*e*Infrastructure

Building blocks for the European research area

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Foreword

In March 2002, the European Council recognised the need to progressively increase overall levels of expenditure in Europe on research, development and innovation, and set themselves the target of 3 % of GDP by 2010. This shows Europe's determination to establish, maintain and reinforce leadership in key research fields.

More recently, in October 2003, the European Council called on Member States to maintain sound macroeconomic policies, accelerate structural reforms and promote investment in networks and knowledge. The European Council has highlighted the importance of speeding up the roll-out of European electronic communication networks and of increasing investment in human capital. These are crucial steps to boost growth, better integrate an enlarged Europe and improve the productivity and competitiveness of European businesses in global markets.

The advent of more sophisticated network infrastructures has radically changed the way in which research is done today in Europe. In the very same way, the 'European initiative for growth' builds on the fact that the widespread, more effective and inclusive use of the Internet and broadband networks will be key to raise productivity in the private and public sector.

The research community in Europe has recently been enjoying the benefits of an ever more effective electronic infrastructure that has been put into place. One of the major success stories in Europe has been the establishment of the multi-gigabit pan-European research network, GÉANT, as a world leader in research networking. GÉANT, in close articulation with the national research and education networks (NRENs), has abolished distances between researchers, thus contributing to more effective cooperation between research communities.

The innovative characteristics of GÉANT, the advances resulting from experimental test beds addressing key technologies such as grids, Internet protocol version 6 (IPv6) and optical networks and the synergies being exploited through all these complementary research actions, constitute a major asset on which further actions are now being built, especially in the context of the sixth framework programme.

With the progressive deployment of a two-layer infrastructure, based upon GÉANT and grid-enabled infrastructures, Europe is implementing a world pioneering eInfrastructure that will revolutionise the way in which ICT resources will be shared. At the same time, this eInfrastructure will be a foundation for the European research area (ERA).

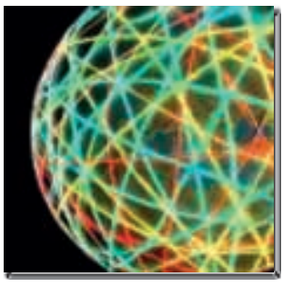
The fifth framework programme has formally come to an end and projects are finalising their work. This brochure provides a valuable insight into the developments and achievements of research networking initiatives on a European level in recent years and sets the scene for the main developments expected to occur when the sixth framework programme gets off the ground.

Viviane Reding

European Commissioner
for Information Society and Media

eInfrastructure:

Building blocks for the European research area



Networks and knowledge are widely recognised as the key enablers of the knowledge society. In its efforts to pursue the strategic goal for Europe: 'to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion' the European eInfrastructure is fast gaining momentum.

Research networking has acquired political significance as an instrument facilitating cooperation and convergence. Europe is in the process of creating a pan-European grid-empowered research networking infrastructure to support all fields of cooperative research. GÉANT is currently serving over 3 000 universities and research centres, more than 18 000 higher education sites and more than 3 000 hospitals, libraries and other institutions with high capacity connections. It brings together researchers from all regions of Europe and constitutes a key component of the European research area with an ever accelerating speed of knowledge creation and knowledge exchange between all research-user communities.

This edition of the brochure on research networking in Europe provides you with an overview of European research and development projects and activities in the field of research networking. The previous edition of this publication had the subtitle: 'Striving for global leadership'. This year, more emphasis is given to the challenges that high-speed communication networks offer in the building of the knowledge society. The emergence of the so-called eInfrastructure with its new shared use of computing and data resources across diverse technological administrative and national domains has the high potential to become one of the key 'building blocks for the European research area.'

The brochure has two parts. It starts with discussing the research infrastructure concept, its actors, its challenges, its potential and its anticipated impact, within the context of eEurope 2005 and the evolution from the fifth to the sixth framework programme (FP5, FP6) for research and technological development. A brief description of the main areas of work (GÉANT, grids, IPv6) serves as an introduction to the main part of this brochure: an overview of all running and/or recently ended projects.

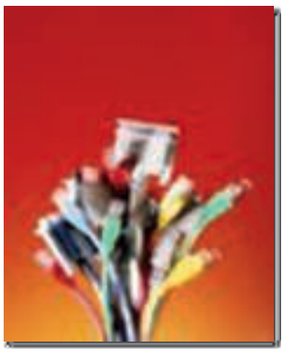
Given the fact that all projects were started up in the fifth framework programme, special attention is given to the major results identifiable at this stage.

We would like to use this opportunity to draw your attention to a complementary report collecting some user views with the purpose of informing new users of the broad range of benefits of infrastructures for research networks, entitled 'Changing the way research is done: the user perspective on eInfrastructure'.

We hope and expect that these publications will stimulate your interest in R & D in the domain of research infrastructures.

Acknowledgements

This document is the result of the collective effort of the IST projects in the area of research networking and the members of the research infrastructure team of the European Commission. Their time and efforts to come to a transparent and consistent presentation of all activities in the area of research networking in IST are gratefully acknowledged.



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The project summaries on pages 25 to 74 are written by the project consortia. These pages identify the project manager of each project.

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For up-to-date information on research infrastructures please consult the website: ***www.cordis.lu/ist/rn/home.html***

The European perspective on research networking

Context

Building high-capacity research networks is an important and urgent priority of European Union policy. Research networks are a source of innovation and have a clear European dimension.

High-capacity research networks, once complemented by enabling technologies capable of promoting the seamless sharing of computing resources in an international scale, are expected to give a further breadth and depth to the collaboration amongst researchers in Europe.

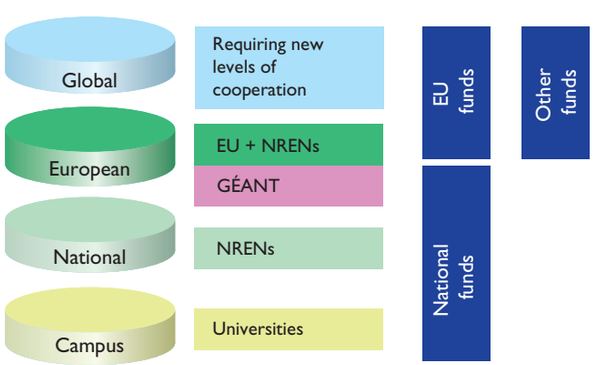
Nevertheless, complementary action is needed at national and local levels as well. Interconnecting national research and education networks at very high speeds can only be of value if similar capacities are reached within the national networks themselves and in the intranets of educational and research institutions. Constant and strategic investment in research on networking is also needed so as to exploit the opportunities provided by new advanced technologies and approaches.

Research networking is a key area within the FP5 information society technologies (IST) programme. Work focuses on two complementary approaches: the broadband interconnection of national research and education networks and the establishment of advanced European experimental test beds.

The IST programme is extremely well placed to respond to the challenges defined by the eEurope initiative. This brochure aims to provide an overview of the broad set of activities carried out at European level, mainly in the context of IST, on topics related to 'information infrastructures for research' and 'research on advanced networking technologies'.

The approach

One of eEurope's objectives is to increase the competitiveness of European research through the provision of a world-class research infrastructure. This requires a structured approach which is typically based on the principle of subsidiarity and implemented via a layered model.



- The university campus, research institute or school network constitutes the foundation layer.

General objectives of research networking in Europe

- To create and maintain a modern, high-capacity information and communication network infrastructure, which permits the development of advanced applications and services for research and education.
- To promote research on advanced network information technologies and to test large-scale test beds.
- To strengthen economic and social cohesion in Europe.
- To establish Europe as a global connectivity leader.
- To contribute to the scientific, technological and subsequently economic competitiveness of the EU in the world.
- To serve as the basis of the new European research area.
- To play a pivotal role in the creation of the information society.

• The interconnection of the local sites via a national research and education network (NREN) constitutes the second layer, essentially supported by national funds.

• The pan-European network interconnecting the NRENs, co-funded by national and European funds,
is the top layer, which is further connected to equivalent networks in other continents.

The pan-European research backbone, GÉANT, assures the long-term perspective and the stability necessary to allow researchers in Europe to invest their efforts in the development of new applications, experiments and usage practices. This backbone is in FP5 supported by the four year IST project GN2. It benefits from Community funding because, on the one hand, it employs state-of-the-art technology and, on the other hand, it fosters European cohesion by interconnecting the research networks of more than 30 countries.

In parallel, it is necessary to stimulate research on networking. Research communities in the various areas of information and communications technologies (e.g. distributed architectures, network management, optical communications, security, protocols) need to create, integrate, test and validate new (possibly disruptive) technologies in the context of user-driven applications. As advanced networks increase in scale, it becomes more difficult to develop an alternative vision of the network, both in organisational and technical terms. Deploying large-scale networking test beds and involving the right set of actors proves to be an effective way to accelerate the evolution and the take-up of new technologies. It also promotes the adoption of new organisational models by the European research networks. In this way, Europe is playing a leading role in the definition, standardisation and validation of the next generation of network protocols (including those for the Internet) and other emerging broadband technologies.

The actors

The nature and scope of these activities requires the collective effort of various groups.

• **The research community in Europe** is traditionally open to change, has innovative ideas, is internationally oriented and shares a strong community identity. Researchers have the reputation of being the 'avant-garde' of the Internet and historically have played the leading role in testing and implementing the most innovative information technologies. Researchers in both academia and industry play an active role.

• **Industry** in the broad sense (including manufacturers, operators, service providers, start-ups, etc.) is interested in cooperation at European level to get first-hand experience on advanced networking technologies (equipment and infrastructures). This enables it, in turn, to deliver innovative and competitive products and services.

• **The national research and education networks** provide services to the research and education communities. They have the required knowledge of the needs of those end-users. NRENs aim to deploy the most advanced national infrastructures for research. This implies that they finance, define requirements and specifications, tender for and manage the network infrastructure and services. They also join efforts with peer entities in Europe to deploy the pan-European backbone for research and to ensure a coherent global perspective.

• **The European Commission** plays a steering role and exercises an essential influence on the development of research networking in Europe by means of its multiannual research programmes and various initiatives (European research area, eEurope action plan, eEurope+, etc.). Since free-market forces naturally tend to focus mainly on short-term perspectives and market opportunities, the EC provides a global long-term objective and perspective. It results in a network that is kept continuously at the forefront of technological development. It also stands for a guarantee that the needs of all the Member States are catered for in a fair way. The European Parliament and the European Council have been strongly supportive and closely associated with the evolution of the research networks in Europe.

Research networking in IST

The official text of the FP5 specific programme IST and the subsequent work programme text clearly identify the area of research networking as having a dual objective.

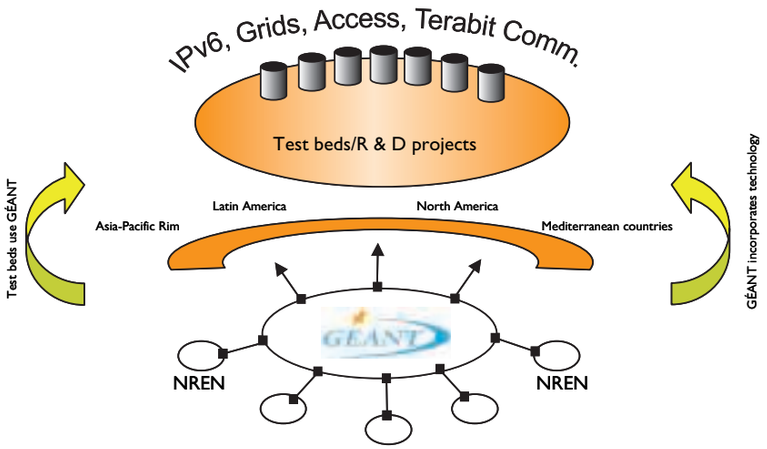
- **Networks for research:** to deploy a pan-European advanced information network for the use of researchers in all disciplines and to foster interconnection to other continents.

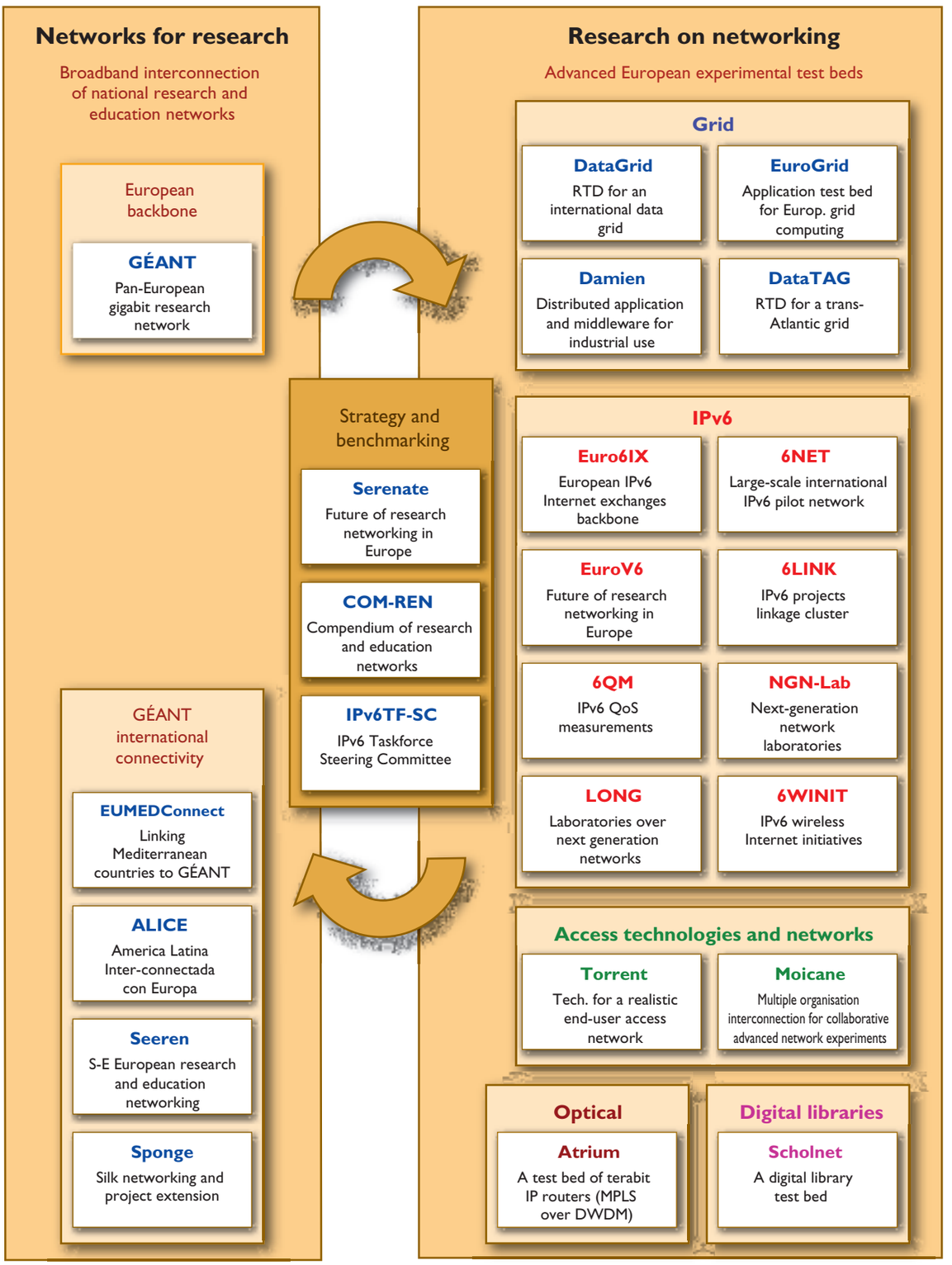
- **Research on networking:** to promote research on advanced information network technologies by setting up test beds, which serve as a focal point for integration and validation of all aspects of these technologies in the context of advanced user-driven applications.

There is a close interrelation and mutual benefit to be derived from these two objectives.

- Scientists need the most advanced communication technology to carry on successfully their work and to be competitive in their respective areas of research. They are also critical users and early adopters of innovative technologies, very well placed to play their part in the cycle of research–development–deployment.

- The advanced network features of the European research infrastructure are used as test beds to experiment, validate and demonstrate new technologies and services on a large scale and in real-world settings. In addition, test beds promote international cooperation and foster partnership between academia and industry. In this way Europe is able to contribute significantly to the development of standards and play a leading role in defining the next-generation networking and application technologies that go beyond the current state-of-the-art.





Networks for research

The GÉANT network

GÉANT provides the highest capacity and offers the greatest geographic coverage of any network of its kind in the world. GÉANT is now considered as a key element for the realisation of the European research area (ERA). Through GÉANT, scientists are able to explore new ways of how to do research (e.g. experiments that took weeks until the data were available after processing can now be done via GÉANT instantly).

GÉANT is based on a multi-Gbps resilient core network, exploiting dense wavelength division multiplexing (DWDM) optical technology. GÉANT had, in 2004, a total transmission capacity of around 200 Gbps (more than twice as much as any other network). In 2003, GÉANT and the national research and education networks in Europe deployed Internet protocol version 6 (IPv6) on their operational networks.

GÉANT continues the dual role of providing an infrastructure to support researchers, as well as providing an infrastructure for (network) research itself. This infrastructure constitutes an environment for demonstration and validation of advanced networking applications based on new services. Its scale caters for the realistic testing and improvement of desirable new capabilities for which there are, at present, insufficient commercial incentives. This is the case with experimentations on topics such as new IP protocols, premium IP, virtual private networking, guaranteed quality of service and all-optical networking. Regarding disruptive technologies, for which experimentation may have to be confined to experimental test beds, GÉANT can also provide a useful service as the network provides access and interconnection between geographically separated test beds.

The innovative characteristics of GÉANT and the synergies being exploited through complementary research actions on grids and optical networks constitute major successes on which further actions are being built in the context of the FP6.

GÉANT has been designed to offer interconnections with research networks in other regions of the world as a fully integrated part of its overall service. The set of GÉANT nodes at which interconnections may terminate make up the European distributed access (EDA). A connection to the EDA can be seen from other parts of the world as an effective connection to GÉANT as a whole and to all the connected NRENs. Through these global collaborations with other regions around the world (Mediterranean, Latin America, Asia-Pacific) the model of a federated backbone infrastructure is spread.

GÉANT is financed collectively on a shared-cost basis by the national research and education networks — NRENs (mostly funds are coming from universities or government) and the European Commission via its research budget. Given its necessary pan-European dimension, a very large consortium of NRENs in Europe joined forces to implement it. The consortium is coordinated by DANTE, a non-profit-making organisation set up to build and manage advanced network services for the European research and educational community.

The GÉANT consortium adopts a series of cost-sharing principles to ensure that the benefits of an overall cost-effective infrastructure are shared among the participants in a stable way, thus strengthening their commitment and ensuring European cohesion. A two-part cost allocation model is adopted, taking into consideration both the geographic element and the central set of shared costs. Especially in the core, the effects of liberalisation in Europe have ensured an extremely significant progressive decrease of the bandwidth costs, and this factor (which may not be so visible in some regions of Europe) is therefore reflected in the cost charged to all the participants.

International aspects of GÉANT

Connectivity with the equivalents of GÉANT in North America (Abilene, Canarie, ESnet) and in Japan (SINET) exists and is upgraded on a regular basis.

The initiatives to expand GÉANT connectivity to other world regions (and developing countries) benefit from a close cooperation between the Information Society Directorate-General (IST programme), the External Relations Directorate-General and the EuropeAid Coordination Office of the European Commission.

Mediterranean rim

The **EUMEDconnect** initiative develops a major Internet network in the Mediterranean dedicated to research and education, interconnecting GÉANT with the NRENs in the Mediterranean neighbours' countries.

North America

The linkage to North America has reached some 14 Gbps in 2003 and continued expansion in 2004. In addition, some 5 Gbps of experimental connectivity are in place allowing for joint advanced network research to be carried out.

Latin America

The **ALICE** project aims to provide connectivity to 18 Latin American countries/NRENs. The ALICE project created the first regional research network for Latin America — RedClara — and ensured its interconnection to Europe via a 622 Mbps connection to Madrid. The first phase of implementation of RedClara builds a 155 Mbps ring interconnecting Brazil, Argentina, Chile, Mexico and Panama (complemented by a 45 Mbps link to Venezuela); soon other connections will be ensured to the remaining countries.

Asia

A link interconnecting Japan with GÉANT is provided by the Japanese Ministry of Education; in 2004 this link is a 2.5 Gbps to SINET routed via North America.

Furthermore, the **TEIN2** action targets the provision of a research and education network backbone in the Asia-Pacific region (ASEM partners — Asia Europe Meeting partners) and its interconnection with GÉANT, in the context of the joint Trans-Eurasia information network (TEIN) initiative. Currently, a direct link between Europe and South Korea reaches the level of 155 Mbps.

Russia

Initiatives such as **NeDAP** (Northern eDimension action plan) focus on the support of research networking activities in north-western Russia. In the context of the FP6, it is expected that Russian research networks will be further integrated in the GÉANT efforts.

Central Asia and the Caucasus

The IST-funded **Sponge** project provides management and experimentation facilities for the **SILK** initiative (virtual silk highway), a NATO-funded project providing satellite based connectivity of the central Asian and Caucasian NRENs amongst themselves and to GÉANT.

Balkans

Seeren (the south-east European research and education networking) project supports the extension of GÉANT to the Balkans (some parts of the Seeren initiative are also supported by numerous international organisations such as the UNDP and NATO).

Research on networking

Grids

The grid is a middleware infrastructure which functions on top of a conventional network. It has certain specific features and properties that enable a new class of services to be provided to end-users supporting the sharing of IT resources, the creation of virtual organisations and collaboration on a global scale. The resources managed by the grid (computing power, data, sensors, equipment, etc.) can be distributed worldwide and can be of a completely heterogeneous nature. They can be very large in size, in scale or of immense numbers. These resources are usually managed by administratively independent and diverse organisations. The goal is to provide a shared, integrated, collaborative, reliable and secure use of the resources to diverse communities of users also distributed worldwide. The grid operates from and to diverse platforms, but provides unified services via unified interfaces. In the long term, the grid is expected to be easily accessible from practically everywhere and economically viable for a wide public.

Grid technologies have the potential:

- to facilitate the interconnection of a large range of heterogeneous devices to the Internet and to enable the delivery of a new class of services — the grid provides solutions to the immense data communication and data access requirements that arise in this context;
- to strengthen the role of the network in providing anywhere, at anytime, an immense variety of services to the user — in this way it leads to a closer convergence between computing and communication technologies;
- to make computing and data resources which are distributed worldwide appear as a single resource via the underlying high-speed Internet;
- to introduce revolutionary new models of doing work and business over the Internet based on virtual organisations and global collaborations;
- to play a major role in strengthening European competitiveness in research, industry and business.

Several projects address one or more of these challenges.

The **DataGrid** project supported advanced scientific research within a grid environment, offering capabilities for intensive computation and analysis of shared large-scale data sets, from hundreds of terabytes to petabytes, across widely distributed scientific communities. Such requirements are emerging in many scientific disciplines, including physics, biology, and earth sciences.

The **Eurogrid** project developed the interconnection of complex heterogeneous high-performance computing systems in a cross-organisational and cross-domain manner. Application domains are biology, meteorology and engineering. Functional extensions were developed in the areas of failsafe file transfer, dynamic resource discovery and brokering, application coupling, ASP services and interactive access.

