19.01.07

Deliverable DN3.0.3,1: Specific Support Actions: Addressing the Needs of the Network's Most Demanding Users

Deliverable DN3.0.3,1

Contractual Date:	28/02/06
Actual Date:	19/01/07
Contract Number:	511082
Instrument type:	Integrated Infrastructure Initiative (I3)
Activity:	NA3
Work Item:	N/A
Nature of Deliverable:	R (Report)
Dissemination Level	PU (Public)
Lead Partner	DANTE
Document Code	GN2-06-260v6

Authors: John Chevers (DANTE)

Abstract

This document describes support actions aimed at addressing a targeted group of GÉANT2 users, including a range of advanced user-focused services.

Table of Contents

Table of Figures

0 Executive Summary

This document describes support actions aimed at addressing a targeted group of GÉANT2 users. It describes the rationale behind the definition of this user group and the steps which have been taken to implement a successful support structure and a range of advanced user-focused services. The report includes an overview of the various actions that have been taken to progress the user support initiative.

Briefly, these are the provision of point to point services, network monitoring and measurement tools, and end-to-end quality of service provision, which are available to this group in addition to the generic on-line user support services

1 Introduction

It is estimated that GÉANT2 connects more than 30 million researchers, academics and students across Europe. Added to this figure are the many millions of users of networks beyond Europe that are connected by GÉANT2's international links.

The first section of this report details the actions taken to establish a successful user support service for demanding users, for whom straightforward access to the standard GÉANT2 IP service is insufficient and for whom a multilateral cooperation between DANTE and the GÉANT2 NRENs must be established. The establishment of this service included setting up a dedicated single point of contact, establishing a clear process for the provision of point to point services, providing performance monitoring services and creating the Performance Enhancement and Response Team (PERT).

The second section describes the support offered to demanding user groups from a wide variety of disciplines in their international networking activities. The users' projects, their partners, goals and networking requirements are described, together with the support given to these projects, their current network usage and their future plans.

2 Description of the GÉANT2 User Support Service

2.1 Definition of Demanding Users

It is important to the GÉANT2 project that the community known a 'demanding users' is clearly defined. It is assumed that these users will be drawn from the research, education and not-for-profit sectors and be pan-European or international in scope.

The definition is based on four major criteria:

- The importance of the user group to GÉANT2 in terms of the justification of the network's existence, its design and the details of its implementation, technologies and services.

- The importance of GEANT2 to the user group. If a user group meets acceptable use criteria and is dependent upon GÉANT2 to meet its reasonable goals, it is the network's function to meet those needs. This group comprises users whose networking requirements could not otherwise be met

- The necessity or preference for GÉANT2 partners to know details of the networking activities of a particular user group, for technical, operational or other reasons

- The reasonable and appropriate use of advanced services (monitoring, MPLS, point-to-point optical path, QoS etc) to enable, expand or enhance valid educational or research projects.

If a user group meets any of these criteria, their network usage is such that it can be differentiated from the majority of GÉANT2 users, in that such users' needs will not be wholly met by the standard GÉANT2 IP service. To address these needs, GÉANT2 will offer such users a dedicated service in order to support these projects fully in their networking goals. Given the diverse nature of potential user groups meeting these standards, the level of service applicable to each will vary, based upon the requirement and the resource available. A common framework should, however, be applied to bring accountability and transparency to the decision making process and to the allocation of a 'class' to user groups.

Demanding users typically:

- are dealing with large volumes of data and therefore require high bandwidth
- are looking for:
    - No/low packet loss
    - Low latency
    - Low/no jitter
    - Effective/efficient network diagnostics, performance enhancement, configuration and consultancy
    - Performance monitoring tools
    - Coordination across networks – solution design

Above all, demanding users are characterised by their requirements for dedicated resources – whether this comprises expert consultancy and solution management or actual network services.

It should be remembered that by definition all users of the GÉANT2 network are projects which connect to at least two NRENs, one of which must be within Europe. As such, any network support given to users must address the multi-domain network path as an end-to-end solution.

2.2 Role of GÉANT2 User Support

The role of the GÉANT2 User Support service is to provide a dedicated single point of contact for demanding user groups. The user support service offers advice on appropriate network solutions and the management of the necessary resources.

