GARR

The Italian Academic & Research Network
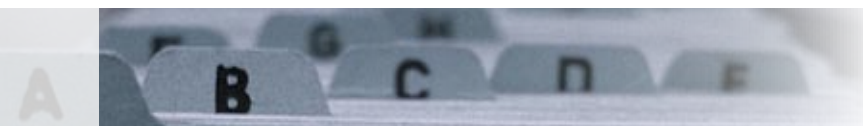
GARR and the NRENs
Q&A about Research
and Education Networks

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1. What is GARR?

GARR is the Italian Academic and Research telecommunication network. Its main goal is to provide high-bandwidth connectivity and advanced services to the national scientific and academic community. The GARR network is fully integrated into the worldwide Internet.

2. Who manages the GARR network?

The GARR network is planned and operated by Consortium GARR, a non-profit organization created under the patronage of the Italian Ministry of Education, University and Research. GARR promoting partners are the major Italian Scientific and Academic organizations: CNR, ENEA, INFN and Fondazione CRUI, the latter on behalf of all Italian Universities.

3. Do National Research and Education Network exist in other countries?

Yes. National Research and Education Networks exist in all European Countries, as well as in most advanced countries worldwide. GARR is the Italian NREN.

4. Why do we need National R&E Networks?

The scientific community often uses leading-edge applications, requiring specific technological solutions and have demanding network requirements compared to both consumer and business average users. NRENs were born to fulfill these needs, by developing innovative technologies, often forerunning their commercial uptake of several years.

As it happened with the creation of the Internet, NRENs are constantly developing new services and applications, afterwards adopted in other domains.

The most evident case to state the need for NRENs is brought up by applications and user communities with very demanding network requirements in terms of dedicated services, that cannot be easily implemented by ISPs: a few examples include experiments in domains such as Radioastronomy (e-VLBI), High Energy Physics (LHC), Oceanography and Seismology.

5. Why GARR and the NRENs are different from traditional commercial networks?

Many aspects make GARR and the NRENs different from commercial networks, the most prominent being the technical profile, both for infrastructure and services.

e-VLBI
Electronic Very Long Baseline Interferometry is a radio-astronomy project that involves the high-speed interconnection of telescopes to gather, synchronize and analyze large amounts of experimental data in real-time.

http://www.evlbi.org

LHC
Large Hadron Collider is the new particle accelerator to study collisions between protons and heavy ions, whose purpose is to investigate fundamental questions of the nowadays Physics.

http://www.cern.ch/lhc

NRENs are highly specialized in meeting the researchers' needs, including cases where there is a need for tailor-made solutions and for the adoption of still under development technologies. Aggregating these special user needs is the only way to permit exploiting such advanced solutions and technical excellence. Moreover, it also allows a better cost-sharing and access to service for these communities.

Another distinctive feature of NRENs is a special attention to the international scenario, in order to facilitate the adoption of interoperating solutions and hence promoting international cooperation.

Besides being physically interconnected worldwide, NRENs also closely collaborate with each other and when developing new technologies and services, NRENs define common specifications for them. This means that the new services can be deployed in a true end-to-end environment whenever they are eventually offered to users, (i.e. from the computer of a user up to the one of his/her correspondent, even if they are connected on different networks and they are geographically located far away from each other).

6. Why GARR and the NRENs meet the R&E user requirements better than ISPs?

The GARR network has always been built upon user needs. Technologies and solutions are adopted on the basis of how well they can satisfy the requirements of the Research and Education community, both in terms of network connectivity and services.

NRENs are generally non-profit organizations, and they are not market-driven as ISP are. This is a fundamental aspect when there is the need to support the requirements of small but scientifically relevant user communities.

A second key feature is the availability and capacity to closely collaborate with users: thanks to this attitude, users can actively contribute to define

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and test new services, thus helping network engineers to find the best solution to meet their needs.

7. Which Organizations connect to GARR network?

The GARR network and its services are dedicated to the Italian Academic and Research community. Currently, about 500 user sites, including Research Organizations, Universities, Observatories, Laboratories, Scientific Research and Health Care Institutes, (IRCCS), Music Conservatories and Academies of Performing Arts, Libraries, Schools, Museums and other Scientific and Educational Facilities of national and international relevance, for overall more than 2 Millions end users.