The **Damien** project aimed at designing middleware to support a particular kind of distributed application, known as a close-coupled application, and at assessing the middleware using industrial applications across the European GÉANT network.

The **DataTAG** project created a large-scale multi-vendor transatlantic test bed for data-intensive grids. Together with the European DataGrid (EDG) project and other related grid projects in the USA such as GriPhyN, iVDGL and PPDG, this allowed the exploration of advanced networking technologies as well as interoperability issues between different grid domains.

Internet protocol version 6 (IPv6)

The rapid and continuous growth of the Internet requires new measures to ensure that it can continue to meet emerging requirements. Europe's ambition to be the most competitive and dynamic knowledge-based economy by 2010 can only be realised if the EU is at the forefront of this upgrading of the Internet's capabilities. Europe will only be able to maintain and build on its leadership in wireless and mobile communications if a rapid transition is made to the next-generation Internet based on IPv6.

IPv6 is an upgrade of the Internet protocol, designed as a successor to Internet protocol version 4 (IPv4), the predominant communication protocol in use today. At present, IPv6 is gradually being introduced. For example, mobile phones equipped with IPv6 are becoming more commercially available. At the end of 2003, the GÉANT network started offering IPv6 services. The early introduction of IPv6 should ensure a more open and competitive arena for the provision of new-generation services, and avoid much higher transition costs if that process is delayed. While IPv6 offers a bright future for the Internet, IPv4 will not disappear overnight. As IPv6 is being deployed today, it is being used alongside IPv4.

Within the IST programme, several IPv6-related projects were launched in 2001 and 2002. Directly related are the projects **6NET**, **6WINIT**, **6QM**, **Euro6IX** and **LONG**, all of which are providing IPv6 platforms for experimentation. Two other projects, **IPv6TF-SC** and **Eurov6**, are dealing with the promotion aspects of IPv6 and another project, **6LINK**, is taking care of the clustering activity.

The IPv6 cluster (www.ist-ipv6.org) started in June 2001 with the objective to set up a platform for exchange of information and experience on agreed methodology for the benefit of the IST projects. Standardisation activities are addressed through concerted contribution and the distribution of reports. 6LINK is supporting the activity of the IPv6 cluster.

IPv6TF-SC supports the European IPv6 task force, launched in 2001 on the initiative of the European Commission. Driven by major European and worldwide players, it provided a series of recommendations pertaining to the implementation of IPv6 by all relevant ICT sectors. In a second phase, it is providing a regularly updated review and plan of action on the development and future perspectives of IPv6 in order to coordinate European efforts on IPv6.

A worldwide consortium of leading Internet vendors and NRENs are shaping the IPv6 forum (www.ipv6forum.com). Its mission is to promote IPv6 by dramatically improving the market and user awareness, creating a high quality and secure next-generation Internet and allowing worldwide equitable access to knowledge and technology.

Other areas of work

Optical networks

GÉANT and the NREN infrastructures provide an opportunity for the photonics community to collaborate on advanced high-speed test beds and realistic field trials. The most prominent test bed in photonic networks was provided by the **Atrium** project.

Access technologies and networks

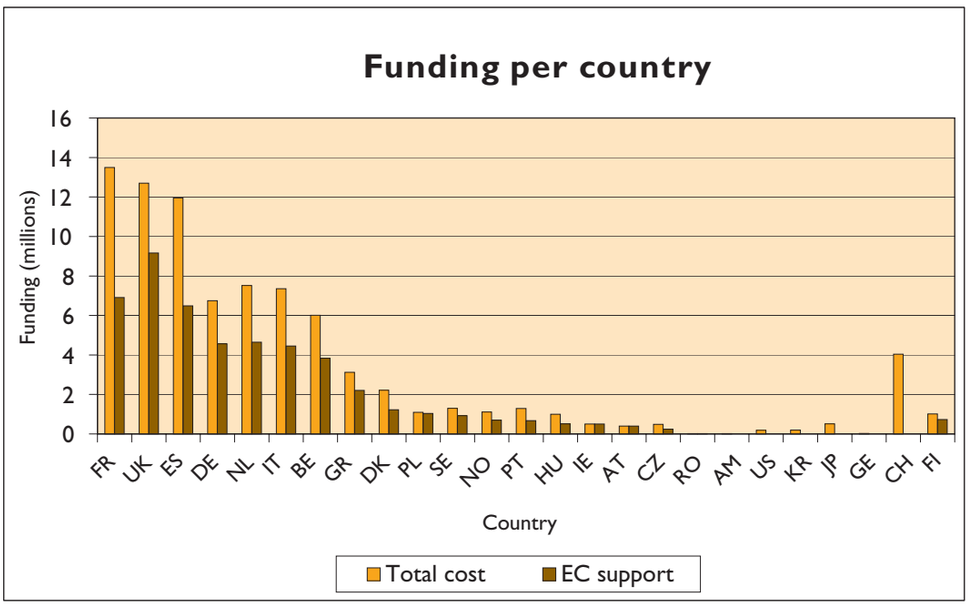
Torrent investigated hardware and software architectures that allows the quality of service expectations of a home user to be met. The main objective of **Moicane** is the enlargement of the 'virtual laboratory' service concept over an IP pilot among entities like universities, research institutions, network device manufactures and network carriers.

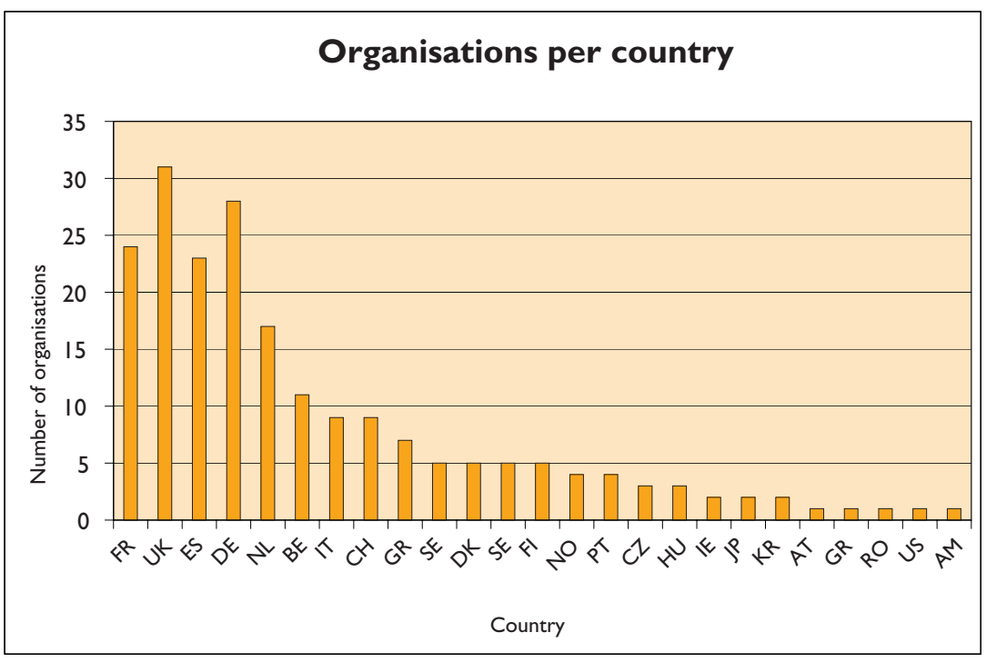
Digital libraries

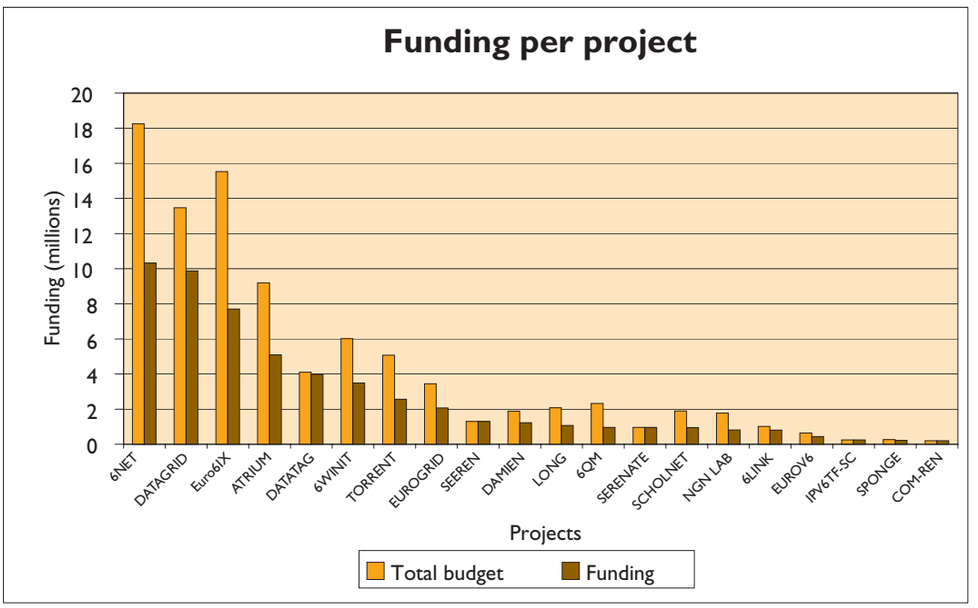
Scholnet developed a digital library test bed for networked scholarly communities. In addition to traditional services, the project also supports multimedia interfaces, hypermedia annotation, cross-language search and retrieval, personalised information dissemination, and so on.

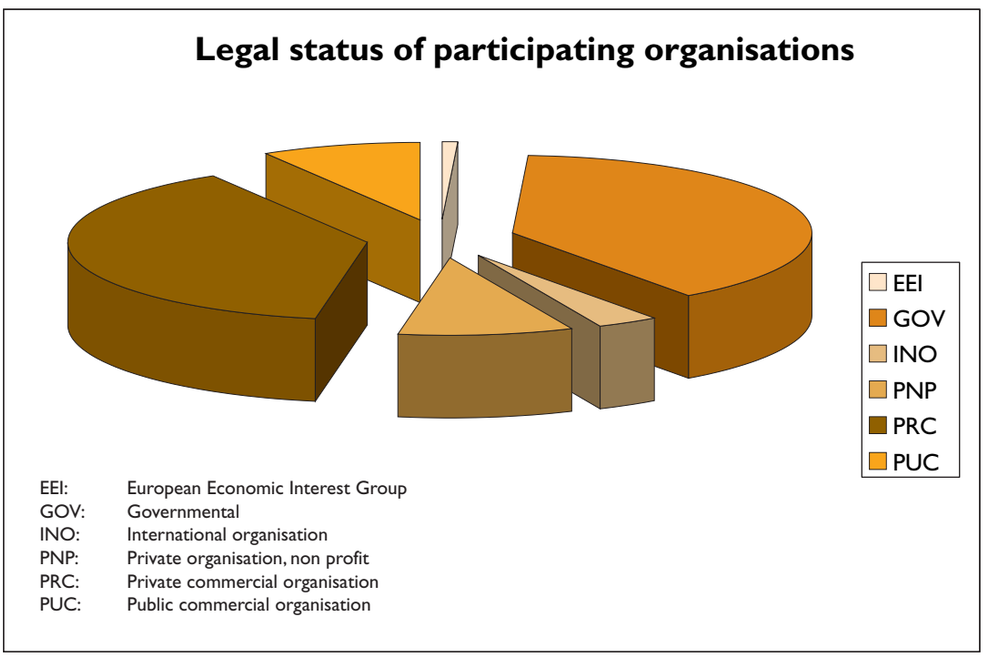
Research networking in figures

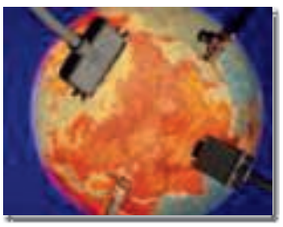
NB: The following graphs do not include the project GÉANT.











The concept of eInfrastructure

The basis: the FP5 GÉANT and the test beds

The achievements of the pan-European network for researchers GÉANT (deployed by the FP5 IST project GN1) mark the beginning of a new era for research in Europe. The GÉANT network provides new means for research and collaboration within the scientific community by making seamless interaction possible over large distances. It provides equal access for all scientists to research facilities in Europe. At the same time, GÉANT allows more cost-effective and efficient ways of scientific collaboration — like almost instantaneous exchange of data and serving user communities with specific needs (e.g. astronomers, high energy physicists, etc.).

The improvements of GÉANT and of research networking in general have been closely linked to the success of some key European test beds, such as the ones addressing optical communications and the new IPv6 (supported by the FP5 IST research networking area). More flexible schemes to provide broadband to the researchers and the increased address space allowed by the adoption of IPv6 have been aspects explored in FP5.

In parallel, the emergence of grids and the targeted support provided by the FP5 IST programme helped to open the horizons regarding the infrastructural support that can be provided to very demanding user communities. A broader vision of what a research infrastructure could turn out to be has been influenced by the possibilities opened by grids. A key component of grids is a middleware layer which functions on top of a conventional network and has certain specific features and properties that enable a new class of services to be provided to end-users, based on the sharing of ICT resources, on the creation of virtual organisations and on collaborations on a global scale.

FP5 supported, since early 2000, the development of large-scale international grid test beds in the IST programme (funded in research networking). Considering the broad nature and the multidisciplinary approach of grid research, a cross-programme action (CPA) was created in 2001. Grid activities expanded significantly in this context. Most of the projects included test beds which brought grid technology from the laboratory into the real world. Several application areas were covered: high energy physics, astrophysics, quantum chemistry and drug design, earth and environment, biology and medicine, risk management, computational fluid dynamics, industrial simulations, and so forth.

The advent of the eInfrastructure concept

The eInfrastructure concept was first proposed in 2003 to coin a vision for the development of a next generation of transnational information and communications technologies (ICT) research infrastructures in Europe.

This concept envisions the researcher's ability to have a controlled, secure, seamless, easy and economical access to shared science and engineering resources, enabled by the provision of a fully integrated advanced information and communication infrastructure.

By the provision of an advanced eInfrastructure, the most advanced ICTs — such as broadband, grid, IPv6, semantic web, mobile, etc. — play a strategic role in changing the way science and engineering will be carried out in the future — in the various fields such as e-science, astronomy, environment, business, aeronautics, education and learning, social research, and so on.

Various infrastructural layers — communication, middleware, computing and services — are required to create pan-European virtual centres of excellence and research laboratories. On top of communication and computing capabilities, ICT research will provide technologies for collaboration, knowledge sharing and experimentation in various areas of science and engineering.

Building the European research area

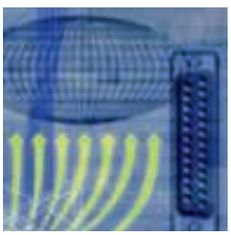
The concept of eInfrastructure, responding to the needs of advanced research communities eager to get the benefits of 'virtual collaborative environments', has been well adopted in Europe.

The eInfrastructure concept is building upon Europe's strong position in communication networks for research (national research and education networks, and the European backbone, GÉANT) and on the successful results of experimental large-scale grid test beds (such as DataGrid, Eurogrid, Damien or CrossGrid).

Furthermore, a number of national programmes in Europe are creating similar models for the shared use of resources across different institutional and user application domains. This favours the development of a common approach, in which the European and the national efforts are complementary (the 'subsidiarity' principle) and can be of mutual benefit. One of the most characteristic examples is the *e*Science programme in the United Kingdom, whereby a grid-based infrastructure is being built to enable next-generation scientific research based on the shared use of computing and data resources across the country and across numerous scientific disciplines.

The eInfrastructure concept is key for the realisation of the ERA, as it has the potential of bringing the power and the services of big facilities to the desktop of the researcher. At the same time, it provides a truly European dimension to facilities of European interest, independently of their physical location (resource virtualisation), promoting cohesion and rationalisation of investments.

The eInfrastructure initiative runs in parallel with similar ICT development programmes in North America (e.g. cyberinfrastructure and iInfrastructures) and Asia-Pacific (e.g. Naregi and APGrid). It is currently being implemented in the context of FP7.



Implementing the eInfrastructure — Building the European research area

eInfrastructure: the concept

An eInfrastructure is a set of persistent services and processes bringing the power of distributed ICT-based resources to a virtual community, in other words, an eInfrastructure brings together a complete collection of tools, facilities and digital resources that are needed nowadays for advanced scientific collaboration.

The eInfrastructure benefits from the integration between an underlying high-speed network and an emerging middleware technology layer, capable of allocating resources and delivering access to them to users and applications. Such integration includes various technologies and components like communication channels, computing power, data storage and grid-based middleware, to ensure the seamless, transparent, secure, pervasive and inexpensive access to remote resources of all kinds.

eInfrastructures are critical to a number of research communities; but at the same time, eInfrastructure challenges the user communities to change the way they organise themselves. User communities' methods, applications and tools will have to be adapted to fully exploit the possibilities opened by large clusters of computers and other digital resources. An important element in this strategy will be the provision of a pan-European authentication and authorisation infrastructure that will cater for secure access to resources.

The approach

The eInfrastructure can effectively only be realised upon the integration of several distinct elements:

- the pan-European networking infrastructure for research (GÉANT and NRENs);
- the distributed computing, storage and data resources provided by national or international facilities all over Europe, as well as the available instrumentation of all types (from heavy instruments such as the large hadron collider up to the most tiny specific sensors);
- a new generation of grid-based middleware services, which allow any authorised user to efficiently share resources for collaborative research work, embedded in a pan-European infrastructure bringing together the key science and engineering facilities in Europe;
- a framework of administrative and policy mechanisms to break down barriers related to deployment and use of new technologies.

A strategy to coherently address the deployment of such eInfrastructure is central to the sixth framework programme, namely in the context of the communication development network (CND) scheme of the research infrastructure programme (specific programme 2) and of the IST thematic priority (specific programme 1).

The achievements

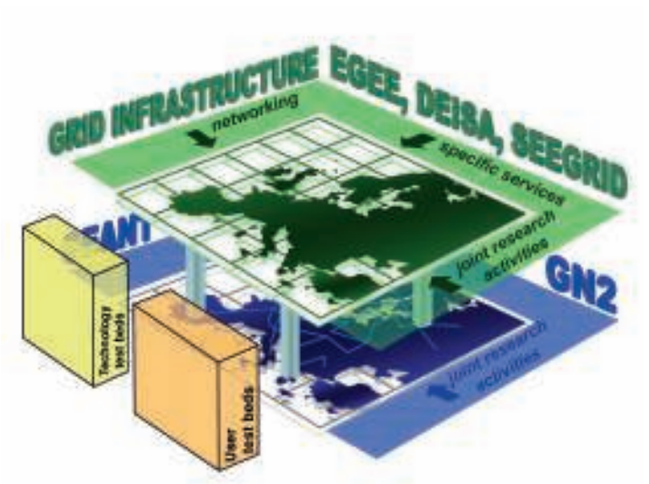
The concept of eInfrastructures builds strongly on the achievements of FP5 projects in the area of research networking (namely GÉANT and the IPv6 and grid test beds).

Beginning in 2004, a first wave of new projects help the eInfrastructures concept to materialise:

- **GN2**, a project that will be responsible for the second generation of GÉANT, extending and improving the functionalities and the services provided by the current GÉANT network;
- **EGEE**, a project that will be deploying the largest international grid infrastructure with the combined capacity of over 20 000 CPUs, federating 70 institutions in 20 countries, supporting amongst others the high-energy physics and the biomedical communities;

- **DEISA**, a project that aims at building a distributed tera-scale supercomputing facility made up of six major supercomputing centres across Europe;
- **SEE-Grid**, a project extending the pan-European grid infrastructure to south-eastern Europe;
- a series of **test beds**, promoting the integration, testing, validation and demonstration of networking technologies and favouring the up-take of technologies by fostering the interoperability of solutions across different disciplines.

Further to this R & D effort, experience shows that the full exploitation of a new innovative paradigm with such a broad scope and cross-border relevance like the eInfrastructure concept can better happen when the appropriate administrative and policy mechanisms are put in place. Consequently and in line with the recommendation of an event organised under the aegis of the Greek Presidency, an eInfrastructure reflection group (EIRG) was established during the Italian Presidency, composed of members appointed at ministerial level. The main objective of the EIRG is to give support at the political, advisory and monitoring level, create a policy and administrative framework for the easy and cost-effective shared use of electronic resources in Europe (focusing on grid computing, data storage, and networking resources) across technological, administrative and national domains.



The impact

The current developments are creating the expectation that the underlying technologies are maturing quickly enough to support the emergence of eInfrastructure. The *e*infrastructure concept is a concrete implementation of a new paradigm according to which the shared use of computing and data resources across diverse technological, administrative and national domains will become a commodity service. It is obvious that such a paradigm has the potential to dramatically change the way in which people work and do business over the Internet.

Such state-of-the-art infrastructures need to combine the stability of an operational infrastructure with the innovative characteristics required by the research communities interested in fully transparent virtual cooperation. Beyond these operational infrastructures, there should be mechanisms such as large-scale knowledge test beds for piloting next-generation networking technologies, applications and services built on open standards and providing secured service on demand. In an area in which the widespread adoption of the eInfrastructures is fundamental, policy support actions like requirements capture, prospective studies, benchmarking and take-up measures are of key importance.

Project pages

Information Society and Media

GÉANT network

Abstract

GÉANT is one of the most advanced research and education networks in the world today. It operates at the leading edge of networking and employs state-of-the-art technology and techniques to provide a networking service that interconnects the services offered by national research and education networks across more than 33 European countries. Supporting the European academic and research community, GÉANT exploits developments in telecommunications and makes available previously unimagined transmission capacities for the scientific community.

Objectives

The primary objective of GÉANT is the creation of a multi-gigabit pan-European research network backbone interconnecting Europe's national research and education networks. Moreover, the intention to build upon the fundamental network platform since its inception has been a key goal driving the continued expansion of the network both in terms of the increase in its transmission speeds and its extension in geographic coverage in Europe (i.e. the Balkans and newly independent States). Improving global connectivity has been a continuous effort and work is under way to establish additional connections to NRENs from other world regions (Asia-Pacific, Latin America, the southern Mediterranean region and southern Africa).

GÉANT has already created the most advanced international networking infrastructure in the world. It also provides and maintains a stable and dependable set of services on which a large and diverse end-user community can rely. The service portfolio offered by the network has been expanded from a basic IP service to encompass a quality of service offering which currently consists of four services provided on GÉANT: Premium IP, Best efforts, Less than best efforts and Multicast. In addition, IPv6 services have been fully implemented in GÉANT. This represents a major development in the services provided to Europe's research and education community.

GÉANT is the sixth generation of pan-European research network connecting European countries at backbone speeds of up to 10 Gbit/s. It continues to follow the trend established, that each successive generation of network exceeds the achievements and number of European countries involved compared with its predecessor. GÉANT continues to expand during its operational life, both in terms of the number of countries it connects and the capacity of its backbone and access links. In addition to connecting the existing 15 EU Member States, GÉANT now provides services to the 10 accession States due to join the EU in 2004, and to Croatia, Romania, Russia and Turkey. In total, the GÉANT backbone interconnects more than 3 500 research and education institutions in 33 countries through 29 national and regional research and education networks.

Since the beginning, GÉANT has been developing the range of services available on the network like the deployment of IPv6 services. A number of other service developments have been initiated, to provide IP quality of service, IP multicast and virtual private networking. Network performance measurement tools and network security have also been the focus of significant development.

