



Project Number: IST-1999-20841
Project Title: SEQUIN

Deliverable D4.1b

Dissemination and Use Plan - Update

Deliverable Type: PU-Public
Contractual Date: 30 April 2002
Work Package: 4
Nature of Deliverable: RE - Report

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Abstract:

This deliverable describes the approach of the SEQUIN consortium towards dissemination of project results into the scientific and networking communities, and strategies for the application of these results in the implementation of novel network services for the European research community.

Keywords:

QoS, Differentiated Services, IP Premium, Dissemination

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EXECUTIVE SUMMARY

This document describes the approach undertaken in the project SEQUIN to the dissemination of project results into the scientific and networking communities, and lists activities for creating broad public visibility to project activities.

The wider application of these results will lead to the implementation of unique network services for the European research community. Given the impact and relevance of the issues addressed by the project, the consortium considers the task of dissemination of its results as exceptionally important. In order to ensure that all information reaches the intended audience, the project has planned a comprehensive communication strategy that addresses the information needs of each of its target groups, and it has produced material and documentation tailored to their specific requirements.

In addition to producing information content and making it accessible through the project website, SEQUIN has adopted an active role in disseminating its outcomes by organising a workshop and through participation in other events where project results have been presented and discussed with a wider audience. The dissemination plan in this report documents the efforts undertaken by the project consortium to reach its target communities.

1. INTRODUCTION

This document outlines the strategy taken by the project consortium to disseminate the results of the SEQUIN IST project. It is an updated version of the document released in October 2001 taking into account activities performed since then and presenting an outline on on-going and planned future actions that help to spread project results into the scientific and networking community.

The objective of the SEQUIN project is to define and implement an end-to-end approach to Quality of Service for IP networks that will operate in a heterogeneous environment across multiple management domains. SEQUIN has defined a Premium IP service that provides assured bandwidth, low delay and negligible packet loss. It realises a service that is capable of offering predictable and stable quality across multiple domains and various networking technologies. SEQUIN performed first field trials that implemented Premium IP in the pan-European GÉANT backbone (IST project "GN1", IST-2000-26417). Various technologies had to be used in the National Research and Education Networks (NRENs) to connect end users to the Premium IP backbone network. On-going trials with user groups from outside the project allow to further examine the Premium IP provisioning process and to derive recommendations for a future production use of the service.

The ultimate goal of SEQUIN is to ensure that researchers across Europe have access to networking facilities which support QoS and can be tailored to the requirements of individual user groups. This requires co-operation on the part of many different networks including GÉANT, the NRENs and campus networks of the institutions hosting the end user groups. Therefore, prime dissemination tasks will be directed towards technical and managerial decision boards in those networks in order to get commitments for support of the Premium IP approach. SEQUIN addresses the network engineers who design, build and operate these networks. For them, the results of SEQUIN will provide support and training material for the configuration and operation of Premium IP networks. In addition, potential users of the Premium IP service must be made aware of its existence, they must be given the necessary information how the services can be accessed and how it can be used to support their respective applications.

Section 2 identifies the particular nature of the project research work and the results achieved, and places them in wider context to derive suitable means and a communication strategy for target communities. In section 3, we will identify a set of groups which should be targeted by project dissemination efforts and detail their specific information needs. Section 4 will show the different means that are used for dissemination towards those groups. The documentation allowing for successful implementation of SEQUIN results will be the focus of section 5. In section 6, we list groups, both inside and outside the IST community, which are approached for cooperation and concertation efforts. Section 7 lists the project dissemination activities to date.

The first version of the dissemination plan had been published before GÉANT had gone operational and, thus, before there had been a chance to evaluate the proposed framework for Premium IP in early proof-of-concept trials. After successful completion of those trials, in which the practicality of Premium IP could be demonstrated, the project consortium had come to a position for planning of more concrete steps towards a wider implementation of Premium IP. In this report major efforts for creating a larger awareness for Premium IP, which had subsequently been undertaken, are documented.

The successful implementation on a wider scale of IP QoS, as developed within SEQUIN, requires activities and further developments that go beyond the scope and the lifetime of the project. SEQUIN develops recommendations and devises activities for those next steps which will be fully described in the forthcoming accompanying deliverable D4.2 QoS Implementation.

2. DISSEMINATION STRATEGY FOR SEQUIN

The development of a Europe-wide networking infrastructure supporting co-operative Research and Development across Europe belongs to the key strategic objectives of the Fifth Framework Programme of the EC. SEQUIN project results can contribute here substantial input for the realisation of an advanced infrastructure that helps to put Europe in a position to play a leading role in defining the next generation of networking and application technologies.

SEQUIN addresses end-to-end QoS in IP networks, which is a complex problem that extends to a technical and a policy level. It is necessary that the networking equipment along the complete end-to-end path is capable of supporting the required QoS level but, in addition, it requires the co-operation and the commitments of all involved parties to actually make co-ordinated use of QoS features. SEQUIN approaches IP QoS at a very specific time window. Only recently, equipment for core networks has become available on the market that is capable of actually implementing the DiffServ-based approaches as used within SEQUIN. SEQUIN was able to demonstrate these features for the GÉANT backbone, but it may still take up some time until it can be expected that equipment fully supporting Premium IP is deployed on a wider range in most adjacent NRENs (cp. SEQUIN questionnaire on available networking equipment in participating NRENs).