8. Is GARR network intended for advanced used only?

No. The GARR network is a valuable tool for the whole research and education community. It facilitates all users' daily activities and it is essential for specific research activities in a number of scientific domains.

Its advanced services are conceived to reach each final user up to his/her computer, connected to their home organization's LAN. With an eye on new services and ways of exploiting it, the network infrastructure provides all users with further opportunities in the short and medium term. The GARR network is ready to fulfill the requests of late adopters, i.e. users that, as of today, make a limited use of network applications and services but are bound to adopt them in a short time frame.

A recent survey[1], that involved more than 4.000 European university teachers, lecturer and researchers, shows that more than 1/3 of those not currently using digital libraries in their work, plan to do so in 2 or 3 years. A significant increase is envisaged also in the adoption of online computational services (i.e. for instance of Grid computing) and storage (with a foreseen growth of 43% in comparison to current levels of usage), e-learning platforms (+26%), video-conferencing services and hardware/software equipments (+52%), services of bandwidth reservation (+45%) and, last but not least, the new version of the IP protocol, IPv6 that is going to represent the major network innovation of the next few years with a foreseen growth of 92%.

The Research and Education Networks are already providing these services and promoting their adoption to the whole user community.

9. What is the GARR added value for the user community?

Being part of the GARR community enables users to play an active role in the network development and to test and adopt innovative

[1] T. Lery, P. Bressler
Report on Researchers' Requirements, December 2007.
This survey was carried out in the framework of the EARNEST (Foresight Study into Research and Education Networking) European project.
It is downloadable at:
http://www.terena.org/activities/earnest/docs/20080204-researchers-requirements.pdf

technologies, even when the market is not mature for them.

GARR users can thus rely on a leading-edge tool, enabling them to easily join and convene international collaboration activities, thanks to the wide-spread adoption of the NREN model in Europe and worldwide.

The GARR network provides:

- an effective support to international cooperation activities;
- advanced and customized data transmission solutions, with maximum value for money;
- a Europe-wide network of trust, capable of simplifying digital authentication and authorization procedures and minimizing duplications of credentials, thus facilitating researchers' and students' mobility and resource sharing;
- quick and transparent provision of links, especially when dealing with tailor-made solutions in interdomain environments;
- re-configurability and scalability of solutions, that allows to re-configure a link when there is a change in requirements;
- a wide availability of public IP addresses, indispensable for some applications and services.

10. What services are offered on the GARR network?

GARR provides to its user community both operational and application services; the former ones are closely connected to the management and evolution of the network, while the latter are oriented to end users.

Operational services include configuration and management of network equipments, management of network failures, prevention and response to security incidents, domain names registration, allocation of IP (v4 and 6) addresses, etc.

Further service are: Certification Authority, support to user mobility (Eduroam), and Authentication and Authorization Infrastructure (AAI).

The following application services are available: multi-videoconferencing service (Vconf), News distribution and Mirror service. A special attention is dedicated to multimedia activities support, e-Learning, and VoIP, as well as distributed computing activities, such as those based on the Grid paradigm.

GARR implements end-to-end dedicated connections to support specific project, both on its network only and in an international environment, and participates to European R&D project, such as GÉANT and FEDERICA.

Interdomain
A domain is the set of resources (i.e. in particular procedures, data and services) and policies of a given organization, and therefore represents the border of the organization's liability. Inter-domain is a term used to define interaction between different domains.

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GÉANT
Gigabit European Academic Network Technology, is the pan-European R&E networks, interconnecting 30 Millions users in 34 European Countries. It is funded by the European Commission and the National Research and Education Networks in Europe.

http://www.geant2.net

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FEDERICA
(*Federated E-Infrastructure Dedicated to European Researchers Innovating in Computing network Architectures*) is an EC-funded project to implement a virtual testbed infrastructure for conducting disruptive network experiments on future internet and virtual distributed systems.

http://www.fp7-federica.eu

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11. Why is the European Union investing on R&E networks?

The European Union has long ago recognized the NRENs' technological excellence as a key enabler for building the so-called European Research Area: a frontierless area of shared resources and knowledge, meant to improve the level of competitiveness and qualified employment in Europe.