Technical approach

The technical approach is to procure advanced transmission and routing components via competitive tender and to integrate them to create an advanced network. Having done this, a programme of development is being carried out using the infrastructure.

Project name:
GÉANT

Contract No:
IST-2000-26417

Project type:
RTD

Start date:
1 November 2000

Duration:
48 months

Total budget:
EUR 200 042 001

Funding from the EC:
EUR 80 000 000

Total effort in person-months:
48

Website:
http://www.dante.net/geant

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Project participants:

ACOnet	Austria
ARNES	Sweden
Belnet	Belgium
Cesnet	Czech Republic
CYNET	Cyprus
DANTE	United Kingdom
DFN-Verein	Germany
EENET	Estonia
FCCN	Portugal
GRNET	Greece
HEAnet	Ireland
Hungarnet	Hungary
IMCS LU	Latvia
INFN	Italy
IUCC	Iceland
KTU	Lithuania
MCYT	Spain
NORDUnet	Denmark
PSNC	Poland
Renater	France
Restena	Luxembourg
Roedunet	Romania
SANET	Slovenia
Surfnet	Netherlands
Switch	Sweden
Ukerna	United Kingdom
Unicom-B	Bulgaria
University of Malta	Malta

Keywords:
NRENs

Collaboration with other EC-funded projects:
Caesar
Comren
Serenate

Europe has an active presence in the development and testing of Internet technologies. This is particularly the case in the area of quality of service (QoS). It is also true for developments such as IPv6 and multicast. The management of services, across differing technologies and multiple management domains is a serious challenge. In the global Internet community, much work is also in progress on the investigation and development of technologies to support QoS features in IP networks, multicast developments and trials of IP over DWDM. Bandwidth reservation and allocation, and the management of end-to-end QoS across different technologies and management domains are also key areas that have been the focus of considerable investigation.

Test bed

Given the growing number, and the complexity, of the services being made available on GÉANT to NRENs, a multi-vendor test bed has been deployed, where new services like new routing protocols, quality of service, lambda networking or catering for specific communication needs of IST projects (e.g. 6NET, Aquila, Atrium, Moicane) can be tested and validated before they are made available on the production network.

Innovation

The innovative elements of the project continue to be acquiring, integrating and deploying the most advanced transmission systems, routing equipment and services available to create a network which remains at the forefront of research networking developments. GÉANT is committed to providing European researchers with a world class network.

Results

As research becomes increasingly international, GÉANT forms a core resource for an ever-expanding number of researchers whose demands on the network are constantly increasing, not only in terms of bandwidth requirements, but also for network services. These constantly expanding requirements demand that GÉANT remains committed to developing connectivity with equivalent research networks in other world regions. Connectivity has been strengthened with the existing equivalents of GÉANT in North America (Abilene, Canarie, ESnet) and in Asia-Pacific (TEIN and SINET). There are currently five circuits to other world regions, four of which are to North America. Three operate at 2.5 Gbit/s and there is an additional 10 Gbit/s connection which is not funded by GÉANT but which supports one 2.5 Gbit/s connection to Abilene and a further two 1 Gbit/s connections to Canarie. These four links dedicated to research and education purposes have been implemented in cooperation with North American research networks. A further 155 Mbit/s direct circuit to the Asia-Pacific region completes the picture in terms of GÉANT's global connectivity. Additionally, there is 2.5 Gbit/s connectivity to Japan available via the GÉANT North American links. International connectivity in GÉANT is achieved through a European distributed access, which provides a number of access points for connection with other world regions.

SPONGE

Silk project operations, networking and GÉANT extension

Abstract

The ancient Silk Road was not only a trade route but also an all-important road for the transfer of information and knowledge between major regions of the world. The Silk project is bringing cost-effective, global Internet connectivity to the research communities in the newly independent States (NIS) of the Caucasus and central Asia through state-of-the-art satellite technology, thus creating a virtual Silk information highway. The aim of the Silk project is to increase significantly the exchange of information with, and between, academic and educational institutions in these regions. Under the Sponge project we are providing complementary services needed to ensure that the Silk network operates well and gives maximum benefit to the NIS users.

Objectives

The NATO Science Committee has awarded a grant (Silk) for the provision of a VSAT-based network, which will provide GÉANT access to the NRENs of the newly independent States (NIS) of the southern Caucasus and central Asia. Additional grants provide for operating the VSAT hub, LAN equipment for connecting the NRENs and special tariffs for the satellite bandwidth. None of this may be spent on European staff. The Sponge project is a complementary initiative that will ensure a maximum benefit for NIS grantees; Sponge will provide overall management for Silk, infrastructure services needed (like documentation, a website and information services), and training help. Technical structures will provide performance information on the system, and mechanisms for optimal tuning. Under Sponge we will explore mechanisms for providing better person-to-person communication on an IP basis using the Silk network. The management structure provided under Sponge will enable the NIS NATO Silk grantees and the NGO funding bodies in the Silk countries, to make operational and upgrading decisions. Much of the technical information on which these decisions are made will come from the activities of Sponge. Finally, the organisational activities set up by Sponge should assist in attaining sustainable longer-term services.

That this complex network has been brought up within a relatively short time, and that other bodies are considering making further investment into the Silk network, are factors in a success story in their own right.

Technical approach

With a limited budget of USD 2.5 million over the period 2001–04 for this project, the Silk project has installed a VSAT system with the 5.6 m hub at DESY (Hamburg), and eight VSAT stations (2.4 m or 3.8 m) — one in each of the countries the southern Caucasus (comprising Armenia, Azerbaijan and Georgia), and central Asia (comprising Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). This size of deployment was required partially for political reasons, but the system design is such that the number of earth stations and of networks can be considerably increased. Moreover, we have also received from Cisco a generous donation of a router, switch and 155 GB content engine at each site, to tie in their NRENs, and DESY is providing the network operating centre free of charge. Our systems design seems to be paying off; several non-governmental organisations (NGOs) are proposing to make additional investments in the Silk system.

Sponge provides management, infrastructure services, measurement and personal communications for Silk. For project management, we have set up a Silk Board, and Executive Committee chaired by the Sponge project manager. The infrastructure services will include liaison with other projects. We have already established a website to disseminate information about Silk/Sponge, and have set up facilities for e-mail exploders, coordinating teleconferences, and organising relevant training sessions and workshops. To provide a sustainable system after 2004, our management structure will aim at the transition of a lot of management to eastern countries. The workshops are aimed at the transition of maximal operational know-how to eastern NRENs. The partnership of the groups in Armenia and

Project name:
Sponge

Contract No:
IST-2001-37580

Project type:
Accompanying measure

Start date:
1 October 2002

Duration:
30 months

Total budget:
EUR 261 473

Funding from the EC:
EUR 220 000

Total effort in person-months:
47.5

Website:
www.silkproject.org

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Project participants:

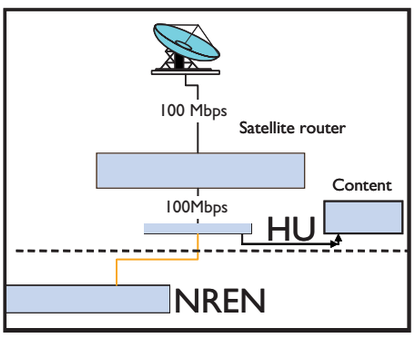
ARENA	Armenia
GRENA	Georgia
RUG	Netherlands
UCL	United Kingdom

Keywords:
International pilot network
Central Asia and Caucasus
Research network

Collaboration with other EC-funded projects:
Seeren

Georgia is specifically to build up local centres of enterprise. We are providing a financial structure that is attractive to NGOs and other aid agencies. For technical information we ensure that relevant statistics are gathered at the earth stations and routers. We are building monitoring facilities to derive operational performance data on many aspects of the system. We will gather data on the advantages gained from the content caches available at each earth station, and experiment with optimising the cache parameters in this environment. In Silk countries multi-party telephone calls and multimedia conferencing are unavailable. We will ensure voice/IP and multimedia conferencing between Sponge partners. Wider deployment to all Silk partners may require further investment.

Region covered by the Silk network



Equipment at each Silk node

Applications

Sponge has started various experiments to ensure that it is possible to carry out H.323 conferences and VoIP over the Silk network. Also some work is being done on tuning the cache parameters, to improve the throughput of the system.

Normal NREN applications are carried over the Silk network. However, in addition we are providing voice/IP and have started multimedia experiments.

Results

All eight remote sites have now been brought up; the remaining equipment problems are being resolved. The Silk Board has had three meetings, and the Executive Committee many teleconferences. Information about Silk and Sponge is available on the web at http://www.silkproject.org/. VoIP has been integrated with the Silk network and with the Cisco audio conferencing system. The Sponge partners have contributed to several workshops, and further ones are planned.

SEEREN

South-east European research and education networking

Abstract

The Seeren project aims at expanding European research networking in south-eastern Europe by providing connections between the national research and education networks in eligible countries (Seeren NRENs) and GÉANT, the pan-European research and education network. Its ultimate goal is to ease the 'digital divide' that still separates the region from the rest of the continent. To that end, the project promotes the cooperation of scientific and educational communities of EU Member States with south-east European countries and provides a platform for dissemination and development of next-generation Internet technologies in those States that are on course to joining the EU. The project involves the NRENs of, Albania, Bosnia-Herzegovina, Bulgaria, the former Yugoslav Republic of Macedonia, Greece, Hungary, Romania and Serbia and Montenegro (called regional NRENs). In addition, the pan-European research and academic networking bodies, DANTE and Terena, contribute to the European integration dimension of the project.

Seeren has contributed to the establishment and extension of a human network, which will boost the development, dissemination and utilisation of networking services and applications.

Seeren has stimulated the interest of the industrial world and the cooperation between the south-east European scientific community and European industry; relations have been established with international organisations that are actively involved in the region and additional funds which have been obtained, have contributed to the materialisation of the project.

Within the framework of the project, the first training workshop was held in February 2003, with the participation of representatives from the industrial world, aiming at providing the Seeren partners with technical know-how and technical vision.

Seeren established a communication channel among user groups with different characteristics and education needs, but with a common requirement: access to high-quality services that can support them in their research, learning and training endeavours.

The Seeren infrastructure can potentially be exploited for the development and use of grid technology, one of the major global research and development topics of this decade. It will pave the way towards the participation of the south-east European grid communities into the pan-European and worldwide grid efforts.

International projects, such as Seeren, involving EU, NAS and non-EU members of the extended European research area have a positive effect on strengthening the democracy and equity cause worldwide.

Objectives

- Interconnect the NRENs of south-eastern Europe to the major GÉANT points of presence (PoPs) in this area and thus to the pan-European research network.
- Create an e-science regional platform for south-eastern Europe, integrated to major European international initiatives.
- Ease the 'digital divide' that still separates most of the south-east European countries from the rest of the continent.
- Build awareness of IST in south-east European non-EU countries and serve as a paradigm for bridging the digital divide in other areas.
- Provide a platform for cooperation of scientific and educational communities of EU Member States with newly associated States (NAS) and third countries.
- Investigate additional sources of funding from the EC, from EU States' national funds and international organisations that are actively involved in the south-east European region, such as Unesco and NATO.

Technical approach

Based on SEE NREN connectivity requirements, market conditions, supplier capabilities and technical, operational and commercial requirements, all possible implementation approaches and topology options of GÉANT–Seeren interconnections were assessed.

The offers, which were received from the connectivity suppliers that had expressed interest, were evaluated technically and financially, and negotiations with them took

Project name:
Seeren — South-east European research and education networking

Contract No:
IST-2001-38830

Project type:
Accompanying measure

Start date:
1 December 2002

Duration:
18 months

Total budget:
EUR 1 297 481

Funding from the EC:
EUR 1 297 481

Total effort in person-months:
41

Website:
http://www.seeren.org

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Fax (30) 21 07 47 44 90
Mob. (30) 69 77 60 66 23

Project participants:

DANTE	United Kingdom
GRNET	Greece
Hungarnet	Hungary
Roedunet	Romania
Terena	Netherlands
AMREJ	Serbia and Montenegro
INIMA	Albania
ICTDA	Bulgaria
Marnet	former Yugoslav Republic of Macedonia
Biharnet	Bosnia and Herzegovina

Keywords:
International pilot network
South-east Europe
Research network
IPv6 backbone

Collaboration with other EC-funded projects:
GÉANT
EUMEDconnect
6NET
COM-REN

place. The Seeren consortium has proceeded to the selection of suppliers as well as the final topology of GÉANT — Seeren interconnection which will be implemented in October 2003.

GRNET, Hungarnet, RoEduNet, DANTE and Terena have key roles in the project; to ensure the success of Seeren and the wide applicability of its results to the research and education communities involved and indirectly to other important socioeconomic development aspects of the region (healthcare, industry, culture, tourism, trade and public administration).

Innovation

South-eastern Europe is not yet integrated, neither internally, nor to the European space at least for part of the region. With the implementation of Seeren, the academic and research communities of south-eastern Europe will acquire the means to assist in its integration into the European and international digital developments of the new-generation state-of-the-art Internet networks, as well as into the corresponding research-academic applications of the information society, such as tele-education, grid storage and computing in high energy physics, meteorology, biology, material science, seismological research, and so on.

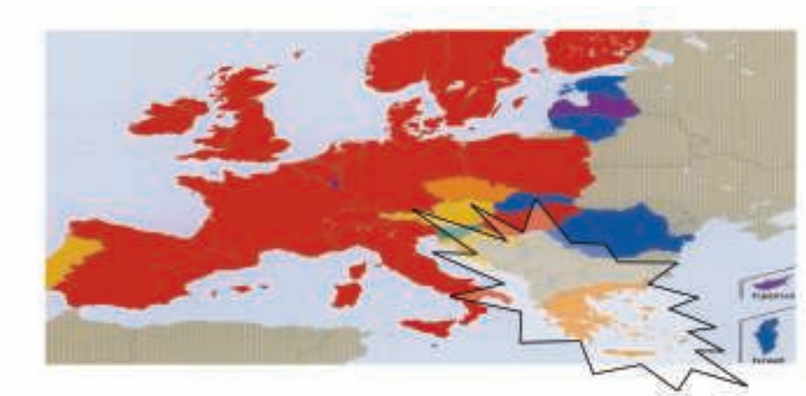
Results

The implementation of the Seeren infrastructure will greatly facilitate joint research and educational activities of the research and academic communities in the south-east European region, as an integral part of the European research and academic community, via connections to GÉANT and, through it, involve the region in research activities throughout the world (Internet2, Canarie, etc.).

Seeren will boost the creation and exploitation of a range of new services and best current practices to support research and education by offering facilities for collaboration and experimentation carried out as part of the sixth framework programme and other international programmes, including the deployment of native IPv6 to the desktop.

The Seeren project will act as a vehicle for the participating countries to become technology-competent. The know-how transfer concerning project management and implementation will be achieved by means of direct or electronic interaction in the region, complemented by joint RTD projects, relevant workshops and task force participation.

The project will have a positive effect in the area of 'brain-drain' prevention making the right information and knowledge resources accessible to the scholars both locally and globally.



The vision … to ease the digital divide in south-eastern Europe

EUMEDconnect

Abstract

The EUMEDconnect project was formulated in early 2001 through a series of advisory expert meetings hosted by the EC to address the challenges of increasing infrastructure for Internet-based research and education in the Mediterranean region. Developing this infrastructure forms a key element of the European Commission's EUMEDIS programme which supports the development of the Euro-Mediterranean information society. In turn, the EUMEDIS programme is part of the EC's MEDA programme which is implementing the conclusions of the 1995 Barcelona Euro-Mediterranean Conference to support the technological and societal development of the Mediterranean partner countries. The MED partner countries are Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Israel, Syria, Tunisia and Turkey.

Today there remains a significant and growing digital divide between the communities in the MED partner countries and Europe. Internet connectivity is still a relatively scarce resource in almost all these countries: only Cyprus, Israel, Malta and Turkey are connected to GÉANT, and there are virtually no direct connections between MED partner countries.

EUMEDconnect is a two-phase project developing an international Internet infrastructure to link the research networks in MED partner countries with GÉANT. Phase 1, completed in 2002, consisted of a range of technical, commercial, financial and organisational studies to test the practicality and identify the best approaches to achieve the Phase 2 objectives. Phase 2 intends to tender, implement and operate the network.

Regardless of the economic and political situation of some of the countries, all of the MED partners supported the initial phase of the project. With regard to the procurement phase and despite the fact that all MED partners, except Israel, were found to have a monopoly of national operators, the strong lobbying exercise helped to ensure their operators supported EUMEDconnect as a non-commercial project, offering significant price reductions during negotiations. The project has been signed by 11 countries and has assured connectivity to GÉANT by six of them by the end of 2003.

Objectives

EUMEDconnect is aiming to achieve the following objectives:

- to provide international connectivity that links the national research networks of MED partners to the GÉANT pan-European research network, and to other research networking accessible through GÉANT;
- to increase international research networking connectivity within the Mediterranean region;
- to provide international network services that assist other EUMEDIS pilot projects and promote increasing research and education collaboration with MED partners;
- to promote good practice in providing effective network services within each beneficiary country; and
- to ensure that the network services and international structures set up as part of the EUMEDconnect are sustainable beyond the end of the project in June 2006.

Technical approach

During the early stages of Phase 2, the project focused on the programme of activities to provide the connectivity, network equipment, network management and operations needed to develop the EUMEDconnect network. Connectivity has been tendered using negotiated

Project name:
EUMEDconnect Phase 1

Contract No:
EUMEDIS contract handled by the EuropeAid Coordination Office

Project type:
Phase 1: Grant
Phase 2: Grant and special fund

Start date:
Phase 1: 14 December 2001
Phase 2: 15 November 2002

Duration:
Phase 1: 9 months
Phase 2: 43 months

Total budget:
Phase 1: EUR 144 000
Phase 2: up to EUR 12 256 000

Funding from the EC:
Phase 1: EUR 115 000
Phase 2: up to EUR 9 805 000

Total effort in person-months:
Phase 1: 10
Phase 2: 139

Website:
www.eumedconnect.net

Contact person:
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Project participants:

Cerist	Algeria
CNRS	Lebanon
CYNET	Cyprus
DANTE	United Kingdom
EUN	Estonia
GARR	Italy
GRNET	Greece
HIAST	Syria
IUCC	Israel
Marwan	Malta
MTIT	Poland
NIC	Jordan
REDiris	Spain
Renater	France
RNRST	Tunisia
Ulakbim	Turkey
University	Malta of Malta

Keywords:
EUMEDconnect
EUMEDIS
MEDA
National research and education networks

Collaboration with other EC-funded projects:
ALICE
Comren
EUMEDIS pilot projects
GÉANT
Serenate

procedures to give maximum scope for negotiation with supplier and flexibility in determining the scale and topology of the infrastructure. The project has continued to involve the European and MED partners in Phase 2 to ensure that the results align with best national research network practice and meet the needs of the potential beneficiaries. As the project has progressed, plans have been prepared for operating the network and transferring technical know-how to the beneficiaries.

Applications

End-users in the MED partner countries and European research communities will benefit from this new data communications infrastructure and their work will profit from the possibilities of rapid information exchange. Through the collaboration with user groups the project will be able to demonstrate the wider usefulness for society in general.

Phase 1 results

Phase 1 concluded that it was justified to proceed with implementing the project and defined how the project should be developed to maximise the chances of achieving its objectives. Key results were as follows.

- The project was confirmed to be technically feasible and the network should be designed to allow capacities and the performance of the network to increase during and beyond the lifetime of the project.

- Despite limited fibre in the Mediterranean it was determined that there was sufficient capacity to achieve and provide some options for network topology.

- Apart from Israel, all MED partners were found to currently have a monopoly of national operators and needed to ensure their operators supported EUMEDconnect as a non-commercial project delivering significant national benefits.

- The project developed a model for allocating MED partners' shares of costs based on each partner's access capacity to, and hence benefit from, the network.

- The project was recommended to maintain the organisational approach that had worked successfully during Phase 1.

- All European and MED partners supported Phase 1 activities.

- First results were disseminated via brochures and presentations to national governments.

Phase 2 expected results

- The EUMEDconnect network procurement programme has remained on track despite the challenges of conducting it in the Mediterranean region.

- First contracts with service providers are expected to be awarded during late 2003, allowing the national research networks of the MED partners to connect to GÉANT from early 2004.

- The use by not only the national research networks but by EUMEDIS pilots will be encouraged. EUMEDconnect has the potential to accelerate the development of connectivity for international research within the Mediterranean region, with benefits for the wider economies and societies of the region. Its benefits could be extended into the wider communities with longer-term benefits for development and prosperity in the Mediterranean area.

America Latina Interconectada Con Europa

Abstract

The @LIS programme (http://europa.eu.int/comm/europeaid/projects/alis/index_en.htm) was launched by the EC in December 2001 to extend the benefits of the information society to all citizens of Latin America and to bridge the digital divide. To achieve these objectives, @LIS has opened the political and regulatory dialogue between Europe and Latin America and will fund a range of infrastructure application projects and technical support programmes. As its principal infrastructure project, @LIS will support the ALICE project which will carry out the recommendations brought forward by the Caesar study (March–August 2002).

The ALICE project will develop an IP research network infrastructure within the Latin American region and towards Europe.

Objectives

ALICE is aiming to achieve the following objectives:

- to create and consolidate a regional Latin American research network infrastructure which interconnects the research and education networks in Latin America;
- to operate and manage the Latin American research network infrastructure from Latin America;
- to directly interconnect the Latin American research network with the pan-European research network, GÉANT;
- to operate and manage the interconnection between the Latin American research network infrastructure and GÉANT jointly from Europe and Latin America;
- to closely cooperate between EU NRENs, Latin American partners and DANTE on all matters concerning ALICE;
- to provide the necessary infrastructure for the @LIS demonstration projects as well as for researchers and students involved in collaborative research between the two regions.

Technical approach

Connectivity has been tendered using negotiated procedures to give maximum scope for negotiation with supplier and flexibility in determining the scale and topology of the infrastructure. It is foreseen that the Latin American network will consist of one or two major rings inter-linking the more advanced NRENs in the region. All other NRENs in Latin America will have access links to the rings. The regional network will be built based on dedicated high capacity elements between the PoPs based in the Latin American countries and will use advanced traffic routing equipment to allow for high-speed Internet access. Wherever possible, the Latin American network will be built using fibre optical cable to achieve highest performance levels.

Applications

End-users in the Latin American and European research communities will benefit from this new data communications infrastructure and their work will profit from the possibilities of rapid information exchange. The project foresees to closely cooperate with the user communities in Latin America and Europe. During a preparatory meeting of the project, user groups working in research areas such as astronomy, radio astronomy, biodiversity, the el niño effect, virtual libraries and distance learning have been singled out as the areas with most common research interest between the two regions. Through the collaboration with user groups the project will be able to demonstrate the wider usefulness for society in general.

