GigaPort3

Annual Plan 2012

SURFnet, 28 November 2011

1 Executive summary

GigaPort3 is a 5 year project, funded out of the FES round 2009 in the knowledge domain 'Large Infrastructures'. GigaPort3's ambition is to create advanced networking and middleware services which provide the best possible support for Research and Education. Both the underlying technology and the connected applications are constantly evolving, leading to new demands on the network. The GigaPort3 project prepares to meet these demands even as they evolve. GigaPort3 will not only continue to provide the research and education community in The Netherlands with a state of the art research network. It will also facilitate the integration with other elements of the ICT infrastructure for research, providing the framework for e-Research.

This annual plan defines the objectives, activities, and deliverables of the GigaPort3 program during the year 2012, and is based on the GigaPort3 Project plan 2009-2013. SURFnet executes the GigaPort3 project under the supervision of Stichting SURF, and in partnership with suppliers, users, and research partners.

GigaPort3 consists of three areas of activity: Networks for Research, Research on Networks, and User Participation and Knowledge Dissemination. The work planned for 2012 is divided in seven work packages with the following aims:

1. *Photonics* - In 2012 GigaPort3 will perform a technology assessment of the next generation photonic technologies. Additionally, an architecture study of the next generation photonics for SURFnet8 is performed.

2. *Next Generation Ethernet (NGE)* – In 2011 the Next Generation Ethernet industrial partner was selected, the design of the SURFnet7 network completed and the first SURFnet7 equipment ordered and installed. In 2012 the transition will be completed and the SURFnet7 services will be augmented with new NGE features.

3. *Enabling Dynamic Services* – In 2011 a proof of concept was delivered for the support of e-Science applications and resources. In 2012 these e-Science services will be made available for routine use via the SURFconext platform, while the existing Dynamic Lightpath Service will be integrated into SURFconext.

4. *NetherLight and global connectivity* – NetherLight's leading role and position will be reinforced by introducing new Next Generation Ethernet services. Global connectivity will be further enhanced by participation in the creation of an open lightpath exchange in London. Additionally SURFnet intends to join forces with other NRENs to bundle Trans-Atlantic connectivity as soon as 40G and 100G Trans-Atlantic links become available.

5. *Mobility and Fixed-Wireless* - The GigaPort3 ambition is to implement the anywhere, anytime and any device paradigm. In 2011 a study was performed for opportunities, such as the integration of the eduroam infrastructure with a 4G infrastructure at the campuses of Dutch centres for education and research. In 2012 we will develop and pilot new wireless services and mobile applications in collaboration with interested 4G operators.

6. *IP innovation* - GigaPort3 will keep SURFnet7 current with developments in the domains of both IP (e.g. IPv6, secure routing) and DNS (e.g. DNSSEC) and share the expertise gained with institutions and peers. Future Internet developments will be followed closely.

7. *User Participation and Knowledge dissemination* - GigaPort3 will work in close partnerships with advanced users and user groups from different scientific disciplines to investigate and explore novel uses of networking and e-Research services and will ensure that all know-how created through GigaPort3 will become widely available. These activities will be executed in close collaboration with other e-infrastructure providers like the Netherlands e-Science Center, SARA and BiG Grid.

Several of the work packages are supported by Research on Network activities in 2012 as described in chapter 5.

2 Program Structure

GigaPort3 consists of three areas of activity to support the execution of the work packages described in the chapter "Work packages and deliverables in 2012". These areas are *Networks for Research*, *Research on Networks*, and *User Participation and Knowledge Dissemination*:

- *Networks for Research* develops and implements new network architectures and new technology in the operational network, resulting in new next generation services for the connected institutions.

- *Research on Networks* investigates the possibilities of new technology and architectures, and creates knowledge, methods, tools and demonstrations. To achieve this, SURFnet will organise and initiate research activities together with external research partners.

- *User Participation and Knowledge Dissemination* stimulates and promotes the use of new networking technologies, new services, and new concepts, while ensuring that the knowledge gained within GigaPort3 reaches beyond SURFnet.

The three areas each have their specific role and each area is complementing the two others. There will be constant interaction between each area and advanced users from both the research and the general user community. The areas of activity, and the main interactions between them and other parties, are illustrated in Figure 1.

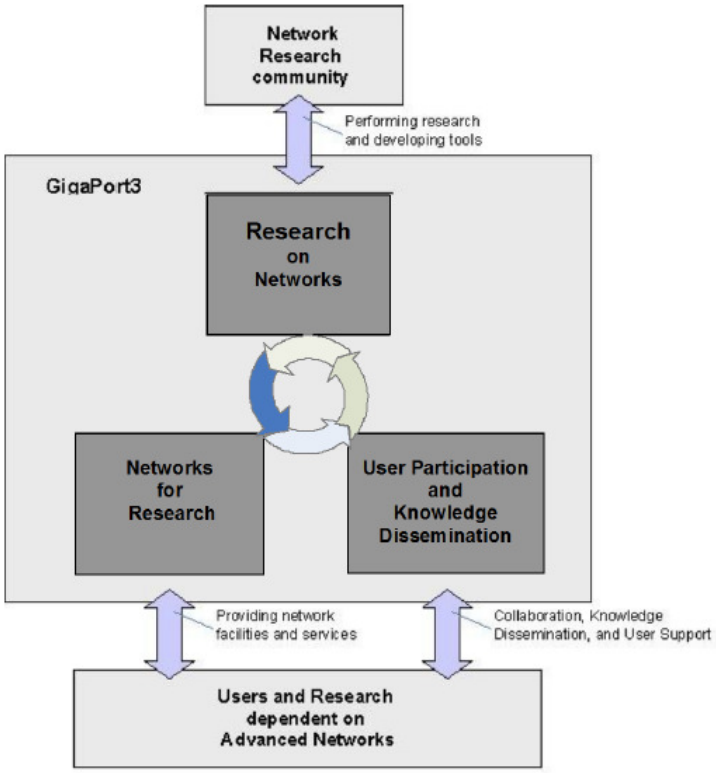

Figure 1: GigaPort3 areas of activity and interactions

In 2012, SURFnet will move to a new organisational structure in which the three areas of GigaPort3 activities are more closely integrated with each other and with corresponding activities within SURFworks, SURFnet's other major program. The generic middleware development within the

GigaPort3 EDS work package will be integrated with the SURFconext development activities within SURFworks

2.1 Networks for Research

Networks for Research provides the framework for the implementation of new concepts into the network; this ensures that the network and the services remain state-of-the-art and that the network serves the growing demand for bandwidth and advanced network services of the users.

Based on user input, technological developments, the experiences from operations and the insights gained from the Research on Networks activities a number of GigaPort3 objectives have been identified which require specific development, including photonics, Next Generation Ethernet and the middleware layer to enable dynamic services.

Activities in the Networks for Research area build on the experience from the previous GigaPort projects, the knowledge of SURFnet and its partners, and on the results from the work done within Research on Networks.

2.2 Research on Networks

Research on Networks is the instrument to explore new technologies, to gain knowledge on the future of networking technology, and to develop tools for next generation networking and services. This may include proof of concepts and demonstrations of new methods and/or technologies.

In Research on Networks, SURFnet and external partners investigate approaches and solutions for the challenges that emerge with the new architectures and network applications, in order to understand and prepare for future developments in networking. This yields continuous input for the development and innovation of the network and the services.

During the previous GigaPort projects the emphasis of Research on Networks was on network technologies. Research concerning networking technology at the photonic, Ethernet and IP layers will continue to be of great importance, for instance in defining architectures which minimise the environmental impact. However, during the GigaPort3 timeframe the services and applications that are enabled by the network, and the middleware needed to support them, will become more important areas for research.

SURFnet, in close collaboration with the research partners, identifies topics to be researched, in order to address a number of questions that need answers to further grow and scale the new generation networks and prepare for the integration in broader dynamic services into the living e-Infrastructure ecosystem essential for today's modern research.

Where possible the GigaPort3 Research on Networks projects is executed in close co-operation with international organisations and activities like GLIF, TERENA Task Forces and research (network) organisations such as JIVE, CERN and ESnet, and EU Framework projects such as GN3.

2.3 User Participation and Knowledge Dissemination

Through partnerships with users and user groups, GigaPort3 will work with advanced users to investigate novel uses of networking services. In these partnerships, GigaPort3 will provide users with network resources, and work with them to establish first and best practices that will form appealing examples to other potential users. This will generate knowledge about the way end users utilise new technologies and concepts developed by SURFnet; feedback from users about their requirements will be used in the innovation process. Partnerships therefore can significantly contribute to the development process within SURFnet. Partnerships will also stimulate the use of the network and services developed in GigaPort3. In the course of the project SURFnet will engage in several partnerships - preferably from different research disciplines. Candidates for partnerships are scientific projects with innovative demands and with a leading position in the international community. Industry is welcome to participate in these partnerships.

Next to this, barriers for the adoption of new technologies will be identified and where possible reduced. By facilitating early adopters with dynamic lightpaths within the framework of innovative pilot projects, those scientific users will get easy access to the lightpath infrastructure. In collaboration with these users, SURFnet will identify other barriers that users experience, and develop solutions to reduce these barriers.

Working closely with users will help to timely make them aware of the opportunities that new and advanced ICT services can offer to them. It will also help to identify their demands in an early stage to allow the development of the new services to benefit from these insights.