The high level of coordination necessary for end-to-end QoS introduces a kind of chicken-and-egg problem. Introduction of QoS support requires substantial equipment investment on the part of the network provider and moreover in human resources for training, operation and maintenance. A single provider would be unwilling to take up these risks without corresponding willingness for cooperation on the side of other peering providers. The resolution of the deadlock situation requires that major players start to give strong commitments towards IP QoS in order to create a large enough critical mass to get the transition process started. Though SEQUIN cannot enforce such commitments by itself, the project represents a major step on the way to end-to-end QoS, and project results can provide significant contributions to initialise a transition towards wider QoS support in IP networks on a Europe-wide scale.

The following should be considered as main achievements of SEQUIN:

- it shows technical feasibility of Premium IP in current SoA gigabit networks.
- it demonstrates the safety of the approach for introduction in production networks, i.e. configuration and operation of Premium IP service does not lead to adverse degradation of best-effort production traffic.
- it allows to gain first experiences in service provisioning and in business processes required in the coordination of the involved parties
- it creates a well-founded technical basis to evaluate benefits gained from the introduction of Premium IP against its cost and effort of operation. This information allows NRENs to make informed decisions on their own policy with regard to the adoption of IP QoS services in their service portfolio.
- it outlines a roadmap for the introduction of IP QoS in production networks identifying open issues and areas needing further development efforts, such as e.g. the development and deployment of a supporting QoS monitoring infrastructure.

Taking the impact and relevance of the issues addressed in the project, the consortium considers the task of dissemination of its results as exceptionally important. In order to ensure that all information reaches the intended audience, the project has planned a comprehensive communication strategy that addresses the information needs of each of its target groups, and it has produced material and documentation tailored to their specific requirements. In addition to producing information content and making it accessible through the project website, SEQUIN has adopted an active role in disseminating its outcomes by organising a workshop and through participation in other events where project results have been presented and discussed with a wider audience. The dissemination plan in this report documents the efforts undertaken by the project consortium to reach its target communities.

3. TARGET AUDIENCES FOR DISSEMINATION

The activities and results produced by SEQUIN are of interests to various communities. Target groups for the dissemination of SEQUIN results have been identified. Depending on their relation to the work carried out by SEQUIN and their particular information interests, tailored communication strategies have been developed and there have been planned means of interaction between these groups and the SEQUIN consortium to ensure that each group will be reached appropriately.

The major dissemination groups comprise:

- a) Managerial and policy decision boards of GÉANT and the European NRENs
- b) Network engineers from the European research backbone (GÉANT) and the national research and education networks (NRENs)
- c) Network engineers from campus networks
- d) European researchers and academic networkers whose applications require, or could benefit from, quality of service guarantees from the network.
- e) Researchers and practitioners in the area of network quality of service mechanisms
- f) Vendors and implementers of networking equipment and software, tools for monitoring and measurement
- g) Commercial network operators, Internet service providers,

The first group has the strongest impact on the exploitation of project results. The managerial and policy decision boards of GÉANT and the European NRENs have to decide on investments and allocation of capital and human resources in their network. They make choices on the introduction of new technologies and services within their own domain and have to reach a consensus amongst the interconnected NRENs, to come to a common understanding and establish common practices. This decision process must be based on firm technical evidence and there is a need for thorough validation and clear assessment of potential risks. The recommendations derived from the experience gained in SEQUIN can help them to make informed decisions on their own policy towards QoS. SEQUIN demonstrated the feasibility and safety of IP QoS features in production networks. The adoption of the QoS strategy outlined by the project allows for an approach of gradual roll-out of QoS in the network. SEQUIN is communicating its message by means of internal consulting, giving advice and technology assessment within GÉANT and the participating NRENs. Besides it also addresses the community level of European NRENs to promote the approach towards QoS and to encourage wider commitments for support of these activities.

Network engineers from the European research backbone (GÉANT) and the National Research and Education Networks (NRENs) will have to implement the proposed QoS-enhanced network service in their respective network domains, they need to configure routers, debug and troubleshoot the set-up of the service. They have to process service requests and operate and monitor the network. Similar tasks need to be performed by network engineers from campus networks who have to map the proposed QoS-enhanced service appropriately to their local infrastructure. In addition they must support potential service users in getting access to the service and help to install appropriate configurations of their applications. For these tasks they need education, training and technical reference material; they require a supporting environment and tools for troubleshooting and monitoring.

In SEQUIN, much experience in these tasks has been gained which has been documented in the produced deliverables. Networking engineers from GÉANT and the NRENs involved in the Premium IP trials gained expertise that has already been further disseminated to other groups in the common user trials by supporting them in configuration and operation of their respective environments. Much of this information is currently reworked to become available in a more accessible form under the technical section of the project website. SEQUIN presents under this section recommendations on networking equipment, configuration examples and supporting packages for Premium IP.

