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Deliverable DS2.0.3,3: Report on GÉANT2 Advanced Services – Lambdas and Switched Optical



Deliverable DS2.0.3,3

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Abstract

This document provides a summary of the take-up of GÉANT2 advanced services, *GÉANT Plus* and *GÉANT Lambda*, during Year 4. It introduces each service and the End-to-End Coordination Unit (E2ECU), 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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0 Executive Summary

GÉANT2 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. This dual role makes GÉANT2 unique: it is the first hybrid production network operating on an international scale.

GÉANT2'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 higher-volume network, but also for guaranteed availability, capacity and performance. The point-to-services offer circuits of between 1 Gb/s and 10 Gb/s that provide dedicated, guaranteed network capacity to the user group concerned, ensuring reliable, secure, high-bandwidth, end-to-end (E2E) connectivity.

GÉANT2'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 22 new point-to-point circuits were delivered on the GÉANT2 infrastructure during Year 4, 18 of them for use by 6 key projects. 17 were *GÉANT Plus* links; 5 were *GÉANT Lambda*. The FEDERICA project had the most new links delivered, with 8 x 1 GE *GÉANT Plus* circuits. The total number of links in use as at Year 4 end was 51; LHC has the most with 14 (both *GÉANT Plus* and *GÉANT Lambda*), followed by FEDERICA with 8 (all *GÉANT Plus*) then DEISA with 7 (all *GÉANT Lambda*). (Figures for links delivered between Year 4 end and the date of the last version of this document – 16/02/2009 – are provided in Appendix B on page 20.)

Reflecting the increased scope and sophistication of the point-to-point links, a significant coordination and monitoring effort is required to ensure their optimum availability. A global monitoring function, the End-to-End Coordination Unit (E2ECU) is in place to provide this. During Year 4, the E2ECU tracked the resolution of 440 planned and unplanned outages. Overseen by DANTE Operations, the processes, procedures and tools used by the E2ECU are subject to continuous review and improvement.

Planned service developments for advanced services include the ongoing enhancement of the web interface, to improve communication with service requesters and allow them to track the progress of their service requests.

This deliverable reports on the use of advanced services during Year 4, and their status as at Year 4 end. As such it is a snapshot of ongoing developments and achievements; further work is still required to realise fully the services' many potential benefits.

1 Introduction to Advanced Services

Optimising the latest developments in technology and the telecommunications market, the GÉANT2 network offers the European research and education community a unique range of opportunities for international collaboration. In addition to the basic service, known as *GÉANT IP*¹, which provides access to the shared European Internet Protocol (IP) 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*² and *GÉANT Lambda*³. Each of these is described below. (A description of the basic 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 more detailed description of GÉANT's services, see [1] and [2].)

1.1 Basic Service

1.1.1 Overview

The basic service, now known as *GÉANT IP*, provides access via the GÉANT2 network to the shared European Internet Protocol (IP) 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 seventh generation of the European research and education backbone, the GÉANT2 IP network is over-provisioned by design, to allow small-to-medium-sized traffic flows (i.e. up to 1 Gb/s) 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.

¹ To give the services offered by GÉANT an easily recognisable identity, each has been given a new brand name. *GÉANT IP* is the new brand name for the service referred to in previous iterations of this deliverable as the standard or basic service.

² *GÉANT Plus* is the new brand name for the service referred to in previous iterations of this deliverable as GÉANT+.

³ *GÉANT Lambda* is the new brand name for the service referred to in previous iterations of this deliverable as full 10 Gb/s wavelength.

GÉANT IP access is available to members of the GÉANT consortium at capacities of up to 20 Gb/s (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 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 (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 1 week. There is no extra charge for L2 VPN configuration.
- Premium IP (PIP) service offering a low-loss, low-delay, low-jitter service for priority traffic. Useful for real-time data transfer such as videoconferencing, Voice over IP (VoIP) and specialist project traffic. There is no extra charge for PIP.
- Backup protection against circuit failure at up to the full subscribed bandwidth on an appropriate interface is included in the basic IP subscription. Alternative dedicated backup capacity is available at an additional charge.
- IP peering. Transit for IP traffic is offered to a defined set of NRENs and networks beyond the GÉANT service area.
- Physical interface types range from T3 (34 Mb/s) to STM-64/10 GE (10 Gb/s). Access is available at capacities of up to 20 Gb/s, subject to technical and commercial considerations.
- Setting up a connection to the IP network is a bespoke activity; delivery time will depend on NREN requirements.

1.2 Advanced Services

Despite over-provisioning, unmanaged flows above 1 Gb/s introduce the risk of impacting other traffic on the GÉANT2 IP network and causing congestion. The GÉANT2 point-to-point advanced services offer circuits of between 1 Gb/s and 10 Gb/s that avoid congestion and provide uncontended bandwidth over the GÉANT2 domain.

GÉANT2 offers two distinct classes of point-to-point services to National Research and Education Networks (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.