To successfully accommodate the requirements of the most demanding GÉANT2 users, it is important for the project to have workable internal processes to liaise internally to meet these demanding users' needs. The majority of requests will require the involvement of DANTE and NREN operations and network planning departments. Some will involve policy decisions and financial costings. Many require liaison with the corresponding functions in networks across Europe and globally.

The final important aspect of the service is to set up a process for ordering point to point services, to coordinate and progress these requests. Every point-to-point service is, by definition, a dedicated user-specific resource. As such, careful management of these resources is necessary to ensure that the solution meets user requirements and is successfully integrated with all networks on the end-to-end path -including campus networks, regional networks, NRENs and GÉANT2.

The initial point of contact with GÉANT2 is often the project website (www.geant2.net). This service is available to all users and potential users and is described elsewhere.

2.3 Provision of Point-to-Point Services

One of the most significant features of the GÉANT2 network is its ability to provide both IP services and dedicated point-to-point connections. The provision of such point-to-point connections in an efficient, timely and professional manner is essential to the success of the innovative and ambitious hybrid network created by the GÉANT2 project.

A mechanism has been established which allows point-to-point services to be requested, the policy, technical and financial issues considered and a swift response made to the enquiring party. An effective process has been documented so that data relating to the projects and their requirements for point-to-point services can be recorded. A mechanism has been set up to track the current status of the request through the process, to ensure that all necessary steps are taken and that the request is processed in a timely manner.

The point-to-point service request form and details of the request lifecycle are available to all project partners on the GÉANT2 intranet (for registered site users only) at

http://intranet.geant2.net/server/show/nav.922

This form and a flow chart describing the progression of a point-to-point service request are detailed in Appendixes 1 and 2 of this document respectively.

Point-to-point services are currently offered on European dark fibre routes and also on some transatlantic links. The processes for point-to-point services where an end site is not a customer of a GÉANT2 partner NREN are currently under consideration.

2.4 Performance Measurement and Monitoring

The research activities carried out within the GÉANT2 project are all concerned with the development of advanced services for the benefit of the network's userbase. One of the first such services to be rolled out to major network user groups will be the perfSONAR framework of measurement and monitoring tools.

perfSONAR has been developed by a consortium of networking organisations, both from within the GÉANT2 project and from research networks and engineers in the United States (Internet2 and ESnet) and Brazil (RNP).

The networking supply chain for any GÉANT2 user will consist of at least five separate domains (campus network-NREN-GÉANT2-NREN-campus network). It is important for network engineers and users to access data on all of these domains to maintain awareness of the status of end-to-end paths and to facilitate troubleshooting if a reduction in performance is observed. perfSONAR offers the opportunity to monitor multiple

network domains from a single visualisation tool. Data from multiple network domains can also be displayed and sorted regardless of its original source, but rather upon its relevance to the enquirer. A user can therefore investigate the utilisation of each network interface between two sites, despite the fact that these may be located in multiple network domains.

perfSONAR is thus an excellent example of a tool specifically aimed at the needs of the advanced research network user community and of direct relevance to the issues they face.

Many of the perfSONAR visualisation features are now in place and work will continue to expand the number of network domains accessible by the tools and to facilitate the roll-out of perfSONAR to the networks most demanding users.

2.5 Performance Enhancement and Response Team (PERT)

The GÉANT2 Network Operation Centre (NOC) and the DANTE Operations Team are dedicated to ensuring that the pan-European backbone functions as it should. An additional service, the Performance Enhancement and Response Team (PERT) is committed to helping network users gain the best possible performance, not only from GÉANT2, but from all network domains on the chosen path.

The virtual team created by the PERT brings together inter-disciplinary expertise to examine reported instances of less-than-optimum network performance. These specialists or 'Subject Matter Experts' are drawn not only from the NREN project partners, but also from the networking community at large. In addition, the PERT is staffed by a rotating team of GÉANT2 Case Managers, ensuring that there is always at least one person on duty during core hours.

Direct access to the PERT is available to recognised demanding users (as defined in section 2 of this document), whilst other users can benefit from the service by escalating a performance issue through the normal support channels.

Offering a dedicated technical service, aimed at optimising end-to-end network performance is a significant step forward in addressing one of the most important issues faced by network users. Perhaps the most distinguishing features of research networks are the high level of performance and the advanced services offered. Ensuring that these features result in the anticipated benefit to the user community is thus critical in delivering an advanced network backbone.