Knowledge Dissemination focuses on distributing and exchanging knowledge and results of GigaPort3, and on stimulating and promoting the use of the network and its services. The scientific knowledge and information gained in the participating projects can be an inspiring example to the broader SURFnet community of end users. We will promote the use by communicating the solutions GigaPort3 brings. We will not only explain how the new network will function but also how to make the best use of it. In this process it is important to find co-operation with the IT departments of the institutions. The Enlighten your Research contests as well as other project that make use of (dynamic) lightpaths have learned that a state-of-the-art campus infrastructure is instrumental for the successful uptake of lightpaths and hence SURFnet will closely collaborate with the IT-departments of the institutions. The staff at the IT-departments will also be directly involved in the communication towards the end users.

The practical and scientific knowledge gathered in GigaPort3 shall be made public to the SURFnet community and special interest groups via workshops and seminars. Documents containing 'first- and best practices' will be developed, and results will be written down in publications.

SURFnet will ensure that the information and knowledge created through the projects becomes widely available, not only to the SURFnet user community, but also to industry, the international research community, the NREN community, and the general public.

3 Management Structure

SURFnet executes GigaPort3 as a program under supervision of Stichting SURF. The management structure of the GigaPort3 program is based on the model used in the successful GigaPort Next Generation Network program. Work Packages and their activities within GigaPort3 are either managed as separate projects, or as regular line activities within the SURFnet organisation. GigaPort3 is tightly coordinated with SURFnet's other major innovation program, SURFworks.

Controlling documents
The GigaPort3 controlling documents for 2012 are the following:

- GigaPort3 Project plan 2009-2013;
- GigaPort3 Annual plan 2012 (this document);
- List of decisions by the GigaPort3 Program Director, which may modify the previous two items during the course of 2012.

Figure 2 depicts the program's governance structure:

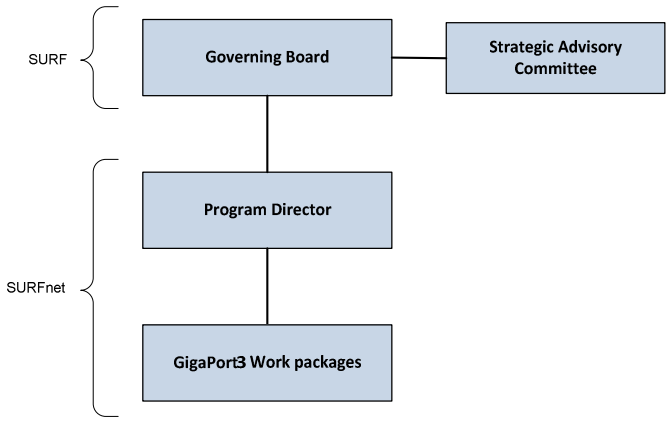

Figure 2: GigaPort3 program governance structure

The Program Director reports on the project twice per year to the GigaPort3 Governing Board. The Governing Board steers the GigaPort3 program on a strategic level to ensure that the project remains on track, based on biannual reports by the Program Director. It provides direction and overall guidance to the GigaPort3 program and, together with the GigaPort3 Program Director, determines whether adjustments in planning or strategy are necessary. The Governing Board evaluates the results and progress of the program and approves annual plans and reports. The Governing Board is composed as follows:

Chairman

Dr. R.J. van Duinen	Former President of the ESF and of NWO

Members

Dr. J.J. Engelen	President NWO
Drs. R.J.M. Hopstaken	Vice-President Board of Directors, AMC
Prof.dr.ir. J.G.H. Joosten	Director Corporate Technology, DSM
Dr. W.B.G. Liebrand	General Director SURF Foundation
Dr. S.J. Noorda	President VSNU
Drs. E.P. van Maanen	HBO-raad

Secretary
Dr. L.A. Plugge

The Governing Board has set up an independent Strategic Advisory Committee (SAC), which judges the quality of the results achieved in the program, i.e., the network facilities, the research results and the technical and outreach choices made within the projects. The SAC advises the Governing Board on strategic future developments and technical options. The SAC consists of international experts in the field:

Dr. Tom DeFanti	Research scientist at the California Institute for Telecommunications and Information Technology (Calit2) at the University of California, San Diego.
Dr. David Foster	Deputy Head of IT at CERN. Manager of the strategy for the Large Hadron Colider (LHC) computing grid technology;
Dr. Jysoo Lee,	Director of the Supercomputing Center and Networking at the Korean Institute of Science and Technology Information (KISTI);
Dr. Gudmund Høst	Special Adviser to the Research Council of Norway and Chairman of the e-Infrastructures Reflection Group (e-IRG).

The SAC will perform a mid-term review in 2011 and an end-term review on the project.

The Program Director will, when required, propose major changes to the GigaPort3 Program Board for its approval.

4 Work packages and main deliverables of 2012

The table below shows an overview of the GigaPort3 main deliverables over the years, highlighting the main deliverables for 2012:

Year Work Package	2009	2010	2011	2012	2013
1. Photonics (PHO)	• Flexible photonics introduced into the network	• 40G waves introduced • 100G tested • New Planning tool • Study new technologies	• Technology Assessment • Introduction of tuneable XFPs	• Technology assessment next generation photonic technologies • Architecture Study next gen photonics for SURFnet8	• Design for SURFnet8 photonic network
2. Next Generation Ethernet (NGE)	• Technology Assessment • Architecture study	• Procurement process SURFnet7	• Proof of Concept tests and preparations for new service provisioning • SURFnet7 NGE services up and running (pilot)	• SURFnet7 NGE rollout completed • New NGE features introduced	• Evolution in NGE network • Architecture study SURFnet8 switching layer
3. Enabling Dynamic Services (EDS)	• Multi-domain dynamic lightpaths Proof of Concept • Architecture Study	• Federated and Multi-domain lightpath Services introduced • Integrated resource services, studies and Proof of Concepts	• Proof of Concept for e-Research Service	• e-Research Services available through SURFconext • New bandwidth on demand services based on NGE	• Expand reach and width of e-Research services • Dynamic lightpaths into campus networks
4. NetherLight and global connectivity (INT)	• NetherLight upgraded to scalable new platform	• NGE services available at NetherLight • Additional 10G intercontinental lambdas available	• Dynamic GOLE and NGE pilot services on NetherLight • 100G on Cross Border Fiber introduced	• New NGE features introduced in NetherLight • Strengthening the position of NetherLight through additional links to GOLEs • Positioning NetherLight as a hub for e-Research Services	• Dynamic GOLE as production service
5. Mobility and Fixed-Wireless (MOB)		• Technology and legal Assessments • Operator & Vendor scans	• Wireless application Living lab established with operators	• Wireless services and mobile application pilots with operators	• Heterogeneous service offering
6. IP Innovation (FIP)	• Core router upgrade	• IPv6 support for connected institutions • Testing with 100G interface • Network Operations Center renewed	• IPv6 support for connected institutions • Routing security pilot • Report on Internet routing developments	• Publications on IP routing and DNS • Technology assessment Future Internet and vision for SURFnet8 • 40G for IP service	• Preparations for SURFnet8 IP layer
7. User Participation & Knowledge Dissemination (DIS)	• EYR Lightpath contest • Contact with research projects	• EYR3 preparations • 3-5 new research-projects • Knowledge domains • Events	• EYR3 contest • 3-5 new research-projects • Knowledge domains • Events	• Start of EYR4 • 3-5 new research-projects • 4 Virtual Organisations linked to SURFconext • Events • Campus support	• EYR4 continued • GP3 closing event • Advanced user projects • Campus support

Table 1: GigaPort3's main deliverables over the years, highlighting 2012.

The work planned for 2012 is divided in seven work packages with the following main aims:

1. *Photonics* - In 2012 GigaPort3 will perform a technology assessment of the next generation photonic technologies. Additionally, an architecture study of the next generation photonics for SURFnet8 is performed.

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As mentioned in chapter 2, SURFnet will move to a new organisational structure. In this structure, multidisciplinary teams will be responsible for GigaPort3 activities as well as SURFworks activities in their respective areas. Each team is responsible for a specific set of deliverables, which can be mapped to the SURFworks objectives and the GigaPort3 work packages.

The following table shows the relation between the GigaPort3 work packages and the new teams:

GigaPort3 Work package	***Area***	***Teams involved***
Photonics		Team 1: hybrid network
Next Generation Ethernet		Team 1: hybrid network
Enabling Dynamic Services	Bandwidth on demand	Team 2: dynamic networking, international connectivity and connecting clouds/grids
	Middleware infrastructure	Team 4: SURFconext infrastructure
	Services	Team 5: Vendor management & services SURFconext
NetherLight and global connectivity		Team 2: Dynamic networking, international connectivity and connecting clouds/grids
Mobility and Fixed-Wireless		Team 3: Mobile and Wireless access to SURFnet7
IP Innovation		Team 1: Hybrid network
User Participation & Knowledge Dissemination*	Enabling Your Research 4	Team 2: Dynamic networking, international connectivity and connecting clouds/grids
	SURFconext adoption for e-Research	Team 6: SURFconext adoption

* In addition, all teams are involved in knowledge dissemination for their respective work areas.

Table 2: Teams involved in each work package

The following paragraphs describe each work package and its deliverables for 2012 in more detail.

4.1 Work package 1: Photonics

The SURFnet6 network was initially built using fixed 10 Gbit/s wavelengths because the technology for dynamic wavelength configuration was not yet available at that time. In the following years, agile photonic networking was added by introducing innovative photonic technologies such as electronic dispersion compensation, tuneable lasers, 40 Gbps transmission and Reconfigurable Optical Add/Drop Multiplexers (ROADMs) based on Wavelength Selective Switches (WSSs) at important network nodes.

