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Deliverable DS1.3.2,3: Annual Advanced Services Usage Report

Deliverable DS1.3.2,3

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Abstract

This deliverable reports on the take-up and usage of GÉANT's advanced services, GÉANT Plus and GÉANT Lambda, during Year 3 of the GN3 Project. It introduces each service and the End-to-End Coordination Unit (E2ECU) that supports their operation, and provides figures for new point-to-point links delivered, the overall status of advanced services, and the E2E circuits and outages managed by the E2ECU.

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Executive Summary

GÉANT is a hybrid network, combining the operation of a shared Internet Protocol (IP) infrastructure with the ability to provide additional dedicated point-to-point links reserved exclusively for particular user groups.

GÉANT's point-to-point services, GÉANT Plus and GÉANT Lambda, optimise the latest developments in technology and the telecommunications market to meet an ever-growing demand from the user community, not only for a high-capacity network, but also for guaranteed availability and performance. The point-to-point services offer circuits of between 1 Gbps and 10 Gbps (support for 40 Gbps is available, but has not been requested to date) that provide dedicated, guaranteed network capacity to the user group concerned, ensuring reliable, secure, high-bandwidth, end-to-end (E2E) connectivity.

GÉANT's point-to-point circuits are offered between National Research and Education Networks (NRENs) in Europe where it has been possible to procure at an affordable price the necessary network infrastructure – usually dark (unlit) fibre optic cables on which circuits can be incrementally added as demand requires.

A total of 14 new point-to-point circuits were delivered on the GÉANT infrastructure during Year 3 (1 April 2011 to 31 March 2012). These supported 7 named projects (namely GEYSERS, GreenStar Network, PRACE (formerly DEISA), FEDERICA, JIVE, OFELIA and LOFAR) as well as 4 circuits for generic NREN usage unrelated to specific projects. Of the 14 circuits, 10 were GÉANT Plus links ranging from 155 Mbps to 2 Gbps and 4 were 10 Gbps GÉANT Lambda.

13 links from the overall total of installed links were cancelled, 2 of which were GÉANT Lambda and the remainder GÉANT Plus. Reasons include projects coming to an end (e.g. Phosphorus) and consolidation of circuits, such as GreenStar Network combining their 3 smaller bandwidth circuits into 1 new 1 Gbps circuit. Other terminations were the result of DANTE focusing effort in Year 3 on encouraging NRENs to cancel officially circuits that are no longer required, to enable more circuits to use the available GÉANT Plus and GÉANT Lambda capacity. In addition, 1 circuit was moved to a more optimal path for the NREN, which necessitated a cancellation/new order process being followed; some circuits for DEISA have simply been renamed to show the new PRACE project name.

The total number of GÉANT Plus and GÉANT Lambda links in use at Year 3 end was 68 (45 GÉANT Plus, 23 GÉANT Lambda). The FEDERICA and LHC projects have the most circuits with 14 and 11 circuits respectively, followed by AutoBAHN (8) and DEISA / PRACE (8 circuits). The ongoing effort to test and support AutoBAHN is part of the GÉANT project itself and, together with the end-user projects on whose behalf the NRENs have requested circuits, is a direct beneficiary of GÉANT advanced services.

The total of 68 excludes wavelengths used either to pre-provision extra GÉANT Plus capacity or to provide IP trunks between GÉANT backbone routers. It also excludes Layer 2 Virtual Private Networks (L2 VPNs, also known as Label Switched Paths (LSPs)); DANTE implemented 2 new L2 VPN circuits, for the GEYSERS project, in Year 3.

A new type of service has been provided to NRENs this year, namely connections from NRENs to the Layer 3 VPN service for the Large Hadron Collider Open Network Environment (LHCONE). LHCONE is designed to connect the LHC Tier 1 and Tier 2 sites using Border Gateway Protocol / Multi-Protocol Label Switching technologies.

The End-to-End Coordination Unit (E2ECU) is in place to provide coordination and monitoring for a subset of these point-to-point circuits, namely, those that are multi-domain, across all the various networks. During Year 3, the E2ECU tracked the resolution of 534 incidents such as connectivity problems, circuit monitoring faults and planned maintenance. Whilst some of these tickets reflect valid connectivity faults successfully captured using the E2EMon tool, there are still several occasions where the E2EMon system and associated NREN-created and maintained scripts are generating “false alarms”. A review is being undertaken of the E2EMon software package and the related E2ECU function, to ensure resources are being deployed appropriately.

Year 3 saw the planning, setup and launch, in collaboration with GN3 Service Activity 2 Multi-Domain Services (SA2), of the Multi-Domain Service Desk (MDSD), which offers comprehensive one-stop-shop support to handle general queries for multi-domain services and technical assistance for multi-domain tools. Complex queries are escalated to various Subject Matter Experts within SA2.

Planned service developments for advanced services include the ongoing enhancement of the website for NREN partner users, the Partner Portal, to add information on new GÉANT services and to integrate it with other system tools to provide a real “one-stop shop” for account management.

In addition, DANTE and several NRENs are continuing to work with GN3 Service Activity 2 (Multi-Domain Services) to formalise the provision of services under the umbrella of Multi-Domain Static Wavelength Service and the increasingly popular Bandwidth on Demand service. This will help ensure that all the participating organisations agree to the same Service Level Specification, and work to the same Operating Level Agreements and service metrics.

This deliverable reports on the use of advanced services during Year 3, and their status as at Year 3 end. As such it is a snapshot of ongoing achievements and of the planned developments that will help to realise fully the services’ many potential benefits.

1 Introduction to Advanced Services

Optimising the latest developments in technology and the telecommunications market, the GÉANT network offers the European research and education community a unique range of opportunities for international collaboration. In addition to the standard service, known as GÉANT IP, which provides access to the shared European Internet Protocol (IP) research and academic network, advanced services are available, delivering international point-to-point network connections free from the constraints inherent in a shared, routed infrastructure. Foremost among the advanced services are GÉANT Plus and GÉANT Lambda. Each of these is described below. (A description of the standard service, GÉANT IP, is included to provide a context for the advanced services; the remainder of the deliverable is concerned with the advanced services only.)

For a map of the GÉANT network, see "GÉANT Topology Map 2012" [TopologyMap]. For a more detailed description of GÉANT's services, see "Deliverable DN4.2.1: GÉANT Services Portfolio" [DN4.2.1].

1.1 GÉANT IP Service

1.1.1 Overview

The standard service, known as GÉANT IP, provides access via the GÉANT network to the shared European Internet Protocol (IP) research and academic network. It offers a robust, high-bandwidth solution to the international connectivity requirements of the majority of academic users, allowing transit for IP traffic between European NRENs, and between European NRENs and associated networks globally. Part of the European research and education backbone, the GÉANT IP network is over-provisioned by design, to allow small-to-medium-sized traffic flows an uncongested path. The IP service is resilient in the case of hardware failure or fibre cuts, and uses advanced routing equipment to ensure fast recovery from unexpected events.

GÉANT IP access is available to members of the GÉANT consortium at capacities of up to 20 Gbps (subject to technical and commercial considerations) and is paid for by an annual subscription. Access can be given to non-consortium NRENs by special agreement.