2.6 Specific Support Actions for GÉANT2 User Groups

As listed in the above sections, a distinct action plan has now been developed for the establishment of a formalised user support service within GÉANT2. Specifically the action points are as follows:

Create a set of procedures to deal with the lifecycle of user support for GÉANT2. This should encompass initial information-gathering, agreement on an acceptable solution and management of the implementation and operation of that solution. **Completed February 2005**

The design and implementation of a user support web-presence within the GÉANT2 website, including a 'Contact GÉANT2 User Support' web order form. **Completed February 2006**

Creation of a procedure for the request, confirmation and provision of point-to-point services over GÉANT2. This should include a request lifecycle flow-chart and service request and confirmation forms. **Completed May 2006**

Development of parallel mechanisms for point-to-point services beyond Europe. Due date: **September 2006**

The establishment of a formal network of user-support contacts from the European NRENs and beyond will take place, beginning in Q4 '06. This will clearly be an ongoing task and steps to facilitate the interworking of the user support, PERT and operational functions of research networking organisations will continue over time. **Ongoing**

3 Support Offered to Specific User Groups

3.1 LHC-OPN

Background

CERN is the world's largest organisation for research into particle physics.

CERN is based in Switzerland and funded by 20 European Member States. However, today CERN is a world-wide enterprise involving many other states with scientists and engineers of many nationalities. It is an important example of international collaboration: the nature of the experiments conducted at CERN is such that no single state could afford to fund them on this scale.

CERN's most ambitious project to date, the Large Hadron Collider (LHC), is currently under construction. This facility, able to smash fundamental particles together at unprecedented energies, is said to be the largest scientific endeavour in history. It will produce data about the collisions, and the exotic and short-lived particles they create, at a rate of 15 Petabytes (15 million Gigabytes) per annum. It would be impossible to process all of this data at CERN, so it must be distributed to computing sites around the globe for analysis. GÉANT2 and the connected NRENs are tasked with meeting this challenge.

User support provided

The function of the LHC OPN (Optical Private Network) is to distribute the LHC data to 12 Tier 1 sites, each connected to Tier 0 (CERN) by a dedicated wavelength switched path of 10Gbps. These paths are provided by the new hybrid (IP routed/ wavelength switched) structure of GÉANT2. Corresponding dark-fibre lightpaths will be provided by each of the European NRENs involved.

Each Tier 1 processing site will support a number of secondary Tier2 sites, often within the same country but including international circuits over GÉANT2. Connectivity between Tier1 and Tier2 sites will be provided by the relevant NREN. DANTE and these NREN partners (GARR, UKERNA, SURFnet, DFN, RENATER, RedIRIS, NORDUNET, ESNET and ASNet) are currently engaging with the high energy physics (HEP) community to establish the necessary infrastructure.

The point-to-point circuits requested so-far to facilitate the LHC-OPN are listed below:

10Gbps Circuits Delivered

- ☐ SURFnet-CERN –connecting SARA, Amsterdam
- ☐ SURFnet-CERN –connecting FNAL, USA
- ☐ SURFnet-CERN –connecting ASGC, Taiwan
- ☐ DFN-CERN –connecting the University of Karlsruhe,
- ☐ GARR-CERN –connecting INFN, Bologna
- ☐ UKERNA-CERN –connecting RAL, Oxford
- ☐ RENATER-CERN connecting IN2P3, Paris

10Gbps Circuits On Order:

- ☐ SURFnet-CERN –connecting USLHCnet, USA

GÉANT+ Gigabit Ethernet Circuits Delivered:

- ☐ DFN-CESNET –connecting the Universities of Karlsruhe and Prague
- ☐ RENATER-ESNET -connecting FNAL, USA and IN2P3, Paris (via Paris-NY circuit)
- ☐ RENATER-ESNET -connecting FNAL, USA and IN2P3, Paris (via London-NY circuit)

Related Dissemination Activity

A press release detailing the GÉANT2 support for the LHC OPN initiative was issued on 7th November 2006 and can be found on the GÉANT2 website at:

http://www.geant2.net/server/show/conWebDoc.2243

3.2 DEISA

Background

DEISA is a consortium of leading national supercomputing centres in Europe. It aims to jointly build and operate a distributed terascale supercomputing facility. The project consists of several phases.

