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Abstract

The Deliverable provides an overview of how GÉANT fits into the H2020 programme, showcasing the wealth of possible support for H2020 projects. It aims to act as handbook covering the different aspects such as connectivity, international collaborations and user support.

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Executive Summary

This deliverable aims to provide information to Horizon 2020 (“H2020”) research projects on the services that GÉANT and other e-Infrastructures can offer in support of data-driven and collaboration-based research activities.

The deliverable describes GÉANT service offerings and procedures and seeks to promote and support the use of the GÉANT infrastructure and services by H2020 projects. It is part of the outreach commitment from GÉANT but takes into account the other e-Infrastructures available to H2020 programme participants.

The Deliverable consist of three parts: The first part gives a background on the context and objectives of the H2020 programme and the role and objectives of e-Infrastructures within the programme. The strategic positioning of GÉANT in H2020 is explained.

The second part explains the background of R&E networking and the GÉANT infrastructure and service portfolio available to H2020 projects and introduces the user support function. Three use cases from areas relevant to H2020 projects are used to illustrate this function.

The third part locates GÉANT in the wider context of the e-Infrastructures, explaining the overall landscape and ICT services offered. Addressing the growing demand from users for collaborative service solutions, the deliverable concludes by outlining how users can find out if they are already connected, which services are available to them and the best way of contacting GÉANT to benefit from the outlined services.

The information in this deliverable will be used as a basis to produce a publicly available Handbook relevant to H2020 project participants. This publication will take advantage of the marketing, design, print production and promotional expertise available to GN4-1 NA2.

1 Introduction

Researchers involved in the EC's funding Programme Horizon 2020 may be using GÉANT and its services to conduct their research activities, often without them knowing. GÉANT is there as a commodity and researchers can collaborate across countries or continents without having to be concerned with the technicalities of networking: they can focus on their research.

There are, however, a large number of researchers with more specific or demanding requirements for data transfer and collaboration. Examples include:

- Transfer of extremely large data volumes over large distances for physics experiments.
- Real-time distribution of monitoring data to provide early warning of impending natural disasters, such as earthquakes or typhoons.
- Dedicated private connectivity between two or more institutions for research projects with specific security or computing needs.
- Parallel dissemination of satellite data to weather agencies using multicast.
- Simulations via distributed infrastructures requiring colossal amounts of computing power and bandwidth.
- Seamless secure access to distributed data archives via single sign-on.
- Deployment and testing of innovative network technologies and protocols (SDN, InfiniBand over a WAN).

High ICT demands are not limited to R&E networking. It affects all ICT aspects of data-driven research collaborations: from data management and storage, High-Performance and Grid computing, up to efficient Middleware enabling collaboration across countries. The EC organises and supports a set of complementary e-Infrastructures to address these needs to the R&E community.

These e-Infrastructures form an important part of the H2020 programme, providing a building block for the success of research projects within the H2020 programme and beyond. In parallel, the H2020 programme sets out, via dedicated initiatives within its framework, to bring individual e-Infrastructures closer together, align their services and develop a truly integrated service offering.

This deliverable aims to provide information about GÉANT and the links to other e-Infrastructures, giving researchers in H2020 the information they need to make use of the offered services. In particular, it aims to:

- Introduce the H2020 programme.

- Give a brief overview of the R&E networking landscape.
- Introduce those elements of the GÉANT service portfolio that H2020 projects can benefit from.
- Show use cases from relevant areas where researchers have made use of specific GÉANT services and support.
- Introduce the various e-Infrastructures relevant to H2020.
- Illustrate how GÉANT is currently collaborating with other e-Infrastructures.

2 Horizon 2020

In 2014, the European Commission set out to boost research and innovation through a new funding programme called Horizon 2020 (“H2020”). The overall objective of H2020 is to drive innovation to promote economic growth and create jobs. The programme addresses European researchers, public bodies and public-private partnerships. H2020 is the biggest European research and innovation programme (and financial instrument) ever, with nearly €80 billion of funding available over seven years from 2014–2020 [[H2020](#)].

H2020 provides several work programmes of different duration. Each programme funds projects addressing three themes in a direct or indirect way. These are:

- Excellent science.
- Industrial leadership.
- Meeting societal challenges (e.g. health, environment, energy, security).

The European Commission explicitly envisages a boost to their innovation efforts by joining forces with industry. This is done in two ways: by supporting public-private partnerships (PPP) and innovation in SMEs, and by actively seeking partnerships with industry to scale up the funding budget through industry contributions. Across H2020, innovation will be achieved through:

- Support for testing, piloting and demonstrating new technologies.
- Supporting the market for innovation, including new standards and procurement support.
- The introduction of a new financial instrument for SMEs, promoting collaborations between SMEs and researchers.
- The development of joint financial instruments with the private sector to scale up funding support.

As part of H2020, the European Commission also funds European e-Infrastructures. The term e-Infrastructure refers to a combination and interworking of digitally-based technologies (hardware and software), resources (data repositories and digital libraries, computing/processing), communications (protocols, access rights and networks), and the people and organisational structures needed to support modern, internationally leading collaborative research.

The relevant e-Infrastructures are:

- GÉANT, providing the networking infrastructure and foundation.
- PRACE and EGI, addressing High-Performance and Grid Computing.

- EUDAT and OPENAire, providing middleware services and tools around data management and collaboration.

In addition, GÉANT supports other collaborative initiatives aimed at R&E users such as Helix Nebula. This is a collaboration between ESA, EMBL, CERN and a number of commercial service providers to define how cloud services can support science.

The e-Infrastructures already have a history of providing services and support for the wider R&E community. Today, researchers can call on a wide range of services in these areas. There is a growing demand from researchers to use services from different e-Infrastructures and receive a comprehensive service offering. The EC has responded to this development in the current work programme for 2016–2017, providing a framework to:

- Integrate and consolidate the e-Infrastructure platforms by developing a single service catalogue and work towards a seamless service experience.
- Foster innovation by prototyping innovative platforms and services based on tested and approved technologies and by working closely with users.
- Enhance policies and international cooperation to facilitate data access and distribution.

2.1 GÉANT strategic positioning within H2020

GÉANT is an integral part in the H2020 programme as a critical enabler, directly contributing to the “free circulation of knowledge” as ratified in the Lisbon Treaty¹. In 2014, GÉANT created the strategy “Over the Horizon 2014–2020” to position itself and define how GÉANT will contribute to the programme.

The strategy was developed in an iterative two-way (bottom up/top-down) approach, actively seeking input from all stakeholders. The user’s perspective was gathered via the GÉANT International User Advisory Committee (IUAC) comprising 12 members from large research collaborations. They provided input and feedback to the GÉANT 2020 strategy on several occasions, ensuring that the user’s requirements and view was incorporated and ultimately that the strategy is fit for purpose.

Towards 2020, the GÉANT community will provide an open, innovative and trusted information infrastructure for the European knowledge economy. It will:

- Maintain the position as a provider of infrastructure services ahead of the commodity market.
- Focus on collaborative efforts to innovate the service portfolio, creating advanced services and providing seamless and tailored ICT service solutions.
- Organise the whole ecosystem of service delivery between NRENs.
- Harness the services of the NRENs to create a one-stop-shop for international organisations.