In 2010 the GigaPort3 network was enhanced to provide full photonic flexibility in the core of the network, thereby creating an architecture that allows the network capacity to grow more efficiently, both at the edges and in the core. Today, 100 Gbit/s transmission capacity per optical channel is already available and will be implemented where appropriate. A first 100 Gbit/s connection was delivered in 2011 on the 1650 km Cross Border Fiber link between Amsterdam and Geneva. This implementation was shown to be possible on the existing infrastructure that was originally designed for 10 and 40 Gbit/s DWDM transmission; it was the longest deployed 100Gbit/s connection in the world at that time.

This work package will also provide the substrate for the NGE work package and the Dynamic Light Path service. Both will make use of the capabilities of the current photonic layer, with the increased flexibility that has been added recently. The photonic layer will be further upgraded during the NGE roll-out to accommodate the new NGE architecture. During the design phase, we have established that the bulk of this can be covered using standardised 10G DWDM pluggable optics. Their signals will be carried as alien wavelengths onto the photonic core, which reduces costs, power and space required to build the NGE core network.

Objectives in 2012

GigaPort3 will use the photonic capabilities introduced in 2010 and 2011 to facilitate both the further roll-out of the NGE network and the roll-out of high-bandwidth dynamic services by adding bandwidth where required. Furthermore the evolution of photonic technologies will be closely monitored to assess the steps required to take the network to the next step. During 2012, these activities will result in an architecture study for the photonic layer of the next generation of the SURFnet network, SURFnet8.

The photonic network is capable of supporting alien waves. Following experiments in 2011, the project intends to implement one or more alien waves on the network during 2012 as a pilot service.

Research topics in this area will focus on the next generation of flexi-grid photonics using optical superchannels, the implementation of a hypercube photonic architecture (for 1+2 protection), and on dynamic switching within DAS-4. Other topics are alien waves, including implementation options for alien waves, and the implementation of "super-GPS" transmission of atomic clock time signals. We will also investigate a new architecture for optical fiber transmission, where the transmission system consists of one or two main nodes and a number of remote nodes. The main nodes broadcast a spectrum which contains all information for the remote nodes, the remote nodes will select the data intended for their site by using low-cost coherent technology.

Deliverables in 2012

Reference	Title	Planning
	Photonics – team 1	
PHO-12-1	*The NGE substrate for NGE roll-out:* in parallel with the NGE roll-out the photonic network is expanded and adapted to match the capacity and architecture required for NGE. This builds on the enhancements that were made in 2010 and 2011. [implementation]	Q2
PHO-12-2	*Architecture Study into next gen photonics for SURFnet8:* based on the RoN activities of 2011 and 2012, and on the evaluation of photonic technologies in 2011, an initial study is performed to define the photonic layer of the next generation of the SURFnet network, SURFnet8. [document]	Q4
PHO-12-3	*Alien wavelengths:* implementation [pilot]	Q4

4.2 Work package 2: Next Generation Ethernet

GigaPort3 will introduce Next Generation Ethernet (NGE) technology - also known as connection oriented Carrier Ethernet – to the network. Next Generation Ethernet technology is seen as the future proof transport layer that will significantly improve the flexibility and scalability of the lightpath service.

Next Generation Ethernet will deliver flexibility and scalability to the network and its users, as well as enabling potential future services. GigaPort3 will implement Next Generation Ethernet as a single layer on top of the photonic layer, creating SURFnet7, while preserving the investments in the photonic layer. The NGE implementation in SURFnet's infrastructure will allow for a smooth transition from the current SONET/SDH based lightpaths to Next Generation Ethernet based lightpaths, and will also efficiently replace the existing Ethernet aggregation layer for IP connectivity. This will result in a single transport layer built on the existing SURFnet DWDM network.

Next Generation Ethernet (NGE) technology builds on the advantages of existing Ethernet, while adding the functionality and robustness needed to take Ethernet beyond the local area and campus networks and into the core network. Using NGE, fixed lightpaths can be provisioned more flexibly and with less operational effort, and dynamic lightpaths can be provisioned more efficiently.

In 2010 the results from the technology scan and architectural studies resulted in the publication of a public tender to identify a NGE industry partner. This tender was successfully concluded during the first half of 2011, leading to an agreement with Ciena for the supply of NGE equipment.

The introduction of NGE in the core of the network was started in 2011 and will be completed in 2012. An NGE access solution will be implemented in the CWDM city rings during 2012, in order to benefit from the flexibility and scalability of the NGE network from edge to core. Existing IP and lightpath services will be transitioned to the NGE network during the rollout, whereas new NGE based services will be implemented once the rollout is complete.

For this work package, the research activities build on the work done in 2010 and 2011. A set of activities looks at the specific behaviour of NGE services in different deployment scenarios and the consequences for network planning and operation, including aggregation behaviour of multiple flows.

Another research activity will focus on the potential of OpenFlow – a technology that opens up Ethernet switches for new switching paradigms implemented independently from each other – and on virtualised networks.

Objectives in 2012

The NGE work package will deliver the Next Generation Ethernet layer of SURFnet7, providing the basis for IP, static lightpath, and dynamic lightpath services. The work package will also migrate the existing IP and static lightpath services from SURFnet6 to SURFnet7, and provide new services based on NGE. As dynamic lightpaths are part of the broader vision of dynamic services, the migration of dynamic lightpaths to SURFnet7 is managed as part of the EDS work package.

In 2012. the current services will be transitioned to NGE with minimal impact, and the new NGE based services will be piloted with specific connected institutions and then introduced as production services.

Phasing

During the transition period (Transition Phase), both networks (SURFnet6 and SURFnet7) will be operated in parallel and both networks will support production services. The existing services must be migrated from SURFnet6 to SURFnet7 without any change to the service parameters (i.e. 100% CIR for lightpaths).

After the transition, new NGE based services will be introduced, and existing services may be optimised through a shift to these new services (Optimisation Phase). During the Optimisation Phase a review of the actual build is done, which may lead to the removal of less elegant solutions and a change in the number of nodes. One element of the optimisation is the replacement of a limited number of temporary 40 Gbit/s boards (4x10G ports) by 100 Gbit/s boards (10x10G ports), due to the late availability of the 100 Gbit/s boards during the initial roll-out. At this time, the project will also design a future architecture based on 100G links, and define a gradual transition plan towards such an architecture depending on the increase in demand.

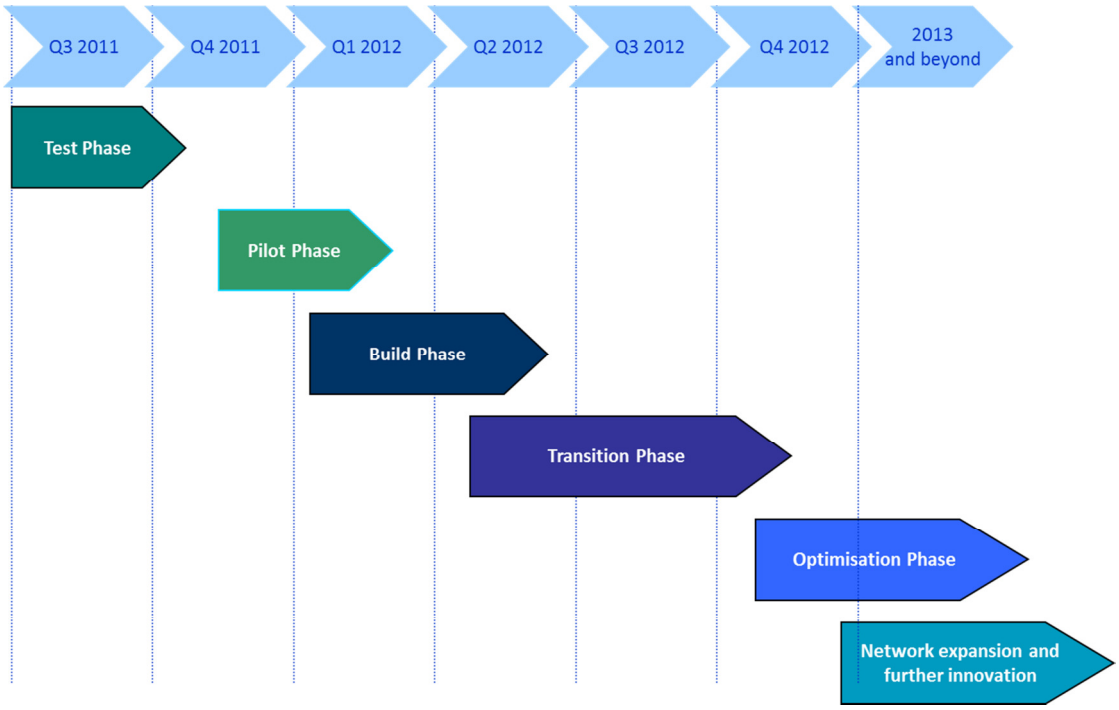

Figure 3: Phasing of the introduction of NGE

Deliverables in 2012

Reference	Title	Planning
	Next Generation Ethernet – team 1	
NGE-12-1	All IP services transitioned to SURFnet7 [service]	Q2
NGE-12-2	All static lightpath services transitioned to SURFnet7 [service]	Q4
NGE-12-3	New NGE services defined and tested: new services that are enabled through NGE are defined as part of an integrated service portfolio, and set up as a pilot service in collaboration with connected institutions • Service Portfolio definition [document] • Pilot service with one or more connected institutions [service].	Q4
NGE-12-4	Future network design using 100G completed [document]	Q4
NGE-12-5	*NGE capability update:* where needed, temporary low density 4x10 Gbit/s boards are replaced by 10x10 Gbit/s boards as called for in the original design. [infrastructure]	Q4

4.3 Work package 3: Enabling Dynamic Services

One of the results of the GigaPort Next Generation Network project was the implementation of the concept of dynamic lightpaths: a service providing on-demand access to network facilities. In the future e-Research infrastructure, the network will be just one of the resources available to an application. Networking, computing and storage, as well as specific instruments and other facilities, will be made available to research applications in the form of on-demand services.