European researchers and academic networkers whose applications require, or could benefit from Quality of Service guarantees from the network represent the user group of Premium IP service. This includes, for example, users of audio/video conferencing technology and other real-time collaboration tools, researchers in distributed high-performance computing and GRID environments, and resource-hungry network services run by national and organisational research networks on behalf of their constituencies. In order to reach the user community, an awareness of the service must be created. Users must be informed of service capabilities, conditions for getting access and its terms of usage. They need to know about the application and ordering procedures and about what information is required from them by GÉANT and the adjacent NREN for service provisioning

SEQUIN has taken an active role in reaching its user community, although it must be evident that SEQUIN is not operating on a production level, and this activity is less of a sales campaign. Instead this meant that a careful selection process was initiated to find co-operation partners for testing of the service in its beta-test phase. During the introduction phase, Premium IP had to remain limited to a relatively small number of selected user groups, as there are restrictions on service coverage and the number of service requests that can be handled. Only when provision procedures are further streamlined and have become semi-automated by a supporting environment, will it become possible to handle more service groups. Given the scarcity of resources in this early phase it is currently necessary to focus on finding convincing application examples that are able to demonstrate the full benefits of QoS-enabled networks.

SEQUIN started with four project groups and demonstrated how Premium IP can be provisioned in a multi-domain environment. These activities will be continued within the context of GÉANT. Broader provisioning on a larger scale will depend on a wider adoption of Premium IP by the European NRENs, and an improved supporting infrastructure for service provisioning and QoS monitoring that will reduce the organisational and managerial burden. SEQUIN has produced informative material directed towards user groups and outlined steps that should be taken in order to build up such a supporting infrastructure.

Researchers and practitioners in the area of network Quality of Service mechanisms, such as those participating in other IST projects, contributors to the respective working groups of the Internet Engineering Task Force (IETF), or the Internet2 Qbone community, have a scientific interest in the results of the project. For them it is of interest to get access to project results and outcomes of the experiments performed by SEQUIN. Members of the SEQUIN consortium are actively participating in those forums and there have been presentations and papers at several conferences. There is a close cooperation with the Internet2 group with mutual participation and presentations at organised events. For example the Virtual Internet2 Member Meeting and the SEQUIN workshop. SEQUIN is regularly represented at TERENA networking conferences, and SEQUIN received a timeslot for an invited presentation at QofIS2001. This is the major event organised by the COST263 – Future Quality of Internet Services community. SEQUIN will also present its results at the forthcoming 2nd TEQUILA workshop on Future Prospects for Quality of Service, and there is a feature article planned by the SEQUIN project consortium in a special issue of IEEE Communications Magazine focusing on QoS initiatives in Europe. This is to be published in early 2003.

Vendors and implementers of networking software, router equipment and tools for monitoring and measurement, have commercial interests in the results, in as far as they receive feedback on operator requirements that can be applied for product improvement and in the development of new services and products. During the lifetime of SEQUIN, the consortium had close contacts with Juniper and CISCO, the main manufactures of router equipment deployed at GÉANT and the NRENs. These links helped to get fast support and access to pre-releases. Extensive equipment testing had been performed on site and at vendor labs. Other co-operations included Spirent and Agilent, major manufacturers of measurement equipment. Spirent provided equipment loans that were used in the trials. In addition a co-operation with RIPE has been established to test their active QoS measurement system and feedback was given on requirements for usage in production networks.

Commercial network operators and Internet Service Providers have a strong interest in the possibility of introducing new QoS-enabled services in their networks. Approaches and methods that have been validated in the environment of Research Networks can be modified and transferred into the commercial market. SEQUIN could show the feasibility and practicality of QoS enabled services and much of its approach is amenable to commercialisation in the telecom market. The work of SEQUIN could establish a reference implementation and help to define 'best operational practice' for IP QoS services. Dissemination in this area has been achieved through presentations at conferences, published papers, direct contacts with representatives of the commercial service industry and through information exchange on the level of national research projects.

4. MEANS OF DISSEMINATION

4.1. SEQUIN Web site

A Web site hosted and maintained by DANTE is the official home of the project on the World-Wide Web (<http://www.dante.net/sequin/>). It is the general data repository for all project related information and acts a central reference point and information exchange for all Premium IP related documentation. The web site gives interested users access to Premium IP specification documents, recommendations for implementation and usage, configuration examples, technical requirements and How Tos.

This Web site also contains a password-protected area for access by project members only, which serves as a shared work area for all internal documents produced in the project.

The homepage leads to pages with general description of the project and its goals, participating partners, connected testbeds and information to related work. It is used to distribute official products such as public deliverables and project brochures. A section devoted to the SEQUIN Workshop in Feb 2002 provides access to the presentations on project work and those of participating co-operating projects.

The technical information section is currently undergoing a re-structuring and the formerly distributed organisation of technical information at a second Web site under <http://www.switch.ch/lan/sequin/> is becoming fully integrated into the central site.

4.2. Workshops and other Meetings

The co-operation of campus networks, National Research and Education Networks (NRENs) and GÉANT is required to provide pan-European quality-enhanced network services. Therefore, workshops for network engineers from DANTE, the GÉANT NOC, NRENs, and campus network administrators are considered an important vehicle for dissemination, implementation, and feedback.

