



GÉANT Strategy 2020

Implementing the Strategy



Executive Summary

Throughout the period leading to 2020, GÉANT will maintain 'Over the Horizon' as its constant and guiding principle. This strategy was outlined in a companion document 'GÉANT Strategy 2020: Over the Horizon'.

This document: 'GÉANT Strategy 2020: Implementing the Strategy' briefly outlines how 'Over the Horizon' principles will be implemented and is organised under the following headings:

- Positioning.
- Innovation.
- Collaboration.
- Users.
- Services.
- People.

Both documents are the result of the work in the Strategy and Innovation Committee (SIC). This GN3plus working group was set up to provide a long-term vision, strategy and innovation agenda for GÉANT. All the work is strictly related to the Framework Planning Agreement (FPA) working areas and guidelines.

The work in the SIC has been governed by the Terms of Reference set by the GN3plus Assembly.

Note that terms defined in the 'GÉANT Strategy 2020: Over the Horizon' document have also been used here.

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Positioning

A Communication Commons of European NRENs

The European NRENs and the European Commission share the goal of maintaining and developing the GÉANT Community as a 'Communication Commons' for the European Research Area (ERA). The NRENs combine their efforts into the GÉANT partnership to share knowledge and to serve European and Global knowledge communities, from flagship 'big science' projects, to the single talent of the citizen researcher.

Although NRENs differ in their specifics (for example in their legal form, user communities, services, funding, goals, as can be seen from the annual GÉANT Association Compendium), the long term working business model based on exchange of services, innovation, the sharing of knowledge, the aggregation of requirements and demand for purchasing, and so forth, has been remarkably successful within the GÉANT environment. But, while NRENs vary, they also share much in common, and this common ground brings and keeps the GÉANT Community and partnership together.

The NRENs' networks and services are fundamental to almost every activity in the European Research Area, meeting the widely shared needs of the GÉANT Community. In this environment, the NRENs are and will remain positioned closer than other

e-infrastructures to their constituencies, focusing easily on the community needs. GÉANT is therefore a critical enabler for all other e-infrastructures, making them easily available and accessible to their users. This overall collaboration model, together with the existing exceptional human expertise, are two of the GÉANT Community's most important assets. The evolution of this Commons will continue to be the focus of the community partners for the next years.

NRENs and GÉANT as a global communications fabric

The GÉANT infrastructure and services provide and enable their users to access all other e-infrastructures easily: from generic services, such as storage and compute, to specific or special purpose facilities and instruments. Thus GÉANT has the challenging role to serve as the communication fabric for the knowledge community, facilitating this access and, as necessary, adapting promptly in response to their varied and changing needs.

The GÉANT Community must therefore use the close relationships that it enjoys with its users (from organisations to individual researchers) to ensure that their access to these e-infrastructures, facilitated through GÉANT's infrastructure and services, is fit for purpose. To achieve this, the GÉANT community will engage as early as possible

with these other stakeholders in discussions and shared planning activities to optimise the use of resources and avoid duplication of activities.

A global hub for research and innovation networking

GÉANT's proposition already extends far beyond the geographical boundaries of its European community, creating a 'GÉANT at large' environment which shares common and similar provisions. This positions GÉANT, the European Communications Commons, as a global hub for research and innovation networking which will continue to collaborate with other global regional networks through common or similar interworking provisions.

The GÉANT network's global connectivity will continue to develop to enable easy and efficient connections and so attract more regional communities to connect. The GÉANT network and its services will be constantly refined to obtain the best possible and most appropriate service, increasing its connectivity and capacity while reducing costs and the digital divide.

Similarly the use of GÉANT's other services will be promoted and proposed to other regions, facilitating a consistent and coherent user experience for the GÉANT community globally.

Peering with the rest of the world

Recognising the importance of significant commercial and other services that are often connected to other providers outside the GÉANT and other NRENs community, the GÉANT network will expand and diversify the present peering arrangements with key content and ISP providers, building on existing NREN expertise in this area.

A one-stop shop for global communities

GÉANT, as the principal European consultancy and service provider for their knowledge communities, will be the 'one-stop shop' for experts, products, and services. From the user's perspective, the experience must allow the perception of a single 'provider' even if the delivery entails the collaboration of multiple GÉANT partners. GÉANT must provide a comprehensive 'one-stop shop' experience, supported by a federated organisation capable of implementing and delivering federated services and initiatives in Europe and beyond. This function will build on established internal procedures developed and operated by the entire GÉANT partnership. These will be transparent to the user, allowing for NRENs to act locally on behalf of the central or federated function.