1.1.2 Features

GÉANT IP provides the following features:

- A standard “best effort” IP service, i.e. with no bandwidth or performance guarantee between any communicating pair of addresses.
- Dual-stack (IPv4 and IPv6) core backbone based on packet-switching routers. The provision of IPv6 services means that GÉANT IP forms part of the world’s first global next-generation Internet network.
- Multicast enabled, efficiently delivering data traffic in both one-to-many and many-to-many scenarios.
- Layer 2 Virtual Private Network (L2 VPN) facility, built on the common IP infrastructure yet appearing to the user as a dedicated protected circuit. Configured using Multi-Protocol Label Switching (MPLS) and including multi-domain VPNs. Delivery time is one week. There is no extra charge for GÉANT L2 VPN services.
- Backup protection against circuit failure at up to the full subscribed bandwidth on an appropriate interface is included in the standard IP subscription. Alternative dedicated backup capacity is available to those NRENs on the fibre cloud, as part of their GÉANT Plus subscription (see Section 1.2.1 below).
- IP peering. Transit for IP traffic is offered to a defined set of NRENs and networks beyond the area covered by the GÉANT backbone and partner networks.
- Physical interface types range from T3 (34 Mbps) to STM-64 or 10 GE (10 Gbps, or multiples thereof, subject to technical and commercial considerations.
- Setting up a new connection from an NREN to the GÉANT IP network is a bespoke activity; delivery time will depend on NREN requirements.

1.2 Advanced Services

Although GÉANT is over-provisioned by design, unmanaged flows above 1 Gbps introduce the risk of impacting other traffic on the GÉANT IP network and causing congestion. The GÉANT point-to-point advanced services offer circuits of between 1 Gbps and 10 Gbps that avoid congestion and provide uncontended bandwidth over the GÉANT domain. (40 Gbps wavelengths have been implemented in the backbone to support IP services, but to date no NREN has requested 40 Gbps as a point-to-point service.)

GÉANT offers two distinct classes of point-to-point services to NRENs who require dedicated international circuits for their users: GÉANT Plus and GÉANT Lambda. The principal benefits of each are identical: they provide dedicated, guaranteed network capacity to the user group concerned, ensuring reliable, secure, high-bandwidth, point-to-point connectivity.

1.2.1 GÉANT Plus

1.2.1.1 *Overview*

The GÉANT Plus service allows NRENs to request point-to-point circuits of between 155 Mbps and 10 Gbps across an existing network of pre-provisioned links. It provides a reliable, high-speed, secure, end-to-end service with guaranteed bandwidth. GÉANT Plus is built on common infrastructure, but appears to its private users to be dedicated to that user’s needs, thus combining the privacy and availability of a private circuit with the cost efficiency and robustness of a shared, managed infrastructure.

The service provides the NREN with up to 10 Gbps of pre-provisioned point-to-point capacity between the GÉANT Point of Presence (PoP) in its own country and other GÉANT PoPs connecting similarly subscribing NRENs. Because the capacity is provisioned in advance, circuits can be implemented or reconfigured at short notice and without incremental cost to the NREN (provided the NREN subscription or interface is not full; if it is full, a new interface can be ordered, at a cost to the NREN and with the appropriate lead time). The circuits can also be extended across the Atlantic.

This capacity can be used to provide connections dedicated to individual research and education projects, particularly those with participants in multiple locations who wish to collaborate as if they were operating on the same local network.

The GÉANT Plus service is paid for by an annual subscription, which secures a 10 Gbps circuit capacity allocation to the NREN.

Additional capacity and interfaces are available.

1.2.1.2 *Features*

GÉANT Plus provides the following features:

- Dedicated sub-wavelength point-to-point circuits configured over a network of dark fibre[1] 10 Gbps trunks and Time-Division Multiplexed (TDM) switches.
- Circuits can be provided to the NREN at a granularity of 155 Mbps (VC4) up to a total of 10 Gbps (64 x VC4).
- Each NREN subscribing to the service is allocated 10 Gbps of circuit capacity, which may be used flexibly for different services to multiple locations.
- The 10 Gbps capacity allocation is fixed, regardless of the capacity of physical interfaces.
- Each NREN subscribing to the service is provided with access to the circuit on a single dedicated 10 Gigabit Ethernet (GE) or STM-64 interface on the GÉANT equipment at the national GÉANT PoP, as agreed by DANTE and the NREN.
- A circuit can be configured or reconfigured on the GÉANT plus interface within five working days of receipt of request, assuming that sufficient capacity is available in both the subscribing NRENs' capacity allocations.
- Circuits may be configured for any specified service period.
- Circuits can be established between many European NRENs and from many European NRENs to a non-GÉANT organisation/destination, such as those behind Internet2, ESnet, CANARIE and USLHCnet. The transatlantic E2E links use existing 10 Gbps circuits between New York and various points in Europe.
- A further 10 Gbps of capacity on a new interface can be provided at a fixed annual cost.

[1] GÉANT Plus subscriptions are usually only applicable to NRENs where the GÉANT backbone infrastructure supports multiple wavelengths. In most cases, this is over a dark fibre connection.

1.2.2 GÉANT Lambda

1.2.2.1 *Overview*

The GÉANT Lambda service provides private, transparent 10 Gbps wavelengths between GÉANT NRENs. (40 Gbps wavelengths have been implemented in the backbone to support IP services, but to date no NREN has requested 40 Gbps for GÉANT Lambda.) It is only available to NRENs connected to the GÉANT dark fibre cloud.

The GÉANT Lambda service is paid for by an annual flat-rate fee for each 10 Gbps wavelength deployed.

1.2.2.2 *Features*

GÉANT Lambda provides the following features:

- Transparent 10 Gbps wavelengths between transmission equipment in GÉANT PoPs.
- Two standard interface types are available: 10 GE or STM-64.
- Circuits can be configured with one of the following optics, specified at each NREN interface and provided by GÉANT: 10GBaseLR (1310 nm), intra-office STM-64 (1310 nm), or short-reach STM-64 (1550 nm).
- If dissimilar interface types are required on each end of a single 10 Gbps circuit, this can be accommodated using the GÉANT MCC switching equipment.
- A Lambda takes up to ten weeks to establish, due mainly to the lead time for the GÉANT optical equipment.
- An additional charge is raised to cover the cost of each Lambda requested.
- A Lambda can be used as part of an E2E link, and in conjunction with a partner organisation, to connect to a non-GÉANT organisation/destination.
- If protection against fibre cuts or equipment failure is required, a full 10 Gbps back-up Lambda can be provided on an alternative, resilient route. This secondary Lambda will be configured over a fully diverse path to the specified primary Lambda.

1.2.3 Dark Fibre Dependency

The provision of point-to-point services is dependent on the use of dark fibre for the underlying infrastructure. For reasons relating to the availability and/or economic viability of dark fibre, it is not possible to offer point-to-point services to all GÉANT-connected NRENs.

2 Use of Advanced Services in Year 3

2.1 Overview

14 new point-to-point links were delivered in Year 3 of GN3 (1 April 2011 – 31 March 2012): 10 GÉANT Plus and 4 GÉANT Lambda. This compares with 9 delivered during the previous year (Year 2). All the links were in addition to those ordered and delivered in previous years. 13 links were cancelled (11 GÉANT Plus, 2 GÉANT Lambda), bringing the total number of links in use at Year 3 end to 68 (45 GÉANT Plus, 23 GÉANT Lambda).