4.2.1. SEQUIN Workshop

On February 1 2002, a one day event organised by SEQUIN took place at Hilton Hotel, Schipol Airport. The aims and objectives of this workshop included:

- To disseminate the results of the SEQUIN project to that date.
- To allow the SEQUIN project partners to receive feedback on the work undertaken.
- To provide an opportunity for the academic and research community to express its requirements for network QoS so that plans for the provision of QoS to pan-European user groups can be formulated.
- To initiate wider participation beyond the project partners, and to set co-operation with interested user groups for common experiments in the final phase of the SEQUIN testing programme.

The workshop had an attendance from other IST projects, NRENs and representatives from the telecom and network equipment industry. A main goal for the workshop was to progress the co-operation with potential user groups for service experiments. Groups who had formerly been interviewed on their requirements for QoS services had been contacted again for a potential partnership in the planned testing. Additionally, other newly started IST projects had been invited for participation.

The workshop included presentations on the work done by the project, and presentations by those projects, which had responded positively for a potential co-operation with SEQUIN to act as beta-testers for Premium IP service use. Seven user groups gave an overview on their projects and the planned experiments, from which 4 IST projects could finally be identified as suitable candidates for the user group experiments in SEQUIN. These comprised AQUILA, LONG, DATAGRID and MOICANE. The workshop concluded with a panel discussion, where representatives from router equipment vendors, telecom operators and NRENs gave a positive evaluation of the work performed by SEQUIN. A key success factor was that the project did not just define a QoS service, but was able to demonstrate it as a large-scale implementation.

Further contacts and communication channels have since been established with the user groups and experimentation has started already for two projects. The timescales needed for co-ordination of experiments planned by those projects will mean that most of the final user group experimentation will take place outside of the project timeline of SEQUIN and co-operation will therefore be performed in the context of GÉANT activities.

4.2.2. TF-NGN Meetings

The work items of SEQUIN address essential topics in the technical work programme of GÉANT. The SEQUIN project offered a unique opportunity to pool a critical mass of networking expertise in order to perform the challenging task of addressing end-to-end QoS delivery and set up complex multi party testing scenarios for its validation. Throughout the lifetime of SEQUIN, the work performed was disseminated to other European NRENs not participating in the project. The regular TF-NGN meetings offered an ideal forum to reach a broader range of NRENs and to receive feedback on the taken approach. Presentations by SEQUIN members provided an on-going update on the project progress and offered the opportunity for discussion within the TF-NGN community.

4.2.3. Workshops on European Level

GÉANT APM (Access Port Managers) meetings are held at varying intervals to discuss technical issues concerning the GÉANT backbone network. In particular, issues concerning the interface between the backbone and the NREN infrastructures. These meetings provide an ideal forum to reach the target group of networking engineers from the NRENs and they are an excellent opportunity for the SEQUIN project to present its work, discuss the contributions to the service in terms of network configuration and operation that will be required from the different wide-area networks (GÉANT and the NRENs), and obtain feedback from their network engineers. A first such workshop was held at the September 2001 APM meeting in Paris[13].

4.2.4. Workshops on the NREN Level

NRENs organise annual workshops and conferences on a national level for their user communities. Typically, these activities comprise broader conferences addressing a wider audience, where current research topics from the context of the NREN are presented, as well as special ad-hoc events concentrating on a specific topic. Technical information events provide education and training for staff charged with the management of networking and networking services at connected sites of the NREN.

These events provide a suitable outlet for providing awareness of the availability of Premium IP service to potential user groups, to inform them about local requirements for service access and usage, and to educate and train local networking staff on configuration, set-up and trouble-shooting of Premium service.

National workshops, as a means of dissemination, have already been extensively used by the participating NRENs during the duration of SEQUIN to keep their connected institutions informed on the progress of research for QoS-enabled services. JANET organised a one day QoS Workshop in July 2001 (<http://www.ja.net/conferences/qos/index.html>), which discussed the UKERNA viewpoint on QoS in its European perspective.

Presentations on the work of SEQUIN were made as follows:-

- October 2002 at DFN-Symposium 2001
- November 2001 at the National Technical conference of SWITCH in Zürich
- December 2002 at the Journées RESeaux in Lyon.

There will be a presentation by PSNC at their PIONEER 2002 conference in April and there will be a contribution on SEQUIN results at the DFN Arbeitstagung in May 2002. This is a major national conference for the German academic networking community. Furthermore, SEQUIN will be presented at the 'FM-Bone causerie' organised by Renater in June, and at the GRNET workshop in Q2 of 2002.

Means for dissemination on the National level will especially be used at later stages after the termination of the SEQUIN project when Premium IP will find a wider deployment in the production networks. A detailed QoS implementation plan of each participating NREN will be specified in deliverable D4.2 QoS Implementation.

4.2.5. Concertation Meetings

Synergies have been sought with other IST projects that are currently active in the areas of network Quality of Service, and Diffserv-based mechanisms in particular. In section 6.1, some IST projects for which some form of co-operation had been established are listed.

