovation and growth in a datadriven society

... need for an ambitious Italian strategy ...



- Europe has a clear strategy (e.g. EuroHPC, EOSC, EPI, Chip Act, Quantum Flagship) - European Data Strategy
- People, businesses and organisations should be empowered to make better decisions based on insights from data

... to "close the gap" with best in class



- First actions from 2015: Bologna's Technopole, ECMWF Data Centre, Leonardo preexascale supercomputer
- A step forward based on 5 pillars









 Build a world-class supercomputing cloud infrastructure to store, manage and process all the produced data



- Set up centers of excellence with teams of high-level experts to develop domain applications
 - Set up strong links between Academia, Industry and Public Administration

• **Train** the next generation of data scientists and managers to become **experts** in the digital transition

5 pillars of the action plan



 Implement structural measures for innovation and for dissemination









https://www.supercomputing-icsc.it/

Next Generation EU funds

191.5 B€ in Italy

- 30.88 B€ for research and education
 - 11.44 B€ "From research to business"
 - 1.6 B€ for R&D Champions in Key Technologies
 - 320 M€ for ICSC
 - 1.58 B€ for Research Infrastructures
 - 41 M€ for TeRABIT

ICSC Working model



Networks of universities, research institutions, public and private entities aggregated in consortia in «HUB&SPOKE» mode

Started: September 2022

Hub & Spoke model

- Governance structure: Hub and Spokes
- Hub purpose: management and coordination
- Spokes purpose: CN activities execution (research, development, infrastructures and research material hosting, etc.).
- Spoke Leader/Co-Leader: lead the scientific activities coordination. The initial set of Spoke Leader e Coleader will remain in charge for 4 years and each person could be nominated again only once

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SUPERCOMPUTING CLOUD INFRASTRUCTURE **FUNDAMENTAL** RESEARCH **FUTURE HPC & BIG DATA & SPACE ECONOMY** IMPRENDITORIALITÀ, VZE, POLICY, OUTREACH 3 4 **ASTROPHYSICS &** COSMOS EARTH & CLIMATE **OBSERVATIONS** ISTRUZIONE E FORMAZIONE, IMP RASFERIMENTO DI CONOSCENZE, ÖÖ 5 6 **MULTISCALE MODELING ENVIRONMENT & ENGINEERING & NATURAL DISASTERS APPLICATIONS** 8 **Garr Network IN-SILICO** HPC Centre **MATERIALS &** MEDICINE **Future HPC Centre MOLECULAR SCIENCES** & OMICS DATA **Big Data Centre** 10 Future Big Data Centre 9 High-level teams of experts integrating QUANTUM **DIGITAL SOCIETY** the Spokes working groups (mixed cross-sectional teams) COMPUTING **& SMART CITIES**

L'ICSC includes 10 thematic spokes 1 infrastructure spoke









ICSC founders: a public-private partnership



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Public Research Institutions Founding members: **a widespread initiative throughout Italy**

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Annual budget by partners: 6.325 M€











Private companies Founding members: strategic players for digital transformation



fondazione innovazione urbana

Strategic partner to implement and develop the digital twin pilot case of an urban complex system **FAB** INTERNATIONAL FOUNDATION BIG DATA & ARTIFICIAL INTELLIGENCE FOR HUMAN DEVELOPMENTE

Industry-driven not-for-profit international organization aimed at: (1) aggregating companies, including SMEs, to engage with ICSC through a structured partnership, (2) funding research and innovation projects, (3) promoting the Big Data Technopole









ICSC: resources to bring **Research results to Business**



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The Bologna Big Data Technopole



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Role of INFN and HEP

INFN has been chosen by the Italian Ministry for University and Research (MUR) for driving the preparation and execution of the ICSC project

Acknowledgement of the experience in computing technologies and Big Data in particular of **INFN** and **HEP** in general

Strategic partners for the Supercomputing Infrastructure Cloud: CINECA for HPC GARR for networks

INFN leading role also in spoke 2 and 3: Fundamental Research & Space Economy

Astrophysics & Cosmos Observations





Istituto Nazionale di Fisica Nucleare





Finanziato dall'Unione europea NextGenerationEU







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

























Network

GARR-T

Upgrade of the optical network centre-north OLS+DCI (100G+, 400G+)

<u>ICSC</u>

Upgrade of the GARR-X Progress network (OLS) upgrade (100G+, 400G+)

TeRABIT

Acquisition of optical fibre in Sardinia and interventions in souther









Big Data and Federated Cloud

INFN WLCG Tier-1 & Tier-2 infrastructure

Currently about 100,000 CPU cores, 100 PB disk (net), 150 PB tape

About 100,000 more CPU cores, 80 PB disk (net), >30 PB tape + a new library at CNAF

30 M€ investment in ICSC

HPC bubbles: HPC systems in a selected number of sites, equipped with CPUs, GPUs (Nvidia H100), FPGA, fast storage, Infiniband

~10 M€ investment in TeRABIT



New data centres for Disaster Recovery (Gran Sasso) and Space Economy (Frascati) 9 M€ investment in ICSC









A *data lake for research* – High-level view 1 1 400 Data Lake Entry Point A 1988 A 000 A-0-0 The proposed model is based on: ----11 A - 19 A 228 1 .--A 2-2-5 Unified vision 1. Existing infrastructures aggregation, upgraded and made User Community Services available to scientific domains 2. A dynamic model, where infrastructures and domains can Individual communities also be temporary

- 3. A clear separation between the physical and the logical levels
- 4. A high speed network interconnection to hide the actual resource locations
- 5. A unified vision (when needed) of an Italian research data-lake











Physical and logical levels

- The data-lake of a specific scientific domain is connected to a unique entry point (the Italian research data-lake entry point); for example for multi-domain activities or international links
- 2. The data-lake of a specific scientific domain is defined as the sum of the services that provides (portals, SW services, CPU/Disk/Tape resources, ...)
- On the other side of the wall, every physical resource provider may decide to support a specific scientific domain via the publication of «capabilities»
- 4. Each scientific domain service are deployed on suitable resources via a match-making process



Resources view (Physical, as seen by the resource provider) Services view (Logical, as seen by the researcher)









INFN applications (thematic spokes)

Science driven use cases

- from Theoretical, Collider and Astroparticle Physics
- from Medicine

Technology driven use cases

- Single node optimization: GPU, FPGA, alternative architectures
- Machine Learning, Al
- Distributed computing: high rate analyses, data management for smaller experiments, ...
- Cross boundary initiatives, with a strong link to Space Economy satellite data
- Sensitive data management

Technological research

Quantum Computing (systems, algorithms)











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Supercomputing shaping the future

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