Project name:
ALICE

Contract No: ALA/2003/061/696

Project type:
Grant application

Start date: 2 June 2003

Duration: 36 months

Total budget: EUR 12 500 000

Funding from the EC:
EUR 10 000 000

Total effort in person-months:
208

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http://alice.dante.net/

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Project participants:

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Ragie	Guatemala
Arandu	Paraguay
Retina	Argentina
Crnet	Costa Rica
Unitec	Honduras
RAP	Peru
BolNet	Bolivia
RedUniv	Cuba
CUDI	Mexico
RAU	Uruguay
RNP	Brazil
REICyT	Ecuador
REUNA	Chile
Raices	El Salvador
RedCyT	Panama
Reacciun	Venezuela
DANTE	United Kingdom
Renater	France
GARR	Italy
FCCN	Portugal
RedIRIS	Spain

Keywords: ALICE, @LIS, national research and education networks

Collaboration with other EC-funded projects:
EUMEDconnect
Comren
@LIS pilot projects
GÉANT
Serenate
TEIN 2

Caesar results

The Caesar study has shown that, for most Latin American countries, there are well established research network infrastructures. This is the case for Argentina, Bolivia, Brazil, Chile, Costa Rica, Cuba, Mexico, Panama, Paraguay, Uruguay and Venezuela. In addition, in most of those countries that do not currently have a national research infrastructure, there are active plans for its development. It is very significant that there is considerable Latin American interest in cooperating with one another, and with Europe, to organise a coordinated approach to the establishment of connectivity between the two world regions. As part of the Caesar project, an extremely successful workshop was held in Toledo, Spain, between the project participants and 12 Latin American research networks. As a consequence of this initiative the Latin American networks are developing a cooperative model called CLARA (Co-operacion Latino-Americana de Redes Avanzadas).

Expected results

The project will improve the infrastructure available to participating Latin American partners for international research networking within Latin America and between Europe and Latin America, with the aim of fostering greater collaboration and cohesion between the regions. In addition it will provide a cost-effective platform for the @LIS demonstration projects.

There will be a strong component of knowledge transfer considering both the managerial and technical aspects of the project.

The tender for the network connectivity was conducted during summer 2003 and its results will specify the topology of the ALICE network. First service of the ALICE network is expected for early 2004.

Participants

ALICE is coordinated by DANTE and has the following partners in Europe: Renater, GARR, FCCN and RedIRIS, the NRENs of France, Italy, Portugal and Spain respectively, and in Latin America: Retina (Argentina), BolNet (Bolivia), RNP (Brazil), REUNA (Chile), Universidad de Cauca (Colombia), CRnet (Costa Rica), RedUniv (Cuba), REICyT (Ecuador), Raices (El Salvador), RAGIE (Guatemala), Unitec (Honduras), CUDI (Mexico), UNA (Nicaragua), RedCyT (Panama), Arandu (Paraguay), RAP (Peru), RAU (Uruguay) and Reacciun (Venezuela).

SERENATE

Study into European research and education networking as targeted by eEurope

Abstract

The Serenate studies have the broad aim of providing input to the European Commission on initiatives that could help to keep the evolution of European research networking at the forefront of worldwide development, and enhance the competitiveness of the European research area. The Serenate project contributes to achieving these policy goals by investigating the technical, organisational and financial aspects, the market conditions and the regulatory environment.

Objectives

The objective of the Serenate project is to provide important inputs to the development of policies by the European Commission, but also to national governments and funding bodies, the management of universities, and the national research and education networks. By the end of the project, Serenate will have produced a number of reports that will provide inputs to the policy-making of these actors in the field of European research and education networking.

While much of the history of European research networking over the past two decades was characterised by the need to keep up with developments in North America, currently Europe has a leading position in many aspects of networking. Using the opportunity of access to fibre on a much larger scale than before will give the entire European research networking infrastructure — including the trans-European, national and local levels — the possibility to offer not only much larger capacities but also new services that are of great importance for the most demanding users.

Technical approach

Serenate's working methods include desk research, case studies, interviews and workshops. The work is broken down into 14 interlinked work items, each looking into certain strategic aspects that are of crucial importance for the development of European research networks. A public report has been published or will be published on each of these work items.

Results

The Serenate studies have produced important insights into a number of strategic issues that are crucial to development of research and education networking in Europe.

Some of the most important findings include the following.

- Impressive achievements have been made in research networking in Europe over the past five years. Currently the networking requirements of users are rapidly increasing, in all countries in Europe and in all fields of research. At the same time, we see the appearance of different classes of users with widely varying needs. The most demanding researchers require very high capacity networks and end-to-end services. It is essential for the existing research networking organisations to cater for the needs of these most demanding user groups. This will require the introduction of new technologies and new organisational and funding models.
- There is a substantial and arguably increasing digital divide in Europe, which turns the political objective of equal opportunities for researchers throughout the European research area into an elusive goal. National governments and the European Commission will have to take radical actions to address the problem of the digital divide in European research and education networking.
- Although the implementation of the new regulatory package for telecommunications is delayed, in theory regulations in all Member States and accession States of the European Union are such that markets are truly liberalised. However, in practice, the situation leaves much to be desired in a number of countries, where there is no real competition and there are obstacles for alternative methods of infrastructure acquisition. This results in significant

Project name:
Serenate

Contract No:
IST-2001-34925

Project type:
Accompanying measure

Start date:
1 May 2002

Duration:
20 months

Total budget:
EUR 959 890

Funding from the EC:
EUR 959 890

Total effort in person-months:
58

Website:
http://www.serenate.org/

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DANTE	United Kingdom
ESF	France
Terena	Netherlands

Keywords:
Research networks
Strategy

Collaboration with other EC-funded projects:
Comren
GN1

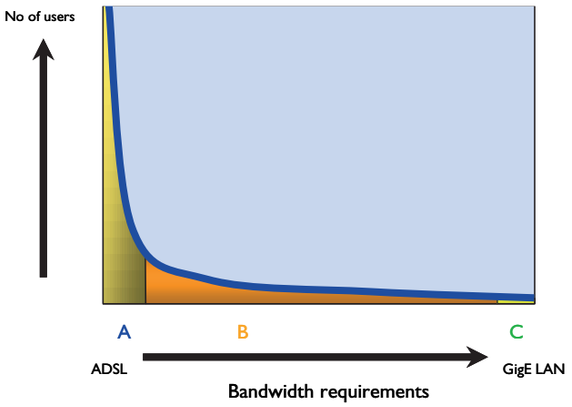
obstacles for the development of research and education networks. National governments, supported by the European Commission, should be more proactive in this field.

• During the lifetime of the Serenate project there have been sudden developments in the international telecommunications market with a high impact. A number of operators have unexpectedly left the marketplace, either temporarily or permanently. It is expected that it will take some time before markets are stable again. In the meantime, the period of revolutionary price decreases for international and national links has come to an end, and is not expected to return.

• The study into the characteristics and availability of equipment for next-generation networks has provided insights into what can and cannot be expected to become available over the next years, as well as some feeling for the costs involved.

• The points above make it possible, cost-effective, or even necessary, for research networks to get direct access to fibre, although probably not for all geographic locations and for all distances. There are various operational, managerial and financial forms of obtaining this access. The European research networking infrastructure of the near future will consist of a mix of different components with varying technologies and management characteristics. The plans for the next generation of networks at the European level (GÉANT), the national level and the campus level, will have to consider the many consequences of this development.

Serenate's final workshop (Bad Nauheim, June 2003)



A -> Lightweight users, browsing, mailing, home use

B -> Business applications, multicast, streaming, VPNs, mostly LAN

C -> Special scientific applications, computing, data grids, virtual presence

The emergence of different classes of users

COM-REN

Compendium of research and education networks

Abstract

The project promotes a better, more detailed understanding of national research and educational networks in all of Europe and the Mediterranean region, by producing and disseminating two issues of a compendium report and one focus study on a particular aspect of NREN work or on policy development regarding NRENs. The project also provides relevant benchmarking information.

Objectives

The objective is to provide inputs to the development of policies by the EC, but also to national governments and funding bodies and the national research and education networks.

Concrete objectives

- Promoting a better, more detailed understanding of NRENs in Europe and the Mediterranean region, by producing and disseminating two issues of the Terena compendium and one focus study on a particular aspect of NREN work.
- Providing information relevant for benchmark indicators.

Many NRENs, Commission officials and policy-makers are finding the compendium an extremely useful instrument for comparing research networking in different countries and for finding out about new ideas and approaches.

Technical approach

Questionnaires are sent to NRENs in which they are asked to provide information about a number of areas, including basic and organisational information, information on staffing and finance, user base, capacity, traffic, plans, services and research interests.

Innovation

The information that is gathered in the compendium has never been available before.

Results

Two issues of the compendium were produced. Detailed country information is available from the website (http://www.terena.nl/compendium).

Project name:
COM-REN

Contract No:
IST-2001-39056

Project type:
Accompanying measure

Start date:
1 July 2002

Duration:
18 months

Total budget:
EUR 199 557

Funding from the EC:
EUR 199 557

Total effort in person-months:
11.7

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http://www.terena.nl/compendium

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Project participants:
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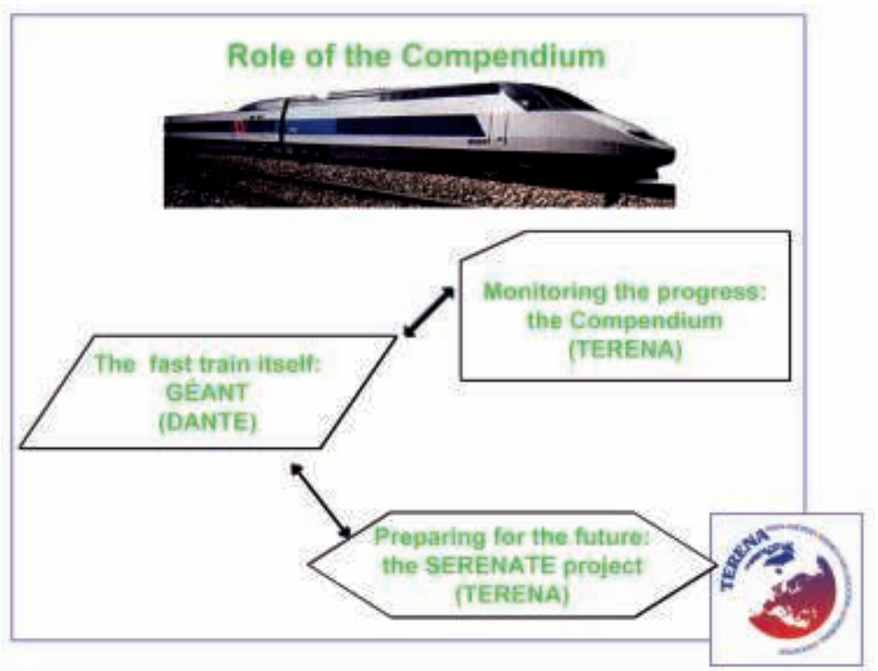
Keywords:
Research and education networking, NRENs, statistics, benchmarking

Collaboration with other EC-funded projects:
data from the compendium are being used for the Serenate and SIBIS projects.

Contribution to standards:
Compendium data were used in the final eEurope benchmarking report, COM(2002) 62 final, of February 2002.



IPv6 Task Force — Steering Committee

Abstract

The idea of the project is to support the introduction of IPv6 in Europe, to liaise with European industries and academia and with standards and Internet governance bodies on IPv6, as well as to collaborate with regional and international groups and initiatives deploying IPv6.

Objectives

The IPv6 Task Force (http://www.ipv6tf.org) was initiated by the European Commission with the support of key representatives from industry, academia and various consortia. Its main objective was to create recommendations in different sectors in order to foster the IPv6 deployment across Europe. In order to ensure the continuation of the task force work, this project, IPv6 Task Force Steering Committee (IPv6 TF-SC), has been established.

1. To perform all required actions aiming at the enhanced coordination and continuation of the work performed within the IPv6 Task Force second phase. The IPv6 TF-SC will set the agenda and with the assistance of the Commission invite participation of representatives of not yet represented economic and industrial sectors likely to be impacted by IPv6, including representatives of national or regional IPv6 councils and appropriate representatives from candidate countries.
2. The IPv6 Task Forces provides a regularly updated review and plan of action on the development and future perspectives of IPv6 in order to coordinate European efforts on IPv6. The IPv6 Task Force Steering Committee will monitor how the recommendations are implemented and remind those that need to take action where appropriate.
3. To create the proper working and liaison environment to ensure that a working collaboration with standards and Internet governance/policy bodies takes place.
4. To establish collaboration arrangements and working relationships with similar initiatives being launched in other world regions, industry and research.
5. To foster dissemination and awareness activities, regarding the IPv6 Task Force work, and other related efforts and initiatives, including the operation of the IPv6 Task Force and the project websites.

One of the main goals is to discover and fill gaps arising from the practical deployment of IPv6, provide strategic guidance with the assistance of a number of industry and academic players, to propose timely measures to the appropriate bodies, to involve the European Commission and to verify sustained activities and implementation of proposed measures.

Together with the newly established IPv6 Task Forces, the IPv6 TF-SC has addressed more than 300 European companies so far. Several high-level events were initiated and a dozen IPv6 events were attended, spreading the word about IPv6 in Europe. The European way towards IPv6 has gained significant recognition in the international Internet community through dozens of outreach activities of the project. The Task Force has been involved closely in the US DoD's decision to migrate to IPv6 and the IPv6 ready initiative. The project currently focuses on the initiation of one or two high-level events with large international outreach.

Technical approach

Ensure a working liaison with standards and Internet governance bodies such as the ISOC, IETF, ICANN, RIPE NCC, 3GPP, ETSI, IPv6 Forum, Eurescom, ETNO, UMTS Forum and GSM Europe.

Provide a regularly updated review and plan of action ('the European IPv6 roadmap') on the development and future perspectives of IPv6 in order to coordinate European efforts on IPv6.

Project name:
IPV6TF-SC

Contract No:
IST-2001-37583

Project type:
Thematic network

Start date:
1 October 2002

Duration:
18 months

Total budget:
EUR 249 961

Funding from the EC:
EUR 249 961

Total effort in person-months:
17.6

Website:
http://www.ipv6tf.org/

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LME	Sweden
Philips	Netherlands
Siemens	Germany
TSN	Germany
UOULU	Finland
UoS	United Kingdom

Keywords:
IPv6, Clusters, Thematic network

Collaboration with other EC-funded projects:
Geant, 6WINIT, 6NET, Euro6IX, NGN-Lab, 6LINK

Establish collaboration arrangements and working relationships with similar initiatives being launched in other world regions.

Key issues

From the perspective of this project, and considering the previous recommendations submitted to the EC, taking into account that these are subject to change as a matter of decision of the IPv6 Task Force second phase, the main goals of the IPv6 Task Force will be to:

- help educate the industry and disseminate information about IPv6;
- draw up an agreed roadmap for deployment of IPv6 in different industry sectors with the help of applicable scenarios where appropriate;
- promote the rollout of IPv6 products, e.g. IPv6 connectivity in consumer-electronic devices on a large scale by approximately 2005;
- encourage active contributions towards the acceleration and alignment of ongoing IPv6 work within standards and specifications bodies;
- make proposals, where appropriate, for IPv6 work activities needed in future EC framework programmes.

Results

The project will facilitate, support and coordinate the continuation of the work of the IPv6 Task Force, with the renewed mandate of a second phase, with the means of a Steering Committee, consisting of IPv6 experienced experts. This will facilitate the successful introduction of IPv6 in Europe and consequently the rest of the world.

International collaboration with the Japanese IPv6 Promotion Council, the North American IPv6 Task Force and IPv6 Task Force organisations in South Korea, China and India have been established. The project has participated through its members in various standards bodies (3GPP, DVB, etc.) and industry consortia (UMTS-Forum, PLC-Forum, Grid-Forum, DVB-Forum, etc.). Various reports (such as 'Current barriers to IPv6 deployment') have been written and are the subject of continued analysis.

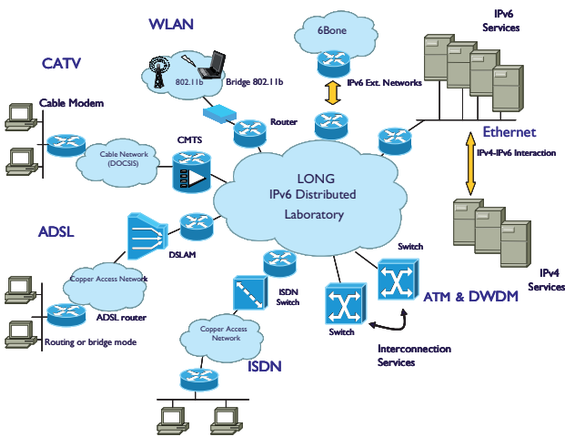
Laboratories over next-generation networks

Abstract

Along the life of the project, December 1999 to January 2003, LONG has aimed to foresee and solve problems related to the design and deployment of next-generation networks and advanced user applications. The project has been focused on IPv6 study and testing, since it was expected to become a key point of next-generation networks when the proposal was launched.

Objectives

The main objectives of LONG were: (a) to deploy a next-generation test bed where IPv6 can be studied and tested over different access and transport technologies; (b) to study and test basic and advanced network services in order to validate their integration in the stable network/test bed; (c) to address basic and advanced user services/applications allocated in the network with the focus on distributed services and collaborative work tools; (d) to study and test IPv4–IPv6 transition mechanisms to incorporate transition scenarios solutions in the test bed.



LONG distributed IPv6 test bed platform

Technical approach

LONG R & D activities, tests and developments have been oriented to the creation of a real IPv6 distributed test bed. The test bed features, functionalities, services and applications have been evolving during project life as other activities were providing stable results or guidelines.

Finally, this stable test bed has been used to perform distributed tests and large public trials to increase results dissemination and collaborate with other projects and researchers.

LONG has realised a large set of experiences over its test bed and other public and R & D networks. These experiences are well documented in the documents available in the website. One of these worldwide dimension events was the simultaneous connection of many IPv4 and IPv6 sites/auditoriums, in an interactive manner (not only video/audio distribution), in the context of the event 'Madrid 2002 global IPv6 summit'.

The project included technical activities studying IPv6 from the lowest logic layer (IPv6 over access and transport technologies), going through intermediate layers (network basic and advanced services such as BGP4+ routing, DNS, Multicast, Mobility, QoS, IPv4–IPv6 transition) and highest conceptual layer (basic and advanced IPv6 user applications browsers, mail, chat, news, online games and collaborative work applications).

Project name:
LONG: Laboratories over next-generation networks

Contract No:
IST-1999-20393

Project type:
RTD

Start date:
1 December 2000

Duration:
26 months

Total budget:
EUR 2 082 910

Funding from the EC:
EUR 1 073 077

Total effort in person-months:
233.3

Website:
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TED	Denmark
Telefónica I+D	Spain
UC3M	Spain
UEV	Portugal
UPC	Spain
UPM	Spain

Keywords:
IPv6
Network services
Transition mechanisms
CSCW applications

Collaboration with other EC-funded projects:
6NET
Euro6IX

Test bed

One of the main goals of the LONG test bed has been the practical usage done by project members. This means that the network was not only used to perform distributed testing but as a real way of communication. For instance, the IPv6 chat system was used when setting up all public events, because it was the best way to organise such complex events (telephone and e-mail were not so efficient when adjusting the configuration of remote platforms and auditoriums).

The test bed was physically made by linking all partner IPv6 laboratories using, in most cases IPv6 over IPv4 tunnels although some links were IPv6 native (IPv6 over ATM mainly).

Having this infrastructure stabilised, and thanks to the basic network services, the LONG test bed could be conceptually seen as a single 'IPv6 distributed lab' where most layer-two technologies were tested and where application servers and clients could interact from one partner premises to others.

Experiments

A wide range of experiments have been performed in the LONG project, basically: IPv6 transport over xDSL, CATV, WLAN, PSTN/ISDN, ATM, FR & DWDM; IPv6 support, stability, performance and interoperability in various OS (Linux, Windows, FreeBSD) and routers (Cisco, Telebit); network services (DNS, RIPNG, BGP4+, Mobility, Multicast and QoS) and user services (Multivideoconference, online gaming, chat, news, etc.).

IPv4–IPv6 transition mechanisms were installed also in the test bed to allow IPv4 access to LONG IPv6 services.

Applications

The LONG project has generated a lot of useful applications for the R & D community, the most important one is the porting to IPv6 of Isabel CSCW application which was not only ported by UPM and tested by all partners but used for project tele-meetings and to distribute and interact in public events with remote auditoriums in Europe, the USA and Asia-Pacific areas.

Innovation

The innovation point of the LONG project was to create a distributed IPv6 laboratory including advanced networking services testing and advanced end-user applications.

Regarding the advanced applications, the focus was put on the collaborative applications where multi-videoconferencing, document sharing and events distribution was performed.

Results and contribution to standards

The project has generated great results, namely: the test bed testing and configuration guidelines, the IPv6 working version of Isabel and other applications and the document 'Programming guidelines on transition to IPv6' that was proposed as a base document in the IPv6 Forum/Technical Directorate by the person in charge.

A lot of experiences when configuring large trials and public events have produced a good set of conclusions and thoughts. It is remarkable that, thanks to the usage of Isabel for some meetings, the project saved more than EUR 20 000 in travel costs.

The document that best summarises and indexes LONG project results, guidelines and 'how-tos' is D1.4, 'Final summary of conclusions and guidelines' which can be obtained at the IPv4–IPv6 website.

6WINIT

IPv6 wireless Internet initiative

Abstract

The 6WINIT project investigated the problems in introducing a range of IPv6-enabled applications over an IPv6-enabled wireless Internet. It covered the areas of end-stations, routers, gateways, generic technologies and applications — with specific emphasis on following the IPv6-related standards emerging in the IETF. Thus mobile IP, road warrior technology, quality of service, agent technology, interworking across WLAN, GPRS and UMTS, and security were of particular concern. Generic applications investigated included conferencing, voice over IP, video streaming, location-based services and home environments. There was specific emphasis on clinical applications, where secure mobile access was demonstrated to clinical data and radiographic images, and emergency treatment from ambulances for accident and emergency. Most of the work was in the context of wireless LANs, since the access to and functionality of GPRS were very limited and the access to UMTS test facilities was provided only at the project end; nevertheless, experiments were carried out both with GPRS and UMTS test facilities.

Objectives

The principal objective of the 6WINIT project was to validate the introduction of a new mobile wireless Internet in Europe — based on a combination of the new Internet protocol version 6 and the new wireless protocols used in WLAN, GPRS and UMTS/3GPP networks.

Technical approach

The basic network components used in the project were a combination of IPv6 and wireless networks. The project provided an insight into the problems in deploying real applications in the emerging IPv6-enabled wireless-enabled Internet; WLAN, GPRS and UMTS test cells were used as wireless networks. We carried through complete systems pilots, and identified what components are inadequate in the applications, network facilities, major components and middleware. The project concentrated on mobile and wireless aspects of the system, but it also linked into the existing IPv6 wired infrastructures provided under the 6NET and Euro6IX projects. The technical approach was to take applications from other activities, which were expected to gain from the mobile IPv6 environment. These applications, which were mainly selected from the clinical healthcare, multimedia conferencing and streaming, in- and outdoor navigation and home control domains, were ported to work over IPv6. This way we ensured that all the requisite technology was available to allow them to work in a wireless-enabled IPv6 environment. Consequently we were also working on IPv6-enabled components: routers, relays, hand-helds, IPv4 to IPv6 transition mechanisms and other software components required by the applications. Because of the limited capability of the GPRS network, some of the traffic had to be run, in that case, in IPv6–IPv4 encapsulation.

As a result of this work, an excellent set of IPv6-enabled components and applications became available to show both that IPv6 was becoming a viable technology, and that wireless-based IPv6 applications could be built. Specifics of the results are being incorporated into the products of the 6WINIT partners; examples are the router components. Others are being used to be the core of new business ventures; an example is the GANS system. Yet others are being used to persuade the regulatory authorities to allow the systems to be used in the hospital environment with real patients; an example is the database access system. Of particular importance is that the wealth of IPv6 applications developed are an important input to two large IPv6 deployment projects 6NET and Euro6IX, and have provided important inputs to many new projects.