4.3. Publication in DANTE and NREN Periodicals

Potential users in European research and education institutions, as well as engineers in the campus and other research networks that support them, can be reached through journals and newsletters that are published by DANTE and the individual NRENs. They provide an opportunity to present the broader European point of view of the project, but also evolving services that are specific to individual NRENs.

4.4. Other Conferences and Publications

The work of SEQUIN is of interest to communities outside the GÉANT/NREN constituencies, such as researchers in the field of network Quality of Service as well as operators of other research and commercial networks. The project has identified conferences and scientific periodicals and submitted papers for presentation and publication. Presentations have been given at the Terena Networking Conference (TNC 2001) [11] and at the 2nd International Workshop on Quality of Future Internet Services (QofIS 2001) [12].

4.5. Standards Organisations

Even if SEQUIN does not include the development of new network protocols, standards organisations such as the Internet Engineering Task Force (IETF) are often interested in operational experience with existing protocols. The continuation of the work performed in SEQUIN could produce Internet-Drafts describing its application of the DiffServ architecture to provide services spanning multiple co-operating domains; the specific forms of Service Level Agreements (SLAs) used for our IP Premium

service; or the mechanisms and conventions that permit the interconnection of “pure” Diffserv domains with networks that use separate virtual connections for QoS-enhanced traffic.

4.6. Interviews

In the first phase of the project, several potential user groups were selected by project participants in their respective countries and interviewed on the subject of their requirements for Quality of Service enhanced network services. This has permitted us to identify important dimensions of Quality of Service as perceived by network users, which have been used for a bottom-up definition of Quality of Service in the context of SEQUIN. The interviews also served to disseminate the basic ideas behind SEQUIN into a part of the community described above.

A continuing relationship with some of the interviewees had been maintained, both as a source of input for design decisions and as a target for dissemination activities and as co-operating partners in early trials of the technology.

4.7. Tests involving user groups

After the various options of implementing Quality of Service enhancements had been analysed and a suitable choice been made, the project put focus on the experimental validation of different mechanisms [D3.1]. Some of these tests can already be performed in laboratory settings using local facilities but, at a later stage, the project was to configure an international testing infrastructure, which is composed out of multiple national wide-area testbeds, interconnected by the new GÉANT backbone.

Early tests made use of “synthetic” test traffic, only simulating such traffic profiles, as well as of the real application traffic. H.323 videoconferencing had been chosen as target application and the user groups consisted of experts that were in part co-located with SEQUIN participants, but also partners from outside had been recruited from the TF-STREAM¹ Task Force in TERENA. This constellation allowed to perform tests under a tight control over the complete network. In the user trials of the final phase of SEQUIN complexity has been raised. Test scenarios have been set-up that involve user groups from outside the project and it required co-ordination with NRENs that were not in the SEQUIN consortium. These tests allowed to gain experience in successfully communicating the SEQUIN approach to other parties, and supporting material had been produced that assists in these processes.

¹ TF-STREAM Web site, <http://www.terena.nl/task-forces/tf-stream/>

5. INFORMATION MATERIAL FOR GÉANT PREMIUM IP

A prime dissemination task is to provide the European Research and Education Network community with the information they need to make their respective network domains compliant with the service implementation models developed in the project. In the following, documentation is listed that had been produced for successful deployment of the Premium IP service.

The per-domain traffic handling tasks identified in the implementation model must be converted into guidelines for network configuration and operation for use by the GÉANT NOC, the operators of National Research and Education Networks (NRENs), and the operators of campus networks. The focus is on the integration into current production networks and their operational procedures.

The Premium IP service must also be described in a way that relates to the perspective of users with particular networking demands. The capabilities and limitations of the service must be clearly stated, and examples of envisaged applications have to be given.

The SEQUIN consortium has produced information material which is specifically directed towards service users who plan to use the service and for networking engineers in the NRENs and campus networks, that have to configure the service. Some of the documents are still currently being under revision, but most of the material will become accessible on the web site within the next weeks.

- *Service Specification and Implementation Guidelines*
General Information on the Premium IP model, the service characteristics is found in deliverables GEANT D9.1 [1], D2.1 Add1 [2]
- *SLA & SLS*
Service Level Agreements on QoS enabled services are needed between adjacent NRENs, and on an end-to-end basis with the service users. SEQUIN has developed a generic SLA/SLS template that can be adapted for both uses. Documentation has been produced that addresses the interdomain [3] and the end-to-end [8] aspects, as well as supporting information that helps in setting up between end user and NREN for the provisioning of Premium IP connectivity [7].
- *Premium IP FAQ*
Provides general information for potential users of the service, includes an general introduction, and hints for requesting the service, measuring and debugging, technical background and references for further information and contacts.[10]
- *Guidelines for Capacity Planning and Service Deployment*
The implementation model for Premium IP includes rules for network capacity planning allowing the NREN to determine available capacity to be allocated to Premium IP usage and to decide on the allocation and access of service by user groups [2].
- *Hardware and Software Requirements for Premium IP Implementation*
SEQUIN performed extensive lab testing of router equipment. The experience gained has been documented and will become accessible by the technical website. Network engineers find here requirements on hardware, router interfaces and operating system releases and recommendations on available IP capable equipment.
- *Configuration Examples*
Easy-to-follow rules for setting up IP Premium capacity according to the SLSs on border and interior devices. SEQUIN makes here available its tested configurations used in user trials. The section will expand with the growing expertise derived in further future trials.