User support provided

The first phase was a proof of concept, carried out during 2004-5. In 2004, four supercomputing sites were connected:

- Forschungszentrum Jülich (FZJ), Germany
- Rechenzentrum Garching of the Max Planck Society (RZG), Garching, Germany
- Institut du Développement et des Ressources en Informatique Scientifique (IDRIS), Orsay, France
- Consorzio Interuniversitario (CINECA), Bologna, Italy

During the second phase of the proof of concept three additional supercomputing sites have been added:

- SARA Computing and Networking Services, Amsterdam, The Netherlands
- Leibniz Computing Centre of the Bavarian Academy of Sciences and Humanities (LRZ), München, Germany
- Finnish Information Technology Centre for Science (CSC), Espoo, Finland

Each end site is connected to its local national research and education network (NREN) with a dedicated gigabit Ethernet connection. The network connectivity is based on routed IP. Within the GÉANT2 network, MPLS LSPs with a Premium class of service are used to offer the high guaranteed capacity requested by DEISA, and to be able to control the routing in order to prevent any possible impact on the best-effort service in case of route changes.

DEISA has ambitious plans for its next phase of network connectivity. This will be based on dedicated gigabit and 10 gigabit Ethernet connections provided by the NRENs involved and GÉANT2. At a project meeting held in July 2005 in Munich, an architecture team was appointed to design and document the new DEISA network infrastructure.

The following GÉANT2 10Gbps point-to-point circuits have now been requested between NRENs hosting DEISA sites and the central DEISA hub in Frankfurt:

- ☐ SURFnet-DFN (delivered December 2006) –connecting SARA, Amsterdam
- ☐ RedIRIS-DFN (delivered January 2007) –connecting BSC, Barcelona
- ☐ RENATER-DFN (to be delivered February 2007) –connecting IDRIS, Orsay

3.3 European Space Agency

Background

The European Space Agency (ESA) is a large international organisation comprising 17 European member states plus collaborators across the world. The ESA's work spans the whole range of space-science activities, from terrestrial navigation to manned spaceflight. The GÉANT2 consortium provides connectivity between the many European sites operated by ESA. A particular example of how GÉANT2 is enabling ESA's work is in their Earth observation activities.

ESA satellites observe the earth for a variety of projects, amongst them meteorology, climate change, oceanography and polar science. The data from these satellites is transmitted to acquisition stations hosted at different ESA sites depending upon the mission. As the data produced by these missions is of interest to scientists at ESA sites other than the one receiving the data, an efficient means of distributing the data is required. GÉANT2 is thus used for the transfer of this information.

User support provided

GÉANT2 user support has engaged with the ESA and, since a meeting in May 2005, there have been regular discussions between the two organisations. In particular, ESA has developed a requirement document, outlining new services required both technically and for the administration and management of the network resources.

The GÉANT2 consortium

GÉANT2 has also been contacted by ESA staff to advise on network transfers from a site in Japan to Europe. A GÉANT2 Performance Enhancement Response Team (PERT) case was opened and a PERT manager assigned to the task. Similarly ESA sites have contacted GÉANT2 user support regarding connections to Japan for a HDTV application and for advice on a dedicated connection to the United States.

3.4 eVLBI

Background

The European VLBI Network (EVN) is the collaboration of major radio astronomical institutes in Europe that works together on the data collected by an array of European radio telescopes. The EVN also works with similar institutes in Asia and South Africa. VLBI (very long baseline interferometry) is a technique that involves the collection of simultaneous observations from these telescopes. Data is then correlated to form very sharp, high-definition images.

User support provided

GÉANT2 is supporting the work of the EVN through the provision of network resources to allow rapid data transfer. Before it began working closely with GÉANT, data was collected at each telescope on magnetic tapes. The tapes were then transported by courier to the central correlator at the Joint Institute for VLBI in Europe (JIVE) in Dwingeloo, the Netherlands - a journey which could take up to six weeks.

If any of the telescopes were malfunctioning, it would be weeks before the problem was diagnosed. In addition, exciting astronomical events were often over before astronomers even knew of their existence.

The use of GÉANT and the NRENs in participating countries enables significantly faster processing and correlating of radio telescope data. Data can now be transferred almost instantaneously via the NRENs and GÉANT. It can therefore be immediately correlated and processed, producing images in near-real time.