Throughout the 2014 to 2020 strategy period, GÉANT will maintain ‘Over the Horizon’ as its constant and guiding principle. The GÉANT User Liaison Team is following this strategy and pursues the

¹ http://ec.europa.eu/archives/lisbon_treaty/full_text/

objectives of H2020 by actively engaging with research user groups and progressing the one-stop-shop principle.

3 The need for dedicated R&E networks

R&E networks are high-speed, high-capacity data-communication networks that are independent of (but connected to) the commercial Internet, and are designed to meet the specific demands of the academic and research communities. These cannot typically be met by the commercial Internet, however building a dedicated infrastructure would not be cost-effective for individual institutions. By consolidating national and global requirements in one network, connectivity costs for individual member institutions are significantly reduced, while at the same time their users receive the benefit of being able to access a wider range of services.

When very high data rates are required, dedicated connectivity can provide reliable and secure data exchange at specified speeds and with an assured quality-of-service, which is especially important for transferring huge amounts of time-critical data. Congestion delays, interruptions and limitations caused by overbooking and competing traffic on public Internet services are avoided.

As well as physical connectivity, R&E networks provide services such as wireless roaming, videoconferencing, media streaming, federated access, troubleshooting, cloud-based computing and storage services. Beyond that, they facilitate community activities, promoting knowledge and best practice sharing.

R&E networks are structured on both a national and an international level. At national level, these networks are organised as National Research and Education Networks (NRENs), which connect universities, research institutions, schools, hospitals and museums within a country. This allows them to benefit from access to increased bandwidth and to share services and applications, working collaboratively on projects of national and global concern. Users who are part of a connected institution gain access to the services offered regionally as well as to those offered at a national level if their NREN is part of a regional network.

In addition, most NRENs are connected to international networks such as GÉANT, which are in turn interconnected to create a global infrastructure serving the R&E community.

3.1 GÉANT – at the heart of R&E networking

The GÉANT network is the largest and most advanced R&E network in the world, connecting over 50 million users at 10,000 institutions across Europe and supporting all scientific disciplines. The network operates at speeds of up to 500Gbps and reaches over 100 national networks worldwide.

The network and associated services are co-funded by the European Commission through the GÉANT project (a collaboration of 38 partners consisting of the GÉANT organisation), 35 European NRENs and NORDUnet (representing the five Nordic countries). The project coordinator is the GÉANT organisation on behalf of Europe's NRENs. Responsibility for the network is allocated to the individual NREN organisations for supporting and maintaining their respective national networks, while GÉANT also maintains and operates the connecting backbone network on a pan-European basis.

Since its establishment over 20 years ago, the GÉANT network has developed progressively to ensure that European researchers are at the forefront of international and global collaboration. Over 1000 terabytes of data is transferred via the GÉANT IP backbone every day. More than just an infrastructure for e-science, it stands as a positive example of European integration and collaboration.

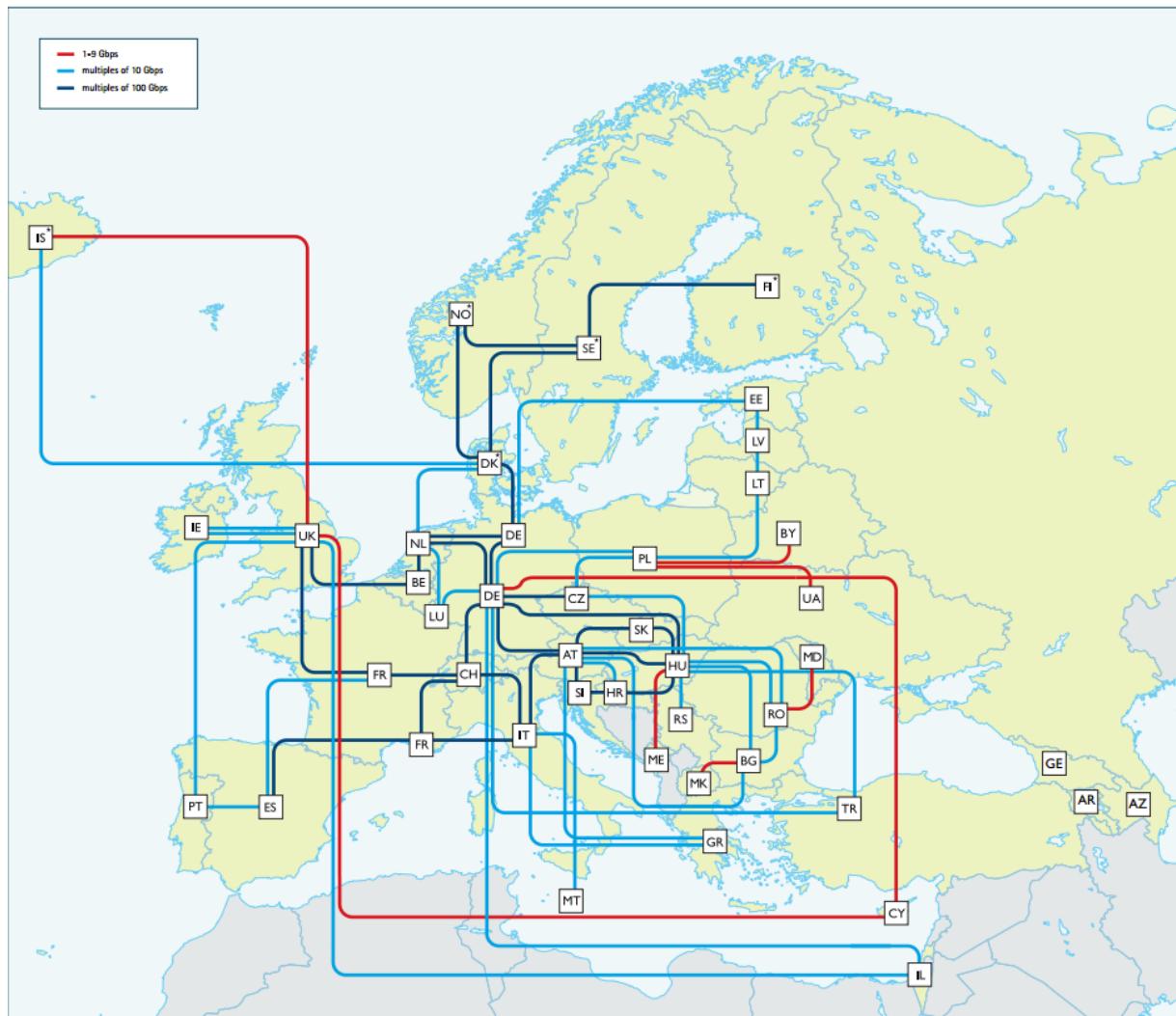


Figure 3.1: GÉANT EU topology, October 2015

3.2 International R&E networks connected to GÉANT

GÉANT provides extensive international connectivity, interconnecting with all world regions and subsequently reaching over 100 countries. This global infrastructure enables European researchers to collaborate on a global scale. H2020 projects can boost their impact by leveraging their global collaborations utilising existing interconnections:

- **Africa** consists of three geographical clusters represented by their respective regional networking organisation: The UbuntuNet Alliance for Southern and Eastern Africa, WACREN in West and Central Africa and ASREN in North Africa and the Middle East. Together they connect more than 22 countries to GÉANT.
- **Asia Pacific and South Asia:** NRENs of the Asia Pacific and South Asia are connected by TEIN, the Trans-Eurasia Information Network. With over 50 million users and representing over 60% of the world's population, TEIN currently interconnects universities and research centers in 19 countries including China, Japan, India and Australia.
- **Caribbean:** C@ribNET is the regional R&E network interconnecting 16 Caribbean countries.
- **Central Asia:** The Central Asia Research and Education Network (CAREN) interconnects research centres and educational institutions throughout Central Asia reaching half a million scientists and students in more than 300 universities and research centres in Kyrgyzstan, Tajikistan and Turkmenistan. Additional connectivity to Afghanistan is provided by the SILK-Afghanistan project between Kabul and Vienna.
- **Southern Caucasus and Eastern Europe:** the GÉANT EaPConnect project sets out to create a regional network of six Eastern Partnership (EaP) countries in the immediate Eastern Neighbourhood of the European Union and integrate them into GÉANT. Two million scientists, academics and students at over 700 institutions across the region will benefit from the connectivity boost.
- **Latin America:** RedCLARA is the regional network for Latin America. It interconnects more than 750 institutions in 13 Latin American countries. In addition, the GÉANT Identity and Trust services are being extended to Latin America.
- **North Africa and Middle East:** Following the events of the Arab Spring, most countries in this region are disconnected. Current connection links exist to ARN, the Algerian NREN and ENSTINET in Egypt.
- **North America:** The North American research networking environment is more diverse than in Europe, with research connectivity provided by CANARIE in Canada, and three main R&E networks in the USA: ESnet, Internet2 and the NASA Integrated Services Network (NISN). There is a longstanding relationship between pan-European research networking and North American research networks supporting large-scale intercontinental projects such as LHC. Dedicated connectivity can be provided between GÉANT and CANARIE, Internet2 and ESNET.

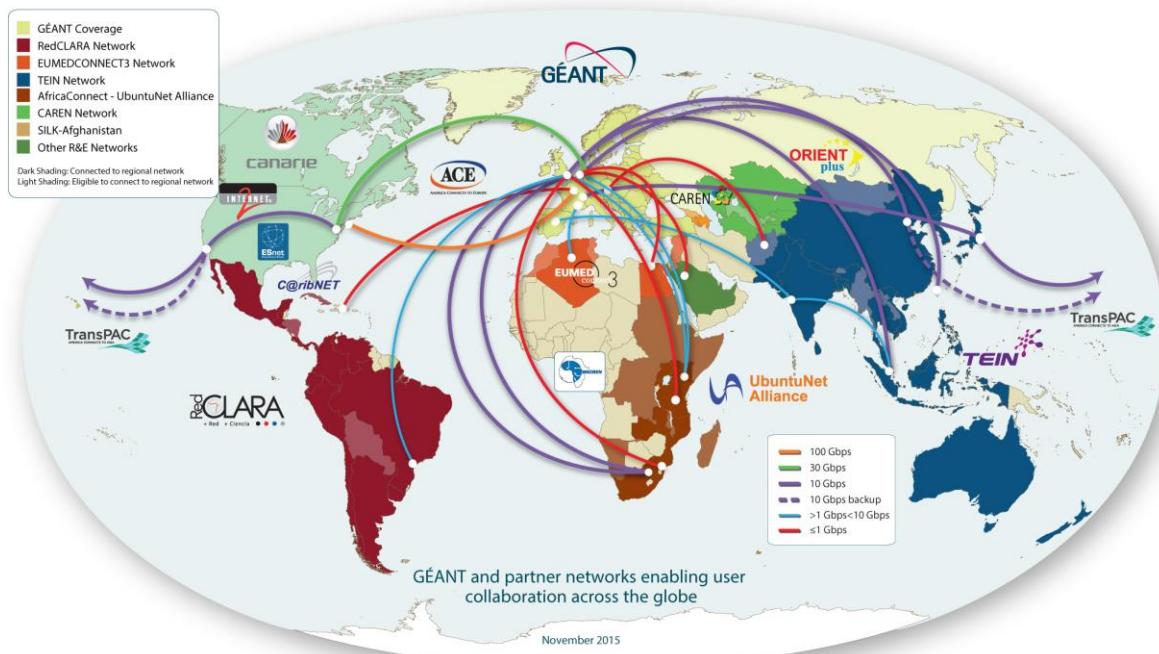


Figure 3.2: GÉANT Global Map, November 2015

4 How can H2020 projects benefit from GÉANT?

For many researchers network connectivity is perceived as a given – it is just there as a commodity – and is able to support that vast majority of researchers' needs.

In many cases, researchers do not know the range of connectivity services that are available and there are potential opportunities that are not being exploited simply because of a lack of mutual knowledge between researchers and GÉANT/NRENs. The following provides an overview of the GÉANT Service Offering available to the R&E community.

4.1 GÉANT Services

GÉANT offers a wide range of innovative services to enhance the experience of its network. Advanced connectivity, network support and access services make life easier for NRENs, institutions, projects, researchers and students alike: GÉANT's portfolio comprises a range of aligned services that allow it to cater for the most varied and demanding needs. In addition, a complete matrix of the service portfolio from each NREN is available via [[NRENservices](#)]. The services are grouped by network, security, identity, collaboration, multimedia, storage and hosting, professional and ISP services.

4.1.1 Connectivity services – the GÉANT IP Network

Transporting data between collaborating institutions is an essential element in facilitating international projects. GÉANT is an experienced, persistent and reliable partner, chosen by many of the world's most data-intensive projects.

Access to the GÉANT network provides standard, high-bandwidth IP connectivity (GÉANT IP) of up to 100Gbps across Europe over its award-winning 500Gbps backbone. The GÉANT network also provides connections of up to 100Gbps into other world regions to support cost-effective international collaboration. This service is available to all European R&E users who are connected to an NREN. The IP service also provides up to 200Gbps of international peering to a range of public and private networks to support advanced services to NRENs.

In addition, GÉANT offers various advanced connectivity options reflecting the flexibility and security needs of its users: the options are highlighted in sections 4.1.2 to 4.1.4.

4.1.2 Specialist Connectivity Services

Many performance-critical services require guaranteed performance levels and additional security that is difficult to achieve through shared IP services. In particular, applications such as data centre backup and replication, real-time mission-critical services and broadcast quality video need the guaranteed bandwidth and low latency that only dedicated circuits separated from general IP traffic can offer.

Point-to-point services over GÉANT provide dedicated connectivity between two sites over the existing infrastructure without the cost and difficulty of building and managing a dedicated physical network. This type of connectivity can provide fixed latency between collaborating institutions, a high level of security and, if needed, guaranteed bandwidth of up to 100Gbps. Furthermore, the possibility of providing a L2 Ethernet channel end-to-end allows the use of network and transport protocol other than the classic TCP/IP, enabling users to experiment with new ways of using network connectivity. Good examples of such advanced use of the service are the SMARTfire and the InfiniCortex projects, using experimental streaming transport protocol and the InfiniBand network stack, respectively. There is also the long-lasting use in Radioastronomy and for the ITER project (linking the Cadarache facility in France to the Elios supercomputer in Rokkasho, Japan).

Many projects may require teams across Europe to be able to collaborate effectively with enhanced privacy. By creating a Virtual Private Network (VPN), all sites on the VPN can communicate without the need to arrange separate physical networks, while benefiting from the privacy and security of a private infrastructure. GÉANT can provide VPNs between many sites (i.e. multipoint-to-multipoint connections) over great distances within Europe and reach the USA (via Internet2 and ESnet), Canada (via CANARIE), and Asia (via the 10 Gbps London-Beijing or London-Singapore links).