- *Premium IP Support on Layer 2 Technologies*
SEQUIN tests involved heterogeneous configuration. Material in this section gives recommendation for use of technologies such as SONET/SDH, ATM, MPLS and IEEE 802.1p.
- *Supporting Material and Packages for Debugging and Troubleshooting*
Includes assisting freeware software tools, Premium IP specific enhancements to tools and small scripts to help in the provisioning and configuration tasks used in the SEQUIN experiments. The packages are made available with accompanying documentation for installation and usage, and example usage scenarios derived from the experiments.
- *Monitoring and SLA Verification*
Guidelines to monitoring QoS features inside a network, in particular the performance of the individual devices participating in the domain's QoS treatment [9].

6. COOPERATING RESEARCH GROUPS

6.1. Other IST Projects

Many IST research projects are currently dealing with network Quality of Service issues. Below is a selection that have been identified for synergies with SEQUIN and with which various levels of co-operation have been established.

6.1.1. GNI (GÉANT)

The new GÉANT network (<http://www.dante.net/geant/>) will be the backbone of the services developed within the SEQUIN project, so close co-operation with this project is self-evident. Besides the participation of DANTE as a lead contractor in both projects, there is also close collaboration between SEQUIN and the GÉANT Test Programme (GTP) performed within the framework of the TERENA Task Force on Next Generation Networks (TF-NGN, <http://www.terena.nl/tf-ngn/>), and several SEQUIN participants have been active in TF-NGN and its predecessors for years.

6.1.2. AQUILA

AQUILA (Adaptive Resource Control for QoS Using an IP-based Layered Architecture, <http://www-st.inf.tu-dresden.de/aquila/>) is concerned with QOS-enhanced end-to-end services. Focus areas include dynamic resource and admission control, business models, and distributed measurement and management.

AQUILA is cooperating with SEQUIN as user group for Premium IP service. Premium IP connectivity between sites in Warsaw and Vienna has been established in early April.

6.1.3. MOICANE

MOICANE (Multiple Organisation Interconnection for Collaborative Advanced Network Experiments, <http://www.moicane.com/>) will set up QoS-capable network islands and try to interconnect them to support networked co-operation for remote experiments. Diverse access technologies such as ADSL, wireless, and IEEE 802.3-class networks will be investigated. MOICANE wants to build a test bed over the GÉANT network and could be one of the pilot users of the IP Premium service defined by SEQUIN.

MOICANE is co-operating with SEQUIN as user group for Premium IP service. Premium IP connectivity between sites in Italy, Portugal and Romania is currently being set up.

6.1.4. DATAGRID

The goal of DATAGRID (<http://eu-datagrid.web.cern.ch/eu-datagrid/>) is to develop and test the technological infrastructure that will enable the implementation of scientific “collaborations” where researchers and scientists will perform their activities regardless of geographical location. The project will devise and develop scalable software solutions and testbeds in order to handle many PetaBytes of distributed data, tens of thousand of computing resources (processors, disks, etc.), and thousands of simultaneous users from multiple research institutions. Data intensive computing applications areas covered by the project are High Energy Physics, Biology and Medical Image processing, Earth Observations

Datagrid has expressed interests to co-operate with SEQUIN as user group for Premium IP service and means for provisioning of Premium IP connectivity to the project are currently under discussion.

6.1.5. LONG - Laboratories over Next Generation Networks

LONG (<http://long.ccaba.upc.es/>) plans to set up a Collaborative Work Environment over an advanced network infrastructure including a mixture of different access (ADSL, CATV, ISDN) and transport technologies. LONG will address issues of IPv4/IPv6 transition, IPv6 and advanced services integration, the interworking of heterogeneous access scenarios and the adaptation of applications to the Next Generation networks.

LONG expressed interests to co-operate with SEQUIN as user group for Premium IP service and means for provisioning of Premium IP connectivity to the project are currently under discussion.

6.1.6. CADENUS

CADENUS (Creation and Development of End-User Services in Premium IP Networks, <http://www.cadenus.org/>) focuses on the general provisioning problem of end-to-end services (such as voice over IP) in IP networks providing "Premium" services through mechanisms such as Integrated Services (IntServ) or Differentiated Services (DiffServ). Areas of co-operation include the interconnection of heterogeneous networks and mechanisms for provisioning and monitoring QoS-enhanced networks.

6.1.7. ATRIUM

ATRIUM (A Test bed of Terabit IP Routers running MPLS over DWDM, <http://www.alcatel.be/atrium/>) is building an MPLS-based, diffserv-capable IP network using Alcatel ATR Terabit routers. The network currently spans three sites in France and Belgium. Topics of interest include QoS provisioning and traffic engineering in both intra and inter-domain cases.

Areas for co-operation between ATRIUM and SEQUIN include:

- Interconnection of the ATRIUM test bed with domains participating in the Premium IP service defined by SEQUIN, enabling experimentation with inter-domain QoS mechanisms.
- Exchange of experience between the operational and network equipment developer perspectives.