This section summarises the new links delivered in Year 3 and provides statistics for the total number of links in use as at Year 3 end. Further information about the projects is given in Appendix A “Projects” on page 21.

2.2 New Links

Table 2.1 shows all new point-to-point links delivered in GN3 Year 3, sorted by Project.

SRF No.[1]	Bandwidth assigned (approx.)	A-End Domain	B-End Domain	Project	Production Date[2]	GÉANT Plus / Lambda
11-002	1 Gbps	RENATER	PIONIER	GEYSERS	2011-07-13	Plus
11-003	10 Gbps	NORDUnet	NORDUnet	NREN-BBEXT[3]	2011-06-30	Lambda
11-004	10 Gbps	NORDUnet	NORDUnet	NREN-BBEXT[3]	2011-06-30	Lambda
11-006	10 Gbps	CESNET	StarLight	NREN-MISC[4]	2011-12-01	Lambda
11-007	1 Gbps	JANET	PIONIER	GEYSERS	2011-10-03	Plus
11-008	1 Gbps	HEAnet	CANARIE	GreenStar Network	2011-11-07	Plus
11-010	10 Gbps	DFN	PSNC	PRACE	2012-03-28	Lambda
11-011	1 Gbps	JANET	SURFnet	LOFAR	2012-01-04	Plus
12-002	1 Gbps	JANET	Internet2	OFELIA	2012-02-03	Plus
12-004	1 Gbps	JANET	RedIRIS	GEYSERS	2012-03-01	Plus
12-005	1 Gbps	RENATER	RedIRIS	GEYSERS	2012-02-23	Plus
12-006	155 Mbps	HEAnet	RedIRIS	GreenStar Network	2012-03-07	Plus
12-007	1 Gbps	PIONIER	SWITCH	FEDERICA	2012-03-05	Plus
12-008	2 Gbps	Surfnet	Ubuntunet	JIVE	2012-03-09	Plus

Table 2.1: New point-to-point links delivered in Year 3 – 1 April 2011 to 31 March 2012

Key:

1. SRF = Service Request Form. Each order is placed using such a form and assigned a unique SRF number, which is then used to designate the point-to-point link.
2. Production Date = Date that DANTE Operations handed the link over to the NREN for the project to use.
3. The project name “NREN-BBEXT” is used where an NREN uses GÉANT to connect to another part of its own network.
4. The project name “NREN-MISC” denotes a circuit used for a variety of projects.

Note: The links identified in Table 2.1 and throughout the document include those point-to-point links created between partner NRENs over the GÉANT production and testbed network for AutoBAHN testing.

2.3 Total Links in Use

2.3.1 GÉANT Plus

As at the end of Year 3, 45 GÉANT Plus links are in use. The total reflects all currently installed links, both those installed in previous years and during Year 3. Figure 2.1 shows these links broken down by project.

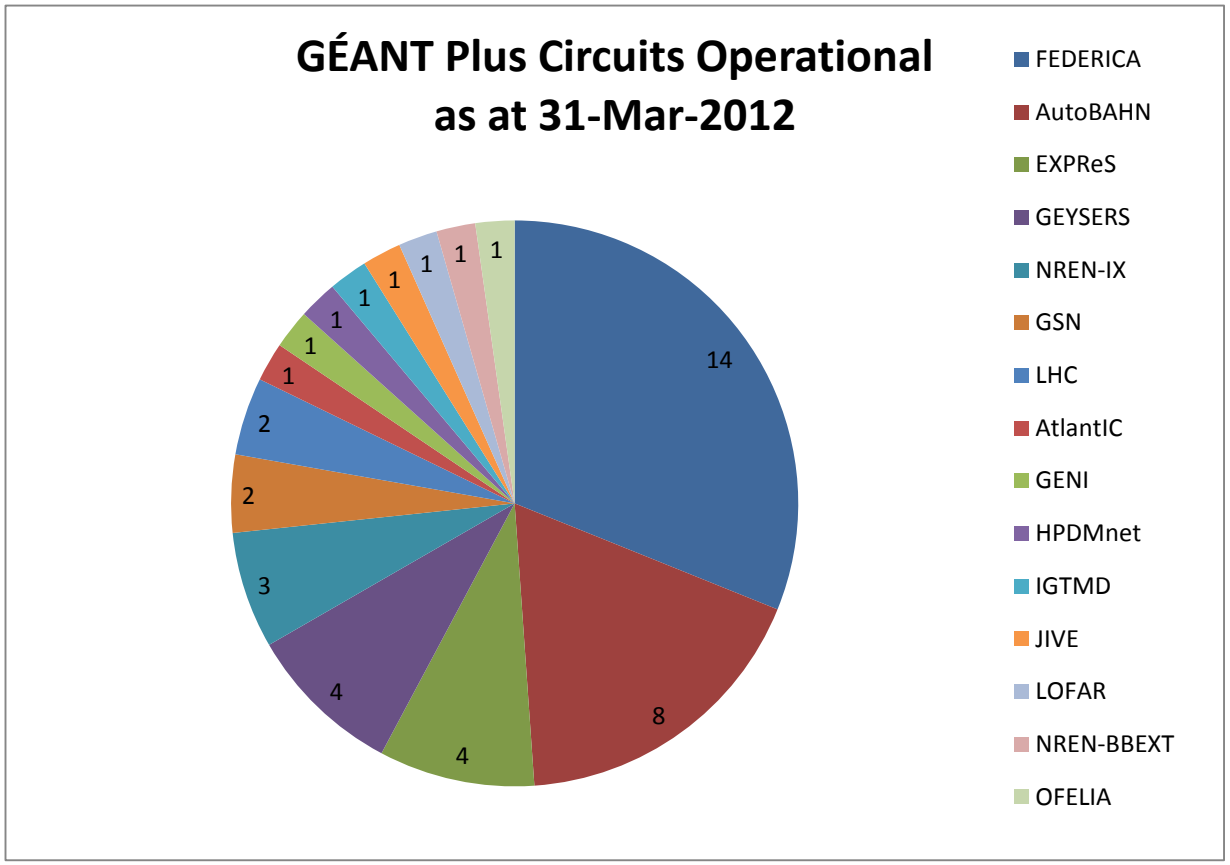

Figure 2.1: Number of GÉANT Plus links as at the end of Year 3

Notes:

1. The project name "NREN-IX" denotes an NREN–Internet Exchange (IX) link, which connects a specific NREN to a specific commercial IX. These links pre-date GÉANT's own IX connections.
2. The project name "NREN-BBEXT" refers to the situation where an NREN uses the GÉANT Plus or Lambda service to connect two areas of their backbone.

2.3.2 GÉANT Lambda

As at the end of Year 3, 23 GÉANT Lambda links are in use. The total reflects all currently installed links, both those installed in previous years and during Year 2. Figure 2.2 shows these links broken down by project.