GigaPort3 will introduce composable e-Research services using services that can be used as building blocks for other services. Such services can range from dedicated lightpaths to complete virtual laboratory environments; however initial implementations will focus on networking, computing and storage resources.

In GigaPort3, the Bandwidth on Demand (dynamic lightpath) concept and the federated authentication, authorisation and collaboration infrastructure SURFconext will be combined to provide the network part of a generic infrastructure for on-demand services for e-Research. Finer grained access and authorization than the standard attributes and groups approach is needed to allow proper setup and management of Bandwidth on Demand. The new BoD service currently under construction implements the network specific elements of the service through the network management system, while the generic elements are provided through a generic middleware layer which is part of the SURFconext platform. This layer can then also be used for other services that may need more fine-grained control, such as IaaS/clouds but possibly also more generic e-Research and other services.

By supporting the concept of Virtual Organisations (VOs), scientists from different scientific disciplines and organisations can work together in more loosely coupled (project) teams. This cannot be done in isolation; collaboration with projects and initiatives that provide other resources in the e-Research infrastructure will be needed. In addition GigaPort3 is working on seamless interworking between VMs, clouds, grids, storage and other e-Research services in collaboration with other partners, including SARA as well as commercial providers.

The on-demand services will be of limited use if they can only be used within a single federated authentication and authorisation infrastructure such as SURFfederatie. Therefore GigaPort3 will also work with GLIF, TERENA (REFEDS), the European NRENs (eduGAIN), the European GRID Initiative (EGI), Open GRID Forum (OGF), Esnet and Internet2 in the US and the astronomers cooperating in

JIVE to make sure that results achieved are useful in a broader scope than SURFconext alone, aiming at worldwide standardisation. In The Netherlands, GigaPort3 will work with projects like SURFworks, BiG Grid, NEXPReS, spin-offs of Virtual Laboratory for e-research (VL-e), and the new Netherlands e-Science Centre.

Objectives in 2012
The main objectives for 2012 are:

- Create a new Bandwidth on Demand infrastructure, based on NGE;
- Improve the generic middleware infrastructure as part of SURFconext, providing flexible support for the composition and orchestration of services from different providers;
- Determine business models including SURFnet's future role in IaaS services;
- Increase the range of services available through SURFconext;

Create a new Bandwidth on Demand infrastructure
During 2011, GigaPort3 redefined the Bandwidth on Demand (dynamic lightpath) architecture, separating the generic middleware functions from the network specific elements. As part of the contract with Ciena to deliver the NGE equipment and software, Ciena has also committed to work with SURFnet in extending the existing network management systems with the scheduling functionality required for Bandwidth on Demand. Ciena will also implement the NSI, the open interface which supports multi-domain Bandwidth on Demand services. In parallel, GigaPort3 will replace the current OpenDRAC platform by a platform that works with SURFconext and with the improved network management systems in order to enable the complete Bandwidth on Demand service.

Improve the generic middleware layer based on SURFconext
The main objective of this activity is to support the (dynamic) delivery of e-Research services from various providers to the research community, through federated identity management, collaboration infrastructures, and dynamic networking services.

Virtual Organisations
In e-Research a lot of work and collaboration is organised within a Virtual Organisation (VO). A VO is a group of individuals working on a project or topic. The definition of VO is ambiguous, ranging from full legal entities (such as CLARIN[1]) and a tightly coupled group, to small teams of students within (or outside) of a project, or loosely coupled. There may also be a hierarchical relationship between VOs. These different types of VOs may impact on what they are able to do (authorization) or purchase.

Roughly speaking, two types of VOs can be distinguished: those aimed at organising the necessary infrastructure for their discipline, such as NBIC[2] and CLARIN, and those aimed at performing research using this infrastructure. The first can be viewed as a provider of a service, while the second can be viewed as a user. Both structures will need to be supported through SURFconext.

With VOs there is also a question as to how authorizations are organised. In the classical 'Identity Provider centric' type of federations such as SURFfederatie all authorizations in the end fall back to the IDP to which a user belongs, but this approach will not work in most VO settings. The same applies to attributes and attribute aggregation: new attributes are introduced which are provided by a VO instead of an IDP. VOs themselves can act as a 'virtual IDP'.

[1] http://www.clarin.eu
[2] http://www.nbic.nl

The first steps to solve these issues were made in 2011 by enabling VO support in SURFconext with the introduction and implementation of the virtual IDP concept and VO controlled attribute release. These additions to the SURFconext will be validated in 2012 in collaboration with one or more VOs, which will probably lead to additional requirements regarding the user interface and the authorisation functionality.

In order to overcome the gap that exists between collaboration service infrastructures, federated identity and -group management, and the current computing infrastructures, GigaPort3 will continue the work started in 2011 on the static service composition of IaaS and cloud infrastructures (in collaboration with SARA and with commercial providers such as GreenQloud). This is done by extending the group and VO awareness offered by collaboration infrastructures such as SURFconext into dynamic service composition of IaaS and e-Research services.

Provisioning and deprovisioning
In a dynamic e-Research environment provisioning (and especially deprovisioning) is an important subject that is notoriously difficult to handle. Provisioning and deprovisioning focuses on enrolment of users, reserving resources, et cetera. It includes aspects of authorization, Virtual Organisations and authentication but it cannot be handled in a single manner. This depends on the (type of) services and resources that need to be combined and also on local (service) policies.

The provisioning/deprovisioning component built in EDS in 2011 will be integrated into the SURFconext middleware platform and extended to support VO specific provisioning for services as well. Target services that need specific provisioning are SaaS services such as Google Apps (especially for VOs) and IaaS services such as those offered by GreenQloud.

Disaggregating data from services
Current service architectures, in particular for commercially available services, tend to take away control over the actual data from the end user. This can lead to vendor lock-in, privacy issues and a lack of clarity on data ownership. GigaPort3 will explore architectures which allow providers to offer services to end-users while leaving ownership and control of the underlying data in the hands of the user. A specific deliverable of this activity will be a Proof of Concept with Unhosted[3].

Generic middleware for dynamic services
It is envisioned that the dynamic lightpath concept can be applied in a more generic manner, such that other services than networks (e.g. storage, instruments, etc) can be scheduled and composed to form a dynamic service. It is crucial to participate in standardization (i.e. Open Grid Forum) to make this concept a success. Studies done in 2011 have shown that the role of generic brokering in the current e-Research environment is limited. The scheduling and brokering needed is either needed 'higher up' (towards applications, e.g. composition of scientific workflows, the composition part) or is done per specific resource (e.g. finding computing or storage resources, or scheduling a lightpath across domains, the scheduling part). However, GigaPort3 can play a major role in enabling these architectures.

Increase the range of services available through SURFconext
There are many types of e-Research services available. Ranging from microscopes, sequencers to storage and computing facilities. The goal of this activity is to extend the range of e-Research services available through SURFconext.

[3] Refer to http://www.unhosted.org

In collaboration with the SURFworks program, a vendor management team identifies attractive services for the connected institutions, and works with the vendors to provide these services through SURFconext. For the GigaPort3 part of this activity, the focus is on e-Research services. This may include both generic IaaS (Infrastructure as a Service) services, such as commodity storage and computing, as well as more specific services aimed at the research community, in combination with Bandwidth on Demand services. For some of these specific services, we collaborate with the NLeSC and SARA.

As part of this activity line, GigaPort3 will investigate possible business models for the delivery of IaaS services and the role of SURFnet within those models.

The table below lists the deliverables foreseen for 2012. As SURFnet does not do the actual coding, external companies will be hired when development or prototyping is needed for building blocks, prototypes and demonstrators.

Deliverables in 2012

Reference	Title	Planning
	Bandwidth on Demand – team 2	
EDS-12-1	Bandwidth on Demand Development and Innovation: the current functionality for dynamic lightpaths will be modified to interact with the NGE network [service]	Q4
EDS-12-2	New Bandwidth on Demand infrastructure: all dynamic lightpath services transitioned to SURFnet7 [service]	Q4
EDS-12-3	Demonstrate fine-grained authorisation for Bandwidth on Demand [showcase and document]	Q3
	Middleware infrastructure – team 4	
EDS-12-4	Provisioning/deprovisioning functionality available in SURFconext and VO-aware [service]	Q3
EDS-12-5	Extend SURFconext components for new e-Research services	Q2
EDS-12-6	Develop functionality for role management / policy engines (fine-grained authorisation)	
EDS-12-7	Pilot Enabling Dynamic Services: Dynamic Service Composition of the brokered IaaS infrastructure with Bandwidth on Demand and two flexible e-Research services facilitating a virtual organizations utilizing SURFconext[PoC]	Q3
EDS-12-8	Develop Proof of Concept for data ownership and data portability, using an application based on Unhosted	
	Services – team 5	
EDS-12-9	Define business models for SURF/SURFnet role in Infrastructure as a Service	Q1
EDS-12-10	Connect 2 e-Research services	Q4

4.4 Work package 4: NetherLight and global connectivity

SURFnet operates NetherLight, the GLIF Open Lightpath Exchange (GOLE) in Amsterdam, which acts as one of the central hubs in the global lightpath network coordinated inside GLIF. Other GOLEs in different parts of Europe have been emerging as well. In 2010, CERN has started the development of CERNLight. This requires that NetherLight and its international connectivity, both in

terms of its architecture and in the approach to its operations and services, will be kept state of the art.