As international and public-private partnerships grow in importance within the R&E sector, so the high-performance, flexible and neutral interconnection points provided by the GÉANT Open service can offer advantages. Users can connect their own circuits – at 1Gbps, 10Gbps or 100Gbps – and can then request interconnections with any other participant.

4.1.3 End-to-end Monitoring and Performance services

As networking becomes increasingly mission-critical to a wide range of projects, the need to monitor network performance becomes ever more important. **perfSONAR MDM** provides easy, transparent, end-to-end data network monitoring, allowing performance measurements over multiple network domains. It can operate at levels from the local to the global and is scalable to provide at-a-glance information about multiple network paths simultaneously. perfSONAR provides the information to enable network performance teams and operation centres to address performance issues for end users and resolve them quickly. perfSONAR is the result of an international collaboration of GÉANT with ESNET, Internet2 and Indiana University that allows end-to-end monitoring between sites in Europe and the United States.

Leveraging the knowledge of the whole GÉANT community, **eduPERT** engages multidisciplinary support in solving end-to-end performance issues, reducing the time needed to troubleshoot and fix such issues. It provides a forum for sharing knowledge, skills, tools and best practice in this area.

4.1.4 Identity and Trust services

eduroam is the roaming broadband service that enables students, researchers and staff from participating institutions to access the Internet across their campus and at any other participating institutions using the same log-in details as they use at their home institution without any reconfiguration or new password credentials being needed. A pioneer and leader in global roaming services, this secure and privacy-preserving technology is free-of-charge to its users. The service is already available in 36 European countries and in total 74 territories spread across all world regions including North America, Latin America, Australia, Russia and Japan.

eduGAIN enables the trustworthy and secure exchange of authentication, authorisation and identity (AAI) information. It interconnects identity federations around the world, simplifying access to content, services and resources. eduGAIN provides a pan-European Web Single Sign On (Web SSO) (i.e. a single digital identity and password) to access all services provided by the participating federations and their affiliated service providers.

Although the service was initially developed for Europe, it is a huge success worldwide. Currently 95% of production federations are members of eduGAIN (i.e. 42 of 44 federations) across the globe from the USA, Latin America, Australia, New Zealand, Japan and other countries such as Israel.

This service is of special interest for distributed infrastructures or data archives, allowing data to be retained locally while researchers access data sets from different locations via a single sign on.

4.2 GÉANT User support

GÉANT serves the European R&E community. A dedicated User Support Team provides a central contact point and works closely with R&E projects, the local NRENs and other e-Infrastructures to discuss and analyse the user's requirements and offer a tailored service solution.

4.2.1 A one-stop-shop for international users

GÉANT provides a single point-of-contact for international collaborations and organisation for the analysis, implementation and management of their total networking needs. The dedicated User Support Team can be contacted from a single email address: businessdevelopment@geant.org, and supports European researchers with their European and worldwide networking needs as well as non-European researchers wishing to collaborate with sites in Europe. The User Team also provides policy and technical consultancy for public and commercial organisations wishing to connect to GEANT.²

From solving performance issues between two sites to the development of coordinated ICT solutions with multiple e-Infrastructures, GÉANT provides dedicated networks and bespoke services covering performance monitoring, data access and security aspects.

² A detailed description of the process has been provided in the GN3plus Deliverable D4.5: Strategic Report on the GÉANT User Community (30/03/2015).

Although national R&E collaborations are well served by their respective NRENs, there is a need for central coordination for international projects and their internationally distributed users. GÉANT's User Support Team facilitates communication with the NRENs and participating stakeholders to understand their requirements, collect all necessary technical, operational and financial information and present a consolidated and consistent solution for all involved sites. To ensure a seamless service implementation and smooth operation, project and operational service management is provided throughout the whole process.

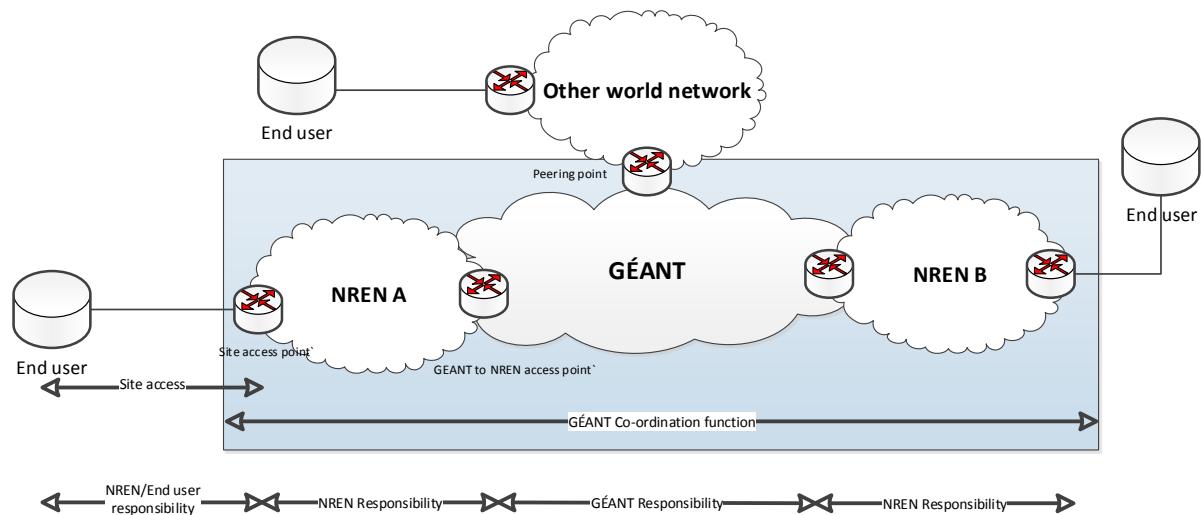


Figure 4.1: GÉANT one-stop-shop responsibilities

4.3 GÉANT User Group engagement

Via the GÉANT User Support Function, GÉANT actively engages with a broad range of user communities supporting international research projects and collaborations from areas such as High Energy Physics, Earth Observation, Meteorology, Arts & Humanities and Future Internet.

The objective is to support users in identifying suitable service solutions and coordinate their end-to-end deployment. Solutions can be manifold and may have to take into account sector-specific standards, tools, data needs, national diversities, work procedures and organisational set ups.

The following three examples provide an idea of the broad topics covered within the user support function. While these use cases focus on the use of GÉANT and NREN services, joint use cases are being added.

Use cases are described for more research communities at [\[GÉANTusers\]](#).

4.3.1 EIDA

Overview

The European Integrated Waveform Data Archive (EIDA) is a distributed data centre established to provide a secure archive for seismic waveform data and related metadata gathered by European research infrastructures [EIDA]. It provides the geoscience research community with transparent access to these archives via a single web portal. EIDA is part of the Earth Plate Observation System (EPOS), which incorporates different earth science communities.

EIDA consists of 10 data centres across Europe (in the Netherlands, Germany, Switzerland, France, Italy, Turkey and Romania) currently storing more than 300TB of data from approximately 140 networks worldwide. In each network, the data is collected by broadband sensors, short period sensors and accelerometers at over 5000 stations. Seismologists can search and download existing datasets via a single web portal. On average, a single user requests around 130 GB of data per day.