There had been a continuous exchange of information between the projects. Provisioning of Premium IP service to user groups having participants within the reach of ATRIUM may use the ATRIUM testbed for getting access to Premium IP service over the GEANT backbone.

6.1.8. COST ACTION 263 - Quality of future Internet Services

Objective of COST 263 is to co-ordinate, from a European perspective, concerted actions amongst involved European participating organisations and research groups active in the field of the Quality of Internet Services. A major event organised by COST263 is the QofIS conference series. SEQUIN has been presented in an invited presentation at the QofIS2001 event Sept. 2001 in Coimbra (PT).

6.1.9. TEQUILA

TEQUILA (Traffic Engineering for Quality of Service in the Internet, at Large Scale, <http://www.ist-tequila.org/>) centres on Service Level Specifications (SLSs) and their definition, provisioning (supported by traffic engineering mechanisms) and monitoring. SEQUIN results will be presented at the 2nd TEQUILA workshop on Future Prospects for Quality of Service May 2002, Maastrich (NL)

6.2. Internet2

The QBone working group (<http://qbone.internet2.edu/>) pioneered deployment-oriented research of Diffserv mechanisms on the Abilene backbone and regional/campus networks. A “Premium” service based on the Expedited Forwarding (EF) behaviour and similar in spirit to SEQUIN’s IP Premium was developed. It has been successfully demonstrated, and the Abilene Premium Service (APS) has been established as a pilot service.

The development of QBone’s Premium service, in particular the challenges encountered in its deployment, have shaped SEQUIN’s IP Premium definition in many ways. In turn, we hope that our experience with the deployment of IP Premium will be valuable to QBone.

A first presentation of our activities in the QBone context is scheduled for the Virtual Internet2 Member Meeting (VIMM) in October 2001. Ben Teitelbaum, the coordinator of the Internet2 QoS activities, attended the SEQUIN workshop and there is a continued exchange of information between US and European activities related to QoS for research networks.

7. LIST OF PUBLICATIONS AND PRESENTATIONS

7.1. Deliverables and other Publications

(<http://www.dante.net/sequin/deliverables.html>)

[1] **[GÉANT D9.1: Specification and implementation plan for a Premium IP service](#)**

M. Campanella, T. Ferrari, S. Leinen, R. Sabatino, V. Reijs, April 2001.

<http://www.dante.net/tf-ngn/GEA-01-032.pdf>

A Premium IP service offering the equivalent of a virtual leased line service on IP level is specified. It is defined on the basis of the Diffserv Expedited Forwarding Per Hop behaviour which is required to offer fixed bandwidth, negligible packet loss and bounded delay and delay variation to traffic aggregates. To deliver an end-to-end service crossing multiple administrative domains, the model is based on a combination of edge-to-edge services offered by each domain. This report outlines mechanisms required on IP routers to implement the service within GÉANT and NRENS. It outlines the tests that the GÉANT working groups will carry out to validate and provide further refinements to the model, in terms of techniques to be used on routers and details of Service Level Specifications between different administrative domains.

[2] **[D2.1 addendum 1: Implementation architecture specification for an Premium IP service](#)**

M. Campanella, October 2001 (work in progress)

This addendum specifies the implementation architecture for the Premium IP service described in Deliverable D 9.1, which aims at offering the equivalent of an end to end virtual leased line service at the IP layer across multiple domains. The architecture is targeted at the GÉANT network and is applicable to each connected NRENS.

The architecture leverages the scalability features of Differentiated Services and takes a pragmatic approach to balance configuration complexity and benefits.

[3] **[D2.1 addendum 2: Service Level Agreements specification for IP Premium Service](#)**

A. Sevasti, M. Campanella, October 2001 (work in progress)

The document elaborates a template for the Service Level Agreement for the Premium IP service. The template is initially targeted for the Service Level Agreements between an NREN and the GÉANT network, but is general enough to be applied between any communicating DiffServ domains in order for them to provide the IP Premium service. It states also the requirements to provide an end to end service on the multi-domain european network.

[4] **[D2.1 Quality of Service Definition](#)**

M. Campanella, P. Chivalier, A. Sevasti and N. Simar, April 2001.

A qualitative and quantitative definition of Quality of Service is needed for implementation in the European networks. This deliverable provides a definition of QoS which is independent of the underlying networking technology. It will sketch the definition of an end-to-end QoS service that can be implemented in a multi-management domain environment across Europe.

[5] **[D3.1 Definition of QoS Testbed](#)**

M. Campanella, M. Carboni, P. Chivalier, S. Leinen, J. Rauschenbach, R. Sabatino, N. Simar, April 2001.

This deliverable provides a description of the international testbed that will be used to validate the architectural models and the technology to be used to provide end-to-end QoS services. It provides a description of the functions in hardware required to provide guarantees on the four parameters which characterise QoS, as defined in Deliverable 2.1, together with a description of the testing activity that will be carried out.