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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 Mb/s and 10 Gb/s 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 Gb/s 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 pre-provisioned, circuits can be implemented or reconfigured at short notice and without incremental cost to the NREN. 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 Gb/s 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 fibre⁴ links and Time-Division Multiplexed (TDM) switches.
- Circuits can be provided to the NREN at a granularity of 155 Mb/s (VC4) up to a total of 10 Gb/s (64 x VC4).
- Each NREN subscribing to the service is allocated 10 Gb/s of circuit capacity, which may be used flexibly for different services to multiple locations.
- The 10 Gb/s 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 5 working days of receipt of request, assuming that sufficient capacity is available in both the NRENs' capacity allocations.
- Circuits may be configured for any specified service period.

⁴ *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.

- 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 Gb/s circuits between New York and various points in Europe.
- A further 10 Gb/s of capacity on a new interface can be provided at a fixed annual cost.

1.2.2 GÉANT Lambda

1.2.2.1 Overview

The *GÉANT Lambda* service provides private, transparent 10 Gb/s wavelengths between GÉANT2 NRENs. It is only available to NRENs subscribing to the *GÉANT Plus* service.

The *GÉANT Lambda* service is paid for by an annual flat-rate fee.

1.2.2.2 Features

GÉANT Lambda provides the following features:

- Transparent 10 Gb/s 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 Gb/s circuit, this can be accommodated using the GÉANT2 MCC switching equipment.
- A Lambda takes up to 10 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 Gb/s 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 GÉANT2-connected NRENs.

2 The E2ECU Function

Key to the successful delivery of the point-to-point services is the End-to-End Coordination Unit (E2ECU), which 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 PerfSONAR and the End-to-End Monitoring System (E2EMon), see [1].

2.1 E2ECU Responsibilities

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

- All the domains are aware of how to install the different PerfSONAR Measurement Points (MPs) and/or Measurement Archives (MAs) so that they send up/down alerts for the E2E circuits that traverse or terminate in their network.
- All the domains populate the MPs/MAs with the correct data.
- All the E2E circuits are named uniquely and each relevant domain is informed of the name.
- All E2E circuits appear correctly in the E2EMon overall visualisation tool.
- Trouble Tickets (TTs) are opened when a fault occurs in a domain that affects the E2E circuit. (The engineers at the E2ECU have written 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 GÉANT2).
- TTs related to any scheduled outage affecting an E2E circuit are updated and forwarded to all the domains involved.

The E2ECU engineers watch their monitoring screen from 06:00 to 22:00 CE(s)T during the week and from 09:00 to 18:00 CE(s)T at weekends.

The E2ECU sends monthly reports to DANTE, 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.

2.2 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”. A domain link is a link that is contained within a single network, such as across the GÉANT network. An inter-domain link 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.

E2EMon polls the individual domain MPs and 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 links to represent the E2E circuit; this is shown on a graphical display that can be viewed with a web browser.

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

The E2ECU receives alerts from E2EMon whenever an E2E circuit has an outage on any of its constituent parts.

2.3 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.

3 Plans for Service Development

3.1 Advanced Services

Development of the advanced services web interface [4] is ongoing, to improve communication with service requesters and allow them to track the progress of their service requests.

3.2 E2ECU

Overseen by DANTE Operations (the E2ECU is part of the DANTE operational function), the processes, procedures and tools used by the E2ECU are subject to continuous review and improvement. To this end, DANTE Operations are also in close cooperation with the GÉANT2 PerfSONAR and E2EMon software developers.

Planned service developments include the provision, in GÉANT3, of a web interface that allows service users to track the progress of the Trouble Tickets (TTs) raised by the E2ECU.

It is expected that in the future the E2ECU will act as coordinator at the time of setting up the E2E circuits.

Currently, the E2ECU and E2EMon are only monitoring circuits for certain projects; it is expected that the scope of these functions will expand to more projects in the future.

4 Use of Advanced Services in Year 4

4.1 Overview

22 new point-to-point links were delivered in Year 4. This compares with 27 delivered during Year 3. No existing links were cancelled during the year; all the links were in addition to those ordered and delivered in previous years. Taking into account the links delivered in Years 1 and 2, and links cancelled during Years 1 to 3, the total number of links in use at Year 4 end was 51.

As can be seen from Table 4.1, the largest number of new point-to-point links delivered during Year 4 has been for the FEDERICA project, with 8 x 1 GE links. More links have also been ordered for this project, which are due to be delivered towards the end of October 2008.

This section summarises the new links delivered in Year 4 and provides statistics for the total number of links in use as at Year 4 end. Further information about the projects is given in Appendix A on page 17. (Figures for links delivered between Year 4 end and the date of the last version of this document – 16/02/2009 – are provided in Appendix B on page 20.)

4.2 New Links

Table 4.1 shows all new point-to-point links delivered in GÉANT2 Year 4. The table is sorted alphabetically by project, then by A-end and B-end NREN. Further analysis is provided in Table 4.2 and Table 4.3.