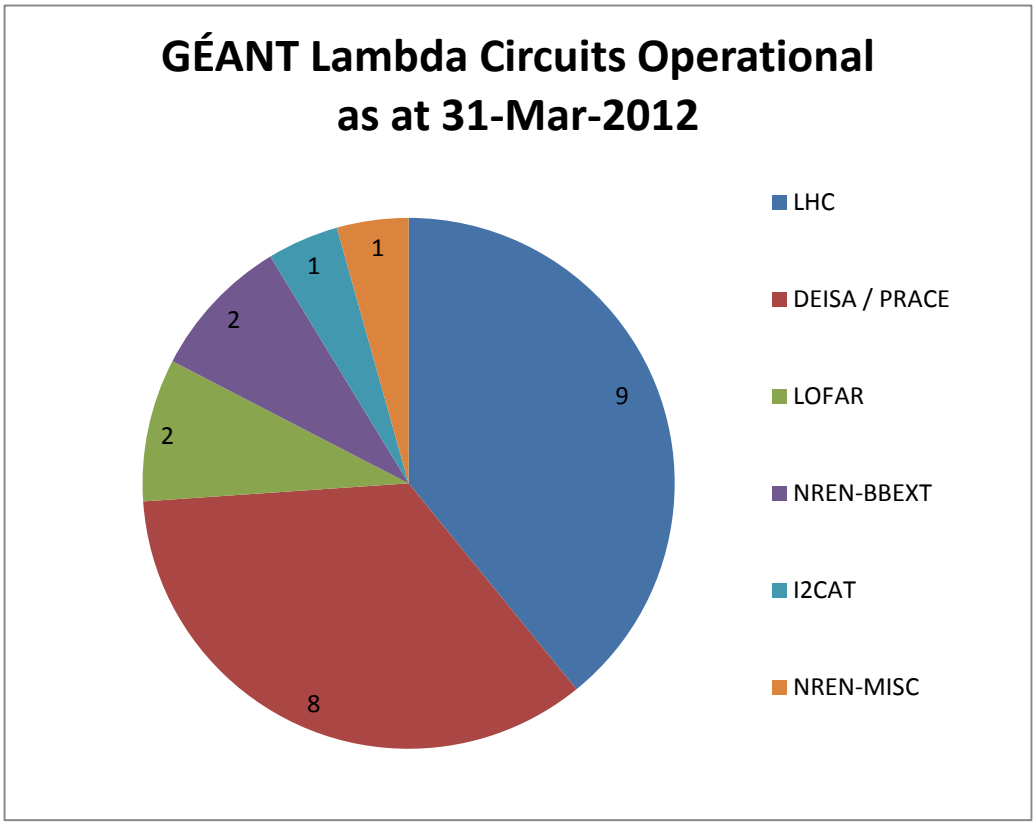

Figure 2.2: Number of GÉANT Lambda links as at the end of Year 3

Notes:

1. The project name "NREN-BBEXT" refers to the situation where an NREN uses the GÉANT Plus or Lambda service to connect two areas of their backbone.
2. The project name "NREN-MISC" denotes a circuit used for a variety of projects.

2.3.3 Combined Totals

Figure 2.3 shows the projects' use of both link types, expressed as a percentage of the combined total. The largest users of the GÉANT Advanced Services are FEDERICA (14 links, 21%) and LHC (11 links, 16%).

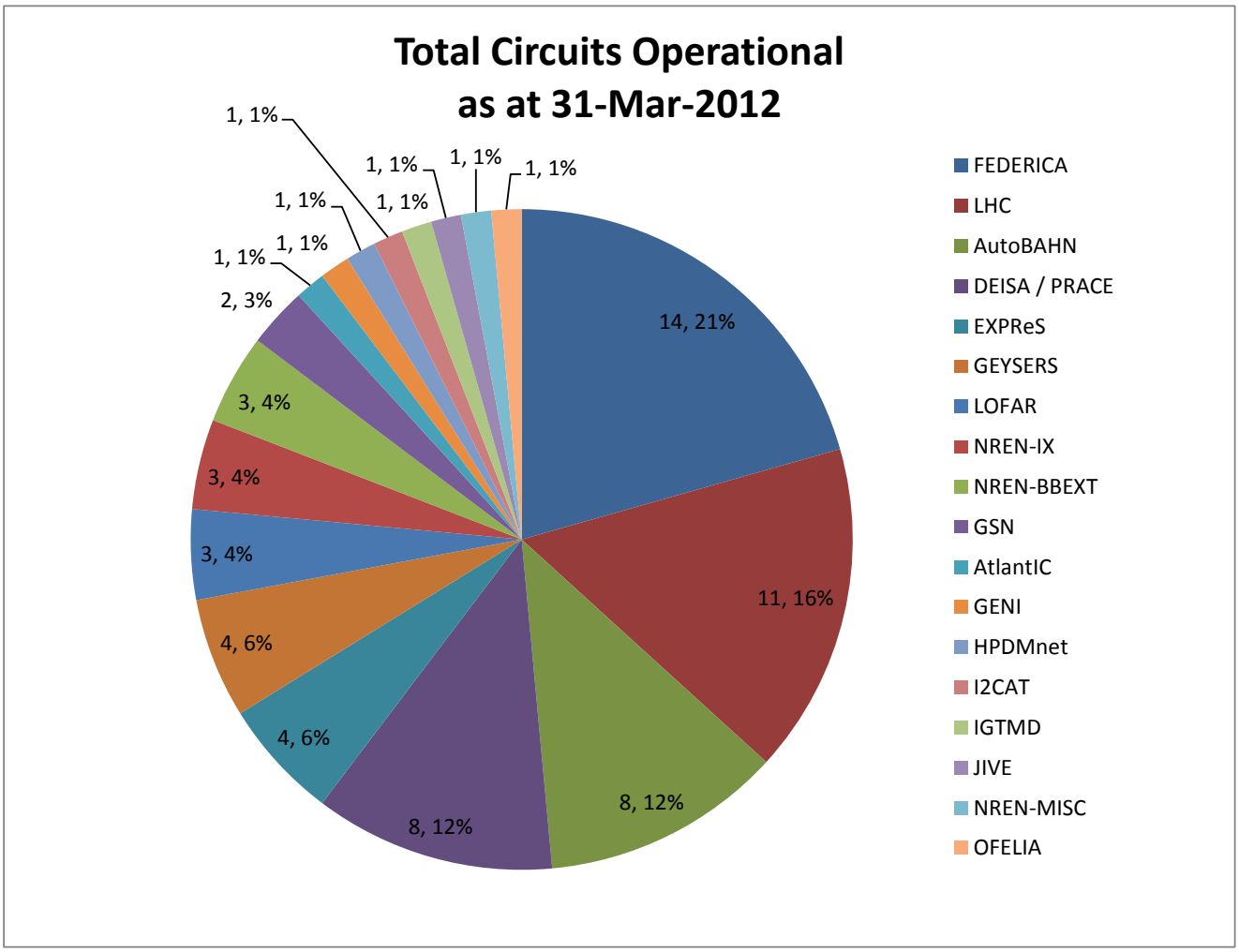

Figure 2.3: Projects' use of both link types combined as at the end of Year 3

Notes:

1. The project name "NREN-IX" denotes an NREN–Internet Exchange (IX) link.
2. The project name "NREN-BBEXT" refers to the situation where an NREN uses the GÉANT Plus or Lambda service to connect two areas of their backbone.
3. The project name "NREN-MISC" denotes a circuit used for a variety of projects.

