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Project Title :	**Traffic Engineering for Quality of Service in the Internet, at Large Scale**

Overview of external liason within (Clustering) and outside IST

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Editor :	**Yves TJoens**
Contributors :	**Lia Tzifa, George Memenios (NTUA), George Pavlou, Ilias Andrikopoulos, Panos Trimintzios (UniS), Christian Duret, Christian Jacquenet (FT-CNET), Carmelo Zaccone, Yves T'Joens (Alcatel), David Griffin, Lionel Sacks, Jon Crowcroft, Dave Lewis, Alex Galis (UCL), Piet Demeester, Pim Vanheuven, Steven Vandenberghe (IMEC)**
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Abstract : This document provides an overview of the position of the TEQUILA project with regard to the host of external activities that both influence the project, and that the project is aimed at influencing itself.
On the level of CoS/QoS provisioning in IP based networks, the IST CADENUS and AQUILA projects are identified as key projects to liaise with, while at the level of international standardisation, the IETF has been identified as key focus point for TEQUILA. Further does this document list possibilities for interaction with national or regional research activities such as Quantum and Internet2.
Active interaction with other IST projects, standardization forums and worldwide IP initiatives will help ensure a cohesive and interoperable advanced networking infrastructure, and the continued interoperability of the global Internet.

Keyword List : IP, IST projects, clustering, IETF

*PU, PP, RE, CO

** Prototype, Report, Demonstrator, other…

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The TEQUILA Consortium consists of:

Alcatel	Coordinator	Belgium
Algosystems S.A.	Principal Contractor	Greece
FT-CNET	Principal Contractor	France
IMEC	Principal Contractor	Belgium
NTUA	Principal Contractor	Greece
RACAL	Principal Contractor	United Kingdom
UCL	Principal Contractor	United Kingdom
TERENA	Assistant Contractor	The Netherlands
UniS	Principal Contractor	United Kingdom

Executive Summary

This document provides an overview of the position of the TEQUILA project with regard to the host of external activities that both influence the project, and that the project is aimed at influencing itself.

To that end, this document covers

- The relation of TEQUILA with its fellow IST projects

  A large number of projects have activities that have affinity with the TEQUILA project. On the level of CoS/QoS provisioning in the network and related definition, operation and management of Service Level Agreements for both intra and inter-domain aspects of IP networking, the CADENUS and AQUILA projects are the foremost important partners to liaise with. This is not to forget projects such as MANTRIP, ANDROID, M3I, FAIN and WINMAN that although not having the wide scope such as TEQUILA, do touch upon aspects of relevance to the TEQUILA project.

  Today, TEQUILA is co-chairing the Key Topic 2 “Definition of QoS/CoS and Service Level Agreements/Specification“ in the concertation mechanism established by the European commission.

- The position of TEQUILA in the context of standardization efforts such as the IETF, ITU and other standard bodies

  The IETF (Internet Engineering Task Force) is the foremost place for standardization of IP related activities. However, today, numerous other initiatives are being started in diverse bodies and newly created forums. The focus of TEQUILA will however be on the IETF, more specifically drawing information from these working groups that cover topics of relevance for the project today, and these may appear over the lifetime of the TEQUILA project. With a number of project participants already highly active in the IETF, the project expects in its turn a large contribution to the IETF community. Of interest might also be the BUDS (Building Differentiated Services Networks) working group at the level of the IRTF (Internet Research Task Force).

- The position of TEQUILA compared to related activities in the US (internet2), Canada (CANARIE) and EU (Quantum TF-TANT)

  The inherent global nature of the Internet enables projects as TEQUILA to liaise directly with other national or regional research activities such as Quantum and Internet2. By means of TERENA, the TEQUILA project has an active liaison to both communities. TEQUILA is expected to participate to events organized by both communities, and by itself will invite these research communities on the TEQUILA workshops that are to be organized over the course of the project lifetime.