In 2010, the first discussions on dedicated connectivity between CERN's Tier1's and Tier2's were held, paving the way for designing and piloting a new architecture in 2011, called LHCONE. Efforts in enhancing this infrastructure are continued in 2012 and beyond.

Multiple experiments have been conducted in 2011 with 40G Alien Waves and 100G from Amsterdam to Geneva, proving the capabilities and possibilities of SURFnet's Cross Border Fiber systems.

Together with a number of NRENs in Europe, SURFnet has positioned NREN owned and operated resources, such as GOLEs and Cross Border Fibers (CBFs), as an important architecture element for the future GÉANT network infrastructure. In 2011, the ACE project (America Connecting Europe) decided to use the NetherLight GOLE as a hub in its transatlantic connectivity. Important user communities such as High Energy Physics are now using the GOLE locations as part of their global connectivity architecture.

Objectives in 2012
The overall objective of this work package INT in 2012 is to reinforce NetherLight's leading role through the introduction of Next Generation Ethernet services.

The positioning of the GOLE model in general and NetherLight in particular will be continuously undertaken:
- inside The Netherlands towards carriers,
- inside The Netherlands towards providers of e-infrastructure services which are relevant for the parties connected to NetherLight,
- in Europe towards large user communities, NRENs and international projects, and,
- around the world towards user communities and advanced NREN-like organizations.

Opportunities for the use of NREN owned and operated Cross Border Fiber (CBF) will continue to be researched, in close collaboration with the users and other advanced NRENs. In particular, a CBF to London will be investigated and, if viable, implemented during 2012.

The Open Grid Forum has been working on standardising the Network Services Interface, as the open protocol for interconnecting dynamic lightpath provisioning systems. A number of dynamic lightpath domains in the GLIF Community have agreed to adopt this open standard, and have demonstrated the interoperability of their platforms in a recent GLIF meeting. This creates the opportunity for a quickly growing standards based platform for multidomain lightpath provisioning. By playing an active role in the adoption of this new standard, GigaPort3 will stimulate its use.

Deliverables in 2012

Reference	Title	Planning
	International / NetherLight – team 2	
INT-12-1	*Reinforce international positioning of NetherLight* In collaboration with advanced European NRENs, we will reinforce the current GOLE and Cross Border Fiber infrastructure through additional connectivity, preferably to other GOLEs and to additional user groups, based on the principles agreed inside GLIF. [service].	Q4

INT-12-2	*NetherLight: NGE introduced as pre-production service:* NetherLight will be enhanced by introducing NGE equipment replacing the current Nortel MERS8600 platform and, Q4, the current Force-10 platform [pilot service].	Q2
INT-12-3	An extended service portfolio for international connectivity will be implemented, including access to traffic measurements and management information for the connected network domains [service].	Q4
INT-12-4	In addition to its international role, NetherLight will also be positioned as a national hub for e-infrastructure services for research and education, in addition to its current international connectivity function [service].	Q2
INT-12-5	*Resilient access:* investigate the need for a second GOLE in the Netherlands (possibly in collaboration with AMS-IX) for national resilient access by e-infrastructure service providers [service]	Q4
INT-12-6	*Automated GOLE:* the existing Automated GOLE service will be upgraded, based on the Bandwidth on Demand infrastructure and the NSI interface,	Q4
INT-12-7	*OpenFlow connection with Internet2:* a set of OpenFlow capable switches are installed within the SURFnet domain and connected to Internet2 through NetherLight, thus extending the Internet2's existing OpenFlow capabilities into the Netherlands. [service]	Q2
INT-12-8	*OpenFlow for e-Infrastructures:* a feasibility study will be performed, investigating the potential of OpenFlow for the interconnection of e-Infrastructure services. [document]	Q4

4.5 Work package 5: Mobility and Fixed-Wireless

GigaPort3 intends to implement seamless network connectivity at virtually every location in The Netherlands, for its users, whether they are connected to the fixed network or to a wireless network infrastructure. The ambition is to allow students, teachers and researchers to work together independent from their location, time of day or device used. For the development of the required wireless services SURFnet will seek partnerships with operators and suppliers of wireless networks.

In doing this, the Dutch research and higher education environment creates an attractive proposition for digital collaboration of researchers, knowledge workers and students from home and abroad. The wireless network infrastructure will therefore be based on international standards where they exist, or drive the development of such standards where they do not exist yet.

The integration of portable devices in the communication infrastructure also offers opportunities for interactive teaching processes that are independent of location by quickly and easily bringing together people and data. The possibility to include direct local data such as images and sound recordings or local measurements offers new opportunities for doing research or teaching, for example by letting students or teachers directly add (local) examples of the subjects from a teaching course, by performing distributed measurements or (in medicine) by keeping track of a persons' (medical) status based on local measurements without disrupting his or her daily life.

On the one hand the addition of portable devices to the communication infrastructure poses high demands on identity management and security, on the other hand the addition of portable devices to the infrastructure also provides new opportunities in that respect; particularly the use of biomedical techniques such as digital iris scans and fingerprints.

Objectives in 2012
During 2012, GigaPort3 will, together with commercial operator KPN, conduct a pilot deployment of a combined 3G/4G/Wi-Fi service at one university campus (currently envisaged to be the Utrecht University campus, pending formal agreement). As part of that activity, the project will develop the user requirements for mobility across multiple networks and the technical specifications to implement a seamless user experience between commercial 4G networks and local Wi-Fi; based on these requirements the project will connect the 4G and Wi-Fi networks through an authentication mechanism based on eduroam. Furthermore, an extension of the eduroam service to a national network of hotspots is envisioned, based on the existing eduroam authentication mechanism.

Living Lab
During the pilot mentioned above, SURFnet will work with the operator and the university in question (as well as the academic hospital and the applied science university located on the same campus) to provide devices and applications to students and staff, and monitor the use of these devices and applications, resulting in a "living lab" environment for wireless application use.

The results of the mobility pilot and living lab will be made generally available as GigaPort3 results.

Deliverables in 2012

Reference	Title	Planning
	Mobility – team 3	
MOB-12-01	First campus pilot implementation [service]	Q3
MOB-12-02	User requirements for mobility [document]	Q1
MOB-12-03	Technical architecture and interface definition for mobility between 4G and eduroam [document]	Q3
MOB-12-04	"seamless" mobility between 4G and eduroam implemented for pilot users	Q4
MOB-12-05	Pilot eduroam integration with KPN hotspot service implemented	Q3
MOB-12-06	Study on the usage of mobile devices and applications in higher education and research (report);	Q4
MOB-12-07	Trend report on fixed/wireless networking [document]	Q4

4.6 Work package 6: IP Innovation
The evolution of IP networks is accelerating again with several 'Future IP" projects all over the planet. SURFnet will take part in this process and closely monitor the developments in this area. New routing protocols for secure routing, faster routing convergence and the transition of IPv4 to IPv6 may lead to opportunities for further enhancement of the IP layer of the network during the coming years. The implementation of the NGE layer, and the availability of 40 and 100 Gbit/s connections in the network, both present new opportunities as well as challenges which may result in significant architectural changes.

Objectives in 2012
In 2012 we will continue our earlier work on internet technology, implementing secure routing updates and investigating further optimization opportunities for the SURFnet IP network. In addition we will continue our efforts in promoting the implementation of the IPv6 protocol. Experiences learned in this trajectory will be included in IPv6 workshops that are organized periodically by SURFnet.

Reports on the evolution of IP networks will focus on the potential impact (opportunities and threats) of new developments on both the SURFnet IP network as well as the campus networks of

connected institutions. Input for these reports is gathered by attending meetings such as IETF, RIPE and NANOG.

In 2012, we expect to pilot a 40 or 100Gbit/s customer connection, leading to changes in the backbone in order to cope with the resulting traffic. We will also investigate opportunities for local caching, in order to reduce the amount of traffic that needs to be exchanged with a few major domains such as Google and Akamai.

Research activities in this work package will include work on the scalability of the current internet, trends in IP networking, possible architectures of the "Future Internet" and the opportunities for greener networks through "Sustainable Networking".

Deliverables in 2012

Reference	Title	Planning
	Future IP – team 1	
FIP-12-01	*Secure routing updates (origin):* implement BGP origin validation in the SURFnet network [implementation].	Q2
FIP-12-02	*Secure routing updates (AS-path):* with Juniper, produce a technical assessment and best practices for AS-path validation in routing updates [white paper and proof of concept]	Q3
FIP-12-03	*Multi-layer architecture:* investigate possibilities for further integration between OTN, Ethernet and IP layers and its consequences for the architecture for the future SURFnet8 [document]	Q3
FIP-12-04	*Local caching:* investigate traffic patterns from top domains and potential for local caching [document]	Q2
FIP-12-05	*40G/100G:* run pilots with 40 and/or 100 Gbit/s connections in core network and on customer connections	Q3

4.7 Work Package 7: User Participation and Knowledge Dissemination

Through partnerships with users and user groups, GigaPort3 will work with advanced users to investigate novel uses of networking and collaboration services. In the course of the project we will engage in several partnerships, the objective is to start 3 to 5 new partnerships each year. Candidates for partnerships are scientific projects, organized in Virtual Organisations (VOs), with innovative demands and with a leading position in the international community. Industry is welcome to participate in these partnerships. Through a number of general communication activities, SURFnet will ensure that the knowledge created through GigaPort3 becomes widely available. These activities include:

- Providing publications, bulletins, press releases and multimedia material;
- Insights in network technology and advanced network uses through the SURFnet website;
- Contributing to the national and international creation of vision on ICT infrastructure for research and education by outreach and dissemination activities in meetings and conferences worldwide;
- Publication of a yearly report with results of GigaPort3;
- Organising high profile events to demonstrate the new possibilities to interested parties in the business and government communities;
- Holding presentations for government and semi-government institutions, both in their role as users of the network infrastructure and in their role as policy makers and regulators;

In the past years a large number of leads and prospects for establishing partnerships has been generated. It appears that in the scientific community there is a lot of interest in collaborating with SURFnet. However, it also became clear that most of these projects and parties have long lead times because they have to organize their own collaboration organizations and funding. To set up an e-Research collaboration is a challenging task and requires more than network infrastructure alone. Dynamic services and SURFconext are appealing to many researchers because there is a demand for integrated solutions in which the lightpaths are integrated in an infrastructure in which several other resources such as computation, instruments and storage are also included and glued together with collaboration workflow tools and authentication and authorization infrastructure. Collaboration with entities such as BiG Grid, SARA and NCDD who offer part of the required resources is therefore necessary. Activities will also be coordinated with the newly created Netherlands eScience Center (NLeSC).