SRF No. ¹	A-end		B-end		Project	Production Date ²
	NREN	Interface Type	NREN	Interface Type		
08-007	ARNES	1 GE	NORDUnet	10 GE vlan	Atlas	17-Jul-2008
08-008	ARNES	1 GE	NORDUnet	10 GE vlan	Atlas	17-Jul-2008
07-019	DFN	10 GE (lambda) ³	GARR	10 GE (lambda)	DEISA	19-Dec-2007

SRF No. ¹	A-end		B-end		Project	Production Date ²
	NREN	Interface Type	NREN	Interface Type		
08-019	DFN	10 GE (lambda)	JANET	10 GE (lambda)	DEISA	15-Aug-2008
07-020	JANET	SDH (4 Gb/s)	NORDUnet	10 GE vlan	EXPreS	02-Jun-2008
08-002	CESNET	1 GE	GARR	1 GE	FEDERICA	03-Apr-2008
08-003	GARR	1 GE	PSNC	1 GE	FEDERICA	03-Apr-2008
08-004	CESNET	1 GE	PSNC	1 GE	FEDERICA	08-Jul-2008
08-005	CESNET	1 GE	DFN	1 GE	FEDERICA	08-Jul-2008
08-006	DFN	1 GE	GARR	1 GE	FEDERICA	03-Apr-2008
08-009	DFN	1 GE	PSNC	1 GE	FEDERICA	19-May-2008
08-014	DFN	1 GE	SWITCH	1 GE	FEDERICA	16-May-2008
08-020	NORDUnet	1 GE	PSNC	1 GE	FEDERICA	08-Jul-2008
07-015	CERN	SDH (lambda)	Surfnet	SDH (lambda)	LHC	03-Dec-2007
08-001	CERN	SDH (lambda)	[USLCHNET]	SDH (lambda)	LHC	01-May-2008
07-014	Surfnet	10 GE (lambda)	CERN	10 GE (lambda)	LHC	12-Feb-2008
08-015	BELNET	10 GE vlan	[Amsterdam]	1 GE	Miscellaneous	03-Jul-2008
08-016	BELNET	10 GE vlan	[London]	1 GE	Miscellaneous	03-Jul-2008
08-017	BELNET	10 GE vlan	[Paris]	1 GE	Miscellaneous	03-Jul-2008
07-021	CESNET	1 GE	Surfnet	1 GE	Miscellaneous	20-Feb-2008
07-016	JANET	SDH (1 Gb/s)	PSNC	10 GE (vlan)	Phosphorus	05-Sep-2007
07-017	JANET	SDH (1 Gb/s)	Surfnet	SDH (1 Gb/s)	Phosphorus	25-Sep-2007

Table 4.1: New point-to-point links delivered in Year 4 – 1 September 2007 to 31 August 2008

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 hands the link over to the NREN for the project to use.

3. “lambda” indicates that a completely new wavelength was provisioned for this link.

Note: The table does not include those point-to-point links created between partner NRENs over the GÉANT2 production and testbed network for AutoBAHN testing.

Project	# GÉANT Plus	# GÉANT Lambda	Total
Atlas	2	0	2
DEISA	0	2	2
EXPREs	1	0	1
FEDERICA	8	0	8
LHC	0	3	3
Phosphorus	2	0	2
Miscellaneous	4	0	4
Total	17	5	22

Table 4.2: Number of new links by project and type

Interface Type	A-end #	B-end #
1 GE	11	12
10 GE	3	3
10 GE vlan	3	4
SDH	2	2
SDH 1 Gb/s	2	1
SDH 4 Gb/s	1	0
Total	22	22

Table 4.3: Number of new links by end interface type

Number of mixed interface links: 7

4.3 Total Links in Use

4.3.1 GÉANT Plus

As at the end of Year 4, 27 GÉANT Plus links are in use. The total reflects all currently installed links, both those installed in previous years and during Year 4. Figure 4.1 shows these links broken down by project. (The label “Miscellaneous” includes one-circuit projects.)