2.4 Trends

Table 2.2 below shows the trend for new, cancelled and total numbers of links since the start of the GN3 project.

Links	Year 1			Year 2			Year 3		
	GÉANT Plus	GÉANT Lambda	Total	GÉANT Plus	GÉANT Lambda	Total	GÉANT Plus	GÉANT Lambda	Total
New	8	4	12	6	3	9	10	4	14
Cancelled	3	2	5	7	4	11	11	2	13
Total at year end	41	23	64	47	21	68	45	23	68

Table 2.2: Trends since the start of GN3

3 The E2ECU Function

E2E circuits are multi-domain, that is, they are composed of multiple sections, each administered by a different domain, usually but not always including the GÉANT backbone. At least two domains will therefore participate in circuit provisioning and management.

The End-to-End Coordination Unit (E2ECU) is responsible for the overall monitoring of E2E circuits and for coordinating the information flow and communications between the actors in the different domains involved in each E2E circuit. The constituent links in the circuit are also monitored by the appropriate national or international Network Operations Centre (NOC), such as the NREN NOC or the GÉANT NOC.

This section describes the responsibilities of the E2ECU, the role of the central End-to-End Monitoring System (E2EMon), the Trouble Tickets (TT) procedure, and plans for future service development.

For more information about the E2ECU's processes, procedures and tools, including the role played by the GÉANT network-monitoring service PerfSONAR and the End-to-End Monitoring System (E2EMon), see [DN3.0.5].

3.1 E2ECU Responsibilities

For the E2E circuits under its supervision, the E2ECU ensures that:

- Trouble Tickets (TTs) are opened when a fault occurs, such as a fibre cut, that affects the E2E circuit. (The engineers at the E2ECU use plug-ins for their proprietary monitoring system so that it receives alerts from E2EMon whenever an E2E circuit has an outage on any of its constituent parts.)
- TTs related to any fault affecting an E2E circuit are updated and forwarded to all the domains involved.
- TTs are raised for any scheduled outages (due to planned maintenance, for example) about which the E2ECU has been notified by the constituent networks (such as GÉANT).
- TTs related to any scheduled outage affecting an E2E circuit are updated and forwarded to all the domains involved.

Connectivity incidents detected through the multi-domain monitoring systems are reported to all the parties involved on a 24x7 basis via emailed Trouble Tickets. Updates on incident resolution are given 07:00 to 22:00

CE(s)T Monday to Friday. During this time the E2ECU will contact the NOC of the domain in which the fault has occurred to obtain further details, and will forward this information to the other parties involved.

The E2ECU creates monthly reports, made available to the NRENs, which include availability statistics for the various point-to-point links and a list of point-to-point links recently added to E2EMon.

The E2ECU is currently resourced at the level of 0.5 full-time equivalent.

3.2 Role of E2EMon

The central End-to-End Monitoring System (E2EMon) represents each physical E2E link as being formed of "domain links" and "inter-domain links". In E2EMon, a domain link is a link that is contained within a single network, such as across the GÉANT network. An inter-domain link (IDL) is a link between two neighbouring domains, such as GÉANT and RENATER; it is divided into two parts, with half of the link in each domain. In reality, an IDL may be a patch cable between two pieces of transmission equipment or a telco-provided circuit between sites.

E2EMon polls the individual domain Measurement Points (MPs) and Measurement Archives (MAs) every five minutes to gather information about the constituent domain and inter-domain links. Since each domain and link is tagged as belonging to a particular E2E circuit and names its neighbour domains, E2EMon can concatenate the status of the constituent links to represent the E2E circuit; this is shown on a graphical display that can be viewed with a web browser. The E2ECU receives alerts from E2EMon whenever an E2E circuit has an outage on any of its constituent parts.

Any errors relating to the population of the XML files used by the MPs and MAs are listed on the central E2EMon Domain View.

Access to E2EMon is managed by DANTE. In addition to the E2ECU, any party who maintains a network that is represented on E2EMon is permitted access. This includes the GÉANT NOC, GÉANT NRENs, CERN, Internet2, ESnet and Fermilab.

3.3 Trouble Tickets Procedure

The E2ECU may be notified of an outage either by E2EMon or by someone in the domain. On being notified, the E2ECU raises a Trouble Ticket (TT) containing information such as the names of the domain link or inter-domain links affected, the name(s) of the domain(s), the name of the project affected, and the time of the outage.

The E2ECU then contacts the relevant domains to request information regarding the outage and to assist them in interpreting the errors; in the case of an inter-domain link, the E2ECU will contact both domains involved.

The E2ECU distributes any updates regarding the outage to all partners in the project affected.

4 E2ECU Activity in Year 3

4.1 Overview

During Year 3, E2ECU monitored a total of 32 circuits for 3 projects: LHC (21), DEISA (10) and IGTMD (1). These links require global monitoring because multiple networks, some outside Europe, contribute sections of the links from end to end. A total of 534 Trouble Tickets (TTs) were tracked and closed.

4.2 Trouble Ticket Statistics

Figure 4.1 shows the number of Trouble Tickets (TTs) closed each month for the E2ECU projects over the twelve-month period ending 31 March 2012.