GÉANT will position itself as the provider of choice and will demonstrate its value by serving its users with cost effective and efficient services ranging from commonly available commodity services for general user requirements to bespoke service solutions addressing the needs of high-end users.

An Open GÉANT Infrastructure

The GÉANT mission states: "To provide an open, innovative, trusted, secure and reliable information infrastructure for the European knowledge ecosystem". Open and transparent will need to be defined. Of course the GÉANT infrastructure is limited to the GÉANT users Community (see section on users), therefore OPEN is not meant to mean open to anyone. Also GÉANT will work on secure access (see next paragraph) and thus is not open in that sense. What is meant by open is that:

- The infrastructure is open to all users in the GÉANT users Community, as they are allowed in by their openly published Acceptable Use Policy
- The infrastructure will peer with similar R&E networks in the world and allow unrestricted traffic exchange that conforms to the AUPs
- GÉANT will be transparent about the architecture and operations of the infrastructure.
- GÉANT will make results from innovation projects openly available

GÉANT security, trust and identity

A key objective of the GÉANT partnership is to provide, together with the NRENs, a secure and trusted end-to-end environment to its users. Further enhancement of GÉANT's Authentication and Authorisation Infrastructure (AAI) and security services will be provided, responding to the challenges of users' requirements. The security services will be proactively applied at an operational level, in view of the number of multiple entities involved in any connection. A forward-looking approach to security development will be necessary to preserve where appropriate the openness inherent in many of the research and education activities, continuing

to provide optimal and top-end services and working conditions

On an operational level, GÉANT will:

- Manage and constantly review the information security risk landscape and perform regular and rigorous security audits.
- Enhance monitoring to mitigate attacks and emerging threats and provide fast and effective responses to computer security incidents.
- Maintain state-of-the-art security through cooperation with the worldwide community of Computer Emergency and Incident Response Teams.
- Operate pan-European Trust and Identity services to support secure, cross border federated access to services including network access (eduroam) and web single sign-on (eduGAIN).

In the longer term, GÉANT will undertake developments to retain the trust of the community through the design of required security features into each new generation of network elements and services at the conception stage. This way, the key security features are embedded from the outset.

Authentication and Authorisation Infrastructure (AAI) services will be deployed to cope with the challenges of access to networks and their connected services. These developments include:

- Global and cross-sector, interfederated AAI service provision for the whole of the European R&E community and potentially, the rest of the world.
- Collaboration with research and learning institutions in Europe and worldwide, for access authorisation.

- The addition of role-based facilities to satisfy the requirements of large international research collaborations.

In taking this forward, GÉANT will collaborate with the European data, computing e-Infrastructure and Research facilities services.

GÉANT collaboration with Industry and Enterprise

The GÉANT Community is striving to expand its current collaboration and liaisons with Industry and SMEs. To achieve this we will:

- Investigate and enhance our understanding of the links between NRENs, universities and research institutions with Industry and SMEs.
- Develop partnerships with Industry and SMEs with the aim of transferring knowledge, developing human capital and identifying opportunities for collaborations, with a particular emphasis on developments that could improve GÉANT's own services. Open Call projects, joint research or testing projects and privileged vendor relations (e.g. pre-release testing and pre-commercial procurement) are all examples of partnership instruments that can be used to ensure that innovative solutions are brought forward.
- Identify opportunities and initiate outreach and support activity to Industry and SMEs and encourage their membership of the GÉANT Association in a competitive and open dialogue

In addition to creating value for GÉANT, Industry and SMEs, our collaborations will also help to create new high-value jobs in Europe.

A sustainable GÉANT infrastructure

The key GÉANT stakeholders want confidence in its long-term sustainability. This confidence must be nurtured and sustained in the context of economic crises and the fast moving environments of R&E and the ICT industry in general, where disruptive challenges can arise with little warning.

The GÉANT Community must therefore continuously monitor the challenges and opportunities present within the demanding and rapidly evolving environment in which it offers its services. This in turn requires that GÉANT's governance is able to recognise where change is needed, and to commit to and effect that change efficiently.