Challenge

To make the data from the different sources secure but accessible, a virtual network is set up. The network interconnects all data centres and appears as one archive to the end user. The data is stored locally and all data centres exchange metadata and routing tables. The information is updated daily.

Most of the data is, after registration, freely available via a web portal. Individual users can request data sets and download them via a desktop-client: the data is encrypted and password protected, with a new password required for each data centre. However, most user requests include data sets from multiple nodes, so multiple passwords need to be submitted every time to obtain the data.

The Geo Science community is working to enhance their international collaboration and sharing of data. As a subgroup of EPOS, EIDA is looking to expand the seismological data archive through further sites joining. It also considers the interoperability with other Geoscience communities which will be combined under the umbrella of EPOS. The underlying infrastructure and services provided by EIDA therefore need to be scalable, allowing the addition of new services in the future.

The objective is to develop a scalable AAI solution, simplifying access and data downloads while complying with seismological and security standards.

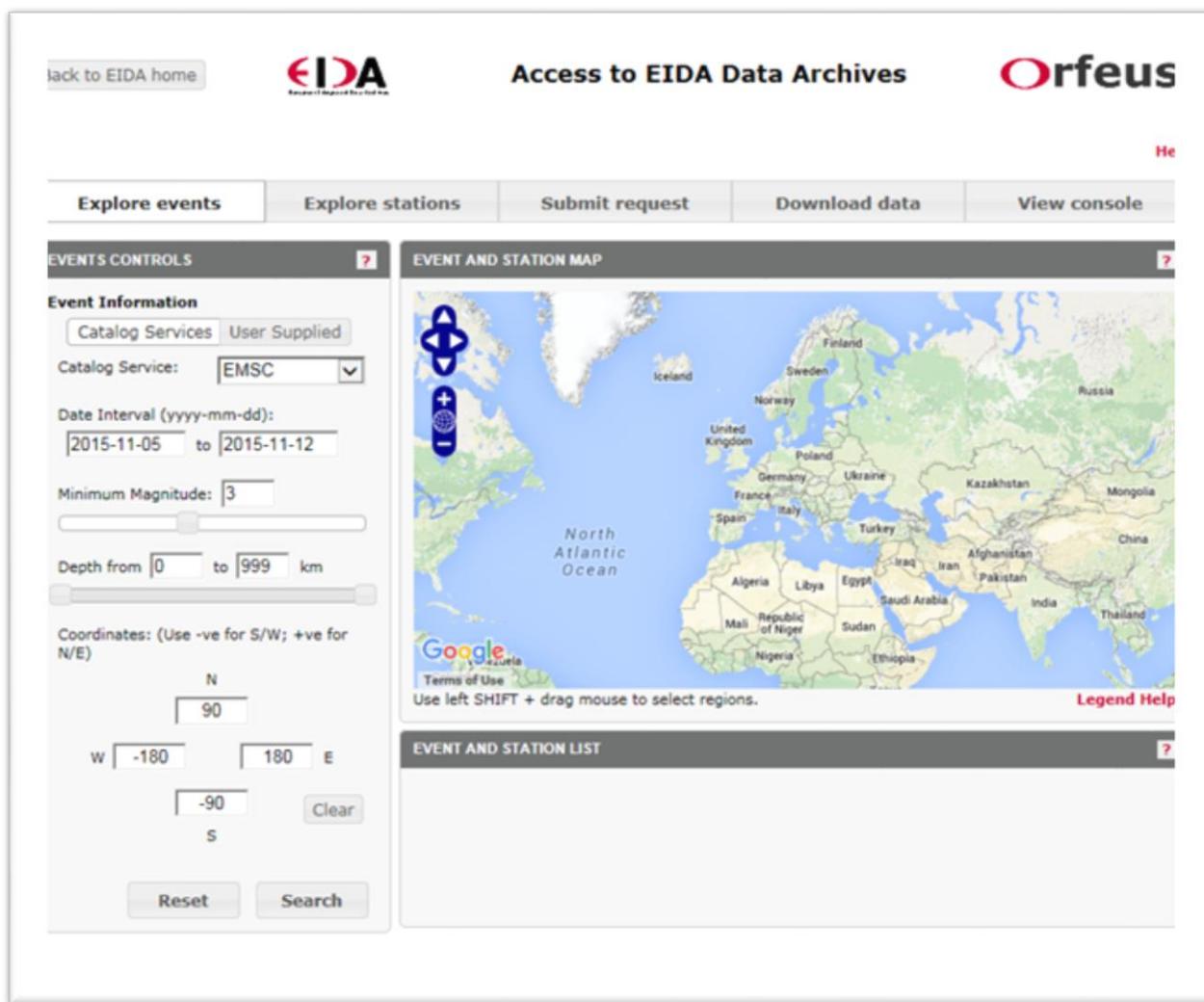


Figure 4.2: EIDA Data archive Web portal, November 2015

Solution

An initial assessment showed that all EIDA sites were connected to the GÉANT network but only one site was already part of an Identity Federation. Starting in January 2015, GÉANT worked closely with EIDA to examine their federated identity management requirements.

The role of GÉANT was to gather the requirements, assess the current status, scope the work required, identify a suitable AAI service solution and to develop a roadmap for its deployment. The GÉANT User Support and the GÉANT AAI experts agreed with EIDA on a three-step approach:

- Integrate single nodes into a national Identity Provider and eduGAIN.
- Set up an Identity Provider for GFZ, the main node of EIDA located in Potsdam, Germany.
- Develop a service provider prototype allowing access to all data sets using the same credentials and download the data sets via the desktop client.

By November 2015, seven out of ten EIDA nodes were integrated into their national IdP and eduGAIN. The Service Provider Prototype has been developed and accepted for rollout to the remaining EIDA nodes.

Benefits

GÉANT supported EIDA to enable federated access for all European data centres and integrate them into eduGAIN while complying with seismological standards. This allows seismologists to use a single password for all data requests. The solution is scalable and allows the extension to further seismological data centres and the integration of other Geoscience communities.