The electronic VLBI (e-VLBI) that is thus made possible allows rapid follow up of significant astronomical events and permits telescope troubleshooting to occur in near-real time. The large amounts of data that can be transferred by the networks allow very sharp, bright images to be formed. Ultimately, using the networks to perform VLBI allows Europe's radio-astronomers to see further back in time.

As well as supporting the VLBI technique, GÉANT can also open the way for astronomers all over the world to access the data and images produced at JIVE. This method, known as "reverse e-VLBI", transfers data from the central correlator in Dwingeloo directly to an astronomer's personal computer for local study and analysis.

For some time GÉANT2 user support has been closely engaged with the eVLBI community. Regular EVN-NREN meetings have been held to facilitate planning and the exchange of news and ideas between the networking and radio astronomy communities. Technically GÉANT2 engineers have enabled premium IP service for the data flows from the telescopes to the correlator and counters at GÉANT2 points of presence have been used to monitor traffic flows across Europe.

In the first 'Science' experiments run by the EXPReS project, GÉANT2 transported more than one million eVLBI data packets without a single example of packet loss.

Recently an extensive programme of network diagnostics and optimisation was carried out to enhance the performance of the end-to-end path between the TIGO observatory in Chile and JIVE in the Neterlands to facilitate tracking of the ESA spacecraft SMART-1. A full report of this activity can be found in the references section of this document.

The future requirements of eVLBI are currently being formulated. GÉANT2 User Support is engaged in discussion with eVLBI scientists and NREN engineers to realise a set of dedicated gigabit Ethernet connections between telescopes and correlators across Europe.

3.5 MUPBED

Background

The huge growth in the Internet, and in projects that rely on fast, reliable network connectivity for their research, has led to an increased interest in the further development of the technologies necessary for both commercial and academic networks to keep pace with customer demand.

One of the most notable network testbed projects using GÉANT2 today is MUPBED (Multi-Partner European Testbeds for Research Networking). Network testbeds such as those created by the MUPBED project allow researchers to test new technologies and techniques on a truly pan-continental scale. MUPBED is a consortium of telecommunications equipment manufacturers, commercial and research network operators, and networking research centres from eight European countries.

MUPBED intends to use large-scale testbeds to test new network technologies such as ASON (Architecture for Automatically Switched Optical Networks) and GMPLS (Generalised MPLS). [Note: these are ITU initiatives aimed at addressing the problem of managing optical networks with network elements and equipment supplied by multiple vendors]. It is hoped that the unique opportunities presented by GÉANT2 and its NREN partners to support such a testbed will allow MUPBED to contribute to the shaping of features and services of the next-generation Internet.

User support provided

Engineers from DANTE, the operator of GÉANT2, and from the NRENs are already working with MUPBED to set up the specialised infrastructure needed for testing to begin. Five MUPBED partner sites in Germany, Italy, Poland, Sweden and Spain have been linked by stitching together a mesh of MPLS paths across the NREN and GÉANT2 network domains. As a result, network traffic between MUPBED sites is directed over particular paths through the various network domains.

Setting up a separate MPLS path for each network, rather than a single path through all of the networks, allows for greater ease of troubleshooting and accurate monitoring. An additional Layer 2 virtual private network (VPN) covering each complete path between partner sites ensures that end-to-end control is maintained.

The smooth implementation of this service, ahead of the scheduled timeframe, is an excellent example of the customer-focused emphasis at the heart of the GÉANT2 project.

3.6 EGEE

One of the main goals of the GÉANT2-EGEE collaboration is to provide Grid applications and middleware with a software component to reserve a network service available across different domains. During Year 2, the EGEE JRA4 BAR (Bandwidth Allocation and Reservation) sub-activity, in which GÉANT2 partners are involved, produced an architecture and a prototype to demonstrate the world's first usage of such a component.

The two projects collaborated on interfacing the BAR system with the Premium IP reservation tool of GÉANT2 SA3, namely AMPS (Advanced Multi-Domain Provisioning System). The interoperability of the BAR and AMPS systems was achieved, through various modifications of the BAR source code. AMPS is therefore expected to interoperate with the BAR software developed by EGEE JRA4.