- The GÉANT community must cohere as an effective European and Global provider, partner, and collaborator.
- GÉANT projects and environment must provide a compelling value proposition to its partners – and thence to their customers and constituencies – as a means of cost effectively addressing aggregated national communities' European and Global requirements, in terms of connectivity, services, innovation, and collaboration more generally.
- GÉANT will focus its efforts on offering propositions where there are no appropriate alternatives available from other market providers. The GÉANT offer shall position itself in a way that it is attractive for members of the GÉANT Community to use the services provided and funded in the GÉANT environment rather than look for alternative solutions.
- GÉANT will, in developing these propositions, foster and exploit the market to the fullest extent possible by using procurements intelligently to encourage providers to offer appropriate products and services.
- The GÉANT Community will leverage its strong purchasing power to create a number of framework contracts in full compliance with Public Procurement Directives and international auditing standards that its partners can make use of to reduce their procurement effort and costs.
- GÉANT will collaborate with industry and SMEs on service offerings as well as relevant hardware and software products.
- GÉANT's cost efficiency will be continuously monitored and improved, consistent with architectural, technological and requirement changes ensuring we will free up available funds for innovation and serving the needs of the NRENs and their users. This will be realised in a number of ways, including:
 - Regular reviews of the network topology and available regional and national resources to maximize their use and avoid any duplication of infrastructure.
 - Continued capacity planning and the sharing of relevant resources from the NRENs and between the partners.
 - Capitalise on technology insight gained through international and supplier contacts.
 - On-going monitoring with the aim of continuous improvement and making sure that GÉANT's offerings are affordable and fit for purpose.
- GÉANT must maintain and enhance its credibility with the European Commission as an asset that contributes to the bridging of the Digital Divide while supporting a range of research, education, innovation and regional development agenda.
- GÉANT will price its offerings fairly, mindful of its mission to serve knowledge communities and the market circumstances in the various parts of Europe. This entails finding a balance between the full economic costs of service delivery for particular NRENs against the benefits of universal service to all NRENs.
- GÉANT's cost-sharing model shall continue to be refined, ensuring transparency of cost and a fair and competitive cost base that can help to reduce the digital divide.
- GÉANT's environment and infrastructure with its increasing scale, diversity, and complexity – ultimately problems arising from success – pose challenges to the cost-sharing model. GÉANT should exploit other funding instruments to drive down the cost, while considering other pricing mechanisms, such as unbundling, that could avoid cost-sharing for offerings where universal delivery is less necessary, or for some premium offerings.
- The GÉANT Community should build on its position to more fully exploit the opportunities arising from the rapidly globalising character of research and, in particular, education. GÉANT should apply its experience of supporting and integrating emerging NRENs, which has yielded a more coherent service area across Europe, towards addressing more comprehensively our proposition for the growing numbers of multi-national organisations operating across continents.
- The GÉANT Community should liaise and work with European and national policy bodies and regulators to progress a range of issues which include:
 - The use of other funding mechanisms to improve the future service offerings of the GÉANT infrastructure.
 - The stimulations of related regional networking policies to improve regional networking and campus access.
 - Data protection, e-identity, and information assurance.
- The GÉANT Community must implement new ways to share services between the partners and their global partners, using a federative approach and avoiding duplication. Similarly, it should explore the potential of new business models, including service provisioning through aggregation of demand and brokerage.
- The GÉANT Community must increase knowledge exchange, working together on innovative ways for collaboration. It must be regularly benchmarked against other advanced international Research and Education Networks from around the globe. The advantage of collaboration and knowledge sharing for all members of the community shall become more and more evident by advertising the results obtained from collaboration inside and outside the GÉANT Community.
- The problem of incumbent monopolies in markets in Europe that are less developed.

GÉANT as an enabler for Future Internet activities

Future Internet (FI) will remain a very important research topic in Europe. The GÉANT Community, network services and Infrastructure, together with the NRENs, are well positioned to deliver in a range of areas related to this. GÉANT and the NRENs will facilitate the FI-related activities providing adequate resources, testbeds and potential testing environments. Moreover, members of the GÉANT Community may take part directly in these FI activities. GÉANT will also implement new solutions resulting from FI activities if they become feasible and useful for the community.

Blue sky research

In general, funding for 'Blue Sky' research (i.e. research which is more than usually speculative and with no foreseeable application) would not be funded by GÉANT. Funds for this type of research would be sought from other Horizon 2020 Research Initiatives. While Blue Sky research fits into the general European Research Area and benefits from the GÉANT environment as a communication fabric, in the GÉANT environment itself, the 'proof of concept' goal is not sufficient to start an activity on its own: the idea needs to deliver an improvement for real users and real services to be implemented.

GÉANT and the environment

Throughout the life cycle of the GÉANT infrastructure, it is a priority to supplement financial and other resource allocation metrics with evaluation criteria covering 'green' aspects, such as energy consumption, travel activity, waste handling and greenhouse gas emissions. Prioritising this higher than commercial providers will be a distinguishing feature of GÉANT.

GÉANT's 'green team' will act as a focus of specialist knowledge and expertise in environmental policy and practice from which to lead the improvement of environmental performance for the duration of the partnership.