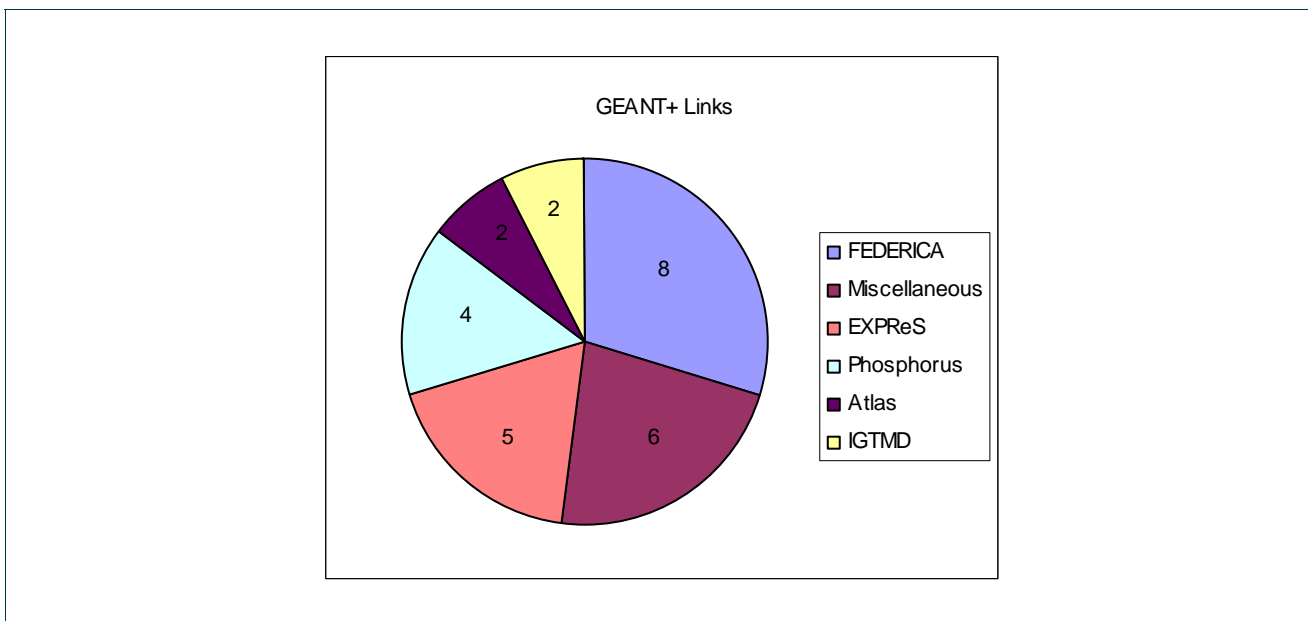


Figure 4.1: Number of GÉANT Plus links as at the end of Year 4

4.3.2 GÉANT Lambda

As at the end of Year 4, 23 GÉANT Lambda links are in use. The total reflects all currently installed links, both those installed in previous years and during Year 4. Figure 4.2 shows these links broken down by project.

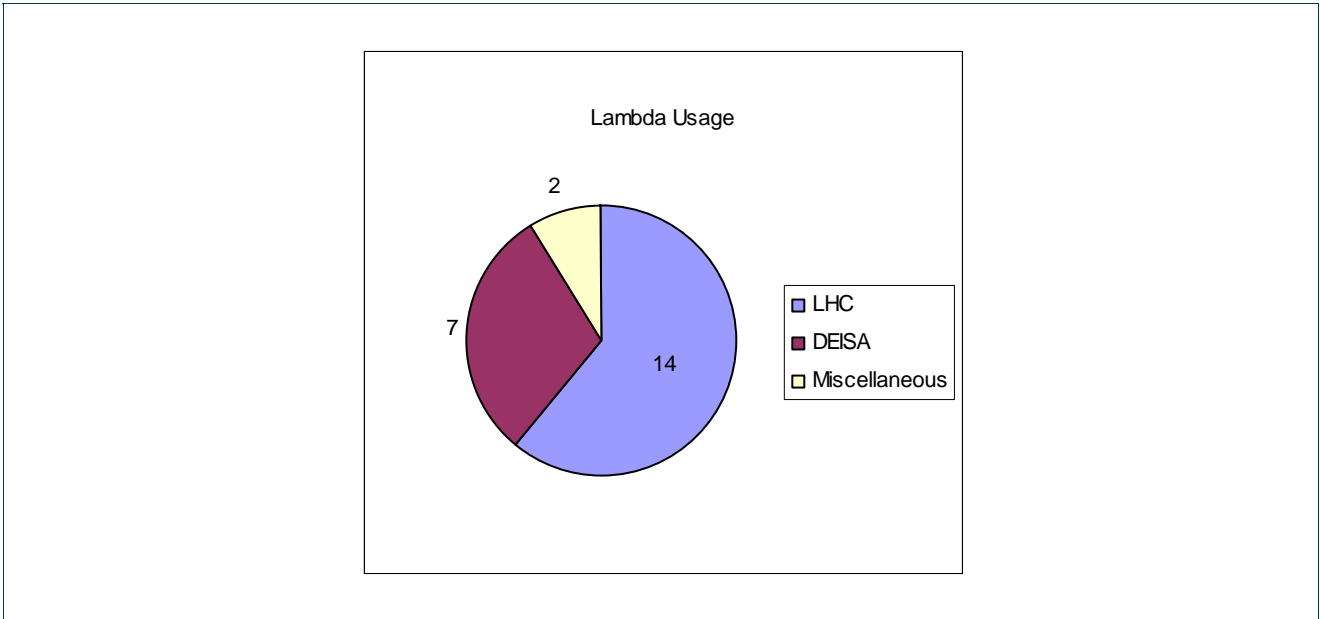


Figure 4.2: Number of GÉANT Lambda links as at the end of Year 4

4.3.3 Combined Totals

Figure 4.3 shows the project use of both link types, expressed as a percentage. The largest users of the GÉANT2 Advanced Services are, in order, LHC (14 links, 28%), FEDERICA (8 links, 16%) and DEISA (7 links, 14%). (As in Figure 4.1, the label “Miscellaneous” includes one-circuit projects.)