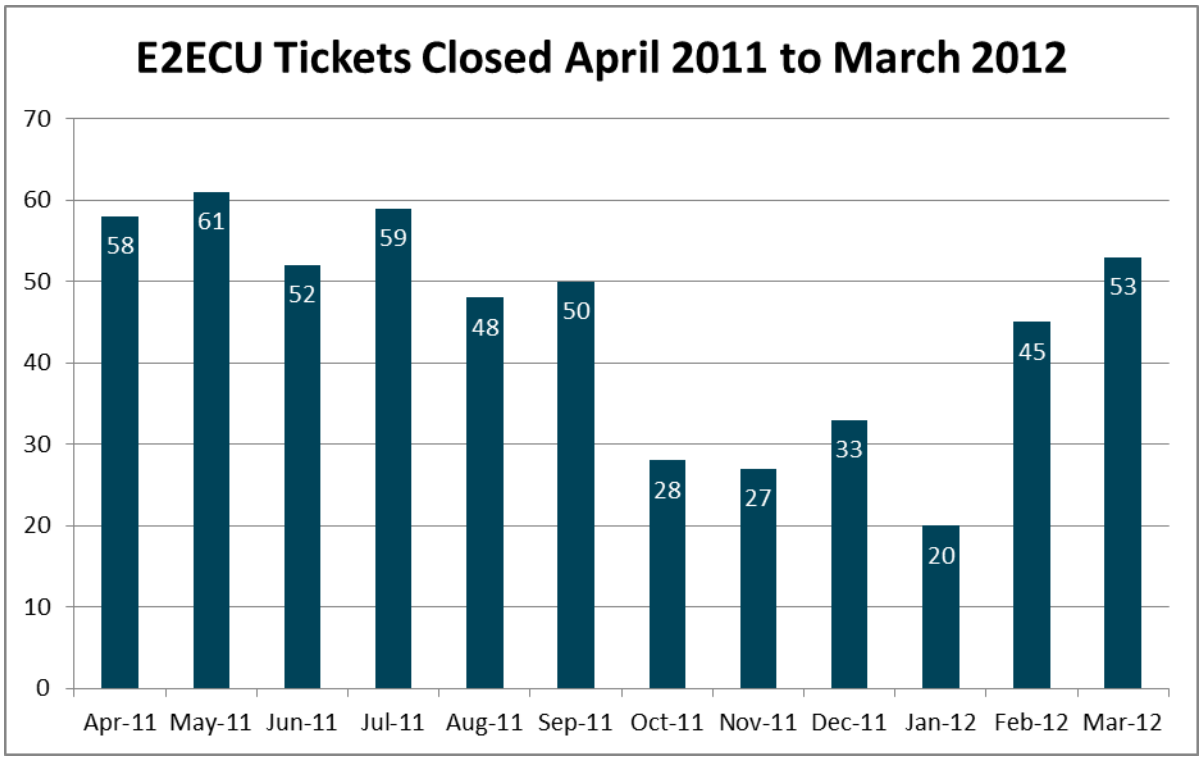

Figure 4.1: Number of E2ECU tickets closed each month 1 April 2011 to 31 March 2012

In the previous year, Year 2, the E2ECU monitored a total of 36 circuits for the same three projects, and closed 704 TTs (170 more). The lower number in Year 3 is mostly due to a change in the handling of outages and mis-configurations for Measurement Points (MPs), rather than the circuits they monitor. These MP incidents are now handled directly by the GN3 SA2 Task 2 (Multi-Domain Network Services, Multi-Domain Service Coordination and Operation) team of experts rather than the E2ECU, since the SA2 team has expert software knowledge and can assist the NRENs in resolving such problems as quickly as possible.

5 Multi-Domain Service Desk

In response to a request from SA2 in 2011, DANTE set up the new Multi-Domain Service Desk (MDSD). The MDSD service is provided by the DANTE NOC team and offers comprehensive one-stop-shop support to handle general queries for services as well as providing a planned-maintenance calendar where known scheduled work that will affect services is publicised and NRENs can request change freezes.

The MDSD provides support for various services, including Bandwidth on Demand and perfSONAR, and technical assistance for the following tools: AutoBAHN, I-SHARe and cNIS. For more complex queries, the MDSD escalates the issues to various Subject Matter Experts within SA2. Full details of the MDSD are available on the Partner Portal [PP_MDSD].

The MDSD pilot was launched in January 2012 to a limited number of NRENs (13 in total) participating in pilots for GÉANT's Bandwidth on Demand, Static Wavelength and perfSONAR services. In February 2012, an overview of the operation and contact details were presented at the Access Port Managers meeting in Dubrovnik, Croatia. To ensure smooth operation of the MDSD, existing procedures and systems, including the ticketing system, were updated. A comprehensive procedural and technical Knowledge Base has been developed by the Subject Matter Experts, in parallel with the MDSD, for use by the MDSD and the NREN community. The pilot has provided the MDSD with the opportunity to test both the systems and procedures in readiness for supporting a larger customer base of additional NRENs requiring the services.

SA2 is currently assessing the pilot phase and will be gathering NREN feedback to establish whether its overall aim of providing a coordinated support function for multi-domain services has been achieved. Formal key performance indicators are being defined to measure the success of the full service once it is launched in June.

6 Plans for Service Development

This section gives an overview of the plans for development in each of the areas covered by the preceding sections of the document, namely, advanced services, E2ECU and E2EMon, and the MDSD.

6.1 Advanced Services

The website for NREN partner users of GÉANT's services, and of the advanced services in particular, was launched in Year 2 (see Figure 6.1 below and [PP]). Known as the Partner Portal, the site was designed to enable NRENs to manage their GÉANT account and services, including obtaining more information about and requesting new services. The portal continues to be well used, providing each NREN with up-to-date information on their GÉANT usage, hosting GÉANT backbone service definitions, and facilitating service requests. It also provides NRENs with news and information about developments within the GÉANT project via a new News page [PP_News] that is linked to from a quarterly newsletter issued by the Partner Relations team. In addition, the site contains the GÉANT Monthly Service Reports, which summarise the operations and activities of the GÉANT backbone services, and the DANTE World Service (DWS) Monthly Reports, which summarise the traffic data, performance and operational activity for NRENS who subscribe to DWS. The Partner Portal is therefore a key service/account management and communications tool for the NREN users of GÉANT's advanced services, hence its inclusion here.

Development of the site is ongoing, with the Finance area launched in Year 3, providing NRENs with more information about the charging process and the cost-sharing model that is used to recover the costs incurred in building and operating the GÉANT backbone network, and the introduction of the News page mentioned above. The Operations area has been enhanced to include details of the new Multi-Domain Service Desk and will continue to be fully populated with tools information, technical processes and policies during Year 4. Also during Year 4, it is hoped to enhance the Portal further to include information on new GÉANT services such as Bandwidth on Demand and perfSONAR, and to integrate it with other system tools such as the Cacti monitoring tools to provide a real "one-stop shop" for account management.

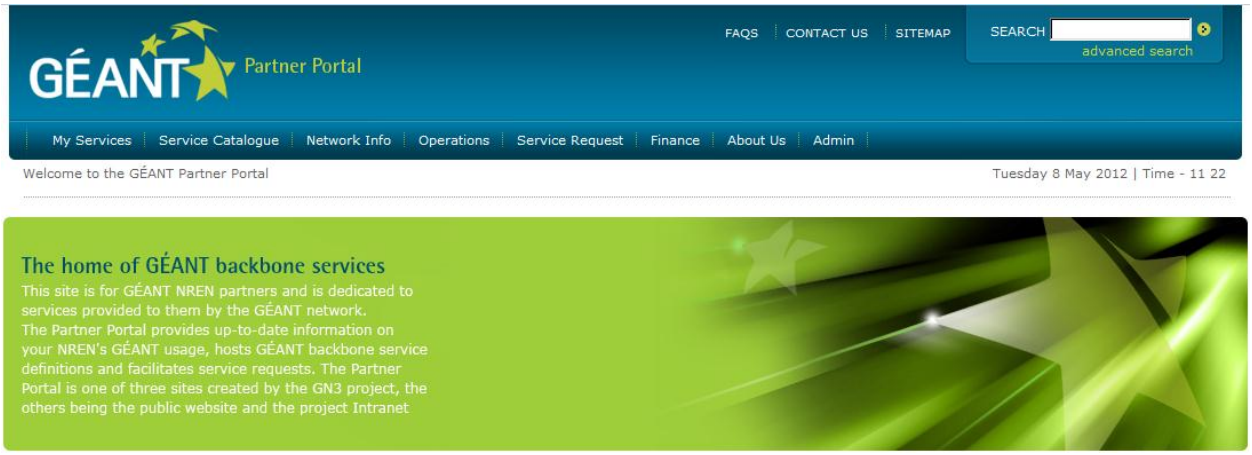

Figure 6.1: Partner Portal home page

6.2 E2ECU and E2EMon

A major challenge for NRENs and the DANTE staff maintaining the GÉANT backbone is the creation, configuration and maintenance of the software elements associated with the MP and MA software. These are vendor specific and usually need to be rewritten or updated if the vendor changes or if the version of vendor software changes. Such ongoing work is resource intensive and if such resources are not allocated in a timely fashion, the information provided to E2EMon by the various organisations becomes increasingly unreliable. This greatly impacts the reliability and trustworthiness of the E2EMon system as a whole, since E2E links are no longer fully or accurately monitored.