The campus domain has proved to be an important factor in the adoption of innovative services. Therefore, we will intensify collaboration with ICT departments in order to help them overcome any bottlenecks within their infrastructure which hinder the adoption of these services. The collaboration will include the outreach to the research community in The Netherlands and in setting up support teams that will help users and institutes setting up their research using (Grid) computing, storage and network resources. In particular, these support teams will help the community to overcome bottlenecks in the local (campus) infrastructure. We will also organise challenges or competitions to stimulate local campus improvements.

Data management is becoming increasingly important to science and research, because science is increasingly data-driven[4]. We believe that data is a main driver for fast networks and therefor important for SURFnet. The Netherlands participation in ESFRI has a focus around data. In 2009 SURFnet has contributed to the e-IRG DMTF whitepaper on data management, and we have started collaboration with the data management community in the Netherlands. Data management is a strategically important theme, which is closely related to topics such as (on-demand and long term) storage, metadata, collaboration infrastructure, trusted identity and access (authentication/authorisation) and dynamic services.

In 2011 we started a storage pilot with SARA, resulting in a pilot in which SARA storage services were made available through SURFconext (BeeHub). We also organized events around data management, continued, in collaboration with Stichting SURF, with the formation of a community around this theme, and we took care of knowledge dissemination. In 2012 we will further contribute to the data management area, but we expect that this will be more pragmatic through involvement in pilots for SURFconext, in collaboration with key players such as SARA NLeSC, Stichting SURF, DANS and others, and through a contribution to the data management blue paper of the e-IRG. In this context, we will also investigate security and privacy concerns which may prevent wider sharing of research data, in particular in the life sciences.

Objectives in 2012

During the course of the GigaPort Next Generation Network project, SURFnet facilitated eleven innovative research projects from different scientific areas. Similarly, GigaPort3 will initiate several (3-5 per year) innovative collaborations in various disciplines and application areas. Those collaborations require commitment from both parties to ensure both sides will benefit. In the process of defining these collaborations, special attention will be given to innovation areas that are regarded as important to the Netherlands such as ESFRI projects. Special attention will also be

[4] See e.g. the "Riding the wave" report of the High Level Expert Group on Scientific Data

given to research projects which were awarded funding by "NWO Large" and those supported by the Netherlands eScience Center (NLeSC).

In 2012 we will start the fourth edition of Enlighten Your Research (EYR4). This contest will again be organised in collaboration with NWO, together with partners such as BiG Grid, SARA and NLeSC. Like EYR3, EYR4 will be aimed at the integrated, real-time use of networking, Grid computing and/or storage resources, preferably linked through SURFconext, and with a special attention to sustainability aspects. In 2012 we will emphasize collaboration with industrial research, either within EYR4 or through a separate, similar initiative. We will also specifically address opportunities to collaborate with the university medical centres, encouraging the use of advanced e-infrastructure in the life sciences.

SURFnet will ensure that the information and knowledge created through the projects becomes widely available, on National and International level. To achieve this we will use publications, press releases, a yearly report, news added in newsletters, multimedia material and presentations at national and international conferences.

An important tool for the dissemination of our research results to the community is the SURFnet website, which will be used to inform both the SURFnet users and the general public about the progress of the project.

Improve the adoption of SURFconext and e-Research services

In 2012, GigaPort3 will work with one or more existing virtual organisations to enable their current work processes through web services and SURFconext, paving the way for a more generic approach in 2013.

In order to improve the adoption of e-Research services through the SURFconext framework, GigaPort3 will actively pursue a number of (virtual) organisations in the research field and connect them to SURFconext. Particular targets are the large virtual organisations supported through NWO, including CLARIN and NBIC, and the three newly created European VOs called KICs (Knowledge and Innovation Communities[5]), all of which have a significant presence in the Netherlands.

As the adoption of e-Research services will, in many cases, require the dynamic networking services within the campus environment, GigaPort3 will investigate the potential of OpenFlow and alternatives to extend the Bandwidth on Demand concept onto the customer premises.

Deliverables in 2012

Reference	Title	Planning
User participation – team 1		
DIS-12-1	With the IT managers of the universities, define a shared vision on the interworking between campus infrastructure, SURFnet services and external e-infra service providers [document]	Q2
DIS-12-2	Set up support teams to resolve bottlenecks within the campus infrastructure [active support]	Q3
DIS-12-3	Set up "challenges" to encourage connected institutions to improve the campus infrastructure and showcase the results	Q4

[5] http://eit.europa.eu/kics1/knowledge-and-innovation-communities/overview.html

User participation – team 2		
DIS-12-4	*New and existing e-Research Partnerships:* GigaPort3 will initiate (and support) several (3-5) innovative collaborations in various disciplines and application areas each year, involving industry as well as research institutions	Q1-Q4
DIS-12-5	The documentation of 3 best practices on the use of e-research services based on the EYR3 outcome	Q4
DIS-12-6	Prepare and implement an EYR4 contest, aimed at researchers, in collaboration with SARA in order to stimulate the use of e-research services	Q4
SURFconext adoption – team 6		
DIS-12-7	Link 4 Virtual Organisations to SURFconext	Q4
Knowledge dissemination – all teams		
DIS-12-8	Corporate communication about GigaPort3 program Public Relations, Annual Report, website ([documents]	Q1-Q4
DIS-12-9	Two events that stimulate development of mobile apps (such workshops, webinars, code jams) [event]	Q3
DIS-12-10	Innovation meetings for networking, in collaboration with SURFacademy [event]	Q4
DIS-12-11	Innovation meetings for collaboration infrastructure, in collaboration with SURFacademy [event]	Q4

5 Research on Networks in 2012

In 2012 SURFnet will continue to work with external research partners on issues that require more than just development or procurement to realise the new network services. During 2010 and 2011 SURFnet has identified a number of relevant topics for research and has selected the appropriate partners. All RoN research activities will be executed within the Work Packages listed in Chapter 4.

Twice a year a RoN Progress Meeting will be organised, building on this successful formula from the GigaPort Next Generation Network, in which all RoN partners are expected to participate. The meeting will be organised as part of WP7. The WP leaders involved in RoN activities will form the program committee.

New issues for research may come up during the year. Therefore, GigaPort3 selects a number of partners and research topics before the start of the year, but also during the year. A fixed budget is available for these activities, part of which is reserved for topics which can be decided during the year.

In 2012 SURFnet plans to work with the following partners:

- KPN
- Ciena
- CERN
- ESnet
- NORDUnet
- GN3 Consortium
- Delft University of technology
- Eindhoven University of Technology
- NLnet Labs
- Novay
- SARA
- TNO-ICT
- University of Amsterdam
- University of Twente
- VU and ES/ESTEC

Below a short introduction of these partners is presented together with a short description of the topics they plan to address.

5.1 KPN

As noted under work package 5 (Mobility), GigaPort3 will conduct a pilot to study closer integration between mobile networks and the Internet together with KPN. Besides implementing a seamless user experience between 4G and Wi-Fi networks, this activity will also provide a "Living Lab" environment to study the way students and staff use the applications provided across these networks. Together with KPN and the participating connected institutions, GigaPort3 will study the behaviour of these users and identify bottlenecks and opportunities for the general introduction of such applications.

5.2 Ciena

In 2011, Ciena was chosen as Industry Partner to deliver the equipment for SURFnet7 Next Generation Ethernet (NGE).

Part of the agreement is a commitment from Ciena to contribute to technology Proof of Concepts, demos and showcases. For example, in September 2011 Ciena participated in the 100 Gbit/s demo on the 1650 km link between Amsterdam and Geneva. During 2012, GigaPort3 and Ciena will work together to define and execute several such activities, demonstrating the possibilities of advanced network technology. In the meantime, Ciena will study options for Dynamic Lightpath provisioning using their existing Network Management System (NMS).

5.3 CERN

The high energy physics experiments at CERN produce huge amounts of data, which is distributed around the world for processing and storage. For this reason, CERN is well connected through several advanced networks, including the LHCnet high capacity lightpath network.

As part of its networking activities, CERN has asked SURFnet to provide a test bed for international connectivity; this test bed was delivered in 2010, based on a dark fiber between Amsterdam and Geneva, and is used in initiatives such as the Amsterdam–Geneva demo mentioned earlier. In 2012, GigaPort3 will work with CERN in the development of an open networking environment for LHC data (LHCONE) and in demos involving the operational Amsterdam-Geneva link.