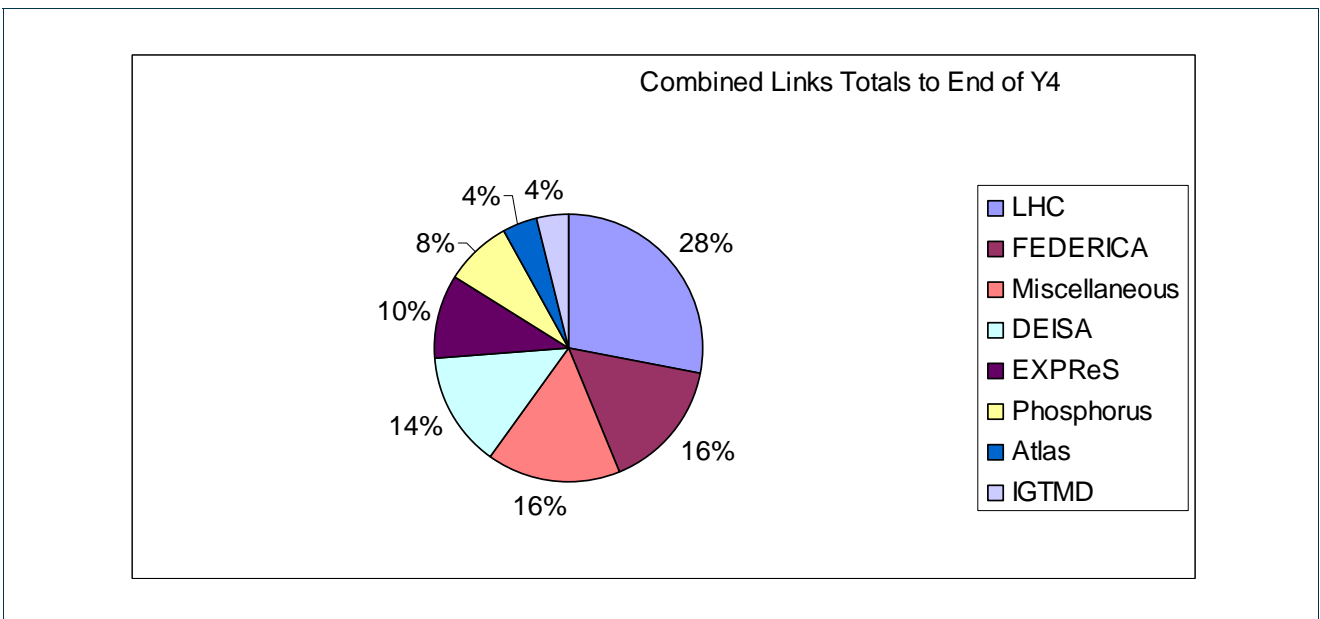


Figure 4.3: Project use of both link types combined as at the end of Year 4

5 E2ECU Activity in Year 4

5.1 Overview

During Year 4, the E2ECU monitored 23 point-to-point links for 3 projects: LHC, DEISA and IGTMD. These links require global monitoring as sections of their end-to-end circuits lie between the end sites. A total of 440 Trouble Tickets (TTs) were tracked and closed.

5.2 Trouble Ticket Statistics

Figure 5.1 shows the number of Trouble Tickets (TTs) closed each month for these projects over the past year.