Resources have been allocated in the GN3 project to create a new monitoring system that supports static circuits (those that have been discussed in this document) and dynamic circuits (those created using tools such as AutoBAHN), which will require less ongoing software development within the network organisations. It is expected that this will be more fully integrated with the PerfSONAR software suite than E2EMon, allowing a robust monitoring system.

In the meantime, a survey has been carried out amongst the various network organisations who have previously, or are currently, contributing data to the E2EMon system, to help decide on a suitable approach for the use of E2EMon. Since the use of E2EMon greatly impacts the E2ECU function, survey questions about the E2ECU were included; the function will be revised based on the outcome of the analysis of this survey.

6.3 MDSD

Over the coming year it is expected that the MDSD will expand its remit to handle additional services and tools and a number of NRENs will participate by taking on additional services which the MDSD will support.

7 Conclusions

The GÉANT network was the first international production hybrid network, combining the operation of a shared IP infrastructure with the ability to provide additional dedicated point-to-point links. The three levels of connectivity service reflect the immense flexibility that the network has been designed to offer, with the advanced services, GÉANT Plus and GÉANT Lambda, meeting the requirements for privacy, security, availability, capacity, robustness and speed of the most demanding user projects.

Utilisation of GÉANT point-to-point services remains strong and a steady flow of new circuit requests has been received with 14 new links delivered in Year 3. This compares with 9 new links in Year 2. Whilst GÉANT continues to serve many circuit users and there has been an increase in the amount of point-to-point circuits ordered this year, it is expected that, in the future, some projects will be looking at alternative methods of connecting NRENs, such as dynamic circuits. These would be greatly supported by the GN3 Bandwidth on Demand project and the GÉANT AutoBAHN software, which has seen a significant increase in uptake during Year 3. The upgrade of the GÉANT backbone hardware is also expected to facilitate a reduction in lead time for fixed circuit services.

The expected increase in use of dynamic circuit services necessitates a review and improvement of the associated pan-community circuit monitoring and support services to enable support of these short-term, automatically created circuits. This also gives us an opportunity to improve the monitoring tools for the static services, of which GÉANT Plus and GÉANT Lambda form part of the portfolio.

Building on the experience gained in recent years, a process of continuous improvement is underway to develop and enhance the point-to-point procedures and services still further.

Appendix A Projects

A.1 Summary

Table A.1 lists (in alphabetic order) the projects using GÉANT advanced services and/or supported by the E2ECU, and gives the URL of their respective websites, from which further information can be obtained.

Project	URL
AtlantIC	http://www.atlanticcalliance.org/
AutoBAHN	http://www.geant.net/service/autobahn/pages/home.aspx
DEISA/PRACE	http://www.deisa.eu
EXPReS	http://www.expres-eu.org/
FEDERICA	http://www.fp7-federica.eu
GENI Testbed	http://www.geni.net/
GEYSERS	http://www.geysers.eu/
GreenStar Network	http://www.greenstarnetwork.com/
HPDMnet	http://www.hpdmnet.net/
i2CAT	http://www.i2cat.net/en
IGTMD	http://www.ens-lyon.fr/LIP/RESO/Projects/IGTMD/ProjetIGTMD.html
JIVE	http://www.jive.nl/about-jive
LHCOPN	http://public.web.cern.ch/public/en/LHC/LHC-en.html
LOFAR	http://www.lofar.org/

Table A.1: Projects using GÉANT advanced services – names and URLs

A.2 Key Projects

The projects with more than one point-to-point link and/or those supported by the E2ECU are briefly described below.

For further information about GÉANT's most demanding users, see [DN3.0.3,3].

A.2.1 AutoBAHN

The Automated Bandwidth Allocation across Heterogeneous Networks (AutoBAHN) system is an automated bandwidth provisioning system for reservation and allocation of network paths, currently at prototype stage. AutoBAHN can provide a Bandwidth on Demand service by configuring on-demand circuits across various networks. The objective of the AutoBAHN Task of the GN3 project is to enhance the AutoBAHN prototype with functionality, extending it to other layers and technologies for dynamic circuit provisioning and improving existing modules (e.g. path-finding computations) or revising its functions where necessary to make them easier to manage and maintain. AutoBAHN will mature so as to be integrated in the multi-domain services portfolio of GN3.

While AutoBAHN is a GÉANT service, the ongoing GN3 effort to test and support it using advanced services is treated as a project in the same way as the end-user projects on whose behalf the NRENs have requested circuits.

For more information, see http://www.geant.net/service/autobahn/pages/home.aspx.

A.2.2 DEISA/PRACE

The Distributed European Infrastructure for Supercomputing Applications (DEISA) is a consortium of leading national supercomputing centres. It aims to foster pan-European world-leading computational science research and to build and operate a distributed terascale supercomputing facility.

For more information, see http://www.deisa.eu.

A.2.3 EXPReS

Express Production Real-time e-VLBI Service (EXPReS) is a three-year project to create a distributed astronomical instrument of continental and intercontinental dimensions using real-time, electronic Very Long Baseline Interferometry (e-VLBI). e-VLBI uses fibre-optic networks, including GÉANT links, to connect 16 radio telescopes on 6 continents to the central data processor at the Joint Institute for Very Long Baseline Interferometry in Europe (JIVE), in the Netherlands, a purpose-built supercomputer which correlates data from the telescopes in real-time. Transferring data electronically and correlating it in real-time eliminates weeks of waiting from the current VLBI method of storing data on disks and shipping them to the correlator for

processing. This allows researchers to take advantage of Targets of Opportunity for conducting follow-on observations of transient events such as supernova explosions and gamma-ray bursts. e-VLBI also allows high precision tracking of space probes.

For more information, see http://www.expres-eu.org/.

A.2.4 FEDERICA

The Federated E-infrastructure Dedicated to European Researchers (FEDERICA) was a project designed to implement an experimental network infrastructure for trialling new networking technologies. The infrastructure is intended to be neutral as to the type of protocols, services and applications that may be trialled, whilst allowing disruptive experiments to be undertaken. The aim was to develop mechanisms that will allow such experiments to be run over existing production networks without adverse effect. Although the project ended in October 2010, its infrastructure remains in place and operational and is used by projects such as Networking innovations Over Virtualised Infrastructures (NOVI), IPsphere and GÉANT. GÉANT currently uses it to interconnect the testbed resources of its virtualisation service GENUS.

For more information, see http://www.fp7-federica.eu.

A.2.5 GEYSERS

Generalised Architecture for Dynamic Infrastructure Services (GEYSERS) is a project funded under the European Union's Seventh Framework Programme. A consortium of NRENs, universities, research institutions, subject-matter experts and manufacturers, its goal is to qualify optical infrastructure providers and network operators with a new architecture, to enhance their traditional business operations.

