

## Starke Partner weltweit

Konnektivität fördern, Zukunft gestalten, Herausforderungen gemeinsam meistern: Nationale Forschungsnetze rund um den Globus betreiben leistungsfähige Infrastrukturen für Wissenschaft, Forschung und Lehre. Ein Blick in die Welt der NREN-Community.

# What IT Takes to be a Community

## A glimpse of GARR, the network powering research and education in Italy

In an era where digital connectivity is fundamental to scientific and cultural progress, national research and education networks (NRENs) are a powerful resource for continuous innovation and, in turn, opportunities for all. Each country organises its own NREN to better respond to the needs of researchers, professors, and students. In Italy, such infrastructure is called GARR, and, as we will see shortly, it is much more than an ultra-broadband infrastructure, but rather a vibrant community shaping the future of digital innovation in the country. Let's take a look.

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### GARR connects a community nationwide and beyond

GARR, which stands for, "Group for the Harmonisation of Research Networks," is firstly an extensive digital infrastructure with about 20,000 km of optical fibre covering the entire national territory. It reaches about 3 million users and connects more than 1,000 sites, mostly public institutions.

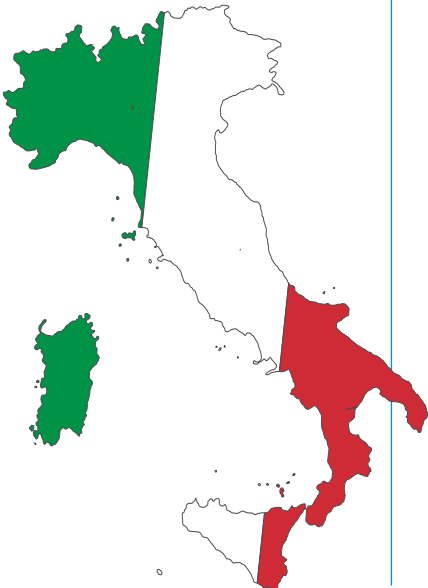
This network has an extremely high transmission capacity (up to 200 Gbps for single access) in both download and upload, with a backbone capacity of 23 terabits per second.

In addition to connectivity and network management, GARR also offers a suite of services ranging from security solutions to mobility and digital identity management, cloud and storage services, and applications for web conferencing and live streaming.

### An infrastructure powered by its community

The GARR user community is diverse, covering different domains from scientific and biomedical research to universities, cultural institutes (like libraries and museums), schools and the performing arts (music conservatories). This vibrant user base has particular requirements, and part of GARR's mission is to design custom network solutions and services. But how can we ensure that GARR hears and understands these different voices? The association's strength relies on its community-driven approach. GARR isn't simply a service provider; it's a network of people collaborating to advance research and innovation in Italy, and this is reflected in its governance model: the network's users are also its main actors. They play a significant role shaping the institution.

This novel approach is reflected in GARR's organisational structure, which promotes inclusiveness and involves users in decision-making regarding the future evolution of the network and digital infrastructures.





Map of the GARR-T network

Indeed, the association was founded in the 1990s by the major Italian research bodies. All state universities and research hospitals later joined as partners with representatives in the assembly. This model ensures that the user community needs directly guide strategic decisions about the network. But there is more: Each connected organisation appoints a local technical manager, a so-called access point manager (APM), who plays a crucial role. The APM ensures the smooth day-to-day operation of the local network and acts as a direct liaison with GARR network experts. Thanks to this constant line of communication, GARR can address specific needs or challenges that may arise, ensuring that each organisation receives tailored solutions in terms of network and services.

### From specific requests to broader solutions

Over the years, the collaboration with users led to the development of solutions that were later extended to the whole community and beyond. One example is LOLA, which is short for LOW Latency audio visual streaming system. This pioneering technology was born from the cooperation between GARR and the Music Conservatory of Trieste. Such a system, now widespread worldwide, has revolutionised long-distance music education by allowing real-time live musical performances with artists located even thousands of kilometres away.

Another example is the IDP in the Cloud service, which GARR initially created to ease access to federated services for the biomedical research community and later employed in similar use cases. The service offers a quick and secure way for organisations without in-house expertise to join the Italy's IDEM federation for identity management and access national and international federated services (through eduGAIN).

Another service that GARR developed for its community is eduid.it, which was set up in collaboration with the Italian Ministry of University and Research and the Italian Erasmus+ agency, INDIRE. An identity provider dedicated to student mobility, eduid.it, enables access to Erasmus+ digital services published in eduGAIN through the MyAcademicID platform, which is managed by GÉANT. It also provides digital credentials to performing arts students, even if their institutions are outside the GARR network.