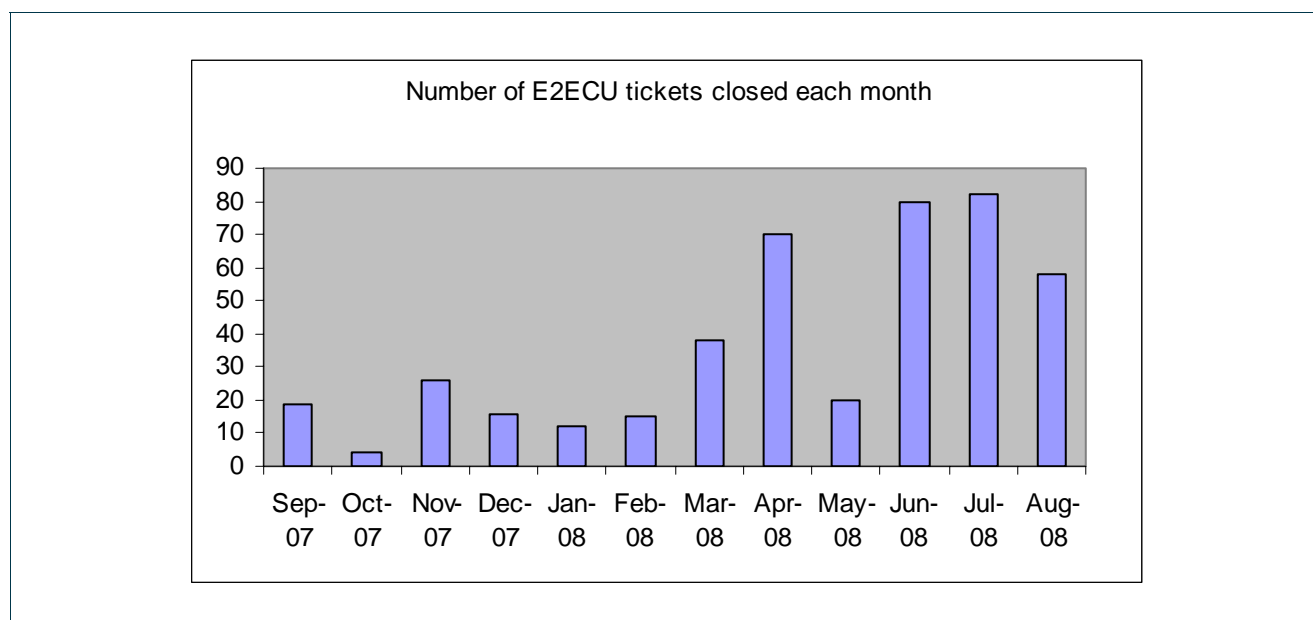


Figure 5.1: Number of E2ECU tickets closed each month in Year 4 – 1 September 2007 to 31 August 2008

6 Conclusions

The GÉANT2 network is 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 point-to-point services *GÉANT Plus* and *GÉANT Lambda* represent a new era in networking and telecommunications technology, and offer unprecedented levels of service to the research and education community.

Indicating the usefulness of and demand for GÉANT2 advanced services, the take-up in Year 4 remained high, with 22 new point-to-point links delivered, others ordered and none cancelled. The main users of the 51 links in place as at Year 4 end were research projects in the fields of particle physics, networking technology and supercomputing.

Reflecting the increased scope and sophistication of the E2E circuits, a significant coordination and monitoring effort is required to ensure their optimum delivery. The E2ECU is therefore key to the advanced services' success, as demonstrated by the number of Trouble Tickets – 440 – that it tracked and closed in Year 4 for the 23 point-to-point links under its supervision.

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 service still further. The high level of take-up is expected to continue during the next period.

7 References

- [1] GN2-07-131v08 Deliverable DN3.0.5: Processes and Provision of Point-to-Point Services in GÉANT2
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- [2] GN2-08-064v9 GÉANT Services Portfolio Definition: Network Services Description
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<http://stats.geant2.net/p2p>
- [4] 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

8 Acronyms

CE(s)T	Central European (summer) Time
DEISA	Distributed European Infrastructure for Supercomputing Applications
E2E	End-to-End
E2ECU	End-to-End Coordination Unit
E2EMon	End-to-End Monitoring System
FEDERICA	Federated E-infrastructure Dedicated to European Researchers
GE	Gigabit Ethernet
IP	Internet Protocol
LHC	Large Hadron Collider
MA	Measurement Archive
MP	Measurement Point
NOC	Network Operations Centre
NREN	National Research and Education Network
PoP	Point of Presence
SRF	Service Request Form
TDM	Time-Division Multiplexed or Time-Division Multiplexing
TT	Trouble Ticket
VoIP	Voice over IP
WLCG	Worldwide LHC Computer Grid

Appendix A Projects

A.1 Summary

Table A.1 lists 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
Atlas	http://atlas.ch/
DEISA	http://www.deisa.eu
EXPREs	http://www.expres-eu.org/
FEDERICA	http://www.fp7-federica.eu
IGTMD	http://www.ens-lyon.fr/LIP/RESO/Projects/IGTMD/ProjetIGTMD.html
LHC	http://public.web.cern.ch/public/en/LHC/LHC-en.html
Phosphorus	http://www.ist-phosphorus.eu

Table A.1: Projects using GÉANT2 advanced services – names and URLs

A.2 Key Projects

The projects with most point-to-point links and/or those supported by the E2ECU are briefly described below.

For further information about GÉANT2's most demanding users, see [4].

Project:	GN2
Deliverable Number:	DS2.0.3,3
Date of Issue:	27/02/09
EC Contract No.:	511082
Document Code:	GN2-08-224v3

A.2.1 DEISA

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.2.2 FEDERICA

The Federated E-infrastructure Dedicated to European Researchers (FEDERICA) is 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 is to develop mechanisms that will allow such experiments to be run over existing production networks without adverse effect.

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

A.2.3 IGTMD

The aim of the IGTMD project is to design, develop and validate mechanisms that make the interoperability of heterogeneous grids a reality. The project concentrates on the following topics:

- Bulk data transfers.
- Replication and referring mechanisms.
- Information system and job management interoperability.
- Grid control and monitoring.
- Usage of statistics and accounting data.

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

A.2.4 LHC

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.