The active interaction with other IST projects, important standardization forums and worldwide initiatives for a QoS enabled Internet will help ensure a cohesive and interoperable advanced networking infrastructure, and the continued interoperability of the global Internet

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1 INTRODUCTION

This document provides an overview of the TEQUILA interaction with initiatives from both within and outside the IST.

Within the IST, diverse methods exist for liaison activities, ranging from concertation activities such as information exchange and joint meetings, over joint workshops and clustering projects, the latter with the specific aim to produce very specific output under contractual agreement with the commission.

Outside the IST, a diverse range of activities can be identified that have a close affinity with the work to be carried out by the TEQUILA project.

Chapter 2, gives an overview of IST projects that have been identified to work on IP related subjects, and thereby by nature are potential partners for liaison activities.

Chapter 3, gives an overview of related international efforts for building QoS enabled (research) networks.

Chapter 4, provides an overview of the standardization efforts under way, and indicates the potential interaction of TEQUILA with these standardization bodies.

The next section reviews shortly the project abstract and objectives.

1.1 TEQUILA abstract

The objective of the project is to study, specify, implement and validate a set of service definition and traffic engineering tools to obtain quantitative end-to-end Quality of Service guarantees through careful planning, dimensioning and dynamic control of scaleable and simple qualitative traffic management techniques within the Internet (i.e., diffserv). The following technical areas will be addressed:

- Specification of static and dynamic, intra- and inter-domain SLSs to support both fixed and nomadic users.
- Protocols and mechanisms for negotiating, monitoring and enforcing SLSs.
- Intra- and inter-domain traffic engineering schemes to ensure that the network can cope with the contracted SLSs - within domains, and in the Internet at large.

All specified functionality will be validated through simulation, prototype development and network experiments.

1.2 TEQUILA objectives

The project has five key objectives:

- Study the issues behind, develop architectures for, and propose algorithms and protocols to enable: negotiation, monitoring and enforcement of Service Level Specifications between service providers and their customers and between peer providers in the Internet.
- Develop a functional model of co-operating components, related algorithms and mechanisms to offer a complete solution for intra-domain traffic engineering to meet contracted SLSs in a cost effective manner.
- Develop a scalable approach, architecture and set of protocols for interdomain SLS negotiation and QoS-based routing to enforce end-to-end quality across the Internet.
- Validate the above through both simulation and/or testbed experimentation .
- Use, enhance and contribute to drafts, specifications and standards of the wider international community, participate in IST consensus activities and disseminate TEQUILA results.

2 IST PROJECTS

Within this chapter, an overview is presented of IST funded projects that are identified to be possible candidates for liaison with the TEQUILA project. As stated in the introduction, various levels of liaison can be envisaged, as follows[1]

- *Information exchange potential* : The project produces output that is expected to be useful to the TEQUILA project, or TEQUILA produces output that can be of relevance to the specified project. However, the information is not expected to severely influence either project's objectives or work approach.
- *Joint meeting/workshop potential* : The project works on topics in the same functional space, and as such active exchange of ideas is beneficial to both projects. The information/ideas exchanged may potentially influence the projects approach to specific problem areas.
- *Clustering potential* : The project(s) works on topics in the same functional space, and potential is recognized to leverage the knowledge in both projects to work to a mutual goal. The liaison between both projects will itself be the subject of working towards a well defined set of objectives and implies extra effort deployed by all interested partners, extra funding by the commission is necessary.

The project overviews have been taken from a document that has been distributed in the context of a clustering meeting organised at the commission's premises in Brussels, February 2000.

The following sections give an overview of related IST projects and a shopping list of technical areas, which are common with TEQUILA. Common partners in these projects may facilitate collaboration, which might involve the establishment of web sites and/or email lists for the exchange of information and deliverables. Collaboration between the projects could work towards common "white papers" on selected topics in the context of wider concertation networks and common interest groups. Further modes of collaboration could also be envisioned which would involve a greater degree of collaboration - such as benchmarking of project results, concerted contributions to standards bodies, or large-scale experiments on interworking of project prototypes. Although some forms of collaboration such as the exchange of deliverables could be undertaken within existing funding, more involved forms of collaboration would require additional funding - possibly through new workpackages in TEQUILA or through partners collaborating on other project proposals.