Innovation

Today, ICT plays a fundamental role in all areas of research and education. Improved ICT facilities will help to increase the quality of research and education. Therefore the GÉANT Community is committed to constantly innovate so as to offer the most advanced services to the European research and education community. While innovation also proceeds at a great pace in the commercial market, there are many specific types of services that the research and education community requires that are not provided by the commercial market. This is where the GÉANT Community distinguishes itself from the other providers: by delivering high quality services targeted at the research and education community and by constantly innovating these services as required.

Continuous innovation is very important since it is one of the distinguishing features of GÉANT. An innovation in GÉANT can be user-demand driven, it can be driven by the need for optimisation (cutting costs and improving quality), or it can be technology driven. In all cases the innovation effort is inspired by the research and education user audience. Often, the innovations made by the GÉANT Community are not necessarily strictly technological, but rather a combination of technological possibilities and new models for utilisation, trust, cost sharing, etc.

Identifying where innovation can make a difference

Innovations within the GÉANT Community are often inspired by advanced user communities such as Metrology, High Energy Physics, Astronomy and other 'big science' users. Development within the GÉANT Community can be relevant in a range of situations:

- For new research activities.
- Improvement of our services.
- Application-specific research projects.

Once a new service has been tested with such an advanced user community the GÉANT Community faces the challenge of making the new service available to the whole of the European research and education community in a simple and reliable fashion.

Agile organisation of innovating efforts

The GÉANT Community has to anticipate the future needs of research and education users, and employ agile processes to transform itself as the needs of its users change. The GÉANT Community should also take risks and act as a research infrastructure on its own, leaving room for the exploration of future possibilities of service offerings. At

the same time, the research activities should have a strong focus on practical usability and sustainability of a service. Balancing these goals is a challenge to the management of budget allocation.

GÉANT organises the innovation in an agile and flexible way, depending on where users, developers and other stakeholders for a specific project are placed. Sometimes universities play a major role and subcontract the whole process, sometimes (a few) NRENs are the main driver, and sometimes a project is initiated within the larger GÉANT project. However, the most common scenario is a combination of these. The creation of agile task forces has proven to be an effective way of starting up many innovations, which then turn into more formally organised activities that finally yield innovative services. In all cases the goal of the innovation is to make the end result available to the whole of the European research and education community.

By providing the most advanced services and facilities to the European users, GÉANT enables them to innovate and excel. This applies to sciences, languages, humanities and all other areas of research and education.

Guiding principles for innovation

Innovation is expensive but essential for the future. Projects of this kind are only initiated when a number of guiding principles are satisfied:

- A proof of concept by itself is not sufficient. The project must make a difference for real users and real services. Exploring unknown areas is acceptable in general, but attention must be given to qualifying and quantifying the expected impact of the conducted work.
- The service or product is not available in the commercial market, or, at least, not within the required service delivery conditions or parameters. Whereas some ideas and projects are the result of a community effort, it is also important to follow the ideas from NRENs and elsewhere, which could be of benefit to the community at large, and then help proliferate such an idea or service to larger parts of the community. In many cases, the originators of the idea or project do not have the resources or the inclination to pursue the proliferation effort. This is a task for the GÉANT organisation.

The GÉANT Community will work on a structured process to take innovation projects further and develop them into trustworthy, high quality services.

Benefits for the global European environment

The innovations developed by the GÉANT Community are carried out in an open and transparent way, involving commercial partners where appropriate. This ensures that the knowledge developed within GÉANT is available for commercial exploitation in Europe.

The GÉANT Community also plays a strong driving role within Europe, promoting open, transparent and trustworthy high-speed access to Internet services. The GÉANT Community does this by setting examples, providing proof of concept and scalability, by contributing to standardisation and by participating in Internet Governance debates.

By providing students with state-of-the-art services, GÉANT is creating a new class of demanding users that, once graduated, will demand that commercial markets follow suit.

Topics for innovation

As indicated, there are many types of innovation within the GÉANT Community and not all of them are technology driven. At the same time technology evolves at a speed that makes it hard to denote specific areas in a strategy. However, some examples of areas where GÉANT projects will innovate over the coming years are listed in the adjacent panel.

The GÉANT Community at large will also produce innovations, beyond the GÉANT projects' specific activities; individual NRENs, Universities and Research Institutions will also support or directly perform activities themselves, including Blue Sky Research and Future Internet research.

Areas where GÉANT projects will innovate

Networks

- Support for Future Internet activities.
- Photonic services.
- Programmable networking (e.g. for access to remote research instruments or for distributed data centres).
- Efficiency of energy and energy budget allocation.
- Support for Blue Sky research.