5.4 NORDUnet

NORDUnet, the joint collaboration by the 5 National Research and Education Networks in the Nordic region, is a regular partner for SURFnet in advanced international networking. In 2012, GigaPort3 intends to involve NORDUnet in a number of research projects, including international alien waves, dynamic multi-domain networking, and 40G/100G connectivity.

5.5 ESnet

ESnet, the US Energy Science Network, provides advanced networking to the US science community. The GigaPort3 project works with ESnet in the definition and implementation of multi-domain dynamic lightpaths through the NSI interface, linking ESnet's dynamic networking system (OSCARS) with SURFnet's. To this end, SURFnet and NORDUnet have signed a collaboration agreement with ESnet[6].

5.6 GN3 Consortium

SURFnet participates in the GN3 project, which aims to create upgraded networking services throughout Europe through a collaboration of the European National Research and Education Networks (NRENs). These services are provided through the GÉANT paneuropean infrastructure, consisting of a European interconnect network, NREN facilities and campus infrastructures.

Part of the GN3 project is a set of Joint Research Activities, in which several NRENs work together to investigate research topics of common interest.

In 2012, SURFnet will partner with other NRENs in GN3 research projects on future internet architecture, federated identity, mobility and multi-domain dynamic services.

5.7 Delft University of Technology

During the GigaPort Next Generation Network project, the group of prof. Van Mieghem of Delft University of Technology contributed substantially to lightpath routing technologies, which resulted in a close collaboration between SARA and this group for adopting the routing technology into the operational management of the lightpath network. As part of GigaPort3 in 2010, the group of prof.

[6] http://www.surfnet.nl/en/nieuws/Pages/ESnetCollaborates.aspx

Van Mieghem delivered an optimized model for the routing and wavelength assignment of lightpaths and IP traffic over the SURFnet photonic layer.

In 2012, the TuDelft will address the optimisation problem of resource scheduling within a given set of constraints. The TuDelft will also extend its earlier work on "green" networking, among others by building alogrithms for energy-aware traffic engineering. Other potential topics for study include resilience in multi-layered networks, and optimal lightpath scheduling algorithms which take into account physical impairments, traffic patterns and trade-offs between resilience and cost.

5.8 Eindhoven University of Technology

The group of professor Ton Koonen at the Eindhoven University of Technology's COBRA Institute is world-renowned for research into and publications about high-speed networking technology. Within the Photonics Work Package of GigaPort3 this group will conduct research on Terabit networking.

Flexi-grid ROADM technology allows for a flexible provisioning of the filter bandwidth - so called - 1 Tbit/s DWDM super channels. Their work will investigate implementation options for flexi-grid flexi-rate technology within the SURFnet network architecture by simulation studies. This work started in 2011 and will be continued in 2012, leading to a report on the generation and implementation of super channels in the SURFnet network architecture as well as a proof of concept.

5.9 NLnet Labs

NLnet Labs is a research and development group that focuses on those developments in Internet technology where bridges between theory and practical deployment need to be built. It is their goal to play an active and relevant role in these areas through the development of open source software, through participating in development of open standards, and through the dissemination of knowledge. Their work is targeted at enhancing the open, secure, and innovative nature of the Internet for all.

NLnet Labs is contributing to the IP Innovation Work Package in GigaPort3. NLnet Labs has expertise in the field of Internet network routing, and closely follows developments of new routing protocols as proposed in the IRTF Routing Research Group. To increase the understanding of the intrinsic mechanisms driving the behaviour of these protocols, (abstract) models are designed for simulation and analysis. Data observed from real-world observations and data from computer (simulation) experiments are analysed to validate the routing models and test hypotheses of its behaviour. Based on this expertise NLnet Labs will provide GigaPort3 with research on new issues in internet routing and on the architecture of the future internet.

5.10 Novay

In relation to the EDS Work Package, Novay has specific expertise in the wide area of distributed systems, middleware and ICT architecture. The Human Centric Services department of Novay is most involved with EDS and has extensive knowledge on - and experience with - identity federations, mobile applications, privacy, context awareness, trust, personalization, user centric computing, service platforms, scalability and interoperability. Based on this expertise they will, in cooperation with SURFnet, contribute to a number of work items within the EDS Work Package. These topics include fine-grained authorization and IaaS service architectures.

5.11 SARA

The Network Research Group (NRG) within SARA will continue to contribute to the RoN program of GigaPort3 in 2012.

In 2012 the NRG group of SARA will contribute to the INT and NGE Work Packages. The major activities of SARA will be within the INT Work Package, where they will work towards 100 Gbit/s networking and deliver a 100G demonstration in cooperation with SURFnet. Within the NGE work package they will contribute to a test bed for the Next Generation Ethernet RoN activities focused on (potential) new services and Ethernet OAM features that SURFnet can provide to its connected institutions. This activity will complement the theoretical assessment done by UvA-KdVI and TNO-ICT. In cooperation with SURFnet and other NRENs there is a possibility of extending this test bed to a European scale.

In addition to this topic, SARA will build an OpenFlow test bed. As part of this activity SARA plans to connect a test node to the GENI OpenFlow network that spans the USA.

5.12 TNO-ICT and UvA / Korteweg-de Vries Institute

TNO-ICT and University of Amsterdam will work together in a team to address key issues in provisioning and management of Next Generation Ethernet technologies to be introduced as part of SURFnet7. From TNO-ICT, professor Hans van den Berg will be leading the activities for GigaPort3. Professor Hans van den Berg (also associated with the University of Twente), specializes in quantitative analysis of quality-related issues of various networking technologies. His group has been on the forefront when it comes to modelling complex networks, and developing techniques to quantitatively assess them including simulation, monitoring, and the analysis of measurements. From UvA-KdVI, professor Michel Mandjes will be responsible for the research activities within RoN. Prof. Michel Mandjes has a strong reputation in mathematical (stochastic) analysis of queuing networks, with applications in networking. This being one of the most appropriate techniques when analyzing network technologies, Mandjes' role in the project will relate to developing and solving suitable mathematical models.

The research activities of TNO-ICT and UvA-KdVI in 2012 will specifically focus on assessment and analysis of potential new services that SURFnet can provide to its connected institutions. SURFnet currently provides lightpaths with fixed and reserved bandwidth. Given the bursty and unpredictable nature of the traffic sent over these lightpaths, the question arises if the fixed bandwidth aspect should be made flexible to include occasional bursts beyond the fixed limit. The proposed service is a lightpath service with committed bandwidth and burst possibilities. The group of Prof. dr. Michel Mandjes and Prof. dr. Hans van den Berg will together assess if the mechanisms underlying the lightpath with bursts are capable of providing guarantees for the committed part of the bandwidth.

Another attractive feature that Next Generation Ethernet adds to lightpath services is Operation, Administration and Maintenance (OAM). Ethernet OAM techniques make it possible for the connected institutions to validate and monitor the lightpath service performance but at the same time also troubleshoot in case of problems (in cooperation with SURFnet). Besides assessing the connectivity of the service, Ethernet OAM also makes it possible to monitor the performance of each lightpath service in terms of throughput, delay and packet loss, which is not possible with the existing lightpaths on SURFnet6. As part of the project the Ethernet OAM techniques will be explored and analysed. Scenarios beneficial in terms of troubleshooting and performance monitoring will be identified. SURFnet's connected institutions and peer NRENs are foreseen as potential users of the Ethernet OAM service features. Furthermore, the scalability in terms of the number of sessions which can be supported will be assessed.

5.13 UvA - System and Network Engineering

GigaPort3 will continue to work with the group of professor Cees de Laat. He leads the System and Network Engineering (SNE) group at the University of Amsterdam, and has a solid international reputation in the field of networking research. The SNE group focuses its research on emerging

new local and wide area optical networks and the associated models, systems and protocols. The group is building tools and proof of concept applications that through demonstrations promote the advanced and novel usage of the high-speed networks. The group develops grid middleware to empower applications to optimally allocate and use these infrastructures. Security of the required mechanisms, infrastructure, middleware, applications and the privacy of data in distributed processing environments is an essential aspect of the research. Members of the SNE group are active in forums such as GLIF and OGF, and participate in projects such as NOVI and GN3.

As part of their RoN activities in 2012 UvA-SNE will participate primarily in the NetherLight and Global connectivity (INT) Work Package. Within the INT Work Package, they will continue to contribute to the NML and NSI working groups in OGF. They will also work on tools for topology expressions and dynamic updates of network topologies. The later will be done in close cooperation with Ciena who will be implementing the NSI. This work will then be applied to the CineGrid use case. Some of UvA-SNEs efforts will also contribute to the Photonics work package addressing the DAS-4. The goal of their research will be to integrate the new devices in the control plane environment of DAS to make the services available to pilot applications (CineGrid or e-VLBI).

5.14 University of Twente

In the context of GigaPort3 (Work Package NGE), the group of Aiko Pras at the University of Twente is researching new techniques for monitoring Next Generation Ethernet. Dr. Aiko Pras is chairing (ad-interim) the Design and Analysis of Communication Systems (DACS) group at the University of Twente. His research interests include network management technologies, network monitoring, measurements and security. He is chairing a number of Working Groups and is a steering committee member of several conferences.

During 2012, the group will provide research on flow-based network security, creating a Proof of Concept for an Intrusion Detection System in the form of a plug-in which works directly on existing flow monitoring tools. The group will also investigate different approaches to end-to-end performance monitoring for cloud services.

5.15 VU and ES/ESTEC

Atomic clocks are indispensible devices for modern society. Compared to traditional atomic clocks using microwave oscillating fields, optical clocks can be far more accurate. However, optical clocks will have to be embedded within a network capable of transporting such extremely accurate signals, and this is where existing time-transfer technologies form a bottleneck. One particularly attractive solution would be the use of optical fibers for transmission of optical clock signals. In 2012, the Laser Centre at the Vrije Universiteit and the European Space Research and Technology Centre (ESTEC) will, with SURFnet, extend the work done in 2011 on implementations of atomic clock signals over fiber.