Project:	GN2
Deliverable Number:	DS2.0.3,3
Date of Issue:	27/02/09
EC Contract No.:	511082
Document Code:	GN2-08-224v3

As at the time of writing, LHC is due to go live in September 2008. It will collide particles at high 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 GÉANT2 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.2.5 Phosphorus

The Phosphorus project aims to create a network testbed using a number of GÉANT2 point-to-point connections. The testbed will be used to develop and test software tools for end-to-end, on-demand provisioning of network services, and to facilitate the integration of data storage and other resources in a multi-domain environment. The project contains several GÉANT2 partners and thus has proved a quick adopter of GÉANT2 circuit services.

For more information, see <http://www.ist-phosphorus.eu>.

Appendix B Links After Year 4 End

B.1 New Links

SRF No.	A-end		B-end		Project	Production Date
	NREN	Interface Type	NREN	Interface Type		
08-010	CESNET	1 GE	GRNET	1 GE	FEDERICA	21-Nov-2008
08-032	FCCN	10 GE vlan	RedIRIS	1 GE	FEDERICA	05-Feb-2009
08-012	GARR	1 GE	RedIRIS	1 GE	FEDERICA	20-Oct-2008
08-018	GRNET	1 GE	NIIF	1 GE	FEDERICA	21-Nov-2008
08-013	GRNET	1 GE	REDIRIS	1 GE	FEDERICA	21-Oct-2008
08-031	HEANET	1 GE	RedIRIS	1 GE	FEDERICA	03-Sep-2008
08-029	HEANET	1 GE	SWITCH	1 GE	FEDERICA	17-Sep-2008
08-011	NIIF	1 GE	SWITCH	1 GE	FEDERICA	21-Oct-2008
08-021	SURFNET	10 GE (lambda)	REDIRIS	10 GE (lambda)	I2CAT	18-Nov-2008
08-033	SWITCH	10 GE vlan	[Amsterdam]	1 GE	Miscellaneous	11-Nov-2008

Table B.1: New point-to-point links delivered 1 September 2008 to 16 February 2009