Easy access to wirefree and mobile networks

- BYOD.
- Economy of scale.

Cloud services

AAI infrastructure

Trust and Security

- Encryption services for genome data – similar for banking – secure transfers.
- Security by default to limit pervasive surveillance and monitoring of users.

Ease-of-use

- Catalogue of services.
- GÉANT one-stop shop (i.e. easy access to all GÉANT services).
- Improvements for cross-domain services.

Leverage the power of the network

- Encourage and make it possible to develop services which use the network in a more efficient manner, as opposed to the contemporary trend of 'everything-over-HTTP'.



Collaboration

The collaboration among the whole community of NRENs is much more than what is included in the GÉANT project. The collaboration is the way NRENs and the whole GÉANT Community act together, both within projects and outside of projects. The collaboration encompasses the way NRENs and user communities exchange ideas and experiences, creating a human network which is fundamental for fostering new initiatives and reducing the digital divide.

The collaboration may also take the form of a ‘coalition of the willing’, where a group of NRENs collaborate. This way, not every NREN needs to participate in everything and often the results can be useful for an NREN even though it did not contribute to the collaboration to begin with.

An environment for sharing

The GÉANT Community is an environment where NRENs share ideas, experiences and learning from each other. Sharing expands where appropriate to NREN users, and allows a quick and easy ‘early stage’ exchange of ideas which may then be developed into projects or activities. Agile task forces and special interest groups are the tools that make this happen.

Acting collaboratively

GÉANT creates and maintains an environment for federated services delivery. This is where NRENs and the GÉANT organisation work together to create services for other NRENs and for international user communities.

This is not just about creating and supporting the services on a technical level. This is also an effort to solve legal and procurement issues as well as cost sharing, ensuring that the knowledge and experience gained is transferred and the availability of services across the community is accelerated.

A significant part of the GÉANT Community also requires services that are not available or affordable from commercial providers. Identifying observed or anticipated user needs will be elaborated into a vendor-independent specification. This will provide a starting point for research, development, implementation, testing and delivery of new services, contributing to differentiation of services for the GÉANT Community. The specification of NRENs’ requirements will be used for Public Procurement of Innovative Solutions and Pre-Commercial Procurement (PPI/PCP) to prepare vendors for future procurements.

Actors/Stakeholders to collaborate with

GÉANT is a collaboration with:

- Other e-Infrastructures, to understand their requirements and develop services.
- Industry, for joint development projects.
- Industry, for joint delivery of goods and services.
- Vertical user groups to support their disciplines (through NRENs).
- Other continents.

The collaboration environment can further expand whenever this makes a benefit for the GÉANT Community.

Outreach from the collaboration

TNC – ‘The Networking Conference’ – is an integral element of community outreach, providing community visibility to users and the industry. GÉANT will continue and possibly expand in other directions and towards other communities via collaborative events with other e-Infrastructure providers. Bringing people’s experiences together shall also be pursued via specific dedicated meetings (for example task forces), blogs, websites and other collaborative platforms, periodicals, press releases, documentation, mailing lists, etc. are all integral parts of the outreach strategy.

GÉANT will make available the results and lessons learned from existing collaborations, both from the GÉANT project and from other collaborative efforts by groups of NRENS

Service portfolio and lifecycle management

Complete service portfolio and lifecycle management takes place at many of the individual NRENS as well as within GÉANT activities although GÉANT organises the community for mutual help in this important management activity. Moreover, in GÉANT, ideas and best practices are shared in the community, helping each NREN to fast track their own service portfolio offerings.

Engagement in regional development efforts

GÉANT engages itself in regional development (DEVCO) projects and these form an integral part of the strategy. They are a means of closing the digital divide and enable equal access to human talent and connections to big science infrastructures, wherever they may be.

Users

The GÉANT Community (i.e. the community including end users) will optimise the use of its assets in such a way that the whole community is best served, and that contributions are delivered by those members in the community (i.e. NRENs and others) that can best deliver.

End users receive the services through NRENs and their respective institutions. Services to selected pan-European entities are based on the NRENs' agreement on federalised delivery. This is usual for pan-European user projects receiving EC funding.

End users receiving services from NRENs are legal bodies involved fully or in part in science, research, development, innovations, or education – according to the Access Policy regulations of member States. Such regulations should be especially open to research facilities and innovation projects in industry for European competitiveness improvement. We should also try to give guidance in order to harmonise the Access Policy regulations inside the GÉANT community, making it possible for more open access.

Members of science, research, innovation or education work teams or individual users can use NRENs' services if they are working for a legal body receiving NREN services, or are its students. NRENs can also provide limited services to communities developing open

source software (as part of NREN support of public activities).