6 Risk management

The relevant risk areas for 2012 have been identified and addressed; the project will continuously monitor these risks and those identified during 2012. The following relevant risks have been identified at this time:

Technical realisation
Standardisation: Next Generation Ethernet protocols are not yet fully defined which may lead to problems concerning future interoperability with other networks and which may cause provider lock-in. Given the choice for a PBB-TE network, provider lock-in is a distinct possibility and the project will monitor developments in this area. If needed, the NGE network can be transitioned to MPLS-TP in the future through a software update on the NGE hardware. Standardisation is also an issue with regards to protocols used in other areas of interest for GigaPort3, e.g. for storage clouds and interdomain Bandwidth on Demand. Even if standards are available and used they may not currently be able to support the goals GigaPort3 tries to achieve, making changes or finding alternatives necessary. GigaPort3 uses agreed standards where possible, and if draft standards need to be used, an upgrade scenario towards the final standard will be put in place.

Quality of hardware and software: the hardware and software will contain the newest technologies, introducing an increased risk of faults. Therefore, extra time will be spent on testing and quality control, and contracts with industrial partners will contain clauses to ensure that the manufacturer will correct any errors that do occur.

Innovative versus current services: In some cases a risk exists that innovation may influence existing services. An example is the OpenDRAC software which is currently used in production for providing the SURFnet Dynamic Lightpath (DLP) service. To avoid disruption of the DLP service development on GigaPort3 related innovations will be done in a separate branch of the OpenDRAC repository. Changes in the innovation branch will only be merged into the production branch when they are needed there and after intensive testing (including deployment in the test network).

Financial realisation
Cost of equipment and services: realistic price-estimates have been used in the budget, and the results from the NGE tender has confirmed the estimates for SURFnet7 equipment, but given the current phase of development all of these estimates are uncertain. If the costs of some items end up higher, SURFnet will either search for additional funding, or shift some of the effort or funding within the project. The project is designed to provide positive results, even with partial implementation.

Planning
Delayed availability of components: the project depends on timely delivery of hardware and software by industry partners. Delays will have an impact on the project timeline; however, delays in one part of the project can free resources which can then be used to speed up other parts of the project, partially compensating for the delay. Where needed, the project may decide to implement temporary solutions in order to maintain progress.

Collaboration with other projects: GigaPort3 collaborates with other projects and (standardisation) organisations. Changes in these projects with respect to planning or goals can impact on the project timeline and the ability to produce results where they depend on those other projects. This risk can be partially addressed by on the one hand keeping close tabs on those projects (and conversely providing them with enough information about GigaPort3), while on the other hand reducing too closely linked dependencies and having alternatives at hand wherever possible.

Appendix A: Glossary of terms

CERN	European Organization for Nuclear Research
CIR	Committed Information Rate (CIR) available to a service.
DNSSEC	The Domain Name System Security Extensions (DNSSEC) is a suite of Internet Engineering Task Force (IETF) specifications for securing certain kinds of information provided by the Domain Name System (DNS) as used on Internet Protocol (IP) networks. It is a set of extensions to DNS which provide to DNS clients (resolvers) origin authentication of DNS data, authenticated denial of existence, and data integrity, but not availability or confidentiality.
DWDM	In fiber-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (colours) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity.
e-IRG	e- Infrastructure Reflection Group - The main objective of the e-Infrastructure initiative is to support the creation of a political, technological and administrative framework for an easy and cost-effective shared use of distributed electronic resources across Europe. Particular attention is directed towards grid computing, storage, and networking.
ESTEC	European Space Research and Technology Center - The European Space Agency (ESA) and its 18 Member States work together to pursue a wide range of ambitious and exciting goals in space. Together, they create fascinating projects that would not be feasible for the individual Member States.
ESF	European Science Foundation - The European Science Foundation (ESF) is an association of 79 member organisations devoted to scientific research in 30 European countries. Since we were established in 1974, we have coordinated a wide range of pan-European scientific initiatives, and our flexible organisation structure means we can respond quickly to new developments.
ESFRI	ESFRI, the European Strategy Forum on Research Infrastructures - ESFRI, the European Strategy Forum on Research Infrastructures, is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach. The competitive and open access to high quality Research Infrastructures supports and benchmarks the quality of the activities of European scientists, and attracts the best researchers from around the world.
ESnet	Energy Sciences Network - ESnet is a high-speed network serving thousands of Department of Energy scientists at over 40 institutions, as well as connecting to more than 100 other networks. ESnet is a pioneer in providing high-bandwidth, reliable connections that link researchers at national laboratories, universities and other research institutions, enabling them to collaborate on some of the world's most important scientific research challenges including energy, climate science, and the origins of the universe.

EYR	Enlighten your Research – Competition organised by SURFnet in close collaboration with NWO and SARA. Researchers connected to an institution connected to SURFnet can enter the competition.
FES	The Economic Structure Enhancement Fund
GLIF	The Global Lambda Integrated Facility – international virtual organization that promotes the paradigm of lambda networking.
GLORIAD	The "GLORIAD" advanced science internet network was launched in January 2004 by the U.S., China and Russia, and expanded its reach in 2005 – to Korea, Canada and the Netherlands – and in 2006 to the five Nordic countries of Denmark, Finland, Iceland, Norway and Sweden. The network promotes new opportunities for collaboration and cooperation among scientists, educators and student.
GN3	The project delivering the next generation GÉANT network. The project partners are 32 European NRENs, DANTE and TERENA; plus an additional four Associate NRENs. Read more in the RoN section.
HEP	High Energy Physics
IETF	The internet engineering task force. The mission of the IETF is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.
IaaS	Infrastructure as a Service: delivery model for cloud services where the service consists of (virtualised) infrastructure elements such as storage and computing.
JIVE	The Joint Institute for VLBI in Europe was formally established in 1993 by the Consortium for VLBI in Europe. The Institute is located in Dwingeloo, the Netherlands, and hosted by ASTRON, the Netherlands Institute for Radio Astronomy.
LOFAR	LOFAR is a real-time multiple sensor array. Very different sensors can be placed along a common infrastructure and make use of it the same time. LOFAR is being developed by a consortium of knowledge institutes, universities and industrial parties, led by ASTRON. LOFAR is funded by the Dutch government and the Northern provinces. All participating institutes provide also some of their own resources to the development of LOFAR.
NANOG	The North American Network Operators Group provides a forum for the exchange of technical information, and promotes discussion of implementation issues that require community cooperation.
NCDD	NCDD is the Dutch national coalition of public sector organisations whose remit includes long-term access to digital data.
NEXPReS	NEXPReS is a three-year project aimed at further developing e-VLBI services of the European VLBI Network (EVN), with the goal of incorporating e-VLBI into every astronomical observation conducted by the EVN.

NLeSC	The Netherlands eScience Center, which supports and reinforces multidisciplinary and data-intensive research through creative and innovative use of ICT in all its manifestations (eScience).
NOC	Network Operations Center
NREN	A National Research and Education Network (NREN) is a specialised internet service provider dedicated to supporting the needs of the research and education communities within a country.
NWO	The Netherlands Organisation for Scientific Research (NWO) funds thousands of top researchers at universities and institutes and steers the course of Dutch science by means of subsidies and research programs.
OpenDRAC	Open DRAC is an open source project that aims to create a state-of-the-art piece of middleware that allows network control by users and applications. It aims to be compatible with open standards, and where these don't exist it wants to be an appropriate proving ground.
OFFSN	Optical fiber frequency standard network.
RPKI	Resource Public Key Infrastructure - Resource Public Key Infrastructure (RPKI) is also known as Resource Certification. Resource Certification is an emerging security framework for verifying the association between organizations and their Internet number resources.
RIPE	The RIPE NCC is one of five Regional Internet Registries (RIRs) providing Internet resource allocations, registration services and co-ordination activities that support the operation of the Internet globally.
SaaS	Software as a Service: delivery model for cloud based services where the service includes the application software.
SONET/SDH	Synchronous Optical Networking (SONET) and Synchronous Digital Hierarchy (SDH) are standardized multiplexing protocols that transfer multiple digital bit streams over optical fiber using lasers or light-emitting diodes (LEDs). Lower data rates can also be transferred via an electrical interface.
Taj (GLORIAD)	The NSF-funded Taj network efficiently builds on GLORIAD and has already dramatically improved existing U.S. network links with China and the Nordic region. It will soon connect India, Singapore, Egypt and Vietnam– and, by planned extension, to science communities throughout Southeast Asia, the Middle East and the African continent.
TERENA	The Trans-European Research and Education Networking Association offers a forum to collaborate, innovate and share knowledge in order to foster the development of Internet technology, infrastructure and services to be used by the research and education community.

TNO – ICT	TNO is an independent research organisation whose expertise and research make an important contribution to the competitiveness of companies and organisations, to the economy and to the quality of society as a whole.
UvA	Universiteit van Amsterdam
VSNU	Represents the 14 research universities in the Netherlands. It functions as an employers' association, promotes the universities' interests and provides a forum for the development of common viewpoints.
VU	VU University Amsterdam
XFP	The XFP (10 Gigabit Small Form Factor Pluggable) is a hot-swappable, protocol-independent optical transceiver, typically operating at 850nm, 1310nm or 1550nm, for 10 Gigabit per second SONET/SDH, Fibre Channel, gigabit Ethernet, 10 Gigabit Ethernet and other applications, including DWDM links.