As part of their joint activities, GÉANT2 and EGEE conducted a joint Quality of Service (QoS) test. The basic goal of this experiment was to put into practice a test of end-to-end service usage, SLA establishment and monitoring, specifically with regards to the networking needs of the EGEE project (EGEE SA2: Network Resource Provision). The particular goals of the experiment were:

- to test if a grid application can use network QoS, namely the AMPS system
- to implement the technical part of the usage of an end-to-end network service
- to evaluate the administrative issues raised by this usage.

The test consisted of launching a grid job onto a cluster of remote computers (resources).

IN2P3-CC (Lyon, France), RRC-KI (Moscow, Russia), HG-01-GRNET (Athens, Greece) and IPSL-IPGP-LCG2 (Paris, France) all took part in the test as grid resources, whilst participating networks were GÉANT2, RENATER (and RAP, the Paris metropolitan network), GRNET and RBNet. Participants were chosen to reflect the heterogeneity of the underlying network infrastructure in a production environment. All the five networks were contacted to create a specific reservation for the IP addresses involved. Figure 3.1 displays the schema of the connected networks during the test of the Lyon-Athens path, however, the principle is the same for the tests conducted on paths between Lyon and the two remaining receiver sites.

To test if the PIP traffic was correctly handled on the whole path, tests were carried out to ensure that the receivers received marked packets as expected, which would confirm that the PIP traffic was correctly differentiated in the networks. Two strategies to verify the marking were adopted:

- Ooserve the traffic at the end of the path and check that the packets were marked
- monitor the PIP queue of the last router facing the Storage Element (SE) in Moscow.

The second proved to be far more difficult due to configuration issues, partial support in the equipment and the required deployment of management tools. No true monitoring figures (delay, loss) were recorded on a particular traffic or reservation during the tests, mainly due to the lack of tools; it was noted there is no production tool in place, either in the NRENs or in the EGEE sites, to monitor a particular traffic or reservation. Results could therefore be collected only for the whole aggregated traffic per router interface or per queue.