The applications developed in the project (6VOICE, GANS, streaming, etc.) are being used in multiple follow-on projects for further features

Experiments

We carried out many experiments with GPRS, UMTS and WLAN networks — together with the appropriate applications. For example, our work with

Project name:
6WINIT — IPv6 wireless internet initiative

Contract No:
IST-2000-25153

Project type:
RTD

Start date:
1 January 2001

Duration:
25 months

Total budget:
EUR 6 018 800

Funding from the EC:
EUR 3 492 000

Total effort in person-months:
550

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ETRI	South Korea
IABG	Germany
RUS	Germany
T-NOVA	Germany
TED	Denmark
Telscom	Switzerland
TZI	Germany
UCL	United Kingdom
UKT	Germany
UMM	Poland
UoS	United Kingdom
VTT	Finland

Keywords:
IPv6, wireless, applications, test beds and mobile.

Collaboration with other EC-funded projects:
6INIT
6LINK
6NET
Android
NGNI
WINE

Research Infrastructure

GPRS showed that the latency was both much too long for interactive conferencing, had much too much short-term variation in its value, and much too low a bandwidth. Other experiments showed that it was possible to use PDAs with the wireless connectivity for getting reasonable resolution of cardiac images. Another showed that in our hospital settings, the WLAN radiation had no discernable impact on the clinical instrumentation — though some of the instrumentation had occasional impact on the WLAN operation (e.g. during MMR scans or anti-coagulator action). We also investigated the precision we could obtain on location sensing indoors, using WLAN technology, and on the rate of hand-offs achievable with the WLAN. Finally we showed that one could have fast multi-access hand-over between the UMTS test-cell and WLAN.

Applications

A wide variety of IPv6-enabled applications were pursued — infrastructure (e.g. mobile IP, road warrior, etc.), generic (e.g. voice over IPv6, media streaming, secure remote control of the home environment, etc.) and clinical (e.g. access to clinical databases, consultation with moving ambulances, etc.).

Results

Our results are fully reported on the 6WINIT website (http://www.6winit.org/). However, a significant number of components and features are expected to be developed further — often in a commercial setting (e.g. the guardian angel system, router components for mobile IP, high-quality streaming, etc.).

Innovation

Many of these results are highly innovative. Simulated ambulance professionals communicate via a mobile terminal, capable of providing voice, video and data on body parameters from a patient like electro-cardiograms and blood pressure. They communicate via both a UMTS test cell and a wireless LAN with other professionals in a simulated hospital. The communication uses mobile IP and simultaneous multi-access, with secured data transmission based on a public key infrastructure.

Contribution to standards

During the course of this work there were many contributions to the standards for mobile IP, simultaneous multi-access, IP security, SIP, multimedia transport and IPv6–IPv4 transition. Almost all these contributions were made to the Internet engineering task force.

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UMM/John Paul II Hospital test bed.

Large-scale international IPv6 pilot network

Abstract

6NET is a three-year European project to demonstrate that continued growth of the Internet can be met using new IPv6 technology. It also aims to help European research and industry play a leading role in defining and developing the next generation of networking technologies.

Objectives

The main objective of the project was to install and operate a pan-European pilot IPv6 network with both static and mobile components in order to gain a better understanding of IPv6 deployment issues.

It also allows migration strategies for integrating IPv6 networks with existing IPv4 infrastructure to be tested, as the two technologies will need to co-exist for several years.

A network also requires services and applications in order to be useful, so the project is porting existing software to work with IPv6. In conjunction with this, it is investigating how legacy software can operate on IPv6 infrastructure.

Last but not least, the project aims to collaborate with other IPv6 activities such as Euro6IX and 6LINK, and contribute to standardisation bodies such as the IETF (Internet engineering task force). It also sees itself playing an important role in promoting IPv6 technology at both the national and international level.

Technical approach

6NET is comprised of several work areas that focus on various aspects of IPv6 technology.

- 6NET built and operates the native IPv6 network infrastructure (including addressing and naming schemes, routing architecture and peering policy). 6NET runs the NOC (Network Operations Centre), and facilitates interconnection with other IPv6 networks (e.g. Euro6IX, Abilene in the USA and KOREN in South Korea). The partners in 6NET carefully assessed interworking and migration issues that allow for the smooth change from IPv4 to IPv6 at all levels of networking (backbone, regional and campus).

- The provision of basic network services on top of IPv6 is key for the success of the new Internet protocol. Partners in 6NET design, implement and test IPv6-enabled network services such as routing (both inter-domain and intra-domain), DNS, DHCP, registry procedures, quality-of-service and multicasting. Additionally, network management issues like configuration, fault reporting and security issues related to IPv6, as well as the development of appropriate management tools have been addressed. The new features introduced in IPv6, such as mobility, autoconfiguration, multihoming and renumbering are fully exploited as well.

The 6NET network has demonstrated that IPv6 is deployable in a production environment with the same functionality as IPv4. Not only does it solve the shortage of addresses, but it also promises a number of enhanced features which are not an integral part of IPv4. The GÉANT network has already moved to dual-stack operation, and other NRENs are planning to do so shortly. The 6NET network itself has been used to provide IPv6 connectivity to a number of worldwide events.

The experience gained during the project is also being turned into 'cookbooks' aimed at network administrators. Cookbooks on migrating backbone and campus networks from IPv4 to IPv6, and network management have already been published, and others are currently being produced.

Test bed

During 2002, a backbone IPv6 network connecting 15 countries and running at 155 Mbps was installed and tested. Local access is being provided through national IPv6 test beds operated by partner NRENs such as JANET (United Kingdom), Renater (France) and SWITCH

Project name: 6NET
Contract No: IST-2001-32603
Project type: RTD
Start date: January 2002
Duration: 36 months
Total budget: EUR 18 413 128
Funding from the EC: EUR 10 323 824
Total effort in person-months: 1 093.5
Website: http://www.6net.org

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Project participants:

ACOnet	Austria
Cesnet	Czech Republic
Cisco	Netherlands
CSC	Finland
CTI	Greece
Dante	United Kingdom
DFN	Germany
DTU	Denmark
ETRI	South Korea
FhG-Fokus	Germany
GRnet	Greece
Hungarnet	Hungary
IBM	France
INFN-GARR	Italy
INRIA	France
Invenia	Norway
NORDUnet	Denmark
NTT-Com	Japan
Oulu Poly	Finland
PSNC	Poland
Renater	France
Sony	Germany
SURFnet	Netherlands
Switch	Switzerland
TELIN	Netherlands
Terena	Netherlands
UCL	United Kingdom
Ukerna	United Kingdom
ULANC	United Kingdom
ULB	Belgium
ULP	France
Univ. of Oulu	Finland
Uninett	Norway
UoS	United Kingdom
WWU	Germany

Keywords:
IPv6
International pilot network
Network services
Applications

Collaboration with other EC-funded projects:
6LINK
6WINIT
Euro6IX
GÉANT
NGN-I
NGN-Lab

(Switzerland). Connectivity to the non-European 6NET partners in Japan and South Korea is provided via the UK6X Internet exchange and Renater respectively.

The 6NET backbone also has connections to Abilene in the United States (via SURFnet), Euro6IX (via the UK6X) and to the 6Bone (which is a virtual network). GÉANT is connected as well, and provides the remaining European NRENs with links to 6NET.

Innovation

6NET aims to encourage the adoption of IPv6 by resolving the two major hurdles that are considered to be hindering its widespread acceptance. These are to demonstrate that IPv6 is fully functional and stable, and to demonstrate that IPv6 offers distinct advantages over IPv4.

The project is working on the new features of IPv6 such as mobility, self-configuration, IPsec (security) and classes of service, with respect to how they might be used, and to identify which elements are missing. The aim is to make these extra features available as quickly as possible, in order to provide an added incentive for people to move to IPv6.

Results

A pan-European IPv6 backbone network has been established and basic routing (using IS-IS and BGP4+), tunneling (IPv6 over IPv4) and DNS support has been set up and tested. A multicast overlay network (M6Bone) has been established, and is being used for conferencing and radio broadcasting (e.g. Norwegian State radio). IPv6 has also been successfully tested over MPLS, ATM and WLAN-based networks, whilst IPv4/IPv6 dual-stack operation has been implemented as a production service on the GÉANT network.

A great deal of experience has been gained with transitional issues. Components important to widespread IPv6 deployment such as DHCPv6, autoconfiguration, multihoming, renumbering and mobile IPv6 have been evaluated, and feedback provided to the developers.

A core set of applications to develop or port to IPv6 have been identified in the categories of videoconferencing and streaming (e.g. GnomeMeeting, Isabel and FreeAMP), online gaming (e.g. Quake and XPilot), e-business solutions (e.g. Globus and OpenLDAP) and edge services (e.g. proxy caching). Some of these are already available, and others will become available towards the end of 2003. In addition, several IPv6 traffic measurement and visualisation tools have been released (e.g. NetSNMP and Smokeping).

The project has organised two informational workshops and several training events on IPv6.

Contribution to standards

6NET actively contributes to the IETF, particularly to the IPv6, v6ops (formerly ngtrans) and multi6 working groups. Indeed, one of the 6NET participants is a co-chair of v6ops.

A number of Internet drafts have been submitted in the areas of site local addressing, multicasting, 6to4 security, SNMP over IPv6, application porting, 3GPP and DNSSEC. These are areas which were previously poorly defined, and 6NET has been able to provide input based on its operational experiences.

6NET has also contributed to the IEEE (Institute of Electrical and Electronics Engineers) in the areas of IPv6 transition and mobile source-specific multicasting. In addition, it regularly provides updates to RIPE (Réseaux IP Européens), a collaborative forum of European ISPs.

EURO6IX

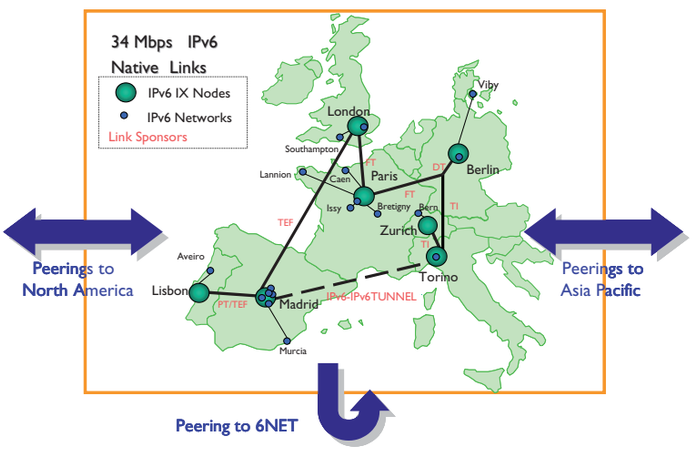
European IPv6 Internet exchanges backbone

Abstract

The goal of the Euro6IX project is to contribute, support and play a key role in the introduction of IPv6 in Europe. One of the main tasks is the research, design and deployment of a native pan-European IPv6 network — the **Euro6IX test bed —** which can be considered as a complete test bed of the future Internet IPv6 since it includes most Internet elements (external peerings, international backbone of IPv6 dedicated links, IXs, leaf nodes) and actors (operators/ISPs, R & D organisations, network consultants, vendors, beta-tester users).

Objectives

The main objectives of Euro6IX are: (a) to design and deploy a test bed where several regional IPv6 Internet exchange points (IPv6 IXs) across Europe get connected; (b) to use this IPv6 IX infrastructure to research, test and validate IPv6-based advanced new applications and services (networking oriented like mobility, security, etc. and end-user oriented like P2P, streaming tools, etc.); (c) to investigate how current IXs can be improved with new functionalities and new backbone models; (d) to introduce beta-testers who will generate the necessary traffic and usage to have a real environment of IPv6 networking; (e) to disseminate, liaise and coordinate with other projects or initiatives as well as to research the legal implications related to privacy concerns about IPv6 addressing.



In May 2003, Euro6IX performed a successful public trial in parallel with the Madrid 2003 IPv6 summit. Many IPv6 demonstrations of Euro6IX and other IPv6 projects were shown thanks to the infrastructure and connectivity provided by the project and the event organisation.

The list of demonstrations included:

- IPv6 mobile in PDAs/WiFi;
- IPv6 radios and TV-multicast;
- Magalia management IPv6 NOCs;
- PKI v6, Smart Card and IPv6 DNSSEC and VPNs.

This and other convincing demos encouraged some operators to move to IPv6 (e.g. France Telecom)

Technical approach

Two relevant IXs and backbone models have been studied and are tested in Euro6IX. In **Model B**, each IX has its own addressing space and ASN. The main functionalities implemented are: regional ISPs Layer 2 peering and transit services (operator NAP). This is the model currently deployed as a working solution. In **Model C**, the Layer 3 mediation function router appears. This element allows the testing of RFC 2374, where a customer may change its service provider without changing its addressing space (also easier multihoming).

Project name:
Euro6IX

Contract No:
IST-2001-32161

Project type:
RTD

Start date:
1 January 2002

Duration:
36 months

Total budget:
EUR 15 527 711

Funding from the EC:
EUR 7 697 308

Total effort in person-months:
1 299

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Project participants:

6WIND	France
Airtel	Spain
BT	United Kingdom
Consulintel	Spain
EandA	Spain
Eurocontrol	International organisation
FT RD	France
NGN	Spain
PTIN	Portugal
T-Nova	Germany
TED	Denmark
Telscom	Switzerland
TID	Spain
TILAB	Italy
UMU	Spain
UoS	United Kingdom
UPM	Spain

Keywords:
IPv6
IX
Mobility

Collaboration with other EC-funded projects:
6NET
6WINIT
GÉANT
LONG
MIND
NGNLAB

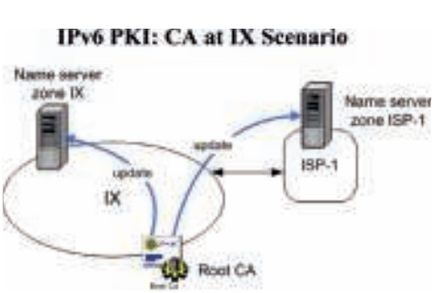
Experiments

Euro6IX includes concrete experiments in internal and public trials as well as continuous experimentation of stable infrastructures and IPv6 services. As an example of a continuous experiment, all telecommunications companies have agreed a routing policy in the backbone (RPv0.4) which enables Euro6IX IXs to share peerings and policies only with other Euro6IX IXs. Another good example of continuous experiments is that beta-tester users are now being included to interact with an initial set of IPv6 stable services. These stable services in all partner premises are listed and updated in the project website.

Regarding concrete trials, Euro6IX performs SIP-based multi-videoconferences involving more than 10 sites as well as concrete tests of multicast (connection to the M6Bone), QoS (a plan for these tests is being prepared), security, mobility, transition, and so on.

Innovation

Key innovative lines are: IX functionalities and backbone policies (RPv0.4), IX multicast services (M6Bone, TV), macro/micro-mobility, SIP signalling (Isabel), shared management functionality in Magalia, DNSSEC and VPNs based in PKIv6, and so forth.



Results and contribution to standards

Many results, guidelines, softwares and current trials are detailed in the IPv4/IPv6 website of the project (http://www.euro6ix.org). Among other results, the following can be found on this site: security guidelines of IPv6 networks (IXs, ISPs, local sites), porting guidelines (document initiated in LONG project and now maintained in Euro6IX), MRTG and free radius IPv6 portings, IPv6 IDS (intrusion detection system), P2P file-sharing tool, Looking Glass, Tunnel Broker, instant messaging tool.

6QM

IPv6 quality of service measurement

Abstract

The project 6QM is devoted to research and development of measurement technologies for quality of service in IPv6 networks. It will create a comprehensive system integrating the various required functions for QoS measurement, such as packet capturing, precise time-stamping, data collection, QoS metrics derivation (delay, loss, jitter, etc.) and result presentation. In order to achieve this goal, requirements for QoS measurements in the future IPv6 networks are analysed and a flexible architecture is proposed including local components for non-intrusive capturing of measurement data and server components collecting the relevant information for further processing. Interfaces and suitable protocols are identified. The project will align with existing standard approaches, and will propose extensions and input to standardisation in problem areas, where enhancements are still required. The developed components will be integrated and locally tested. For gaining wider usage experiences and feedback, the 6QM project will set up cooperation with other IST projects working on IPv6 issues. In particular, there will be liaisons with the two pan-European native IPv6 networks (Euro6IX and 6NET), to serve as major test beds for the validation of the 6QM system. The liaison and the cooperation between 6QM and these projects will allow the study of the impact of the characteristics of the IPv6 networks on the design of measurement tools (probes) and on the specification of the measures (metrics, collection techniques, processing methods). As part of the expected result from the 6QM project, a knowledge base and a set of guidelines will be created, which may be exploited by operators and ISPs to meet the client demand in IPv6 advanced services with guaranteed and differentiated QoS.

The project will have a significant impact on operators' networks (such as France Telecom, partner of the project) as it will ensure that the services provided to the end-users will match the subscribed contract (SLA).

Also, this project will create a synergy between operators (such as France Telecom) and telecommunication infrastructure equipment manufacturers (such as Hitachi, also partner of the project) in order to ensure that end-user needs will be taken as an input for equipment design.

Finally, through standardisation activities, the project outputs will profit the whole telecommunication community.

Objectives

The project will develop a comprehensive approach towards IPv6 QoS measurement. In order to achieve this goal, the project has defined the following objectives.

1. Development of a measurement device for IPv6. The measurement device inserts precise (micro-second order) timestamp information when it captures the IPv6 packet. Each device has a time synchronisation functionality, by GPS, or any other equivalent mechanism, if widely available.
2. Development of a measurement server. The measurement server collects the captured IPv6 packet. It thereby provides not only usage data but also QoS metrics (delay, loss, jitter, etc.) for IPv6 traffic by analysing the collected information through the measurement device.
3. Integration and local test of the developed components, for the further trial and evaluation of the developed system, at least in European IPv6 infrastructures.
4. Generation of a set of guidelines for the possible application and further research of the IPv6 QoS measurement in different scenarios.
5. Dissemination and liaison with other related fora and projects, in order to publicise the project results.

Technical approach

In order to meet the objectives of the project, the following work packages have been defined:

- WP1 (management and coordination);

Project name:
6QM

Contract No:
IST-2001-37611

Project type:
RTD

Start date:
1 September 2002

Duration:
34 months

Total budget:
EUR 2 322 696

Funding from the EC:
EUR 964 860

Total effort in person-months:
143

Website:
http://www.6qm.org

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Project participants:

Consulintel	Spain
FHG	Germany
FT	France
HEL	France
HIT	Japan

Keywords:
IPv6
QoS
traffic measurement

Collaboration with other EC-funded projects:
6NET
Euro6IX
6LINK

- WP2 (requirement study for IPv6 QoS measurement) as a prerequisite for achieving the project objectives in real large-scale scenarios, and outputs for guidelines;
- WP3 (development of IPv6 measurement technology) to address the development of the measurement device and server, and generation of final guidelines;
- WP4 (system integration, testing, and evaluation);
- WP5 (dissemination, liaison and interconnection).

Structure of IP measurement

Innovation

The number of experimental projects for IPv6 networks is radically increasing on a worldwide scale. These projects have been proving the effectiveness of the IPv6 protocol. Moreover, several kinds of applications using IPv6 networks have been proposed, and major applications using IPv6 networks are video-conferencing and game-on-the-net using real-time and peer-to-peer communication. These applications require high throughput, low delay and less data loss. Therefore, the guarantee of QoS will be quite an important issue for IPv6 operations support systems (OSS).

By relating the measured data and network configuration, the network manager can identify the specific network device that should be intensively monitored to avoid network problems. By relating the data from configuration systems with the data from IP measurement servers, the basic information for identifying the rest of the network capacity can be expected. Based on this information, the configuration system can find the best route for establishing new end-to-end paths. Moreover, based on these data, the network operator can forecast the time when the network capacity should be increased. The major applications of IPv6 networks will require the QoS to each end-to-end path.

Therefore, to complete technologies for QoS guaranteeing network operation and management, not only the QoS control technique but also the measurement technologies for IPv6 should be developed.

Results

During the 56th IETF (March 2003) 6QM partners participated actively in the relevant working group sessions. During the RMON session, 6QM partners presented the need of protocol identifiers for configuring measures in active and passive IPv6 and SUB IP points of measures. 6QM partners will propose a draft on this topic.

6QM partners have two other potential inputs into IETF that are inter-related. The first proposes that the definition of spatial metrics become an IPPM WG item, and the second is a solution for measuring the delay per segment in IPFIX.

The role of 6QM is to promote the dissemination of what is lacking in this area.

The ability to build a shared IPv6 QoS measurement system providing the basis for peering European agreement should be a good point to leverage the proposals made in 6QM.

EUROV6

Abstract

Eurov6, the 'European IPv6 showcase' project is in line with the current policy of the European Commission, which has recognised the growing importance of IPv6 and has made it a policy to adopt IPv6 for next-generation networks.

In this context, Eurov6 builds IPv6 applications and services showcases by bringing together devices and systems from vendors as sponsors. The showcases are set up in a few permanent locations in Europe, and a 'mobile' or 'nomadic' version has also been developed, so that it can be easily implemented at various locations.

Objectives

The generic objective of Eurov6 is to show the usage of IPv6 products and services and their impact to anyone at any time. Realising this objective involves:

- bringing together vendors as sponsors to test and demonstrate their devices and systems;
- showing various user applications based on IPv6 products and services, permanently at a few locations in Europe ('fixed showcase'), which can be visited physically or accessed remotely through telematic means;
- organising temporary demonstrations at different locations and/or significant events (concept of 'nomadic showcase').

An example of a Eurov6 'nomadic showcase' event

Technical approach

Eurov6 is developing a number of demonstration facilities or 'showcases', both fixed and mobile, for IPv6 products, applications and services.

Test bed

Three fixed test beds or showcases are available in Eurov6:

- Consulintel in Madrid, Spain
- Telscom (MCLab) in Basle, Switzerland

Project name:
Eurov6

Contract No:
IST-2001-38200

Project type:
RTD

Start date:
1 July 2002

Duration:
24 months

Total budget:
EUR 645 165

Funding from the EC:
EUR 442 691

Total effort in person-months:
48

Website:
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Project participants:

Consulintel	Spain
Ericsson	Sweden
Telscom	Switzerland
VUB	Belgium
ULB	Belgium

Keywords:
IPv6,
next-generation networks,
demonstration,
dissemination, interoperability,
interworking

Collaboration with other EC-funded projects:
6LINK
6NET
6POWER
Euro6IX
GÉANT
IPv6TF-SC
NGN-Lab

- ULB/VUB (EuroDemo) in Brussels, Belgium

A number of mobile test beds or 'nomadic showcases' have been realised during the course of the project, linked to various events, including:

- Zürich: Launch of the Swiss IPv6 Task Force
- Madrid: Global IPv6 summit
- Brussels: Belgian IPv6 event and ETSI IPv6 plugtests

Applications

ping, traceroute, vic, rat, Isabel, DNS, DiffServ, voice over IP, home automation, streaming video, mobile IP, etc.