An NREN can agree with partners outside the GÉANT Community on mutually beneficial services, enabling access of individual users and teams.

Development for the users with the users

The continued close dialogue between the users and GÉANT is considered vital for the survival of GÉANT. GÉANT is not a catalogue supplier delivering standard commodities, but a partnership where the GÉANT offerings are developed in a close dialogue with those users. Services will from the outset be developed with the mindset that neither GÉANT nor the users know what the best solution is: the best solution will be developed together.

Science and scientific services are increasingly multinational, creating a need for a truly multinational service delivery from GÉANT. These users operate in many countries but act as one body and increasingly want to have one partner, one contract and one SLA. Examples are emerging experiments from Meteorology, Space, Astronomy, etc.

Expanding the end-user base

The GÉANT Community has created a large set of very useful services and has a valuable set of assets in its infrastructure, too. Expanding access to these services and assets to other potential users shall be considered as an option. However, allowing access to an expanded set of users must not conflict with the fundamental rules existing for the community in terms of general governance and operations. Such enlargement of course has the potential to generate income and produce cost savings.

High impact and revenue opportunities for NRENs are expected by enlargement of the GÉANT user community, for example in remote hard real-time sensing or control as a service for providing security improvements in industry for innovation projects in H2020.

Services

GÉANT and the NRENs deliver services to their community. While their services are organised and delivered in the context and regarding the requirements of a specific community, they do this within a rapidly evolving commercial and technological environment where users and other stakeholders can easily compare GÉANT offerings with those made available by other providers. It is therefore essential that we develop and maintain a portfolio of services that both meet our users' requirements and that are unambiguously distinct from that of other providers, because increasingly 'users are choosers'.

To make this choice as simple as possible, these services must be affordable to our users and provide them with needed capabilities, or deployed/offered/procured with a different model not offered by other providers. The user, having chosen, must be served to the highest standards. And to maintain relevance, we must periodically evaluate our portfolio to ensure that it evolves in response to the changing environment; either through further development, operational changes, as well as sun-setting of services.

In the context of this strategy, GÉANT's service portfolio will focus on the following key areas:

- Network services, by which GÉANT provides transit of data between parties within Europe and globally.

- Trust and Identity Services, by which GÉANT enable parties to obtain and provide simple, secure and controlled access to networks, data, and applications within Europe and globally.
- Application services, specifically developed and tailored to users' needs and relying on the very special Network, Trust and Identity services which GÉANT provides to the community.

GÉANT Network services

Today the most evident core business of GÉANT and the NRENs is the network. Despite a highly competitive environment, GÉANT and the NRENs continue to offer significant value to their constituencies by providing an affordable network designed around their specific needs. GÉANT IP, GÉANT Plus and GÉANT Lambda services are the core services currently made available through the provision of the GÉANT Network. GÉANT and the NRENs provide multi-domain end-to-end operations within their aggregated footprint, while DANTE World Service provides connectivity to the wider Internet.

This federative, collaborative model, which often includes the full range of business activities from procurement to operations and marketing, enables each NREN to provide their respective constituencies with propositions that meet their users' need for European and global reach. This model also

extends beyond connectivity to many other federated application services which rely on the network infrastructure.

It can often be challenging to find the appropriate degree of federation or centralisation, owing to the constant flux of commercial and technological change within our constituencies and the wider ICT industry, but the principles of subsidiarity and cost effectiveness guide the way. As such, when developing new GÉANT propositions, we must always consider the option of NREN delivery, such as Cross Border Fibre (CBF), that build on existing NREN assets or capabilities.

The use of dark fibre infrastructure by NRENs has also developed since 2004. Customer-Empowered Fibre Networks have opened up the use of the photonic layer to end users, the testing of Spectrum as a Service transmission and the provision of Cross Border Fibres as an international test bed has enabled experimental applications such as accurate time and frequency transfer and the hard real-time remote control of scientific, medical or industrial equipment. The GÉANT community is leading such developments and collaborates with R&E networks worldwide.

Looking to the future we see these general themes for the network:

- We must continue simplifying users' experience of the network; and not just users, but also in preparing for the emerging Internet of Things. Connectivity must just be there, everywhere, and appropriate for the task at hand.
- We must optimise our infrastructure to better serve massive flows of Big Data and high precision real-time interaction.
- We must develop and operate network services (for example Software Defined Networks) that will orchestrate these flows of data between users and machines, the Internet of Things, and the cloud infrastructure they will be integrated with.