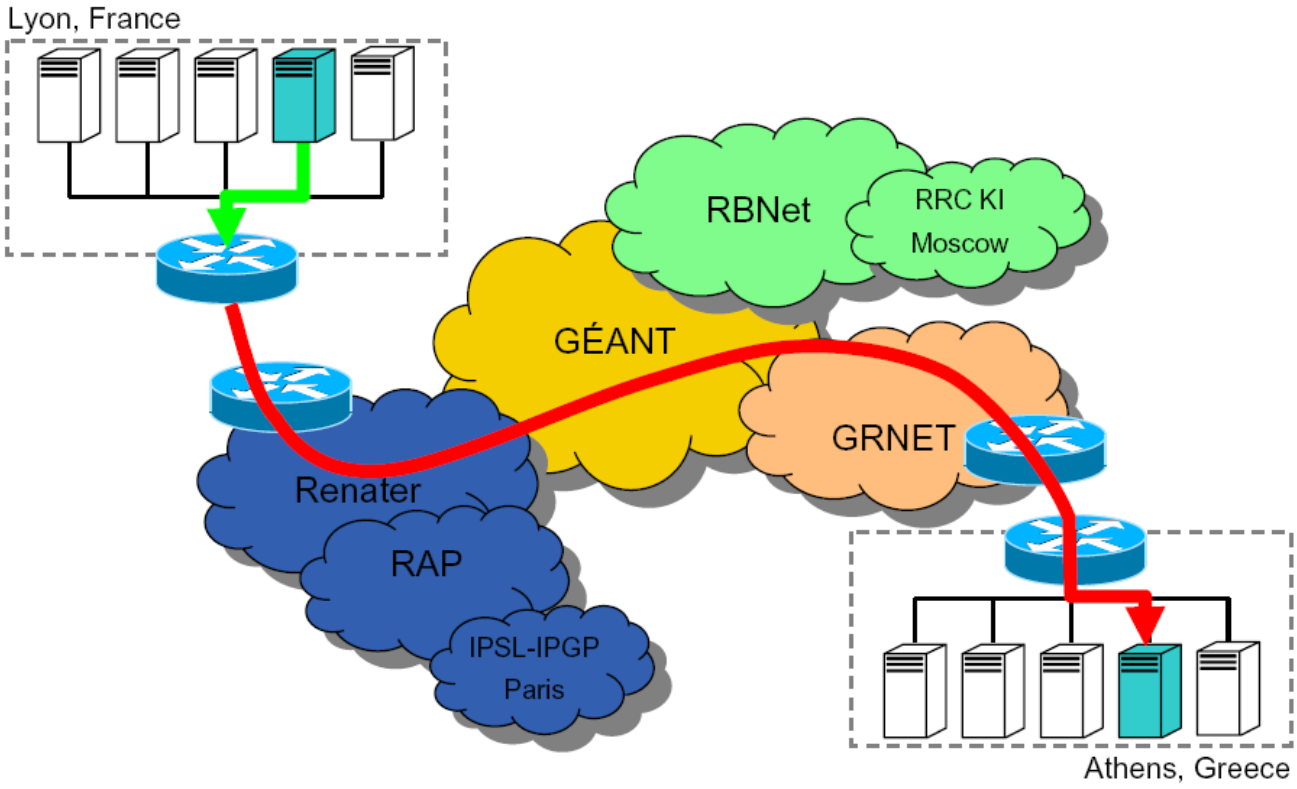


Figure 3.1: Schema of the testbed and DSCP translation

Two main lessons can be drawn from these tests:

1) The unexpected difficulty of use from the network point of view; a lot of administrative and technical communication and coordination is necessary to set up the service. The administrative part, mainly authorisation and SLAs, was particularly time consuming. The use of PIP is feasible for a one-off and mid-term use of a service, however, it does not scale for a deployment in an infrastructure the size of EGEE.

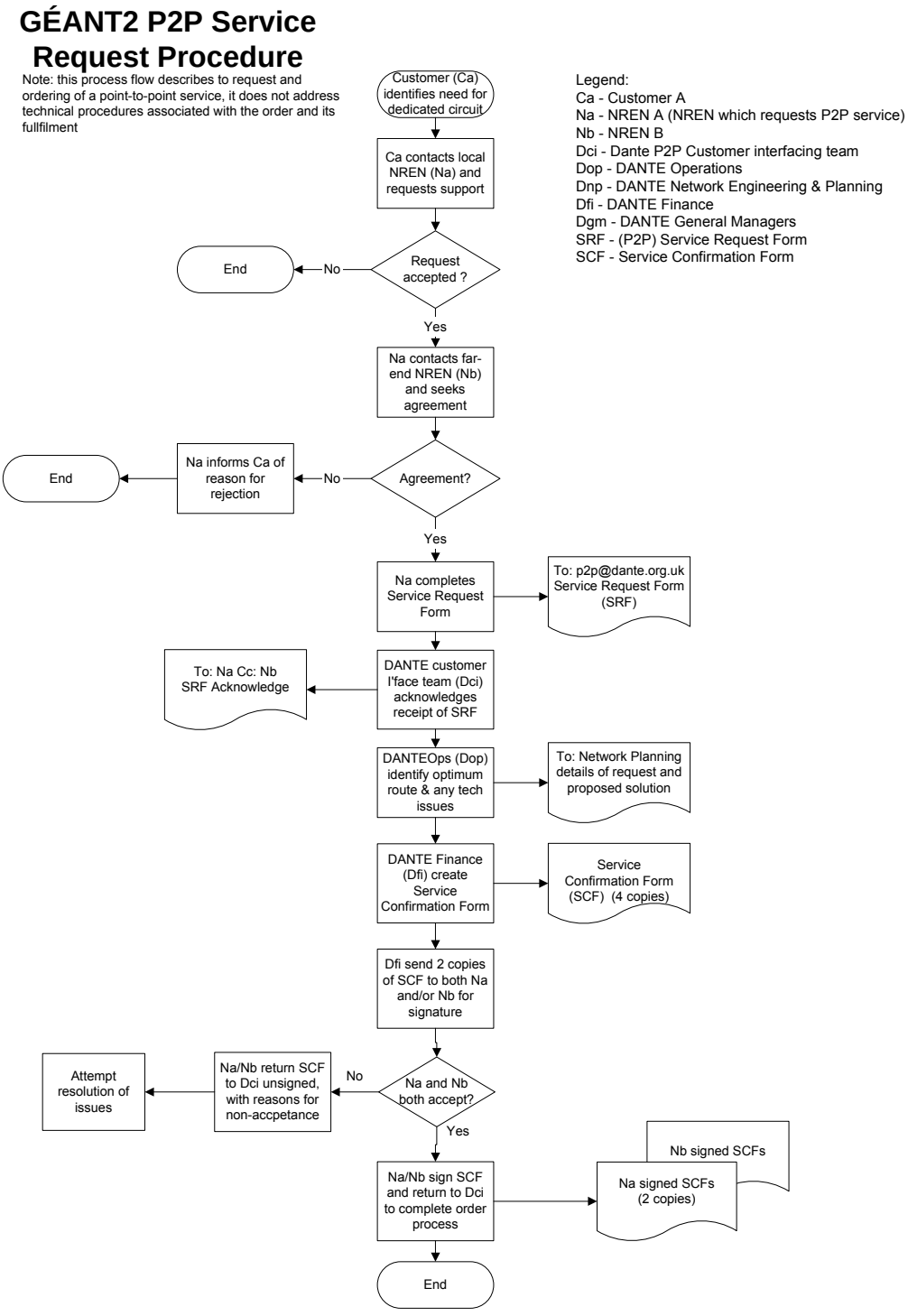
2) An application cannot use the PIP service in the form applied in the test. Substantial modifications to the middleware need to be carried out before such service can be useful. Thus, the middleware is not compatible with the current implementation of BAR even though it is still thought that the principle behind is a good solution: let the application identify its traffic and make the network equipment do the right translation. This does mean some work is required in the middleware to give the application an easy way to use network service and a true network resource management to the grid. It should be noted that, on the application side, the use of a service through BAR is not yet possible due to the lack of middleware support between the application and BAR.