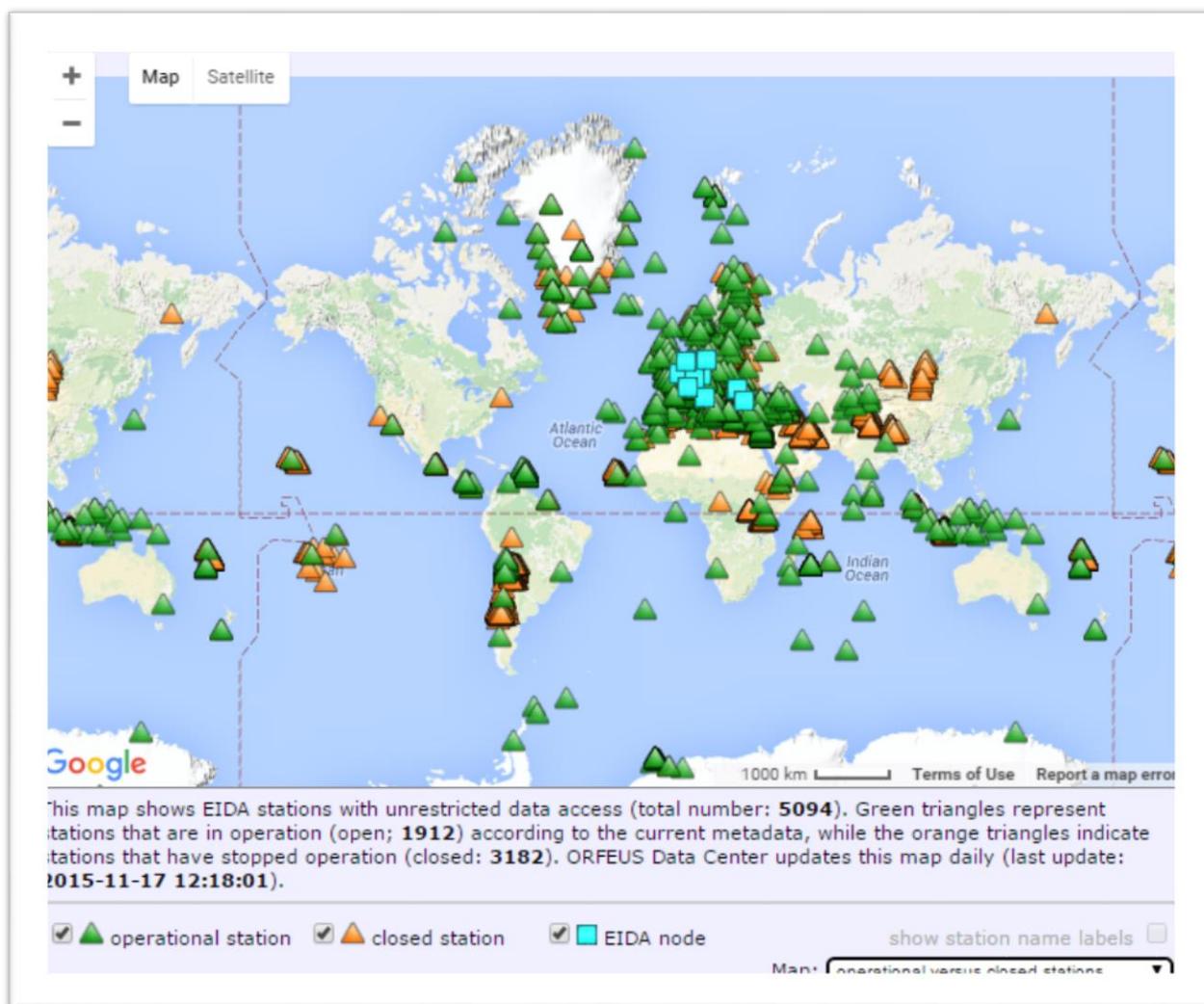


Figure 4.3:Map showing EIDA stations with unrestricted data access

4.3.2 EUMETCast

Overview

EUMETSAT (Europäische Organisation für meteorologische Satelliten) is an intergovernmental not-for-profit organisation that supplies weather and climate-related satellite data, images and products. It operates a system of meteorological satellites gathering accurate and reliable satellite data on weather, climate and the environment 24-hours a day, 365-days a year.

EUMETCast is EUMETSAT's primary data dissemination service. The collected data is sent to the National Meteorological Services of Member States in Europe and to other users worldwide. Established in 2004, EUMETCast has more than 4,000 registered users. EUMETCast is the European component of GEONETCast, the global network of satellite-based data dissemination systems coordinated by GEO.

Challenge

Data from EUMETSAT's fleet of weather and climate monitoring satellites needs to be simultaneously transmitted 24/7 in near real-time to a large number of distributed end users across Europe and beyond. To ensure stable and reliable data access both EUMETSAT and the end users need to be able to closely monitor the data flow and rely on the highest levels of support.

Solution

Following careful analysis of dissemination methods, EUMETSAT identified satellite multicast – with its high levels of reliability and service – as the most attractive solution. Multicast sends data over the IP infrastructure of a network from one data source to multiple end-sites at the same time. Satellite multicasting over a terrestrial network infrastructure (for example via the GÉANT network) therefore offered EUMETSAT with a complementary method of dissemination that is considered far more appropriate for their requirements than other protocols or the Internet.

In early 2015, the first phase of EUMETCast – EUMETSAT's Terrestrial Demonstration service – was established. The data is simultaneously transmitted via IP multicast from EUMETSAT HQ in Germany to multiple client sites across Europe, using the infrastructure and services provided by GÉANT and the NRENs. EUMETSAT end users are able to access the service via their respective NREN and with EUMETCast expected to reach 31 European countries by 2018, the value of GÉANT's pan-European network is clear to see.

Throughout the implementation process, GÉANT acted as a single point-of-contact and coordinator for EUMETSAT and the NRENs.

GÉANT further supported the implementation of EUMETCast with the provision of a centralised network operations and network management service. This includes a custom monitoring and reporting platform together with first level support, including the resolution of anomalies between the involved network operations centres (NOCs).

Benefits

The EUMETSAT and GÉANT collaboration has resulted in an integrated, reliable and highly scalable service solution, including a proof-of-concept, feasibility study and the EUMETCast Demonstration service with user stations in Europe, the USA and Korea.

GÉANT provided a highly scalable network and network management service enabling EUMETSAT to easily add new European end users, while accommodating future plans to extend the service to non-European sites (for example in Africa and Australia). This solution was provided over the existing network infrastructure, with the benefit of an established near real-time network monitoring system and the highest levels of support from GÉANT and the involved NRENs, via a single point of contact.

4.3.3 SMARTFire

Overview

The SMARTFire project [[SMARTFire](#)] is one of the Future Internet (FI) projects. It is an EU-South Korea collaboration aimed at building a shared large-scale infrastructure federating and expanding existing FI testbeds in Europe and South Korea. The platform enables research on advanced wireless technologies, exploring SDN, innovative network protocols, OpenFlow, etc.

The project was funded under the Seventh Framework Programme for a duration of 26 months, from November 2013 to December 2015.

Challenge

The requirement for the project was to have Layer 2 connections between the sites, as the need was to explore the use of network and transport protocols other than TCP/IP. The bandwidth was not a critical factor, since the traffic between the sites was mainly control-plane data, so the estimated volume was below 1 Gbits/s. The sites participating in the testbed were:

- University of Murcia, Spain.
- Korean Advanced Institute of Science and Technology (KISTI), South Korea.
- Seoul National University (SNU), South Korea.
- iMinds, Belgium.
- University of Thessaly, Greece.

The connection of sites in South Korea was complicated by the fact that they were connected to different NRENs (KISTI is connected to KREONET; SNU is connected to KOREN), and the NRENs do not peer between themselves, so there was the need to establish two different multi-domain network paths.

Solution

After a requirements analysis performed with the project coordinators, the proposed solution was to establish two separate intercontinental L2 end-to-end circuits, using the GÉANT Plus service on the segment of the path covered by the GÉANT network, i.e.:

- University of Murcia, Spain to the KISTI, South Korea.

- University of Thessaly, Greece to SNU, South Korea.

The first circuit was established from RedIRIS through GÉANT, then to Internet2 through the StarLight Internet Exchange, then to KREONET. For the second circuit, the solution was simpler, since KOREN is a partner of the TEIN network. The circuit was established from GRnet to KOREN, via the Madrid-Mumbai link from GÉANT to TEIN.