Innovation

Eurov6 is at the forefront of the deployment of IPv6 products, applications and services in Europe, in close relation with similar activities in the United States and other regions of the world, particularly in Asia (China, Japan, South Korea, Taiwan, etc.).

Next-generation network laboratories

Abstract

The project establishes a platform for the development of advanced Internet technologies, by provisioning the required system infrastructure and interactive applications, to realise next-generation network-related experiments.

Objectives

Provision of a test platform for next-generation networks:

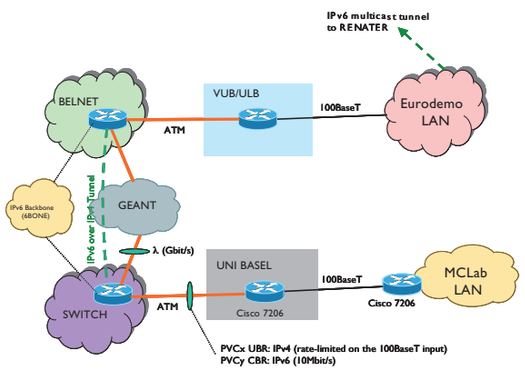
- main topics addressed are: IPv6 and QoS;
- additional topics: mobility, access networks, interworking and interoperability, multimedia.

Support of IST and national research projects for testing their systems:

- applications and test equipment provision;
- GÉANT link to two test beds in Basle (Switzerland) and Brussels (Belgium).

Figure

NGN-Lab IPv6 connectivity between Brussels (EuroDemo) and Basle (MCLab)



Technical approach

NGN-Lab is making advanced networking infrastructure available in two interconnected test beds, to support IST projects to test new technologies such as IP telephony, video streaming and multicast, IP over GSM/GPRS, and so on.

During the last year, the project team has focused its main efforts on issues related to QoS, NSIS (next step in signalling) and DiffServ, as well as to the promotion of the flow label definition as an Internet draft. Overlaps with other EU-funded projects in this area of work were avoided.

Test bed

Two test beds in NGN-Lab: Basle (MCLab) and Brussels (EuroDemo):

- multiple networking technologies, fixed and mobile;
- PCs, laptops, palmtops and advanced mobile phones;

Project name:
NGN-Lab

Contract No:
IST-2000-26041

Project type:
RTD

Start date:
1 January 2001

Duration:
36 months

Total budget:
EUR 1 772 167

Funding from the EC:
EUR 818 633

Total effort in person-months:
132

Website:
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Project participants:

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Dimension data	Belgium
MCLab	Switzerland
NEC	Germany
ResCom	Ireland
Telscom	Switzerland
VUB	Belgium
ULB	Belgium

Keywords:
Interoperability
Interworking
IPv6
Next-generation networks
QoS

Collaboration with other EC-funded projects:
6NET
6WINIT
Aquila
Cadenus
GÉANT
Moebius
Sequin
Tequila
Torrent

- LANs and WLANs;
- ADSL and GSM/GPRS;
- Bluetooth, IrDA;
- IPv6 implemented and tested;
- DiffServ environment available;
- connectivity to GÉANT;
- multiple IPv6 applications.

In both test beds, IPv6 applications are installed on:

- Windows (various versions);
- Linux (Suse, RedHat, Debian);
- FreeBSD 4.4.

Applications

Some of the applications relate to: ping, traceroute, vic, rat, quake, DNS, DiffServ, voice over IP, home automation, streaming video, etc.

Innovation

NGN-Lab is liaising with other national and international test beds and forums to promote the next-generation networks infrastructure for provisioning end-to-end services.

NGN-Lab has also worked on the IPv6 flow label specification and proposed a way to route packets depending on values stored in the flow label field. This work has led to an implementation, but no Internet draft has been issued yet.

The project is active at the IETF especially in the NSIS working group. They have issued documents that were accepted by the working group as working group items, which is the first step to produce standards.

Dissemination

NGN-Lab has achieved very positive results in the area of dissemination, such as the organisation of the next ETSI plugtest.

The project team has also concentrated their efforts in the promotion of IPv6 to a wider, non-technical audience.

IPv6 projects linkage cluster

Abstract

The 6LINK project aims to unite IPv6 projects across the IST programme and beyond, and to bring representatives from identified projects together in a series of meetings. These meetings serve to foster a common view of the status of IPv6 development and deployment in Europe and elsewhere, and permit the identification of the most important issues for IPv6 deployment in Europe. The project seeks to identify common issues and promote shared understanding amongst all participants, and to disseminate this work to as wide an audience as possible. Dissemination vehicles include an annual publication of reports compiled by members of the 6LINK consortium. In addition, the 6LINK project has established an IPv6 web portal which serves as a repository for the outputs of 6LINK as well as providing an important source of up-to-date and detailed information about IPv6-enabled applications and IPv6 standards.

Objectives

The three objectives of 6LINK are consensus-building, dissemination and exploitation. 6LINK brings representatives of IPv6-related IST projects together to identify common experiences and to share knowledge and understanding of the state-of-the-art with regards to IPv6 development and deployment in Europe. Dissemination builds upon the consensus and understanding generated by the first objective and seeks to promulgate the agreements and analyses arrived at by the partners to as wide an audience as possible. The third objective is concerned with capitalising on the synergies, by providing support to participants developing inputs to standards bodies, and by presenting 6LINK participants' submissions at standards meetings. The intention is to bring focus and clarity to the development and deployment of IPv6 in Europe, and beyond, in the hope that this will hasten its widespread adoption as the internetworking protocol of choice, and thereby give European industry and society an important advantage in the global information society.

Two publications, *IPv6 research and development in Europe* and *Moving to IPv6 in Europe*, have been published. These publications represent a shared understanding of the state of IPv6 development and deployment in Europe which has been fostered by the 6LINK project. These publications have been very widely distributed to literally thousands of interested people at various international events. In addition, the most recent 6LINK sponsored meeting of the IPv6 cluster was held during the IPv6 summit in Madrid and attracted an audience of nearly 300 people.

Technical approach

The core of the consensus-building work is a series of meetings, held at least every four months throughout the project, at which partners present and discuss the latest developments, both within the represented projects, and from the global IPv6 community. A global perspective is achieved by including standards development reports as regular inputs to these meetings.

The project has established an online resource centre (http://www.ist-ipv6.org), which provides public access to 6LINK reports, IPv6-related IST news and other developments. Books addressing subjects of interest and importance to the IPv6 technology community are freely available for download from the website, while hard copies are distributed by project partners at conferences, meetings and other events.

The 6LINK project seeks to identify opportunities for common trials across projects, to draw further benefit from the work being done in IST projects, and to build on contacts and partnerships forged at 6LINK meetings. The research and development work being undertaken by the cluster projects is showcased in several exhibitions.

Project name:
6LINK

Contract No:
IST-2001-34056

Project type:
Accompanying measure

Start date:
1 March 2002

Duration:
36 months

Total budget:
EUR 1 017 805

Funding from the EC:
EUR 805 000

Total effort in person-months:
67.3

Website:
http://www.6link.org

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Project participants:

BT	United Kingdom
Consulintel	Spain
CRM	France
DANTE	United Kingdom
Telscom	Switzerland
Terena	Netherlands
T-Nova	Germany
UC3M	Spain
UCL	United Kingdom
UoS	United Kingdom
UPM	Spain

Keywords:
Cluster
IPv6

Collaboration with other EC-funded projects:
6NET
6WINIT
Android
Euro6IX
GCAP
GÉANT
LONG
MIND
MobyDick
NGNLab

Innovation

6LINK provides the first forum for dissemination of developments in the commercial, academic and standards arenas that is focused exclusively on IPv6 technologies. Prior to the 6LINK project, collaboration and discussion between projects took place informally. 6LINK provides a formal, funded framework for such collaboration, and sets clear objectives for the participants in terms of deliverables. 6LINK serves to identify and document the important issues for IPv6 development and deployment in Europe.

Results

6LINK is fostering an improved understanding throughout the IST community of the most important issues for IPv6 development and deployment. 6LINK also serves to heighten awareness of the status of IPv6-related standards development, and helps to promote the standards work of participant organisations within the relevant standards bodies.

Contribution to standards

The 6LINK project has produced very detailed reports detailing the status of IPv6 technology standardisation. These reports are largely based on the proceedings of IETF meetings, but also include relevant developments in RIR policy and other standards bodies, for example, 3GPP. These reports have been warmly received by the community.

Research and technological development for an international data grid

Abstract

The aim of the European DataGrid (EDG) project is to open up a new world of scientific exploration, by providing software solutions for distributed computation and analysis of large-scale databases. The next generation of scientific exploration requires intensive computation and analysis of shared large-scale data sets across widely distributed scientific communities. EDG addresses this problem by building on emerging grid technologies, developing the components essential for the implementation of a large-scale data and computational grid. Very encouraging results have already been achieved in terms of the major goals of the project, which are the demonstration of the practical use of computational and data grids by the high energy physics, bio-informatics and earth observation communities. A production quality test bed has been set up at a number of EDG sites, which provides a set of common shared services and tools available to all authorised users. A number of virtual organisations have been defined for the various research groups involved in the project, and very useful feedback has been collected when scientific applications have been run to measure the performance of the test bed while producing real science. Although a lot of work remains to be done, the validity of the grid concept and operation has been demonstrated, providing a solid base for the future grid infrastructure deployment programme in Europe.

The European DataGrid project has already achieved many of the goals stated at the time of the project conception three years ago. A production quality distributed computing environment has been demonstrated by the EDG test bed, which will now be enriched in functionality, further improved in reliability and extended both geographically and in terms of aggregate CPU power and storage capacity. The community of users has already successfully validated the use of a large set of applications, ranging from high energy physics to bio-informatics and earth observation. EDG software will be used on the large-scale production facility that is being set up for the analysis of data that will be produced by the new CERN accelerator LHC. More developments are currently ongoing to extend the range of functionality covered by the middleware. Collaboration has been established via the GridStart initiative with the other 10 existing EU-funded grid projects. In particular, the EU CrossGrid project will exploit DataGrid technologies to support a variety of applications, all demanding guaranteed quality of service. Collaboration with similar grid projects in the United States is being pursued in collaboration with the sister project, EU DataTAG.

Objectives

The objective of the DataGrid project is to support advanced scientific research within a grid environment, offering capabilities for intensive computation and analysis of shared large-scale data sets, from hundreds of terabytes to petabytes, across widely distributed scientific communities. Such requirements are emerging in many scientific disciplines, including physics, biology, and earth sciences.

Project name:
DataGrid

Contract No: IST-2000-25182

Project type: RTD

Start date: 1 January 2001

Duration: 39 months

Total budget: EUR 12 822 960

Funding from the EC:
EUR 9 227 506

Total effort in person-months:
3 907

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http://eu-datagrid.web.cern.ch/eu-datagrid/

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Project participants:

CEA	France
CERN	International organisation
Cesnet	Czech Republic
CNR	Italy
CNRS	France
CS SI	France
Datamat	Italy
ESA-ESRIN	International organisation
EVG HEI UNI	Germany
FOM	Netherlands
IBM	United Kingdom
IFAE	Spain
INFN	Italy
ITC-IRST	Italy
KNMI	Netherlands
MTA-SZTAKI	Hungary
NFR	Sweden
PPARC	United Kingdom
SARA	Netherlands
UH	South Korea
VR	Sweden
ZIB	Germany

Keywords:
Information processing
Information systems
Scientific research
Telecommunication

Collaboration with other EC-funded projects:
CrossGrid
Damien
DataTAG
Eurogrid
GÉANT
GridStart

Test bed

This first test bed deployment was achieved towards the end of 2001 when the first release of the EDG software was deployed and successfully validated. The project was congratulated 'for exceeding expectations' by the reviewers on 1 March 2002, during the first official EU review. The second test bed deployment was successfully performed at the beginning of 2003. At the time of the 2003 European Union review there were 12 sites participating in the production test bed (see figure), and since then the number has roughly doubled including one site in the United States and one in Taiwan.

The test bed provides significant computing and storage resources to a community of approximately 500 users from 13 different virtual organisations. A separate development test bed addresses the need for rapid testing and prototyping of the EDG middleware. The reference site for the EDG collaboration is at CERN, where, before any official version of the middleware is released, the initial testing of the software is performed and the main functionalities are proven before distribution.

Applications

The past year has seen significant achievements in the use of EDG middleware by the user communities involved in the project. To make well focused evaluations of the performance of the various releases of the software, EDG/experiment task forces were set up at CERN with high energy physics experiments such as ATALS and CMS. The work of the task forces helped the development and reconfiguration of the existing series 1 middleware, prior to moving to EDG 2 in August 2003. Representatives of the HEP experiments have also been working together with representatives from bio-informatics and earth observation, the other scientific fields supported by DataGrid. The main goal is to identify, detail and prepare specific applications to test the DataGrid services. For earth observation, the main objective is to provide processing power to allow data mining and systematic processing of long time series of data, such as the atmospheric ozone data coming from the ERS GOME satellite instruments. In the biomedical field, 10 applications have been developed which cover a wide range of possible uses for the EDG middleware, from the analysis of 3D structure of proteins in biology to mammograms analysis in medicine.

Application test bed for European grid computing

Abstract

The project develops the interconnection of complex heterogeneous high performance computing (HPC) systems in a cross-organisational and cross-domain manner. It has extended its scope even further to the active and wide-scale outreach and cooperation with other related European grid projects. Eurogrid established trans-European grids for important application areas using Unicore as a base middleware. The Eurogrid partners are leading European HPC centres, application developers and user organisations from research and industry. Application domains are biology, meteorology and engineering. Functional extensions are being developed in the areas of failsafe file transfer, dynamic resource discovery and brokering, application coupling, ASP services and interactive access.

Objectives

The objectives of the project are:

- to establish a European grid network of leading high performance computing centres from different European countries;
- to operate and support the Eurogrid software infrastructure. The Eurogrid software will use the existing Internet network and will offer seamless and secure access for Eurogrid users;
- to develop important grid software components and to integrate them into Eurogrid (fast file transfer, resource broker, interface for coupled applications and interactive access);
- to demonstrate distributed simulation codes from different application areas (biomolecular simulations, weather prediction, coupled CAE simulations, structural analysis, real-time data processing);
- to contribute to the international grid development and to liaise with the leading international grid projects;
- to produce the Eurogrid software components. After project end the Eurogrid software will be available as a support product.

Technical approach

In Eurogrid the concept of grid computing is applied to specific application domains and user scenarios:

- Bio-grid for bio-molecular applications and scientific users;
- Meteo-grid for meteorological applications and scientific/general users;
- CAE-grid for engineering applications and engineers as users;
- HPC research grid for traditional HPC applications and scientific users.

In addition, horizontal technologies and grid middleware components useful across application domains will be developed (efficient data transfer, resource brokerage, ASP services, application coupling, interactive access). These new components are integrated into the base grid system and are evaluated in the HPC-grid test bed.

The Eurogrid project has integrated exact accounting and billing with a dynamic resource broker. This, for the first time, enables users of application service providers to identify a supplier that best matches their quality of service requirements and budget, transparently route the end-user requests and the associated input data there, execute the application in a secure sandbox with exact accounting of system and software resources (e.g. licences) used, and receive the results and an itemised bill. The Unicore/Eurogrid grid system served as the integration platform, and the results have been demonstrated on a trans-European grid test bed.

Applications

In the Bio-grid activity, Eurogrid develops intuitive user interfaces for selected bio-molecular pack-

Project name:
Eurogrid

Contract No:
IST-1999-20247

Project type:
RTD

Start date:
1 November 2000

Duration:
36 months

Total budget:
EUR 3 446 497

Funding from the EC:
EUR 2 065 769

Total effort in person-months:
392

Website:
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Project participants:

AM CCR	France
CNRS	France
DSH	Germany
DWD	Germany
ETH	Switzerland
Fecit	United Kingdom
FZ Juelich	Germany
ICM	Poland
Pallas	Germany
UIB	Norway
UOM	United Kingdom

Keywords:
Computational grid
High performance computing
Seamless access
Unicore

Collaboration with other EC-funded projects:
Damien
DataGrid
GÉANT
GridStart
GRIP

ages, and compatibility interfaces between these applications and their databases. The result is an integrated bio-molecular toolkit that allows streamlined work processes, and a job execution component that makes all systems in the Bio-grid available for simulation runs with a uniform and intuitive user interface.

For many uses, precise meso- or microscale weather predictions are required: agriculture, pollution prediction, traffic and public event planning depend on precise localised weather data. To accommodate these users, a flexible framework for on-demand localised weather prediction is being developed in Eurogrid by the German weather service.

The coupling of several CAE codes, each one simulating different aspects of a system's behaviour, is emerging as a key technology to accelerate design and construction of complex systems, reducing prototyping and testing time and costs. A general mechanism for the coupling of simulation packages is integrated in the Eurogrid system, and its use is demonstrated with real-world applications from EADS CCR.

Many industrial companies, in particular small and medium-sized enterprises, lack in-house access to sufficiently powerful HPC systems, yet are increasingly depending on CAE systems and simulation packages. For them, the application service provider (ASP) scheme offers an attractive solution: instead of having to buy and maintain HPC systems and the necessary software licences, an external provider of computing power runs their jobs and bills them according to the system time actually used. Within Eurogrid, T-Systems integrates ASP-specific functions and demonstrates an ASP system for the leading CAE packages on top of Eurogrid.

Innovation

Grid computing is a new way to provide and access computer resources via Internet. Eurogrid lowers the thresholds for users to use high performance computing resources. Hardware and software is available 'on demand', HPC becomes affordable because only the actual usage is paid for and no experts need to be involved. The provision of such 'on-demand' services will be a new business of HPC centres and software vendors. Eurogrid will make several applications available under this model. Furthermore, Eurogrid is designed and implemented to support both Internet and intranet use, in particular for the CAE grid. This capability will be a key factor in the industrial uptake.

Eurogrid starts from an existing grid system (Unicore) and develops new innovative components in the areas of efficient data transfer mechanisms, resource brokerage, coupled applications, interactive access and computational steering.

Results

Eurogrid has achieved results in three areas.

1. Set-up of test beds

An infrastructure for several application-specific test beds has been set up among the participating HPC centres. The Eurogrid Certificate Authority at the University of Manchester has been established to support the Eurogrid/Unicore security concept.

2. Development of plug-ins

Graphical interfaces for seamless job creation, submission, job monitoring have been developed for important applications like Gaussian98, Amber, PDB, LM, LS-DYNA, ACTI3S.

Plug-ins were also developed for general functions like 'list all jobs', file filter, billing, code coupling, etc.

3. New components for Unicore

- An efficient file transfer between Eurogrid sites based on GridFTP was implemented.
- A resource broker was developed which brokers jobs based on resource requests.
- To support ASP models a software accounting system was implemented.
- As an extension to the batch-oriented job submission model a secure interactive access to remote sites is provided (execution of pre-defined commands or interactive access to jobs running in batch mode).

Distributed applications and middleware for industrial use of European networks

Abstract

The Damien project aims at designing middleware to support a particular kind of distributed application, known as a close-coupled application, and at assessing the middleware using industrial applications across the European GÉANT network. The project started in early 2001 and finished in October 2003. It continued the successful work of the European pilot project for grid computing, Metodis. The latter has shown successfully the feasibility of the grid approach in industry. The objective of Damien is to develop further building blocks for a middleware environment for distributed industrial simulation and visualisation in the grid. Besides the multi-protocol MPI-library PACX-MPI for heterogeneous networks, this includes the handling of quality of service requirements in distributed simulations. The coupling code interface MpCCI allows the linking of distributed applications. Tools for performance analysis (Vampir) and performance prediction (Dimemas) offer extended grid awareness. Applications from industry serve as test cases for the developed software.

Objectives

The purpose of Damien is to respond to the emerging infrastructure of computational resources connected by high-speed networks which is generally described as the grid. Damien aims at developing a middleware toolbox which allows application developers to port their applications to computational grids as well as to ease the handling of distributed computing environments. The toolbox is developed by extending existing tools. The second goal of the project is then to test these tools by industrial applications on a test bed based on European and national high-speed networks.

Technical approach

A central part of the Damien architecture are standards used by industry (i.e. the message-passing standard MPI), and libraries and tools, which the users of high performance computing facilities are familiar with. Based on these already existing tools (Dimemas, MpCCI, PACX-MPI, Vampir), Damien defines the necessary extensions to support grid computing environments creating a software development environment for grid computing. The extensions can be split basically into three parts:

- integration of an additional communication layer that has to be introduced to reflect the characteristics of distributed environments;
- integration of quality-of-service handling into the tools for enabling a flexible network resource management;
- ease of the usage of the distributed tools and distributed environments.

During the Damien project a tool-set for distributed grid environments was developed, which is based on widely accepted tools and libraries from the area of high performance computing, and supports the end-user during the development phase of applications and the execution of production runs.

Currently, the Damien solution is being used at EADS CCR to solve multi-physics problems during the development and design phase of the new Airbus cockpit. This will help to reduce development costs which have an important influence on final product costs.

The exploitation of the tools has commenced. For instance, the improvements in PACX-MPI achieved during the project helped to popularise the library. In fact, it is deployed in other IST grid projects (Coregrid and GridLab).

Test bed

The toolbox developed in the frame of the Damien project is being validated on a test bed based on the European high-speed networks between the three research centres of the project (CEPBA, Crihan, HLRS). The usability of the tools has also been demonstrated on a test bed of HPC resources distributed worldwide for the HPC challenge at SuperComputing 2002 in Baltimore.

Project name:
Damien

Contract No:
IST-2000-25406

Project type:
RTD

Start date:
1 January 2001

Duration:
34 months

Total budget:
EUR 1 885 166

Funding from the EC:
EUR 1 229 348

Total effort in person-months:
198

Website:
http://www.hlrs.de/organisation/pds/projects/damien/

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Project participants:

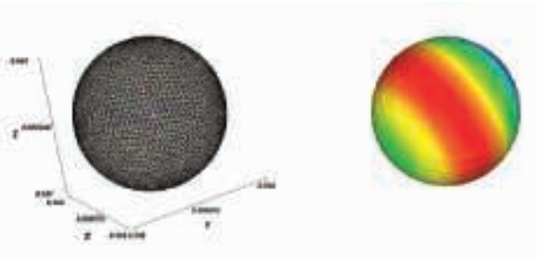
HLRS	Germany
EADS CCR	France
CEPBA-UPC	Spain
CRIHAN	France
Pallas GmbH	Germany

Keywords:
Distributed tools
Grid computing
Industrial applications
MPI

Collaboration with other EC-funded projects:
GridStart
Gridlab.

Application

EADS CCR provides a multi-physics application. The application is a new strongly coupled method for vibro-acoustic simulation, which can be used, for example, to simulate the propagation of noise during the launch phase of rockets or for noise-reduction simulations inside aeroplane cabins. Due to a high number of entities in the company and their geographical distribution all over Europe, this project validates grid computing as a solution for industrial users.



Innovation

Two major innovations are achieved within the Damien project. First, the project provides the first development environment for end-users including standards, libraries and tools, which they are used to dealing with in their regular working environment. Tools like Vampir, Dimemas and MpCCI, are highly accepted in the area of parallel computing, and are now also available in grid environments.

The second major innovation in the project is the integration of the quality of service module into the communication software as well as into the tools. Since the performance of grid applications is strongly influenced by the network between different machines, the management of the network resources is a key issue for grid environments and their applications.

Results

The tools developed in the project have been successfully used to run and verify the industrial application on the test bed installed at EADS CCR.