The results of the GÉANT2-EGEE collaboration in Year 2 were jointly presented by the representatives of the two projects in several events, most notably the TERENA Networking Conference 2006 and the GridNets events in 2005 and 2006.

4 Related Documents

- DN3.0.2: A proposal for the organisation of user support for demanding users
- DS3.3.2: GÉANT2 Performance Enhancement and Response Team (PERT) User Guide and Best Practice Guide
- PUB-06-151v3 Report Describing Research Network Support for eVLBI Tracking of the SMART-1 Spacecraft

Appendix A P2P Service Request Procedure



Appendix B P2P Service Request Form

A. Details of NRENs		
	NREN A	NREN B (details of person contacted who agreed to this service request
Contact Name:		
Organisation		
Position		
Telephone		
E-mail		
B. Commercial Contacts (if different from above)		
Site Name		
Contact Name:		
Telephone		
E-mail		
C. Project		
Project Name:		Field of education or research:
Project Description:		
D. End-sites to be connected		
	Site A	Site B
Site Name:		
Contact Name:		
Telephone No:		
E-mail:		
E. Date Required		
Required Ready for Service Date:		Termination Date:
Further point-to-point services required for this project?		

F. Technical Details of Request							
	NREN A				NREN B			
1. Access Point								
2. Technical Contact Person Name								
Telephone No								
E-mail address								
3. Total Capacity required (Gbps)								
4. *New Interface type facing GÉANT2 equipment	1 or more GEth				1 or more GEth			
	10 GEth full rate				10 GEth full rate			
	10 GEth with VLAN functionality				10 GEth with VLAN functionality			
	VLAN in already existing 10 GEth interface				VLAN in already existing 10 GEth interface			
	STM-16				STM-16			
	STM-64				STM-64			
5. Type of Optics	SDH				SDH			
	GEth				GEth			
	Other (please specify)				Other (please specify)			
6. *In case of 10 GEth full rate interface or STM-64 interface the Service should be provided via								
7. In case of VLAN request, specify the VLAN number to be used								
8. In case of VLAN on a pre-existing 10 GEth interface, are the previously configured VLANs used for a different project(s) (If Yes, please specify)								
9. If STM-16 or STM-64 is required into the TDM switch, which time slots should be used for this project?	From (1-64)		To (1-64)		From (1-64)		To (1-64)	
10. Is a redundant circuit required for protection? (Note: this will be treated as an additional point-to-point request and charged as such)								
G. Payment								
Please indicate how the service is to be invoiced to NREN A and B			NREN A - %			NREN B - %		

* Please note that question is not applicable if the requested service will use GÉANT+