Considering that many of the projects with which TEQUILA may collaborate have only just started, or are awaiting contract signature, or are still under negotiation with the Commission, it is difficult to commit to specific collaboration modes at this stage. It is necessary to examine in more detail the plans of each project to identify specific points or windows of collaboration between the projects in terms of deliverables with similar scope - requirements capture, system architecture and design, prototype development and experimental results. This matter will continually be under review through the concertation meetings organised by the Commission in which TEQUILA will play an active role.

2.1 Aquila

IST-1999-10077

Title : Adaptive Resource Control for QoS Using an IP-based Layered Architecture

[1] Note that the term potential is used frequently to denote that a liaison with other projects will be constantly revised and changes are foreseen over the course of the project.

2.1.1 Abstracts & Objectives

AQUILA defines, evaluates, and implements an enhanced architecture for QoS in the Internet. Existing approaches e.g. Differentiated Services, Integrated Services and label switching technologies will be exploited and significantly enhanced, contributing to international standardisation. The architecture will be designed to be cost-effective and scalable. It introduces a software layer for distributed and adaptive resource control and facilitates migration from existing networks and end-user applications. Technical solutions will be verified by testbed experiments and user trials, including QoS-enhanced on-line multimedia services. Business plans for further exploitation will be studied.

OBJECTIVES :

- To enable dynamic end to end QoS provisioning in IP networks for QoS sensitive applications
- To continuously analyze customer requirements and market situations and to create applicable business plans
- To design a cost-effective, scalable and backward compatible QoS architecture enhancing the Differentiated Services architecture with dynamic resource and admission control
- To enable migration to and deployment of QoS-enabled networks
- To develop a novel resource control layer extending Bandwidth Broker functionality
- To implement prototypes of the QoS architecture as well as QoS based end user services
- To provide a toolkit for migration of end user applications to QoS To create tools for QoS monitoring and management
- To develop and integrate a distributed QoS measurement infrastructure
- To validate the architecture in testbeds and user trials
- To contribute to standardization bodies like IETF, ITU, OMG
- To keep the project open for new concepts and recent developments

2.1.2 Relation to TEQUILA

Both AQUILA and TEQUILA focus primarily on the QoS architecture of the Internet. In that context, and by the very nature and dynamism of the internetworking effort, it is almost inevitable that both architectures should be able to communicate in a standardized way. Therefore, there is a *clustering potential* with AQUILA on the very nature of interdomain SLA negotiation and routing. Note that both TEQUILA & AQUILA are active contributing partners to KT2.

2.2 Cadenus

IST-1999-11017

Title : Creation and Deployment of End-User Services in Premium IP Networks

2.2.1 Abstract & Objectives

The CADENUS project will propose an integrated solution for the creation, configuration and provisioning of end-user services with QoS guarantees in Premium IP networks. The solution is based on the CADENUS framework, which is a structuring set of core functional blocks at the user - provider interface. It will provide service creation and configuration in a dynamic way through the appropriate linking of user related service components (authorisation, registration, etc.) to network related service components (QoS control, accounting, etc.). For the provisioning of end-user services with QoS guarantees, a number of components are required. Some of them have been developed or are under development in standardisation bodies. Other QoS related issues, will be developed in the project. Also, the project will produce recommendations, architectures, mechanisms and policies concerning service configuration and provisioning for both network operators and service providers.

OBJECTIVES : The primary goal of the project is to develop, implement, validate and demonstrate a framework for the configuration and provisioning of end-user services with QoS guarantees in Premium IP networks (eg. for voice over IP). Sub-objectives are: To investigate the system-related architectures for implementing Premium IP network transport services to deliver end-user services with QoS. To specify and realise a framework for end-user services having a range of call features and with QoS guarantees. To develop a system implementing the framework which enables the efficient delivery of services by new enterprises and traditional operators. To trial and demonstrate end-user services with QoS guarantees via this framework. To disseminate the results in standards bodies and to the industry in general.