Research and technological development for a transatlantic grid

Abstract

The main idea behind the DataTAG project was to strengthen the collaboration between Globus middleware-based grid projects in Europe and in the USA. We provide a common dedicated test bed, in order to facilitate the deployment of a 'transparent' grid infrastructure. It gives access to the massively distributed computing infrastructure that is needed to meet the challenges of modern high energy physics experiments such as the data-intensive LHC (large hadron collider at CERN) applications. Consequently, the DataTAG project has addressed the issues which arise in the sectors of high performance inter-grid and interoperability between the grid middleware layers such as information and security services. The advances made have been disseminated into each of the associated grid projects.

Following the upgrade of the DataTAG circuit to 10 Gb/s in September 2003, the first ever transatlantic test bed with 10 gigabit Ethernet access capabilities became available, just in time for live demonstrations at Telecom World 2003 where CERN had a booth on the Lake Geneva region stand. Thanks to this, a new 5.44 Gb/s single stream TCP/IP data transfer record between CERN and Starlight was established by Caltech and CERN on 1 October 2003, and considerable publicity was given to this very significant technical feat by numerous media around the world. Indeed, ultra high-speed data transfer will enable downloading of CDs, DVDs, complex images, and so on, in seconds rather than minutes or hours which, in turn, will pave the way to new innovative applications.

Objectives

The goal is to create a large-scale multi-vendor transatlantic test bed for data-intensive grids. Together with the European DataGrid project and other related grid projects in the USA such as GriPhyN, iVDGL and PPDG, this will allow the exploration of advanced networking technologies as well as interoperability issues between different grid domains.

Technical approach

The grid interoperability issues have been addressed by INFN in collaboration with DataGrid and the Globus team through the definition of a new interoperable schema for describing grid resources such as computing, storage and network elements. The networking issues have been addressed by procuring a dedicated 2.5 Gbps (Phase 1) then 10 Gbps (Phase 2) circuit between CERN in Geneva and the StarLight Internet exchange located at the Northwestern University in Chicago.

Simplified view of the DataTAG project showing the EC project partners as well as the main cooperating networks on both sides of the Atlantic

Project name:
DataTAG

Contract No:
IST-2001-32459

Project type:
RTD

Start date:
1 January 2001

Duration:
24 months

Total budget:
EUR 4 105 196

Funding from the EC:
EUR 3 980 826

Total effort in person-months:
525

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http://www.datatag.org

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Project participants:

CERN	International organisation
INFN	Italy
INRIA	France
PPARC	United Kingdom
UVA-NWI	Netherlands

Keywords:
Grid
Networks
Scientific research
Telecommunications

Collaboration with other EC-funded projects:
CrossGrid
DataGrid
GÉANT
GridStart

Test bed

The transatlantic DataTAG test bed is based on equipment and circuits funded jointly by the European Commission, the US National Science Foundation (NSF) through the electronic visualisation lab (EVL) at the University of Illinois at Chicago (UIC), and the US Department of Energy (DoE) through the California Institute of Technology (Caltech).

The DataTAG multi-vendor layer 2 (Ethernet) and layer 3 (Internet) test bed with equipment from mainly Alcatel, Cisco and Juniper connected to high-end Linux servers at 1 gigabit as well as 10 gigabit Ethernet is believed to be unique. The main use of this test bed has been for advanced network research and demonstrations focusing, in particular, on very high-speed transport protocols, QoS and advance bandwidth reservation techniques. Access to the test bed for experimental purposes is made possible in Europe through GÉANT/DANTE and the national research and education networks involved using transparent VPN layer 2 tunnels, as well as through a 10 Gbps circuit from Amsterdam contributed by Surfnet and a 2.5 Gbps circuit to Lyon contributed by the French VTHD pilot network. The DataTAG test bed is open to other EC grid projects as well as to other network research projects in the field of high performance transport protocols, on a case-by-case basis.

Experiments

Together with Surfnet that also operates a similar transatlantic circuit, the project pioneered Ethernet over SONET/SDH transport networks, in other words, next-generation G.709 networks (digital wrapper).

Applications

Together with DataGrid and the LHC computing grid project, the software of the CERN LHC experiments, ALICE, ATLAS CMS and LHCb have been adapted to the grid environment.

Innovation

The DataTAG project has many innovative components in the area of high performance transport, QoS, advance bandwidth reservation, EU–US grid interoperability and new tools for easing the management of virtual organisations such as the virtual organisation membership server (VOMS) and grid monitoring (GridICE).

Results

Thanks to the excellent cooperative spirit between the European and US teams involved in DataTAG, remarkable results have been achieved in a very short while. Regarding high performance transport, new Internet2 landspeed records for both IPv4 and IPv6 have been established and TCP/IP stacks variants such as FAST, Scalable TCP and high-speed TCP have been extensively tested.

Regarding EU–US grid interoperability, the grid laboratory universal environment (GLUE) activity led to the definition of common/interoperable information specifications to be used for resource discovery.

The GLUE schema has been subsequently incorporated in the Globus and DataGrid middleware.

The WorldGrid demonstrations made at the IST 2002 and SC 2002 conferences and featuring cross-job submission between the USA and EU with GLUE-enhanced EDG and Globus middleware on both sides of the Atlantic marked a very significant milestone towards the interoperability of EU and US grid projects such as DataGrid, GriPhyN, iVDGL and PPDG.

Contribution to standards

DataTAG is heavily involved in GGF activities with presence in the steering group (GFSG) and in several research groups (RGs) and working groups (WGs) such as authorisation frameworks and mechanisms, grid resource allocation agreement protocol, high performance networking, data transport, OGSA, OGSI. The generic AAA work co-authored by the University of Amsterdam (UvA) is described in IETF RFCs 2903/2904/2906 and IRTF draft draft-irtf-aaaarch-generic-policy-03.txt

TORRENT

Technology for a realistic end-user access network test bed

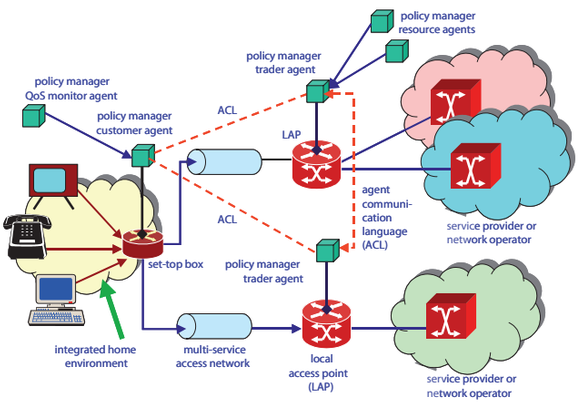
Abstract

Torrent is building a test bed for multi-service residential access networks that will allow the project to demonstrate the benefit of intelligent control, both for the customer and for the network operators and service providers. The test bed will support the definition of architectures that allow a home user's quality of service expectations to be met by employing — in a way that is transparent to the user — the most appropriate core transport network, be it connectionless or connection-oriented. Systems will be prototyped to segregate traffic according to its optimum mode of transportation and to manage routing and charging. Torrent encompasses systems integration activities, new developments, and close liaison with emerging standards and specifications.

Objectives

The main objectives of Torrent are to create:

- test bed to develop architectural frameworks for mapping service characteristics to network performance parameters;
- functionality, using agent technologies, to negotiate with the available core networks on the user's behalf, on issues such as bandwidth, quality of service and pricing;
- capabilities incorporated into a 'residential gateway', to enable communication between user terminals and the network, on policy matters relating to authorisation, authentication and accounting;
- a 'local access point' able to route services over the most appropriate available network standards for home networks.



Overview of the Torrent test bed

Technical approach

Torrent is developing an architectural framework in which service requirements can be mapped to network capabilities. These requirements include service management functionalities for authorisation, authentication and accounting.

Torrent is designing, developing and integrating functionality, using agent technologies that are able to negotiate, on the user's behalf, with the core networks regarding issues such as bandwidth, quality of service and pricing.

Project name:
Torrent

Contract No:
IST-2000-25187

Project type:
RTD

Start date:
1 May 2001

Duration:
30 months

Total budget:
EUR 5 167 706

Funding from the EC:
EUR 2 567 490

Total effort in person-months:
523.4

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http://www.torrent-innovations.org

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Project participants:

Flextel	Italy
Genuity	USA
Intracom	Greece
MCLab	Switzerland
OTEC	Greece
PTIN	Portugal
QMUL	United Kingdom
Telenor	Norway
Tesion	Germany
UST	Germany
Versaware	Spain
WIT	Ireland

Keywords:
Access networks
Home networks
Service policy

Collaboration with other EC-funded projects:
Next-generation networks initiative (NGNI)

Torrent is developing a residential gateway, incorporating suitable service management functionalities and taking into account the need to handle various types of home network and local access networks carrying multiple types of services.

Torrent is developing a local access point that is capable of recognising services coming from home users via a common access network, and routing these services over the most appropriate available core network.

Torrent is combining these features into the Torrent test bed.

Applications

Torrent will show that its test bed approach provides a sound generic platform for the definition, development and selection of new services. Torrent will show that new applications and services can be developed by using standard plug-in software components based on flexible intelligent agent technology.

Torrent will identify an integrated network which could provide a global capability for a full portfolio of applications and services. Torrent will validate the key functionalities of the different layers of the network, as well as those of the gateways between the layers in the test beds. Torrent will identify the enabling technologies required to connect different test beds in a pan-European context.

Torrent will determine the physical performance of the Torrent test bed. The test bed must be able to respond rapidly to a multitude of demanding emerging customer requirements including QoS issues and related service level agreements. In addition, the test bed must be able to provide bandwidths sufficiently large to accommodate these demanding customer requirements.

Torrent will make the results of its basic research available for scientific and technological development as well as to the international standards organisations.

Innovation

Torrent provides innovation in four key areas: intelligence, interworking, multi-service access and user-changeable fine-grain policy routing. The approach based on this combination is technically challenging and has not been attempted before.

Torrent introduces **intelligence** into elements associated with the management of access networks, in order to allow a user's QoS expectations to be met on a session-by-session basis, by selecting the most appropriate transport network at the time, in a way that is transparent, flexible, robust and efficient for the user.

Interworking between different access network technologies is an integral part of this solution, which also provides improvements in response times from the network, and can reduce backbone traffic for applications such as video on demand.

The **multi-service access** nature of the developed test bed integrates several technologies that operators use to provide broadband capacities in the access network including DSL and CATV. The integration of several access technologies that traditionally have been seen as isolated, reduces considerably the uncertainty faced from country to country and from network to network.

User preferences provide a mechanism by which users can be offered a dramatically enhanced form of **user-changeable policy routing** which operates at a very **fine grain** (per residential device, per service type), and is quickly and easily changeable by the user. No changes to user applications or their style of use are required.

MOICANE

Multiple organisation interconnection for collaborative advanced network experiments

Abstract

The Moicane project investigated several aspects related to providing proper end-to-end quality of service in the future new-generation network environment, from both theoretical and pragmatic points of view. Eight network islands featuring different access technologies and implementing the IETF IP QoS models, namely IntServ and DiffServ, within their access and core IP networks were set up. Advanced new components such as RSVP/IntServ-aware applications, QoS-aware DiffServ border routers and bandwidth brokers were deployed along with existing equipment. Trials and tests were then performed and the validity of the currently proposed methods for the support and management of QoS IP services in a single and multi-domain context was evaluated and assessed.

During its life the project partnership was extended involving two network operators and a research centre to ensure an appropriate exploitation of the results, bring in the project the prospective of Romanian users and support the EU effort to pave the way to the future enlargement of the EU.

In November 2002, a joint demonstration with the GÉANT and Atrium projects was successfully organised and carried out at the IST 2002 event in Copenhagen. On that occasion, user-controlled activation of end-to-end QoS over a complex IP network was successfully demonstrated.

Objectives

The project's main goal was to realise a distributed test bed interconnecting several network islands, characterised by different access technologies and supporting different services, such as tele-lecturing, virtual-classroom, virtual-laboratory, on which tests were made by the IETF architectural models for IP quality of service, and their effectiveness was assessed.

In October 2001, the architecture, network elements and applications to be deployed were defined and specified. The development of specific network elements and services was completed in January 2002. The integration of existing and developed elements and services was completed in June 2002.

The Romanian partners joined the project in January 2002 and the integration of the Bucharest islands was completed late in July and the trials were carried out later in the year.

The Moicane test bed is shown in the above map. In total, eight islands were realised: one in Portugal (Lisbon), three in Italy (Ivrea, Pisa, Vimercate), two in Greece (Athens) and two in Romania (Bucharest).

Technical approach

The project considered three network sections, namely the access technology, the access IP network and the core IP network. Four different access technologies were deployed:

- Ethernet-based LANs;

Project name:
Moicane

Contract No:
IST-2000-25137

Project type:
RTD

Start date:
1 January 2001

Duration:
24 months

Total budget:
EUR 4 987 977

Funding from the EC:
EUR 2 674 654

Total effort in person-months:
537

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http://www.moicane.com

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ALA	Italy
CPR	Italy
FLEX	Italy
ICCS	Greece
INESC	Portugal
INOV	Poland
IS	Italy
OTE	Greece
Romtelecom	Romania
Tekelec	France
TEMEX	France
UPB	Romania

Keywords:
Access
Core
IP QoS
Islands
Traffic

Collaboration with other EC-funded projects:
Atrium
GÉANT

- asymmetric digital subscriber lines (ADSL) allowing high bitrates on existing subscriber copper lines;
- wireless LAN (both IEEE 802.11b and 802.15 — Bluetooth) addressing mobility-related issues;
- local multipoint distribution systems (LMDS) offering broadband communications to residential and business customers via radio link in a limited area from a local base station.

Provisioning of IP QoS was based on the two architectural models defined by the IETF:

- IntServ, which makes use of explicit reservation of resources for each individual IP flow, in the access IP network;
- DiffServ, which focuses on aggregates of a number of individual flows having identical sensitivity to the delays and losses introduced by the network, in the core IP network.

Studies within the Moicane project were related to practical operation, management, and performance of implementations of these models both alone and in combination.

Some specific hardware and software network components were developed by the partners. Besides existing and new commercial applications running on hosts, specific applications were developed to match the need of the project especially with regard to their RSVP/IntServ awareness. Specific and commercial applications were used as components of the e-learning and virtual laboratory services that formed the basic traffic for several tests.

Test bed and experiments

The islands used specific as well as commercial network elements and applications. As part of the collaborative work and experiments, each island focused on one or two specific access technologies and results and conclusions were shared with other partners. However, all islands featured standard LANs to support the e-learning service. Most tests were conducted within each island. Tests between interconnected islands were performed through the national and international links provided by FCCN, GARR, GRNET, Roedunet and GÉANT.

Results

The project contributed to the advance of the state of the art in access technologies and QoS implementation for new-generation networks by:

- implementing specific components such as:
  - QoS-aware DiffServ border router;
  - bandwidth broker;
  - end-to-end QoS measurement, instruments;
- integrating them with other commercial network elements;
- testing and validating through the distributed trial the effectiveness of proposed methods for allocating and negotiating resources as well as the efficiency of the relevant communication protocols.

Innovation

Moicane focused on trial and validation aspects. In particular it showed:

- the feasibility of the delivery of an end-to-end transparent IP-QoS transport service across heterogeneous access technologies (wired and wireless) and protocols (e.g. RSVP, HTTP, H.323, SIP);
- the possibility to bridge to network QoS many legacy end-user QoS-demanding applications (with legacy protocols) without any change by properly enhancing network UNI intelligence;
- that QoS delivery at the UNI is today feasible, and can be engineered in such a way to be scalable, sustainable and market-ready.

ATRIUM

A test bed of terabit IP routers running MPLS over DWDM

Abstract

Atrium is validating high-speed network technologies to allow demanding end-user applications (including on-demand video streaming services, video conferencing, gaming and high-speed grid computing). The Atrium advanced test bed supports QoS, Multicast, IPv6 and fast restoration of link or node failures in order to demonstrate applications supporting collaborative activities and providing interactive access to information and resources in a way that is not possible with today's Internet.

Objectives

The objectives of Atrium are to develop an advanced test bed to validate an advanced terabit router (ATR) as both a core router and a border router using several highly demanding applications. Included in this is the development and assessment of a set of unified traffic management algorithms and protocols necessary to operate successfully an ATR in an MPLS-based and DiffServ-capable autonomous system (AS) both intra- and inter-domain, and also the specification and testing of a network management system to operate and monitor IP QoS and MPLS-enabled core networks. Atrium will also provide the research community with an advanced test bed containing the only current European-manufactured terabit router.

Technical approach

The overall work in the Atrium project has followed an incremental phasing.

- Installation of the Atrium test bed, creating connectivity between the sites of Alcatel, France Telecom R & D and the University of Liège.
- In 2002, the test bed was extended towards PSNC Poland and Telefonica I+D. This connectivity was accomplished using a virtual private network service offered by several NRNs (Renater, Redlris) and GÉANT.
- In 2003, an additional site in INTEC Ghent was added to the test bed.
- A set of testing tools was defined and selected. These tools allow extensive interoperability and performance testing of the test bed in heterogeneous and distributed environments.
- Optimised traffic-engineering algorithms were developed. Examples are solutions for the dynamic calculation of LSPs (labelled switched paths) on the basis of actual traffic profiles, fast restoration in case of failures, and for the provision of QoS and Multicast in DiffServ/MPLS networks.
- Development of protocols and mechanisms to support QoS and fast restoration across inter-domain boundaries in MPLS-based networks.
- Exploitation of the test bed with a variety of experiments to better understand the behaviour of an operational terabit core network with the aim of proving that the type of backbone deployed in this project is recommended for the future.

Test bed

The Atrium test bed is an IP/MPLS network based on Alcatel A7770 core routers, interconnected via 2.5 gigabit per second interfaces. Test equipment and routers of other vendors were used to perform the MPLS-QOS-related interoperability tests. The test bed is interconnected to the France Telecom experimental network VTHD, the relevant NRENs such as Belnet, Redlris, Pol34 and Renater and the European backbone GÉANT.

Project name:
Atrium

Contract No:
IST-1999-20675

Project type:
RTD

Start date:
1 January 2001

Duration:
36 months

Total budget:
EUR 9 195 647

Funding from the EC:
EUR 5 094 433

Total effort in person-months:
596

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Project participants:

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FT	France
FUNDP	Belgium
INTEC	Belgium
Mobistar	Belgium
PSNC	Poland
TID	Spain
ULG	Belgium

Keywords:
Core router
MPLS
QoS
test bed
IPv6
grid computing
multimedia
network management
optical networking

Collaboration with other EC-funded projects:
GÉANT
Moicane
Serenate
DataTAG

Experiments

Experiments have been set up on the Atrium test bed in order to analyse and study the requirements and service availability (using Diffserv QOS, MPLS and network resilience) of a set of user applications and of grid middleware. Performance degradation on distributed grid middleware platforms interconnected via long-distance networks has also been studied. Due to the large distances of these platforms, the grid middleware has to cope with significant delay and jitter.

Applications

The test bed has been integrated with multimedia terminals running advanced user applications like multi-party video and voice conference, video streaming and gaming. Grid middleware developed in other IST projects has been re-used to measure the effect that a pan-European network has on the performance of this middleware.

Innovation

The Atrium network is built on the Alcatel 7770 RCP core router which comprises an innovative state-of-the-art hardware and software architecture designed to offer wire-speed performance, reliability, scalability and advanced features like non-stop networking, DiffServ IP, IPv6 and MPLS. The project proposes innovative mechanisms to compute LSPs dynamically according to the actual load of the network, rather than according to the reserved traffic profiles. This will improve the utilisation of the network and thereby increase the profits of the network provider, not only for best effort, but also for traffic profiles with associated QoS. Fast restoration of the data paths, multicast traffic and inter-domain traffic engineering are other key innovation topics.

Results

The main results of Atrium have been:

- the establishment of a non-stop, DiffServ-capable, MPLS and IPv6-based terabit core network, with intra- and inter-domain and border router capability;
- the assessment of performance and interoperability on real size networks;
- a set of traffic engineering algorithms, providing QoS and Multicast in MPLS-based networks and prototype implementations;
- intra- and inter-domain protocols and mechanisms to support QoS and fast restoration in MPLS-based networks;
- proof of the major advantages of the test bed by means of multimedia applications and grid middleware;
- a number of contributions to IETF for standards on inter-domain traffic engineering using BGP, MPLS-TE and QoS;
- deployment and testing of an inter-domain layer 2 VPN to interconnect the Spanish and Polish test bed site to the core test bed. The layer 2 VPN uses inter-domain MPLS connections and is provisioned in the European IP backbone GÉANT and the national research networks Rediris and Renater — successful demonstrations covering MPLS, QoS, Multicast and Ipv6 with live video streams at ECOC and IST conferences;
- testing and evaluation of A7770 core routing technology with GÉANT, national research networks, and PSNC with the goal of introducing the router in the core IP networks of these organisations.

Service quality across independently managed networks

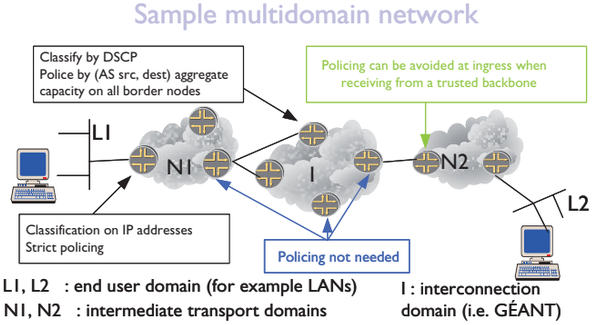
Abstract

An end-to-end definition of network QoS to satisfy needs of international user groups is provided. The definition is complemented by an architecture and implementation model in a multi-domain and multi-technology environment, leading to the definition of a premium IP service. A set of tests, both in laboratory and in live production IP networks has been conducted to validate the implementation model of the premium IP service. The service is complemented by the definition of an end-to-end service level specification and techniques for the monitoring and validation of an end-to-end SLA for QoS. The project concludes with providing guidelines and recommendations for wide-scale implementation of premium IP.

Objectives

The objective of Sequin is to define and implement an end-to-end approach to network quality of service that will operate across multiple management domains and will exploit a variety of networking technologies (IP, ATM). Sequin will ensure that researchers across Europe have access to networking facilities that can be tailored to the requirements of the individual groups, and which will offer predictable and stable quality across multiple underlying management domains and networking technologies.

Sample multidomain network



Technical approach

To achieve the objectives, the workplan has been organised to understand the users' qualitative and quantitative requirements, and a technological analysis of the available networking equipment features was conducted. The combined user and technological analysis led to the definition of a premium IP service based on the IETF DiffServ model, with emphasis on the multi-domain and multi-technology environment. The implementation model was then subject to a set of operational validation tests in a controlled environment, to outline the effectiveness of the model.

With the support of the Sequin project, premium IP has successfully been set up between end-sites of several international groups of users involved in other IST projects: Aquila, LONG and Moicane. This implies the premium IP support on several NRENs and on the GÉANT network to provide this end-to-end service. This is one of the very first times a service such as premium IP has been implemented over several operational networks to offer an end-to-end service to users spread over several networks.