Trust and Identity Services

In the complex, globally distributed and multi-organisational research environment, Trust and Identity is essential in enabling collaborative uses of the network. Trust and Identity therefore not only drives the use of the network, making it cheaper to operate, but also supports collaboration within and between research communities, which is fundamental for all research endeavour.

The GÉANT Community has enjoyed great success in recent years in this area, enabling world-leading services such as eduroam. However, the environment is changing in ways that present challenges to NRENs, but also opportunities if correctly identified and managed. Identity is highly strategic to some commercial providers, who are trying to control the space, which could result in the adoption of a proprietorial or non-interoperable Trust and Identity infrastructure. Trust is also becoming a significant issue. While the network creates many positive opportunities it also introduces risks, particularly with the growth of the Cloud. Users (or their organisations) do not trust some of these entities, and some participants are even considered hostile. Conversely, R&E providers expect a greater level of assurance in the identities they accept. A secure research and education environment requires Trust and Identity capabilities that both enrich the user experience while preventing malicious activity.

Where Trust and Identity are concerned, we must further enhance our ability to provide value and act in the interests of our community. This need is particularly acute today given their importance to the NRENs' other strategic initiatives in areas such as e-Infrastructures, Cloud, and network services. We must build on our leading position to deliver across research and education, and the other sectors of relevance to it, by facilitating an open global Trust and Identity infrastructure, interoperable across all sectors and consistent with the needs of research and education. To derive maximum benefit this must be deployed ubiquitously and trusted by users to support their research and education endeavours.

The GÉANT Community must act coherently across Europe and Globally. Firstly, we must enhance collaboration within the global R&E community by meeting users' needs for Trust and Identity for networks, services and applications. Secondly, we must facilitate collaboration between the research and education community and other sectors, which is a key element of the EC's Horizon 2020 strategy. This must be organised on terms favourable to the research and education community, by reducing costs and risks through making use of vendor solutions interoperable with the NRENs, while mitigating the risk of vendor 'lock in' and monopolistic-like outcomes, particularly with Cloud platforms. Finally, we must support the

needs of other strategic NREN interests, such as e-Infrastructures, ESFRI projects, Cloud, and lifelong and government eID.

We will deliver this through a set of three complementary activities, mindful of our community's federative composition and the need for consensus.

- Harmonise our national Trust and Identity initiatives by agreeing common strategies, policies, operational practices, development roadmaps, communications and marketing where necessary to meet user and operational needs.
- Operate Trust and Identity systems for global research and education by integrating our national initiatives, and supplementing these where necessary, working with other NRENs and community providers of ICT, by:
 - Operating Trust & Identity systems in Europe and elsewhere, such as eduGAIN, eduroam, and similar initiatives, that meet user needs.
 - Consolidating and providing representative executive governance of these to all global NRENs, and including user representation.
 - Developing these further in response to user requirements.

■ Facilitate open global cross-sector systems for Trust and Identity by working with governance and industrial stakeholders and by using the global scale of research and educations to incentivise the market to provide solutions that match the needs of our users.

- A cross-sector Trust and Identity framework and engagement activity to facilitate interoperability between NREN, government, and commercial operators.
- Strategic alliances and partnerships with both commercial and non-commercial entities on initiatives that support the community's needs.
- Community support to research and education communities, such as ESFRI projects, and the populous but dispersed research and education communities that are less well served today.

Application services

The GÉANT Community network and trust services also provide the ground to develop, experiment and deploy Application Services which can only exist in such an environment, because they rely on the unique features of GÉANT. Furthermore, the R&E community needs are also sometimes in need of specific application services which are not available in the commercial world: eduCONF or advanced audio visual services like LOLA are clear examples of this.

GÉANT shall thus encourage, in close collaboration with its users, the development of such services. Development involves maintaining a close dialogue between users expressing their needs and ideas, and network and middleware developers or with appropriate industrial partners.

Supply Chain Management

Until relatively recently, ICT software goods were provided to their customers as products that were delivered using physical media. In the space of a few years this paradigm has been almost entirely replaced by Internet-based services, as it is the most effective and efficient delivery mechanism. Whereas previously users had their ICT needs met almost exclusively by their organisation, a generation of users in the research and education community has grown up choosing their own devices and services instead.

This rapid improvement in the supply and affordability of services has clearly benefited users, but also presented new challenges. NRENs have for some years attempted to help their users and customers to address these challenges and find more appropriate ways of managing the supply of the same or similar services in ways that are more consistent with the specific needs and expectations of the R&E sector.

Given the opportunities presented by collaboration at a European level, GÉANT has already started to explore how it could participate within the management of this supply chain between the providers, NRENs, and their customers and users. The goal is to increase the efficiency of this supply chain by positioning GÉANT to act for the European research and education community.