NRENs and their user communities are a major innovation force for their countries, capable of actively contributing to the creation and transfer of advanced know-how, and ultimately to the industrial and social development.

Thanks to the innovative technologies they develop and use, and to the advanced know-how of their technical staff, NRENs do not only contribute to support the scientific and academic community but, since their origins, they have been acting as a driving force for industry and the society at large, pushing towards new network models and the definition of the future Internet.

12. Who is funding the NRENs?

European and worldwide NRENs may take different legal forms.
Typically, the most popular model in advanced countries is the non profit, independent legal entity (company, consortium, association) indirectly controlled by the research and education community. This form ensure to NRENs a certain independence from national governments, thus making the management and decision making processes quicker and less bureaucratic; meanwhile, this option helps reducing the NREN staff, thus contributing to contain the costs.

The funding model significantly varies from country to country, being strictly dependent on the national context, but it always involves public money in a direct or indirect way. There is not a unique "receipt for success", however it can be noticed that the direct intervention of Governments may be beneficial in some cases. Direct public funding is useful when the NREN is testing and implementing new technologies and services, as they may require an important initial investment in infrastructures/equipments: such an investment may indeed be beyond the financial capacities of the user communities, even when the new technology is cost-effective in the medium-long term. The same funding scheme is envisaged whenever a NREN in a start-up phase, or it operates in a developing country, with limited dedicated funding for R&D.

European Research Area
The European Commission set up the i2010 action plan, that defines the general European strategy oriented to Information Society and Media, in order to create the so-called European Research Area, i.e. a frontierless region of collaboration, shared infrastructures and opportunities for researchers, regardless their geographical provenance.
This new integrated policy aims at fostering the knowledge society as a means of sustaining innovation and economic growth, as well as the creation of new job opportunities. This policy is a part of so-called Lisbon Strategy.
http://ec.europa.eu/research/era

VPN
Virtual Private Network indicates the usage of a network shared with other users in a "private" mode: a VPN physically insisting on a network infrastructure behaves as it was separate and accessible only to entitled users.

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Best effort
Best effort delivery describes a network service in which the network does not provide any guarantees that data is delivered, or that a user is given a guaranteed quality of service level or a certain priority.
In a best effort network all users obtain best effort service, meaning that they obtain unspecified variable bit rate and delivery time, depending on the current traffic load.
Packet loss when the network is congested, and a delivery time variable depending on the network status are typical cosequences of this approach. In case of packet loss, the transport protocol (TCP) ensures information completeness, by transmitting again all those packets that did not reach the destination.

13. How are the European NRENs evolving?

The need for higher bandwidth and new technologies and applications are bringing NRENs towards a model based on the ownership of optical fibers and the direct control of lower network layers, with major implications both in terms of management and technology.

Till a few years ago, the prevailing model was based on leased circuits owned by operators, to whom the management of lower network layers was delegated. This model poses however severe technical limitations, as well as financial ones, to the scalability of the infrastructure and to certain services provision, such as for example Optical Private Networks (a particular form of virtual private networks, VPN).

On the other hand, a few advanced experiences in Europe (Germany, Poland) and worldwide (Canada, Australia, Japan), demonstrate that owning (or however acquiring their right of use in the longer-term) caters for more flexible and scalable solutions, as well as more cost-effective ones already in the short-medium term.

The ownership and direct control of the fiber infrastructure can hence be regarded as a true paradigm shift: until now, NRENs, (acting) on behalf of their community, implemented the users' requests by buying services from a telecom operator, while with the new paradigm they directly own and control the infrastructure, thus assuming on themselves features and duties that were once typical of Operators only.

In a technical perspective, this implies more flexibility and allows implementing, on the same physical infrastructure, diverse networks for different user groups: a feature not available on traditional IP-only networks whose architecture is typically passive and cannot be easily modeled on the users' requirements.

14. Investing on fiber-optics: why?

The widespread adoption of fiber-optics, not only on the backbone but also to deploy last-mile access links, campus networks and Metropolitan Area Networks is a true quality lap.