The role of GÉANT was not only to gather the requirements and deploy the solution on the GÉANT network, but also to coordinate the activity among all the partners (i.e. the end sites, NRENs and project coordinators).

Benefits

GÉANT has provided a complete end-to-end solution for the SmartFIRE project, allowing them to make full use of the service for the life of the project. This solution was deployed over the existing network infrastructure, with no additional costs for the users or the NRENs, since there was no requirement for reserved capacity. Using the GÉANT Plus service allowed the use of existing ports on the routers, avoiding any port fees.

5 Towards an integrated European ICT Ecosystem

5.1 The e-Infrastructure landscape in H2020

The current landscape of e-Infrastructures is composed of network, computing and data infrastructures, along with other services such as instrumentation, software and middleware. These include authentication and authorisation infrastructures and support and collaboration tools. A written description of the landscape has been provided by the e-IRG (the e-Infrastructure Reflection Group), see Appendix A.

Networking infrastructure

As previously noted, GÉANT is the pan-European R&E Network and provides a high performance network infrastructure supporting connections across 43 European countries interconnecting Europe's National Research and Education Networks (NRENs). In addition, it provides international connections to partner networks worldwide enabling international R&E collaboration.

Computing infrastructures

The most well-established Pan-European computing infrastructures are the European high throughput computing and federated cloud infrastructures within the European Grid Infrastructure (EGI)³ and the HPC infrastructure represented by the Partnership for Advanced Computing in Europe – (PRACE)⁴, respectively operated by the organisations EGI.eu and PRACE aisbl. While EGI focuses on high-throughput computing and cloud computing, PRACE offers access to world-class high performance computing facilities and services.

EGI and PRACE offer complementary access modes. PRACE resources are allocated twice a year, based on a unified peer-review process. EGI provides solutions both for the federation of the Research Infrastructures data and compute services, and the access to externally provided resources using various access models. Both infrastructures often have national partners: these are in the form of NGIs (National Grid Initiatives) for EGI and governmental representative organisations for PRACE. In some countries, the national partners are the same for EGI and PRACE, in other countries they are not.

³ <http://www.egi.eu/>

⁴ <http://www.prace-ri.eu/>

Both e-Infrastructures are ready to talk with consortia that prepare a large-scale research infrastructure to understand needs and find out how this matches with their policies, or if it may require a policy change. Besides EGI and PRACE, the Helix Nebula Initiative⁵ has created a federated cloud services marketplace while GÉANT also provides cloud services via the NRENs. There are also many cloud-related national initiatives that aim to support large European research infrastructure on a country-wide or region-wide scale.

Data infrastructures

Data infrastructures are less well established compared to the basic networking and computing infrastructures in the European scene. However, significant steps have been made in the areas of lower-level data services (such as storage and replication) through the EUDAT project and access to publications and other research outputs through the OpenAIRE projects⁶. In addition, much effort is going into the definition and development of common or interoperable data formats, metadata and data management services to facilitate data sharing and interoperability.

The current undertakings aim at the evolution of an e-Infrastructure ecosystem with the appropriate technical and social channels for openly sharing data at a multidisciplinary and global level. Sharing activities are part of the Research Data Alliance (RDA) initiative, a bottom-up organisation with constituents in different regions (such as RDA Europe⁷) and countries, composed of Working and Interest Groups. The goal of RDA is to accelerate international data-driven innovation and discovery by facilitating research data sharing and exchange. This is achieved through the development, adoption, and deployment of infrastructure, policy, practice and standards.

Middleware, tools and related infrastructures

The basic e-Infrastructure services need to be expanded with other services and can include instrumentation, software and middleware services. Examples are collaboration tools and authentication and authorisation infrastructures.

In the highly distributed and mobile world of high capacity and easy network access, researchers freely collaborate across national boundaries. In this environment, research communities need to manage access to their services from participants in many organisations, and individual researchers need to access multiple tools, services and datasets easily and securely. Trust and identity therefore take up a pivotal position as a dedicated layer in the e-Infrastructure eco-system.

Federated Authorisation and Authentication Infrastructures (AAI) simplify access to inter-organisational resources required by the modern researcher, allowing controlled and secure access to diversely located resources. This provides researchers with a trustworthy environment that preserves the integrity of their work without compromising their flexibility.

Federated Authorisation and Authentication Infrastructures (national identity federations and eduGAIN), access services infrastructures (eduroam), digital certificates (PKI), security (CERT) and other related services have all been developed to a high state of maturity within GÉANT. Together, these trust and identity infrastructures form a layer connecting the power of the network with

⁵ The Helix Nebula initiative is a collaboration between CERN, ESA, EMBL and a number of commercial cloud service providers to define a cloud service suitable for science and research. Details are available at <http://www.helix-nebula.eu/>

⁶ <https://www.openaire.eu/>

⁷ <http://europe.rd-alliance.org/>

computing infrastructure and the value of data infrastructure. The Middleware layer is an essential building block to achieve the vision of a truly open, trustworthy and secure European Research Area (ERA).

Details on the individual e-Infrastructures are available at [\[eIRGbestpractice\]](#).

5.2 Collaboration between e-Infrastructures

During 2013, the EIROforum published several papers pointing the way forward for a sustainable e-Infrastructure.^{8,9} Among those documents, was a paper entitled “Implementation of a European e-Infrastructure for the twenty-first Century”¹⁰. This idea has been discussed in several fora including the e-IRG workshops and delegates meetings. Representatives of several of the major e-Infrastructure providers have used the opportunity of the e-IRG meetings to intensify cooperation among participants. This has resulted in a number of initiatives including:

- e-Infrastructure – Earth Sciences Workshop in January 2015, jointly organised by users and e-Infrastructures. The two-day workshop was organised by GÉANT with EGI, PRACE and EUDAT, with help from EIDA (a research infrastructure for seismologists), EPOS and KNMI. It included researchers from satellite data, computational seismology, climate, the British Geological Survey, EIDA, EPOS and solid earth science. The workshop covered Identity management, Data management and computing, and Cloud Services. It provided an in-depth knowledge exchange and identified practical support activities in all areas.
- European Open Science Cloud (OSC) for Research, organised by EUDAT, LIBER, OpenAIRE, EGI and GÉANT. These e-Infrastructures have collaborated on a joint position paper and the organisation of an OSC workshop held in Bari, Italy on 13 November 2015. More workshops are planned during the course of 2016 in order to define the meaning, challenges and opportunities presented by the OSC. One of the key challenges and objectives is making progress towards the e-Infrastructure commons whose essential component is a common service catalogue.
- A joint e-Infrastructure user forum event each autumn is proposed by EGI, EUDAT, GÉANT, OpenAIRE and RDA. This event would be the first to involve the broader scientific community and the e-Infrastructures. It draws on the experience of the successful Earth Sciences workshop. The planning for the first of its kind is underway and is planned to take place in Autumn 2016.

These collaborative initiatives will continue throughout 2016 in order to strengthen the coordination between e-Infrastructures to meet user needs. To ensure a coordinated and systematic approach to the different activities across GÉANT, a dedicated Task will be established in the International Business Development Activity (NA4) in the GN4-2 project.