Establishing this position requires a sense of urgency and a willingness to adapt. It requires new skills and substantial organisational changes to enable effective interactions with providers, and a greater level of sophistication in our delivery of services across this supply chain. Both users and providers, as the demand- and supply-side respectively, must be convinced of the value of engaging with the GÉANT supply chain. This will require a more prominent brand, presence, and remit for both GÉANT and the NRENs as they focus on their parts of the supply chain.

The GÉANT supply chain must create value for both sides, encouraging the supply-side to offer their products and services on more attractive terms than the demand-side could achieve acting alone. This GÉANT supply chain must yield a market place for services – the GÉANT Application Store. This would enable users to choose services safe in the knowledge that they will be cost effective, trustworthy, and integrated with other GÉANT and NREN offerings (such as automated network control and provisioning services), and provide the best possible user experience.

People

The human capital of the GÉANT Community is its most important asset. The exceptional, in-depth skills and experience of the professional staff within the NRENs and their current support organisation GÉANT Association (formerly TERENA and DANTE), are not only highly valued by the user community, and highly regarded and in demand across the industry in general, but also pivotal in ensuring the continuing success of the GÉANT network infrastructure and the services delivered to its users.

- Skills are maintained and developed through:
 - Sharing best practice amongst the partners.
 - Coordinating efforts between Task Force experts and the GÉANT partners.
 - Targeting training related to the implementation of new services.
 - Providing training in the management of geographically distributed teams.
 - Improving the development of management and technical skills and knowledge through work with international NREN partners.
 - Creating opportunities for specific skill gaps to be filled by short-term secondment of staff between partner organisations, as well as from academia and industry.
- Experts from the GÉANT Community provide the services offered by the GÉANT infrastructure and make them available to a huge and influential user community in Europe. The dissemination of advanced services such as eduroam, very high-speed networking, network monitoring, AAI and information security to this influential user community of students, researchers and teaching staff is to the great benefit of the European ICT sector.
- Through the Open Call mechanism, these extensive human capital development processes and opportunities are made available to a broader community, including university staff outside the usual GÉANT Project partnerships and SMEs. The creation of agile task forces, much favoured by the projects, also encourages this precious knowledge spread across the broader community.
- The GÉANT partnership includes NRENs with significantly different levels of size and development, and therefore benefits from a diversity of knowledge and experience, enriching the way the challenges of operating and developing the GÉANT infrastructure are resolved.

The competencies developed within highly specialised fields (e.g. security, AAI, Software Defined Networking and advanced application services) are in great demand from the whole of the European ICT sector. In this way, the work on the GÉANT infrastructure will continue to contribute to the development of a stronger European ICT sector in general.

Knowledge base for NRENs

The GÉANT environment will provide an open knowledge base for NRENs, such that it is easy to find subject matter experts within the community on technical matters, as well as experts on procurement, legal issues and other fields relevant to the community. This base should also contain other assets (technical facilities, measuring equipment, etc.) that could be of use to other members of the community.

Staff training and knowledge sharing

The GÉANT Community should provide the ideal environment for enhancing the knowledge base of all participants in the activities, including NREN staff and in some instances even campus end users. To achieve this we shall engage in the following activities:

- Training for future needs and/or new skills.
- Training for the adoption and take-up of new services.
- Ensure ease of use and promote the take-up of services.

Capitalise on latent human resources

One of the still not fully exploited resources in the GÉANT Community is the production of knowledge and new ideas emanating from user communities. Outreach efforts to make new users aware of the potential of the GÉANT environment shall be increased, to bring new ideas in turn that contribute to the R&D efforts of GÉANT.

Facilitate intra-community team working

In service provisioning and other aspects of NRENs operation, a collaborative approach is often beneficial. GÉANT has the task to identify such areas and promote the collaboration. Furthermore, information and ideas exchanged among different user groups and disciplines about the use of GÉANT and its services shall be promoted, as a seed for new ideas and developments.

Ensure past experiences are not lost

The GÉANT Community has already built up some decades of technical and human knowledge experiences. Some challenges which return to face us have already been debated, or even solved, in the past, but the long list of previous successes (and failures from which we can learn) remains a precious resource inside our community. Appropriate actions, including dissemination and the rigorous archiving of actions ensures that this knowledge is not lost and is available to new GÉANT Community people. GÉANT has also produced and will continue to produce very good experts, innovators and technology leaders that will make Europe a better place.

'Networking the people' across generations, across specialities and across countries shall thus remain the main target of GÉANT.