The first and most important improvement related to this innovation is a larger bandwidth availability that optimizes the usage of a data transmission network, in particular by those applications with demanding performance requirements. Existing solutions, such as prioritizing selected classes of data or guaranteeing their quality when available bandwidth is limited on best-effort traditional IP networks are just palliatives, as they cannot offer the same performances than an adequate network capacity.

Fiber-optics allows providing new services or makes the provision of the existing ones simpler. On next generation networks, for instance, dedicated and end-to-end optical paths can be implemented through a semi-automated procedure between two users needing to exchange data with special bandwidth requirements, speed and security. This allows the implementation of scalable Optical Private Networks, that can be quickly (re)configured. Different OPNs can communicate between them according to the user requirements.

15. Is it enough to implement an optical fiber backbone?

No. A high-bandwidth backbone is fundamental; however, it is not enough if users' access links, or connected Campus Networks and LANs are not correctly dimensioned, or do not allow to deliver advanced services up to end users.

To implement access links between user sites and the nearest network Point of Presence is therefore of the utmost importance, as it allows bringing the benefits of a fiber infrastructure up to end user's computer, while dramatically enhancing global network performances and removing bottlenecks.

Because of their expensiveness, access link costs are a critical aspect for connected organizations. The National Research Network aggregates and rationalize the users' access links: the widespread diffusion of network Points of Presence all over the country is hence fundamental in order to implement cost-effective access links; to further improve such distributed access to the network and its services, agreements with other organizations and public entities, such as universities, town and city councils,

regional or provincial administrations, etc, allow the GARR user community to access the Research and Academic network trough regional and metropolitan area networks.

16. How is the GARR network evolving?

As other NRENs all over the world, GARR is now migrating to a new generation of the Italian network for Research and Education, based on fiber-optics and the direct control of the infrastructure.

Starting from the 3rd quarter of 2009, the current GARR network infra-structure will be gradually replaced by the next-generation, multi-service network GARR-X.

GARR-X will provide new features and a higher level of global performance, thanks to the ownership (or exclusive right of use) of fiber, not only on the backbone, but also in user sites access links. Once the whole network will be deployed, it is foreseen to cater for about 40 times the existing network capacity.

First improvements will be however visible already during the first implementation stage, when about 1/3 of the overall backbone infrastructure will be rolled out, as well as a first group of the fiber access links to user sites. Such actions will allow doubling in a few months the overall backbone capacity, which is foreseen to grow an 8 times factor in the next three years. The same will happen to access bandwidth, that will increase 1,5 times during the first year and continue to steadily grow during the following years.

The backbone is conceived and shaped in order to prevent bottlenecks, and will be more reliable thanks to the adoption of new and more advanced network monitoring tools.

GARR-X will contribute to overcome differences in the availability and accessibility of network services in different Italian regions, thus bridging the digital divide and providing an effective support to research and education activities all around the country.

The existing portfolio of services and advanced network functionalities will be enriched, while the widespread diffusion of services will be facilitated, also thanks to simpler and quicker activation procedures.
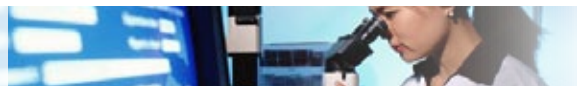
17. How can I get further information on GARR and the GARR network?

To learn more about GARR and the evolution of the GARR network, please visit http://www.garr.it or send a message to: info@garr.it.

GARR

The Italian Academic & Research Network

About us

Consortium GARR is a non-profit organization constituted under the aegis of the **MIUR** (Ministry of Education and Scientific Research).

The founding Members are:
CNR (National Research Council), **ENEA** (Organization for the New Technologies, the Energy and the Environment), **Fondazione CRUI** (Conference of Italian University Chancellors), **INFN** (National Institute of Nuclear Physics).

GARR mission is to implement, operate and extend the national high-speed telecommunication network for University and Scientific Research.

The **GARR network** infrastructure covers the whole national territory in a wide spreading way and its backbone is based on leading-edge optical circuits and technologies. The broadband access fully supports innovative applications such as Grids, Telemedicine, e-Learning, Multimedia, High-energies Physics, Radioastronomy.

It is interconnected with all European and worldwide Research networks and supports collaboration among national and international research activities.

Founding Members

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