[6] **D5.1 Proof of Concept Testbed**

M. Przybylski, R. Sabatino, N. Simar, J. Tiemann, S. Trocha, December 2001

This deliverable provides an overview of the proof of concept testing carried out to verify the functionality of Premium IP. It outlines tests of basic functionality required from routers and outlines tests carried out in the wide area and connecting real users with requirements for QoS guarantees.

- [7] D6.1 QoS Implementation – Addendum:
IP Premium connectivity between end-users over the GEANT backbone
Afrodite Sevasti GRNET
This document specifies the procedures and the information that has to be collected for the establishment of IP Premium connectivity via GEANT between two end-users, in accordance to the ‘SLA specification for IP Premium service’ (D 2.1-Addendum 2).
- [8] D6.1 QoS Implementation – Addendum: Establishing e2e SLAs across GEANT
Afrodite Sevasti GRNET
This document defines the necessary off-line procedures for e2e SLA establishment and a procedure for the verification of the e2e SLA based on monitoring data.
- [9] D6.1 QoS Implementation – Addendum: Monitoring and Verifying SLAs in GEANT
Athanasios Liakopoulos
This document reviews various IP measurements methods and describes monitoring architectures that may be deployed in large-scale backbone networks. Furthermore, it provides a general framework for monitoring QoS provisioning in GEANT.
- [10] Premium IP FAQ – Frequently Asked Questions
Mauro Campanella
Provides general information for potential users of the service, includes an general introduction, and hints for requesting the service, measuring and debugging, technical background and references for further information and contacts.

7.2. Presentations at international workshops and conferences

- [11] [QoS and IP Premium Service Specification Implementation](#)
M. Campanella, [TERENA Networking Conference 2001](#), Antalya, Turkey, 14-17 May 2001. ([PPT](#))
- [12] [The SEQUIN Project and GÉANT Network - QoS for European Research and Education Networks](#)
R. Sabatino, 2nd International Workshop on Quality of future Internet Services ([QofIS 2001](#)), Coimbra, Portugal, 24-26 September 2001. ([PPT](#))
- [13] [Premium IP Service](#)
M. Campanella, GÉANT Access Port Managers (APM) Meeting, Paris, France, 21 September 2001. ([PPT](#))
- [14] [GÉANT Premium IP Overview](#)
M. Campanella, Virtual Internet² Member Meeting, 4 October 2001. ([PPT](#))
- [15] Premium IP over GÉANT
Simon Leinen, SWITCH & SEQUIN Project,
2nd TEQUILA Workshop on Future Prospects for Quality of Service, Maastricht, NL, May 2002
- [16] SLA definition for the provision of an EF-based service
Afrodite Sevasti et al, 16th International Workshop on Communications Quality & Reliability (CQR 2002), Okinawa, Japan, May 14-16 2002
- [17] QoS-enabled Services over GEANT
SEQUIN consortium, in: Feature Issue on QoS Advances in Europe,
IEEE Communications Magazine, to be published approx. Jan. 2003

7.3. Presentations at TF-NGN meetings

(<http://www.dante.net/tf-ngn/meetings.html>)

- [18] Premium IP, Mauro Campanella, GARR-INFN, 2nd TF-NGN meeting, Muenster Feb. 2001
- [19] Premium IP, Mauro Campanella, GARR-INFN, 3rd TF-NGN meeting, Prague April 2001
- [20] Premium IP, Mauro Campanella, GARR-INFN, 4th TF-NGN meeting, Tromso, June 2001
- [21] Premium IP SLS/SLS, Mauro Campanella, INFN-Garr, Afrodite Sevasti, GRnet, 5th TF-NGN meeting, Athens October 2001
- [22] Update on Results of SEQUIN, Roberto Sabatino, DANTE, 7th TF-NGN meeting, Southampton April 2002

7.4. Presentations at National NREN Events

- [23] SEQUIN Presentation
Nicolas Simar, "FM-Bone causerie" (Renater), 20th June
- [24] QoS-Unterstützung in der neuen Generation von Weitverkehrsnetzen,
Rudolf Roth, 16. DFN-Arbeitstagung über Kommunikationsnetze, Düsseldorf, 22-24 Mai 2002
- [25] Poster Presentation on SEQUIN Trials,
Michal Przybylski PIONIEER 2002 conference, Poznan 23-24 April
- [26] Tutorial on QoS
Mauro Campanella, Journées RESeaux JRES 2001, Lyon, 11 December 2001
- [27] QoS across Europe - First Experiences from the Project SEQUIN
Rudolf Roth, DFN- Symposium, 19 November 2001
- [28] Sequin and Premium IP
Simon Leinen, presentation at SWITCH national technical conference, Zurich, 15 Nov 2001
- [29] Premium IP Service
M. Campanella, GÉANT Access Port Managers (APM) Meeting, Paris, 21 Sep 2001

7.5. Articles in NREN Journals, Newsletters, Brochures, etc.

- [30] SEQUIN – Quality of Service, Project Brochure, DANTE, Dec 2001
- [31] A First Step in the World of IP QoS,
Nicolas Simar, DANTE in Print 43, September 2001.
- [32] Erster Klasse durchs Netz – Quality of Service für das G-WiN,
Rudolf Roth, DFN Mitteilungen 57 – 11 / 2001