GEYSERS's vision is to deliver:

- A novel architecture capable of:
  - Seamless and coordinated provisioning of optical & IT resources.
  - End-to-end service delivery to overcome limitations of network domain segmentation.
- A novel business framework for infrastructure providers and network operators.
- A novel mechanism to partition infrastructure resources and compose logical infrastructures.
- A cost- and energy-efficient proof-of-concept implementation.

For more information, see http://www.geysers.eu/.

A.2.6 GreenStar

The GreenStar Network (GSN) is a CANARIE-funded project led by École de Technologie Supérieure (Synchromedia). The goal of the GSN project is to create technology and standards for reducing the carbon

footprint of Information and Communication Technology (ICT). ICT is responsible for 2% of global CO_2 emissions, due to high consumption of electricity produced from coal.

HEAnet is a key European partner in GSN, and is installing wind- and solar-powered hub nodes for the project's extended network. Three GÉANT Plus circuits are used to transport data relating to the project across the Atlantic.

For more information, see http://www.greenstarnetwork.com/.

A.2.7 IGTMD

IGTMD (Interopérabilité des Grilles de Calcul et Transferts Massifs de Données) is a Franco-American project whose goal is the interoperability of two grids: Enabling Grids for E-scienceE (EGEE) and Open Science Grid (OSG14). The project is particularly concerned with addressing the challenges of transferring vast quantities of data over very long distances. The two main centres are the National Institute of Nuclear and Particle Physics (IN2P3) in Lyon and the Fermi National Accelerator Laboratory (FNAL15) in Chicago.

For more information, see http://www.ens-lyon.fr/LIP/RESO/Projects/IGTMD/ProjetIGTMD.html.

A.2.8 LHCOPN

The Large Hadron Collider (LHC) is the most ambitious project undertaken by CERN to date.

CERN is the world's largest organisation for research into particle physics. Based in Switzerland and funded by 20 European member states, CERN is a world-wide enterprise involving scientists of many nationalities. It is a prime example of international collaboration, as many experiments conducted at CERN are on such a scale that no single state could afford to fund them.

The LHC project is now live and has already demonstrated some exciting results. The project accelerates particles to previously impossible energies, producing short-lived and never-before-seen results. It is predicted to produce data at the rate of 15 Petabytes (15 million Gigabytes) per annum. It has been decided to process all this data not in one institution, but using a grid – the Worldwide LHC Computer Grid (WLCG) – so the results will be distributed by GÉANT and connected NRENs to analysis sites around the globe.

For more information, see http://public.web.cern.ch/public/en/LHC/LHC-en.html.

A.2.9 LOFAR

LOw Frequency ARray (LOFAR) is a multi-purpose sensor array. Its main application is astronomy at low frequencies (10-250 MHz) but it also has geophysical and agricultural applications. Its heart is currently being assembled in the Northeast of the Netherlands and spreads over the whole country and over whole Europe.

LOFAR is the first telescope of its kind, using an array of simple omni-directional antennas instead of mechanical signal processing with a dish antenna. The electronic signals from the antennas are digitised, transported to a central digital processor, and combined in software to emulate a conventional antenna. The full LOFAR design involves about 7,000 antennas. To make radio pictures of the sky with adequate sharpness, these antennas are arranged in clusters that are spread out over an area of 100 km in diameter within the Netherlands and over 1500 km throughout Europe. Data transport requirements are in the range of many Tera-bits/sec and the processing power needed is tens of Tera-FLOPS.

For more information, see http://www.lofar.org/.

References

[DN3.0.3,3]	GN2-08-118v5 “Deliverable DN3.0.3,3: Specific Support Actions: Addressing the Needs of the Network’s Most Demanding Users” http://www.geant2.net/upload/pdf/GN2-08-118v5-DN3-0-3_3_Specific_Support_Actions_-Networks_Most_Demanding_Users.pdf
[DN3.0.5]	GN2-07-131v08 “Deliverable DN3.0.5: Processes and Provision of Point-to-Point Services in GÉANT2” http://www.geant2.net/upload/pdf/GN2-07-131v8-DN3-0-5_Processes_and_Provision_of_Point-to-Point_Services.pdf
[DN4.2.1]	GN3-10-040v2 “Deliverable DN4.2.1: GÉANT Services Portfolio” http://wiki.geant.net/pub/NA1/DeliverablesAllGN3FinalAttachments/GN3-10-040v2_DN4-2-1_GEANT_Service_Portfolio.pdf [restricted access]
[PP]	GÉANT Partner Portal https://partner.geant.net/Pages/Home.aspx [username and password required]
[PP_MDSD]	GÉANT Partner Portal MDSD page https://partner.geant.net/Operations/MDSD/Pages/MultiDomainServiceDesk.aspx
[PP_News]	GÉANT Partner Portal News page https://partner.geant.net/news [username and password required]
[TopologyMap]	GÉANT Topology Map 2012 http://www.geant.net/Media_Centre/Media_Library/PublishingImages/1084_GEANT_Topology_03_12_hi_res.jpg

Glossary

AutoBAHN	Automated Bandwidth Allocation across Heterogeneous Networks
CE(s)T	Central European (summer) Time
cNIS	Common Network Information Service
DEISA	Distributed European Infrastructure for Supercomputing Applications
DWS	DANTE World Service
E2E	End-to-End
E2ECU	End-to-End Coordination Unit
E2EMon	End-to-End Monitoring System
EGEE	Enabling Grids for E-scienceE
e-VLBI	electronic Very Long Baseline Interferometry
EXPReS	Express Production Real-time e-VLBI Service
FEDERICA	Federated E-infrastructure Dedicated to European Researchers
FNAL15	Fermi National Accelerator Laboratory
GE	Gigabit Ethernet
GEYSERS	Generalised Architecture for Dynamic Infrastructure Services
GSN	GreenStar Network
ICT	Information and Communication Technology
IDL	Inter-Domain Link
IGTMD	Interopérabilité des Grilles de Calcul et Transferts Massifs de Données
IN2P3	National Institute of Nuclear and Particle Physics
IP	Internet Protocol
I-SHARe	Information Sharing Across Heterogeneous Administrative Regions
IX	Internet Exchange
JIVE	Joint Institute for Very Long Baseline Interferometry in Europe
L2	Layer 2
LAN	Local Area Network
LHC	Large Hadron Collider
LHCONE	LHC Open Network Environment
LHCOPN	LHC Optical Private Network
LOFAR	LOw Frequency ARray
LSP	Label Switched Path
MA	Measurement Archive
MDSD	Multi-Domain Service Desk
MP	Measurement Point
MPLS	Multi-Protocol Label Switching

NOC	Network Operations Centre
NOVI	Networking innovations Over Virtualised Infrastructures
NREN	National Research and Education Network
OFELIA	OpenFlow in Europe, Linking Infrastructure and Applications
OSG	Open Science Grid
PerfSONAR	Performance-focused Service Oriented Network monitoring ARchitecture
PoP	Point of Presence
PRACE	Partnership for Advanced Computing in Europe
SA2	GN3 Service Activity 2 Multi-Domain Network Services
SA2 T2	SA2 Task 2 Multi-Domain Service Coordination and Operation
SRF	Service Request Form
TDM	Time-Division Multiplexed or Time-Division Multiplexing
TT	Trouble Ticket
VPN	Virtual Private Network
WLCG	Worldwide LHC Computer Grid