B.2 Total Links in Use

B.2.1 GÉANT Plus

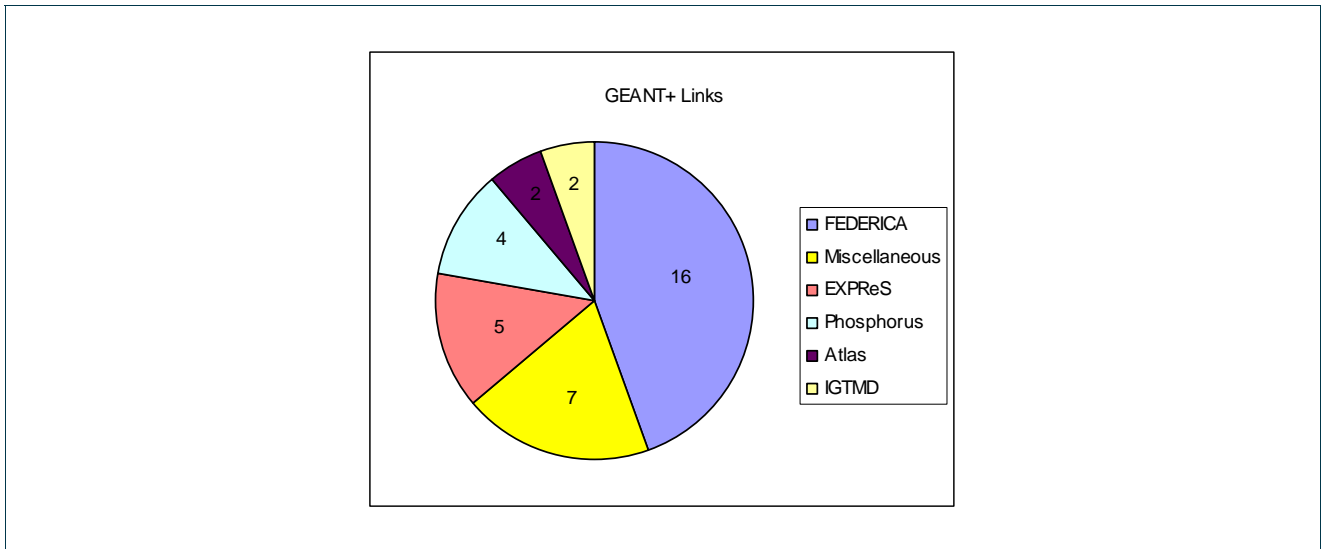


Figure B.1: Number of GÉANT Plus links as at 16 February 2009

B.2.2 GÉANT Lambda

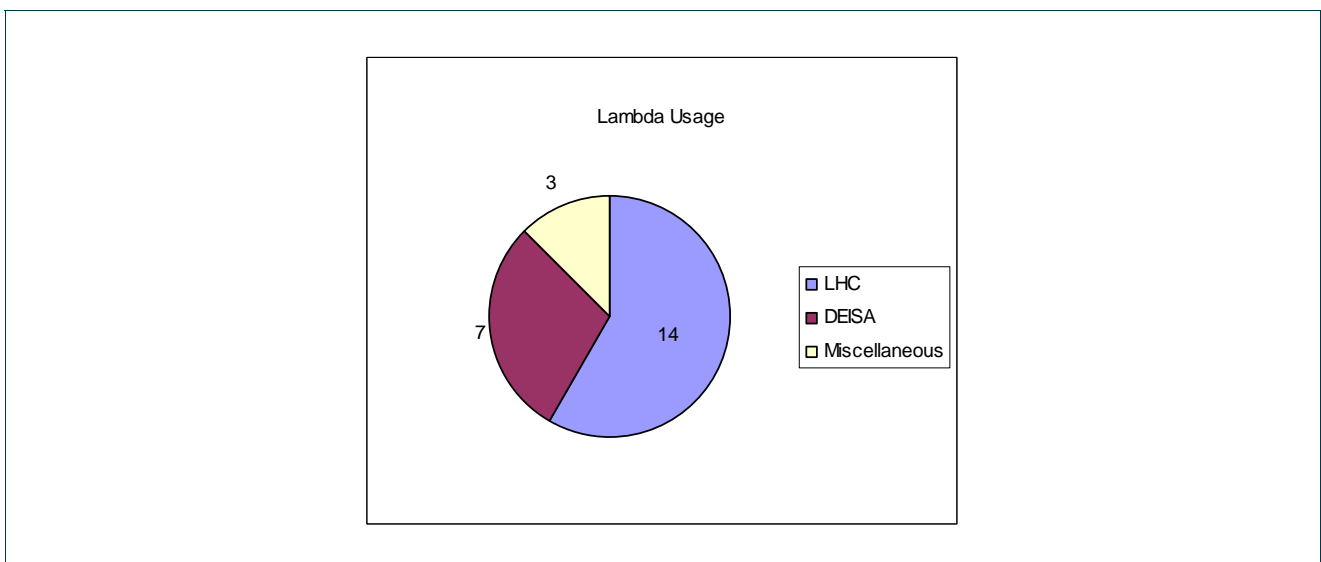


Figure B.2: Number of GÉANT Lambda links as at 16 February 2009

B.2.3 Combined Totals

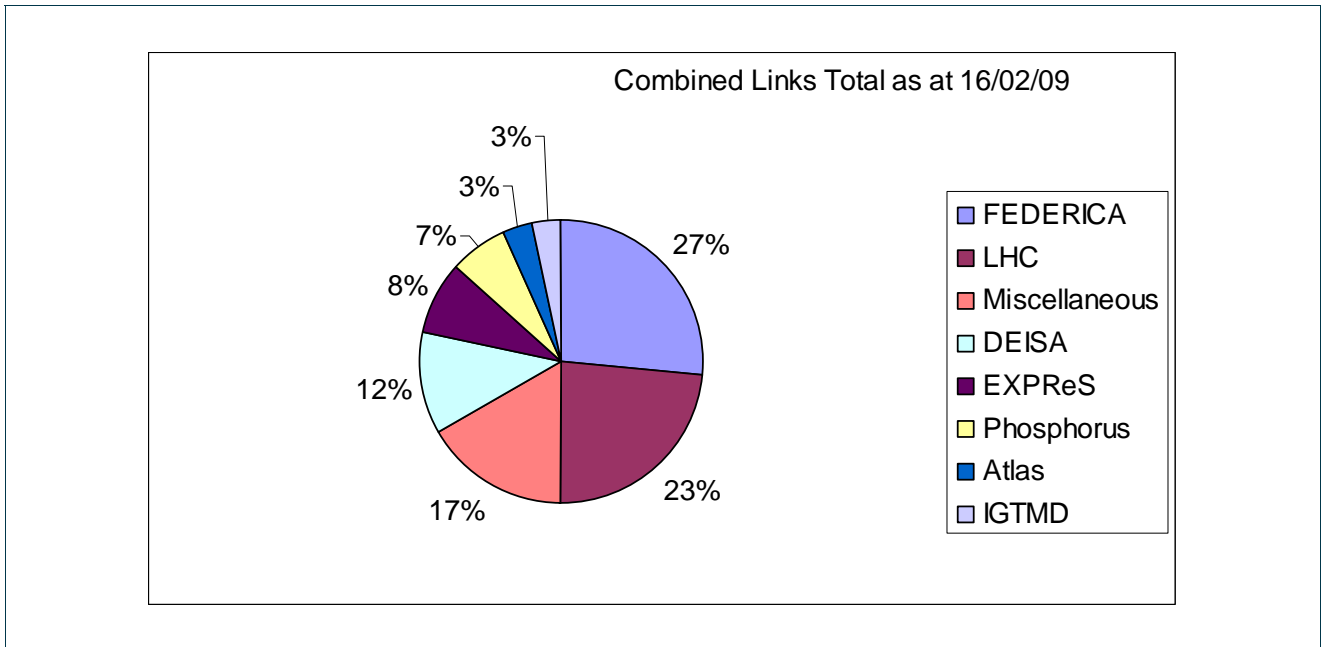


Figure B.3: Project use of both link types combined as at 16 February 2009