### GARR-T: going beyond the network

When it comes to innovation, GARR has recently launched GARR-T, the latest evolution of its network backbone. GARR-T has been fully operational since late 2023 and it expanded the backbone capacity from three to over 23 Tbps and increased the minimum capacity for backbone connections at 100 Gbps.

The novelty of GARR-T lies in its architecture, which features a dual-layer design with a packet layer using a data centre model and an optical layer based on a disaggregated structure that separates fibres and equipment. This design ensures flexibility, scalability, and sustainability by avoiding technological lock-ins and optimising resource use. The adoption of an open line system (OLS) allows dynamic optical spectrum management, enabling advanced services like spectrum sharing and distributed computing. Automation further enhances reliability by streamlining network management, enabling real-time fault detection and rapid service reconfiguration.

One example of GARR-T's impact on Italian research is the spectrum-sharing project between Bologna and Geneva. In September 2023, GARR and the European collaboration of NRENs – GÉANT – connected the national computing centre, INFN-CNAF in Bologna, with CERN in Geneva. The two organisations are over 1,000 km apart. This data centre interconnection, using a multi-domain shared spectrum, achieved a capacity of 1.6 Tbps and a latency of 9.5 milliseconds, allowing researchers at the two centres in Italy and Switzerland to collaborate as if they were right next door.

But this is just the first step. The GARR team continues to enhance and expand its network to other areas of the national territory. While this initial phase of GARR-T was built using GARR funds, its expansion relies on EU Next Generation Funds (NRRP) resources with the TerABIT and ICSC projects. After its expected completion



At a glance: The Italian Education & Research Network

in 2025, the GARR-T network will span 25,000 km and reach a total capacity of about 40 Tbps throughout Italy.

### Beyond terrestrial boundaries: subsea connections and sensing

GARR innovation efforts continue beyond the shoreline. A recent development in this area is the acquisition of optical spectrum in a underwater cable to Sardinia, funded by the EU project TeRABIT. This expansion will exploit the Sparkle BlueMed submarine cable system's spectrum to create a virtual fibre optic bridge between GARR-T optical infrastructure in the Italian mainland and the one on Sardinia, integrating Sardinia's university and research network into the larger GARR national backbone.

Besides an improved connectivity that will benefit the entire island's scientific community, this link will also support the candidature of the Sardinian Sos Enattos area to host the Einstein Telescope project, the European third-generation gravitational-wave detector. But there is more. This subsea cable opens new possibilities in terms of environmental sensing, giving the possibility for researchers to use the optical fibre as a sensor of under-

sea seismic and volcanic activities, as well as for detecting and studying marine life.

### Who will build the network of the future?

A network is not only composed of cables and technology; the human factor is also essential. Like many other NRENs, GARR also faces significant challenges in attracting and retaining young talent, which is mainly due to competition with large corporations and the dynamic nature of careers in information and communication technology. To address this difficulty and to maintain GARR infrastructure at the top of innovative technology, GARR has introduced the GARR Academy, an initiative offering intensive training courses for young students in relevant technical fields, with the possibility of employment at the end of the programme. The idea is not only to provide participants with practical skills and industry insights, but also to allow them to continue their education while gaining valuable experience, ultimately bolstering the ranks of the next generation of network professionals. In its first edition, the campaign attracted 50 applicants, from which 10 participants were selected and trained, leading to five of them being hired on fixed-term contracts, with four later transitioning to permanent positions.

This initiative goes hand-in-hand with GARR's decade-long effort to fund young students' innovative projects, which has led GARR to award 10 scholarships every year.

### In Italy and Europe: an international community

GARR has been instrumental in founding and continually supporting GÉANT, the network of European NRENs. GARR collaborates with GÉANT to provide high-capacity connectivity across Europe and beyond, supporting cutting-edge research projects, including the Large Hadron Collider (LHC) and high-performance computing centres. Within GÉANT, GARR actively participates in EU-funded network projects that underpin its infrastructure development and in the steering committee and user groups, where different European networks bring their expertise and perspectives across various areas.

Recently, GARR upgraded its link to GÉANT to a total international capacity of 600 Gbps, supporting the high data exchange needs of international collaborations. Following the new connection, peaks of over 200 Gbps were recorded during the LHC Data Challenge, highlighting the increased capability to support major scientific experiments.

Thanks to such collaborations, GÉANT and all European NRENs can support the progress of the most advanced user communities, such as those in high-energy physics, radio astronomy, and supercomputing, in Europe and worldwide. ♦