Test bed

A set of proof of concept tests using laboratory facilities to test the functionality required by routers to implement the premium IP service were carried out and have proved successful. The tests focused on router functionality for the classification, marking, policing and

Project name:
Sequin

Contract No:
IST-1999-20841

Project type:
RTD

Start date:
1 November 2000

Duration:
18 months

Total budget:
EUR 921 677

Funding from the EC:
EUR 423 671

Total effort in person-months:
84

Website:
http://www.dante.net/sequin

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Project participants:

DANTE	United Kingdom
DFN	Germany
GRNET	Greece
INFN-GARR	Italy
PSNC	Poland
Renater	France
Switch	Switzerland
Ukerna	United Kingdom

Keywords:
Premium IP
QoS

Collaboration with other EC-funded projects:
Moicane

scheduling of IP packets. A set of tests with an H.323 video-conferencing international user group has been conducted to verify the multi-domain operation of premium IP. It made use of an ad hoc configuration of production routers to support the service. This test has outlined that premium IP can operate well in a multi-domain and multi-technology environment and can offer network performance guarantees in terms of the four parameters identified (capacity, packet loss, one-way delay, delay variation).

Innovation

The main innovations of Sequin are related to the definition and implementation of QoS in a multi-domain and multi-technology environment. Although the devised premium IP model is based on the DiffServ activity of the IETF, there had been no implementation to offer end-to-end QoS in an operational multi-domain environment. The definition of a service level specification and of a service level agreement for QoS in multi-domain scenarios is an important contribution to innovation of this project.

Results

Sequin has provided recommendations and procedures for a large-scale deployment of premium IP across a multi-domain environment using a variety of networking equipment and networking technologies. It has also highlighted the need for monitoring the premium IP metrics to verify them against the SLA and to troubleshoot the service.

Contribution to standards

Sequin and the Internet2 community have agreed to adopt the DSCP 46 for premium IP destination-aware use. This allows the research and education communities in Europe and North America to have an interoperable marking for the premium IP.

SCHOLNET

A digital library test bed to support networked scholarly communities

Abstract

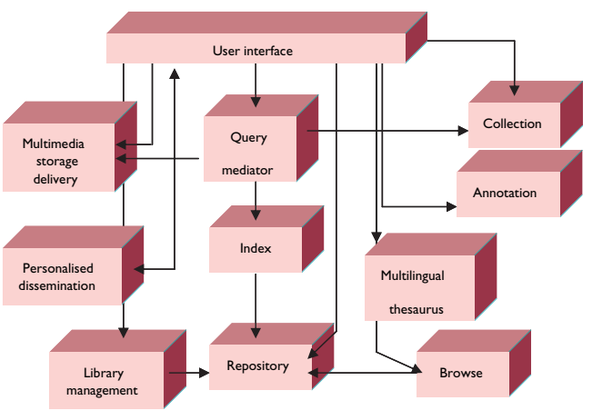
Scholnet was completed in April 2003. The project built a digital library (DL) test bed infrastructure for supporting communication and collaboration among networked scholarly communities. In addition to the provision of standard digital library capabilities for information acquisition, description, archiving, access, search, and dissemination, Scholnet provides support for non-textual data types, hypermedia annotation, cross-language search and retrieval, and personalised information dissemination.

Scholnet is a success from both the research and the application point of view. It has been the first project that has stressed the importance of the digital library management systems and the design of DL architectures. Both these topics appear as strategic goals in the '10-year grand vision for digital library systems' that has been published one and a half years after the starting of the Scholnet project. This vision is an outcome of the DELOS brainstorming meeting: 'Future research directions for a European research programme' (http://delos-noe.iei.pi.cnr.it/ activities/researchforum /Brainstorming/1st-ws.html). Several contacts have been established with many user communities, for example, university libraries, research organisations, private consortia, that are interested in the exploitation of the system. Discussions are under way with some of these organisations for establishing a cooperation agreement that might lead to the development of a 'Scholnet product'.

Objectives

Scholnet built a new-generation DL infrastructure able to respond to a pressing request for software that could enable different user communities to create their own DLs. The accomplished goal was the design of general-purpose software that can be customised to meet the needs of different application frameworks. The role of Scholnet is analogous to the role of a database management system for a database, in other words, it supports the creation and maintenance of distributed DLs. An additional accomplished goal was that Scholnet not only provides the traditional digital library services but also supports non-textual documents, hypermedia annotation, cross-language search and retrieval, and personalised information dissemination. The Scholnet infrastructure is 'open' in order to allow an incremental service extensibility.

A schematic representation of the Scholnet open architecture



Technical approach

Scholnet has been built by extending the basic digital library services and the communication protocol provided by an existing DL system, called OpenDLib. Each service is implemented as a separate module which communicates with the others through a well-defined HTTP-based protocol. The added modules are the following.

Project name:
Scholnet

Contract No:
IST-1999-20664

Project type:
RTD

Start date:
1 November 2000

Duration:
30 months

Total budget:
EUR 1 898 637

Funding from the EC:
EUR 949 316

Total effort in person-months:
230.3

Website:
http://www.ercim.org/scholnet/links.html

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Project participants:

CNR-IEI	Italy
ERCIM	France
FHG	Germany
FIMU	Czech Republic
FORTH	Greece
GMD	Germany
INRIA	France
Lorasi	France
SICS	Sweden

Keywords:
Annotation
Cross-language access
Digital library infrastructure
Digital library services
Multimedia handling
Personalised dissemination
Scholarly communication

Collaboration with other EC-funded projects:
Clarity
CLEF
Collate
Cyclades
DELOS NOE
Eurogatherer

- *Multimedia storage and delivery service*

Supports the storage, the streaming (real-time) and the download delivery of the stored multimedia documents. Furthermore, it provides enhanced mechanisms for the dissemination of parts of the stored multimedia documents.

- *Hypermedia annotation service*

Integrates annotation and reference linking features into the DL infrastructure. It stores annotations on documents and makes them available to authorised users. It is based on the semantic index system (http://www.ics.forth.gr/proj/isst/Systems/sis-tms.html).

- *Multilingual thesaurus service*

Develops a multilingual thesauri and a terminology service able to support cataloguing and distributed access to heterogeneous electronic collections. It is based on the SIS thesaurus management system (http://www.ics.forth.gr/proj/isst/Systems/sis.html).

- *Automatic personalised information dissemination service*

Supports a proactive facility which sends messages when a new document arrives in the digital library to those users who, on the basis of their system-maintained profiles, are potentially interested in its contents. It is based on the Eurogatherer system (http://pc-erato2.iei.pi.cnr.it/eurogatherer).

Test bed

A DL can be created by instantiating the Scholnet software, specifying its initial configuration, and loading and/or harvesting the information content. The initial configuration establishes the value of architectural parameters, like the number of service instances, their allocation and the topology of the communication paths, and the application-specific parameters, like the format of the query language, the language of the terms (thesaurus), the metadata formats. This configuration may be changed later either automatically (e.g. to recover from a server crash) or as an effect of an explicit request formulated by the DL administrator. For example, the administrator can decide to extend the architecture by adding new servers, and/or mounting new service instances, in order to reduce the workload on the existing services or they can decide to support a new thesaurus on the request of a new class of users to use the DL. Two experimental DLs have been created during the project lifetime, others are going to be set up in the near future as part of the follow-up activity of the Scholnet test bed.

Applications

Scholnet facilitates the creation of DLs that support the immediate dissemination and accessibility of technical documentation (and the underlying knowledge) within their target scholarly communities. These DLs can actively be used by the members of the communities in every day individual and/or collaborative tasks and can regularly be updated and extended.

Innovation

The innovation introduced by Scholnet is twofold. Presently, most of the DLs are implemented as ad hoc services created to disseminate specific collections of documents. Scholnet, instead, proposes a generic DL system with a very adaptable archive functionality capable of dealing with a wide range of document types, structures, media, etc. This system allows the creation of DLs by simply instantiating and loading its repositories with the appropriate content.

In addition, Scholnet implements a system for a new-generation of DLs which are not only mechanisms for the dissemination of content but which also support communication and collaboration among scholars.

Results

The test bed is now operational and ready to be used in real frameworks. It is the first running system that provides the features of a **digital library management system**.

Participants' index

Legal Name	Short Name	Legal Status	Country	Participation in Projects
6WIND	6WIND	PRC	F	6WINIT, Euro6IX
AKADEMIA GORNICZO-HUTNICZA IM STANISLAWA W KRAKOWIE	UMM	GOV	PL	6WINIT
AKADEMSKA RAZISKOVALNA MREZA SLOVENIJE	ARNES	PUC	SI	GN1
ALCATEL BELL NV	ALCATEL	PRC	B	ATRIUM
ARMENIAN RESEARCH AND EDUCATIONAL NETWORKING ASSOCIATION	ARENA	PNP	AM	SPONGE
BRITISH TELECOMMUNICATIONS PLC	BT	PRC	UK	6LINK, 6WINIT, Euro6IX, IPV6TF-SC
CENTRE DE RESSOURCES INFORMATIQUES DE HAUTE NORMANDIE	CRIHAN	PNP	F	DAMIEN
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	CNRS	GOV	F	DATAGRID, EUROGRID
CESNET, ZAJMOVE SDRUZENI PRAVNICKYCH OSOB	CESNET	PNP	CZ	6NET, DATAGRID, GN1
CISCO SYSTEMS INTERNATIONAL B. V.	CISCO	PRC	NL	6NET
COMMISSARIAT A L'ENERGIE ATOMIQUE	CEA	GOV	F	DATAGRID
COMPAGNIE IBM FRANCE	IBM	PRC	F	6NET
CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	GOV	I	DATAGRID, SCHOLNET
CONSULTORES INTEGRALES EN TELECOMUNICACIONES «CONSULINTEL», S.L.	CONSULINTEL	PRC	E	6LINK, 6QM, Euro6IX, EUROV6, IPV6TF-SC
CS SYSTEMES D'INFORMATION	CS SI	PRC	F	DATAGRID
CSC SCIENTIFIC COMPUTING LTD.	CSC	PNP	SF	6NET
CYPRUS RESEARCH AND ACADEMIC NETWORK	CYNET	GOV	CY	GN1
DANMARKS TEKNISKE UNIVERSITET	DTU	GOV	DK	6NET, SERENATE
DATAMAT S.P.A.	DATAMAT	PRC	I	DATAGRID
DELIVERY OF ADVANCED NETWORK TECHNOLOGY TO EUROPE LIMITED	DANTE	PNP	UK	6LINK, 6NET, GN1, SEEREN, SERENATE
DEUTSCHER WETTERDIENST	DWD	GOV	D	EUROGRID
EADS CCR	EADS CCR	PRC	F	DAMIEN, EUROGRID
EBERHARD KARLS UNIVERSITAET TUEBINGEN	UKT	GOV	D	6WINIT
ECIJA & ASOCIADOS ABOGADOS, S. L	E&A	PRC	E	Euro6IX
EIDGENOESSISCHE TECHNISCHE HOCHSCHUL ZUERICH	ETH	GOV	CH	EUROGRID
ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE	ETRI	GOV	KR	6NET, 6WINIT
ERICSSON AB	ERICSSON	PRC	S	6WINIT, EUROV6
ERICSSON SP. Z O.O.	ERICSSON PL	PRC	PL	6WINIT
ERICSSON TELEBIT A/S	TED	PRC	DK	6WINIT, Euro6IX
ESTONIAN EDUCATIONAL AND RESEARCH NETWORK	EENET	GOV	EE	GN1
EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH	CERN	INO	F	DATAGRID, DATATAG
EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION	EUROCONTROL	INO	B	Euro6IX
EUROPEAN SPACE AGENCY	ESA-ESRIN	INO	F	DATAGRID
FACULTES UNIVERSITAIRES NOTRE-DAME DE LA PAIX (F.U.N.D.P.)	FUNDP - LISE	GOV	B	ATRIUM
FLEXTEL S.P.A.	FLEXTEL	PRC	I	TORRENT
FONDATION EUROPEENNE DE LA SCIENCE	ESF	PNP	F	SERENATE
FORSCHUNGSZENTRUM JUELICH GMBH	FZJ	GOV	D	EUROGRID
FOUNDATION FOR RESEARCH AND TECHNOLOGY - HELLAS	FORTH	PNP	GR	SCHOLNET
FRANCE TELECOM SA	FT	PRC	F	6QM, ATRIUM, Euro6IX
FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	FhG-Fokus	PUC	D	6NET, 6QM, SCHOLNET
FUJITSU EUROPEAN CENTRE FOR INFORMATION TECHNOLOGY LIMITED	FECIT	PRC	UK	EUROGRID
FUNDACAO PARA A COMPUTACAO CIENTIFICA NACIONAL - FCCN	FCCN	PNP	P	GN1
FUNDACION VODAFONE	AIRTEL	PNP	E	Euro6IX
GEIE ERCIM	ERCIM	EEI	F	SCHOLNET

Legal Name	Short Name	Legal Status	Country	Participation in Projects
GENUITY SOLUTIONS INC.	GENUITY	PRC	USA	TORRENT
GEORGIAN RESEARCH AND EDUCATIONAL NETWORKING ASSOCIATION	GRENA	PNP	GE	SPONGE
GREEK RESEARCH TECHNOLOGY NETWORK S.A.	GRNET	PUC	GR	6NET, GN1, SEEREN
GROUPEMENT D'INTERET PUBLIC RESEAU NATIONAL DE TELECOMMUNICATIONS POUR LA TECHNOLOGIE, L'ENSEIGNEMENT ET LA RECHERCHE.	RENATER	PUC	F	6NET, GN1
HEANET LTD	HEANET	PRC	IRL	GN1
HITACHI EUROPE (FRANCE) SA	HEL	PRC	F	6QM
HITACHI, LTD	HIT	PRC	JAP	6QM
HUNGARIAN ACADEMIC AND RESEARCH NETWORK ASSOCIATION	HUNGARNET	PNP	HU	6NET, GN1, SEEREN
IBM UNITED KINGDOM LIMITED	IBM	PRC	UK	DATAGRID
INDUSTRIEANLAGEN-BETRIEBSGESELLSCHAFT MBH	IABG	PRC	D	6WINIT
INSTITUT DE FISICA D'ALTES ENERGIES	IFAE	GOV	E	DATAGRID
INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE.	INRIA	GOV	F	6NET, DATATAG, SCHOLNET
INSTYTUT CHEMII BIOORGANICZNEJ PAN W POZNANIU.	PSNC	GOV	PL	6NET, ATRIUM, GN1
INTER UNIVERSITY COMPUTATION CENTRE	IUCC	PUC	ISR	GN1
INTERUNIVERSITAIR MICRO-ELECTRONIC CENTRUM VZW.	IMEC	PNP	B	ATRIUM
INTRACOM S.A. HELLENIC TELECOMMUNICATIONS AND ELECTRONICS INDUSTRY	INTRACOM	PRC	GR	TORRENT
INVENIA INNOVATION AS	INVENIA	PRC	N	6NET
ISTITUTO NAZIONALE DI FISICA NUCLEARE (INFN)	INFN-GARR	GOV	I	6NET, DATAGRID, DATATAG, GN1
ISTITUTO TRENTINO DI CULTURA	ITC-irst	GOV	I	DATAGRID
KAUNAS UNIVERSITY OF TECHNOLOGY	KTU	GOV	LT	GN1
KONRAD-ZUSE-ZENTRUM FUER INFORMATIONSTECHNIK BERLIN.	ZIB	GOV	D	DATAGRID
MAGYAR TUDOMANYOS AKADEMIA SZAMITASTECHNIKAI ES AUTOMATIZALASI KUTATO INTEZET	MTA SZTAKI	GOV	HU	DATAGRID
MASARYK UNIVERSITY BRNO - FACULTY OF INFORMATICS	FIMU	GOV	CZ	SCHOLNET
MCLAB GMBH	MCLAB GMBH	PRC	CH	NGN LAB, TORRENT
MINISTERIO DE CIENCIA Y TECNOLOGIA	MCYT	GOV	E	GN1
MOBISTAR	MOBISTAR	PRC	B	ATRIUM
MOTOROLA SAS	CRM	PRC	F	6LINK
NEC EUROPE LTD.	NEC	PRC	UK	NGN LAB
NORDUNET A/S	NORDUNET	PRC	DK	6NET, GN1
NORTEL NETWORKS HISPANIA, S.A.	NORTEL	PRC	E	LONG
NOVAGNET SYSTEMS, S.L.	NGN	PRC	E	Euro6IX
NTT COMMUNICATIONS CORPORATION	NTT COM	PRC	JAP	6NET
OFICIUL PENTRU ADMINISTRARE SI OPERARE AL INFRASTRUCTURII DE COMUNICATII DE DATE «ROEDUNET»	RoEduNet	GOV	RO	GN1, SEEREN
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OULUN YLIOPISTO	U OULU	GOV	SF	6NET, IPV6TF-SC
PALLAS GMBH	PALLAS	PRC	D	DAMIEN, EUROGRID
PARTICLE PHYSICS AND ASTRONOMY RESEARCH COUNCIL	PPARC	GOV	UK	DATAGRID, DATATAG
PHILIPS ELECTRONICS NEDERLAND B.V.	PHILIPS	PRC	NL	IPV6TF-SC
PORTUGAL TELECOM INOVACAO, S.A.	PTIN	PRC	P	Euro6IX, LONG, TORRENT
QUEEN MARY AND WESTFIELD COLLEGE, UNIVERSITY OF LONDON	QMW	GOV	UK	TORRENT
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RESEARCH ACADEMIC COMPUTER TECHNOLOGY INSTITUTE.	CTI	GOV	GR	6NET
RESEAU TELEINFOMATIQUE DE L'EDUCATION NATIONALE ET DE LA RECHERCHE.	RESTENA	PNP	L	GN1
RIJKSUNIVERSITEIT GRONINGEN	RUG	GOV	NL	SPONGE

Participants' index

Legal Name	Short Name	Legal Status	Country	Participation in Projects
ROYAL NETHERLANDS METEOROLOGICAL INSTITUTE	KNMI	GOV	NL	DATAGRID
RUPRECHT-KARLS-UNIVERSITAET HEIDELBERG	EVG HEI UNI	GOV	D	DATAGRID
SICS, SWEDISH INSTITUTE OF COMPUTER SCIENCE AB.	SICS	PRC	S	SCHOLNET
SIEMENS AKTIENGESELLSCHAFT	SIEMENS	PRC	D	IPV6TF-SC
SLOVAK ACADEMIC NETWORK ASSOCIATION	SANET	GOV	SK	GN1
SONY INTERNATIONAL (EUROPE) GMBH	SONY	PRC	D	6NET
STICHTING ACADEMISCH REKENCENTRUM AMSTERDAM (SARA)	SARA	GOV	NL	DATAGRID
STICHTING TELEMATICA INSTITUUT	TELIN	PNP	NL	6NET
STICHTING VOOR FUNDAMENTEEL ONDERZOEK DER MATERIE	FOM	PUC	NL	DATAGRID
SURFNET B.V.	SURFNET	PRC	NL	6NET, GN1
SWITCH-TELEINFORMATIKDIENSTE FUER LEHRE UND FORSCHUNG	SWITCH	PUC	CH	6NET, GN1
T-SYSTEMS ITS GMBH	DSH	PRC	D	EUROGRID
T-SYSTEMS NOVA GMBH	T-NOVA	PRC	D	6LINK, 6WINIT, Euro6IX, IPV6TF-SC
TECHNICAL RESEARCH CENTRE OF FINLAND	VTT	GOV	SF	6WINIT
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TELEFONAKTIEBOLAGET L M ERICSSON	LME	PRC	S	IPV6TF-SC
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Glossary of acronyms

3G . . . . . Third-generation wireless
4G . . . . . Fourth generation
3GPP . . . . . Third-generation partnership programme

A

ACL . . . . . Agent communication language
ADSL . . . . . Asymmetrical digital subscriber line
AP . . . . . Access point
API. . . . . Application programming interface
AS . . . . . Autonomous system
ASP . . . . . Application service provider
ATM . . . . . Asynchronous transfer mode
ATR. . . . . Advanced terabit router

B

BGP. . . . . Border gateway protocol
BTS . . . . . Base transceiver station

C

CAE. . . . . Computer-aided engineering
CATV . . . . . Community antenna television or cable television
CFD. . . . . Computational fluid dynamics
CPA. . . . . Cross-programme action
CPU. . . . . Central processing unit
CSCW. . . . . Computer supported cooperative work

D

DG . . . . . Directorate-General
DL . . . . . Digital library
DNS . . . . . Domain name system
Docsis . . . . . Data over cable service interface specification
DSCP . . . . . Differentiated service code point
DSLAM . . . . . Digital subscriber line access module
DWDM . . . . . Dense wavelength division multiplexing

E

EC . . . . . European Commission
EDA . . . . . European distributed access
ERA . . . . . European research area
EU . . . . . European Union

F

FP6 . . . . . Sixth framework programme
FTP . . . . . File transfer protocol

G

GAT . . . . . Grid application toolkit
GbE. . . . . Gigabit Ethernet
Gbps . . . . . Gigabits per second
GGF. . . . . Global grid forum
GGSN . . . . . GPRS gateway support node
(G)MPLS . . . . . (Generalised) multiprotocol layer switching
GPRS. . . . . General packet radio service
GTRN . . . . . Global terabit research network

H

HA . . . . . High availability
HLR . . . . . Home location register
HPC . . . . . High performance computing
HTTP . . . . . Hypertext transfer protocol
HTTPS . . . . . HTTP over secure socket layer

I

ICT . . . . . Information and communication technologies
IEEE . . . . . Institute of Electrical and Electronics Engineers
IETF . . . . . Internet engineering task force
IP . . . . . Internet protocol
IPsec . . . . . IP security
IPv4 . . . . . Internet protocol version 4
IPv6 . . . . . Internet protocol version 6
IRC . . . . . Internet relay chat
ISDN . . . . . Integrated services digital network
ISP . . . . . Internet service provider
IST . . . . . Information society technologies
IX . . . . . Internet exchange

J

K

L

LAN . . . . . Local area network
LAP . . . . . Local access point
LDAP . . . . . Lightweight directory access protocol
LHC . . . . . Large hadron collider
LMDS . . . . . Local multipoint distribution system
LSP . . . . . Labelled switched paths

M

Mbps . . . . . Megabits per second
MNP . . . . . Microcomputer networking protocol
MoU . . . . . Memorandum of understanding
MPI . . . . . Message passing interface
MPLS . . . . . Multiprotocol label switching

N

NNI . . . . . Network to network interface
NoE . . . . . Network of excellence
NREN . . . . . National research and education network

O

P

PDA . . . . . Personal digital assistant
POS . . . . . Point-of-sale terminal

Q

QoS . . . . . Quality of service

R

R & D . . . . . Research and development
RAN . . . . . Radio access network
RN . . . . . Research network
RSVP . . . . . Resource reservation protocol
RTD . . . . . Research and technology development

S

SGSN . . . . . Serving gateway support node
SLA . . . . . Service level agreement
SSL. . . . . Secure socket layer

T

Tbps . . . . . Terabits per second
TCP . . . . . Transmission control protocol
TEN . . . . . Trans-European network
TF-NGN . . . . . Task force for next-generation networks

U

UMTS . . . . . Universal mobile telecommunications system
UNI . . . . . User-to-network interface

V

VPN. . . . . Virtual private network

W

WAN . . . . . Wide area network
WDM . . . . . Wavelength division multiplexing
WLAN . . . . . Wireless LAN
WLL . . . . . Wireless local loop
WWG . . . . . Worldwide grid

X

xDSL . . . . . Denotes various digital subscriber lines

Y

Z

European Commission

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