⁸ <https://cds.cern.ch/record/1550136/files/CERN-OPEN-2013-017.pdf>

⁹ <https://cds.cern.ch/record/1550136/files/CERN-OPEN-2013-018.pdf>

¹⁰ <https://cds.cern.ch/record/1562865/files/CERN-OPEN-2013-019.pdf>

6 How can H2020 projects access GÉANT and other e-Infrastructure services?

As gateway to reach the other e-Infrastructures, GÉANT is the foundational element and first address for users to benefit from the European ICT ecosystem. If a current or prospective H2020 project wishes to take advantage of the services that the e-Infrastructures, GÉANT and the NREN community have to offer, there are different ways of finding out how they can do it. Most R&E organisations, as well as an increasing number of public institutions and offices are connected to their local NREN. Project teams can find this out by either contacting their IT department or their local NREN (if known) to establish whether the host institution is already connected and what services are available to it.

As an industry partner it might also be possible to connect either to a local NREN for the duration of the project, or directly to GÉANT via GÉANT Open.

In common with other telecommunication services and infrastructures, access and use of the GÉANT network and National Research and Education Networks are governed by Connection Policies (CPs) and Acceptable Use Policies (AUPs). For the GÉANT network the policies are contained within the GÉANT Open documentation at [\[GEANTcps\]](#).

The European NRENs each set their own policies independently to take account of local needs and conditions. As a consequence, there is variation in what is allowable in different European countries. Links to the AUPs of many NRENs can be found at [\[NRENaups\]](#). There are currently discussions and work to develop consensus and consistency in this area.

The GÉANT User Liaison Team can be contacted directly (via: business-development@GÉANT.org). The User Liaison Team can help with initial orientation by identifying requirements and key contacts and by facilitating the initial discussions. A dedicated user account manager is assigned to coordinate further support activities.

7 Conclusion

GÉANT plays an important role for H2020 projects, providing the foundation on which data driven research activities are carried out. Being part of the GÉANT community offers researchers a wealth of services and possibilities for their collaboration that they can benefit from straight away. GÉANT extends this foundation to the other e-Infrastructures, helping users to access these services in a reliable and efficient manner.

The GÉANT user support team provides the first point-of-contact for researchers wishing to benefit from these services. Experts work closely with each user group providing technical, managerial and policy advice to build an integrated, tailored service solution. Throughout the service implementation and after, the user team provides consultancy to ensure smooth transitions and to check that the service offerings continue to be the most suitable. The GÉANT User Support Team plays a crucial role in this endeavour, helping to orientate users in the e-Infrastructure landscape through outreach activities, joint user events, personalised user support and general information

GÉANT and the e-Infrastructures as a whole are a fundamental part of the H2020 initiative. H2020 sets out to bring the e-Infrastructures closer together by providing the framework for a single coherent service offering to researchers.

Appendix A e-Infrastructure Reflection Group

The e-Infrastructure Reflection Group (e-IRG) mission is to pave the way towards a general-purpose European e-Infrastructure. The objectives of the e-IRG were originally drafted in the e-IRG Meeting in Lugano, Switzerland in 2008.

The vision for the future is an open e-Infrastructure enabling flexible cooperation and optimal use of all electronically available resources.

Objectives

- To identify fundamental fabrics, services, and resources needed to enable pan-European e-Science.
- To recommend resource sharing policy guidelines to:
 - National Grid Initiatives.
 - Other regional and European e-Infrastructure projects.
 - Contribute to international policy forums.
 - Give input to other policy bodies e.g., ESFRI (European Strategy Forum on Research Infrastructures) and NRENs.
- To focus at first on eScience application user groups (as enablers of novel architectures), but also to address wider application domains (e.g. eLearning, eGovernment, eHealth, eCulture, eBusiness) within the ERIA (European Research and Innovation Area).
- To identify, inform and promote Grid awareness among communities who can benefit from sharing resources.
- To address Governance issues of Grid deployment.
- To draw upon the experience of the NREN community (Structure, Operations, Acceptable Use Policies).

A.1 Structure

The e-IRG is formed by official delegations of ministries of science from various European countries; the current list of delegates is given at [\[eIRGdelegates\]](#). The e-IRG also coordinates activities with international initiatives outside of Europe. The e-IRG Bylaws structure is described in detail in the [\[eIRGbylaws\]](#). It:

- Consists of appointed Member, Accession and Associated States Representatives, and officials from the European Commission.
- The executive board consists of a chair elected by the members, and three board members representing the rotating EU Presidency (past, current and future presidencies each deliver one board member; see the e-IRG Executive Board below.
- Operational support provided through the European Commission by means of the e-Infrastructure Reflection Group Support Programme 4 (e-IRGSP4) [eIRGsp4].

e-IRG Executive Board

The current e-IRG Executive Board is listed at [[eIRGboard](#)]. The e-IRG regularly delegates work to Task Forces and is sometimes officially represented in external Task Forces and committees.

References

[EGI]	http://www.egi.eu/
[EIDA]	http://www.orfeus-eu.org/eida/eida.html
[eIRGbestpractice]	http://e-irg.eu/documents/10920/277005/Best+Practices+for+the+use+of+e-infrastructures+by+large-scale+research+infrastructures.pdf/9fff8e66-b00e-4e29-949a-9da4800045d9
[eIRGboard]	http://e-irg.eu/board
[eIRGbylaws]	http://e-irg.eu/bylaws
[eIRGdelegates]	http://e-irg.eu/delegates
[eIRGsp4]	http://e-irgsp4.e-irg.eu/
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[GEANTcps]	http://www.geant.org/Services/Connectivity_and_network/Pages/GEANT_Open.aspx
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[OpenAIRE]	https://www.openaire.eu/
[PRACE]	http://www.prace-ri.eu/
[SMARTFire]	http://eukorea-fire.eu/

Glossary

AAI	Authentication Authorisation and Identity
CANARIE	Canadian Network for the Advancement of Research, Industry and Education
CERN	European Organisation for Nuclear Research (Conseil Européen pour la Recherche Nucléaire)
EaP	Eastern Area Partnership
EGI	European Grid Initiative
EIDA	European Integration Waveform Data Archive
e-IRG	e-Infrastructure Reflection Group
e-IRGSP4	e-Infrastructure Reflection Group Support Programme 4
EMBL	European Molecular Biology Institute, Germany
EMBL-EMI	European Bioinformatics Institute, UK
EPOS	Earth Plate Observation System
ERA	European Research Area
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESnet	(US) Energy Sciences Network
EUDAT	European Data Infrastructure
EUMETCast	EUMETSAT's primary data dissemination service
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites, Germany
H2020	Horizon 2020, a seven-year EU Research and Innovation programme
Helix Nebula	A partnership between science and business in Europe to develop and promote the sustainable provision of cloud computing – The Science Cloud
HPC	High Performance Computing
IUAC	GÉANT International User Advisory Committee
KNMI	The Royal Netherlands Meteorological Institute (Koninklijk Nederlands Meteorologisch Instituut)
LHC	Large Hadron Collider
LIBER	Association of European Research Libraries (Ligue des Bibliothèques Européennes de Recherche)
NGI	National Grid Initiative
NREN	National Research and Education Network
OpenAIRE	A network of Open Access repositories, archives and journals that support Open Access policies
OSC	(European) Open Science Cloud
PPP	Public-Private Partnerships
PRACE	Partnership for Advanced Computing in Europe

R&E	Research and Education
RDA	Research Data Alliance
SDN	Software-Defined Networking
SME	Small and Medium-sized Enterprises
TEIN	Trans-Eurasia Information Network