2.2.2 Relation to TEQUILA

While TEQUILA aims at the overall end to end solution to CoS/QoS in the network, the CADENUS project concentrates on the user – provider interface. Within this area, TEQUILA sees also *clustering potential* on a combined effort to come to a well defined definition of Service Level Agreements and the negotiation and policy control architecture that goes along with it. Note that both TEQUILA & CADENUS are active contributing partners to KT2.

2.3 WINE

IST-1999-10028

Title : Wireless Internet Networks

2.3.1 Abstracts & Objectives

WINE studied necessary technologies to build a fully IP-based optimized QoS aware wireless Internet. WINE believes that true wireless Internet system should be optimized without underlying wireless ATM and as far as possible independent from media. The unique goal of WINE is to study all needed issues in protocol layers to find globally optimized end-to-end solution. Starting from theoretical issues for W-IP networks, WINE conducts simulations and large case studies over research networks to verify theoretical basis. We will then implement the results into three platforms. To facilitate independence of wireless media a W-IP adaptation layer is built that is configurable allowing optimisation for different wireless media. The test-beds are Bluetooth, IEEE 802.11 and Hiperlan.

OBJECTIVES : WINE´s main aim is to build fully IPv6-based globally optimized wireless Internet environment with QoS awareness. To reach this, WINE will have sub-tasks heading to the main aim. First, WINE aims to implement three testbeds with simulation models dedicated for specific environments and current IPv4/v6 implementations. Second, WINE aims for solid theoretical understanding of wireless Internet environments. This knowledge will be verified and based on practical tests on testbeds and simulation models and large scale research networks. Based on previous results we aim to implement true wireless Internet solution that is as far as possible radiolink independent. We are building wireless IP adaptation layer, that is configurable so that it can be optimized for different platforms and links. Above the layer objective is to implement wireless Internet protocol fully compatible to current Internet world.

2.3.2 Relation to TEQUILA

While TEQUILA aims primarily at IP version 4 (fixed) networks, its results on CoS/Qos, should be easily extended to the IP version 6 framework. In that context, the relationship is one of *information exchange potential.*

2.4 InHoMNet

IST-1999-11062

Title : In Home High Speed Multimedia Network based on IEEE1394

2.4.1 Abstracts & Objectives

Abstract : The main objective of the project is the development of a next generation in-home network. It will integrate different technologies with regard to new in-house buses and prototypes of end devices including consumer electronics, white goods, and telecommunication devices in order to provide convergence between the different technologies. The main characteristics of this in-home network will be reliability, high interoperability, self-configuration, usability, scalability, performance, plug and play. A further objective is to provide a set of new applications by utilising the developed in-home network and a new generation of user interfaces. In particular the following prototypes will be developed: Multimedia TV Terminal, IEEE 1394 Satellite Frontend, Multimedia-Domotic Controler, Home Navigator including various Home Services. All devices will communicate with each other over an IEEE 1394 data backbone.

Objectives : The consortium will integrate several digital devices and services in complete network architecture. All devices will communicate with each other over an IEEE 1394 date backbone. In the initial project phase the common architecture and the communication szenarios will be specified. This includes the introduction of all system components and their interfaces.

This architecture will allow various A/V devices, white goods and terminals to be interlinked over a multimedia in-home network and be utilised by innovative applications. Gateway to other bus systems and the external world will complete the system architecture.

In closed relationship to that, the evolution and status of available technolgies, standardisation, available components, and legal constraints will be investigated.As a result of the evaluation the consortium will decide for the most appropriate, marketable solution. Based on these decisions, the middleware architecture e.g.HAVi and common API's as well as guidelines for the user interface developments will be specified.

The common specifications will underlie the specifications of the individual devices and applications. These specific specifications and the corresponding developments will take place simultaneously.

The first prototypes and devices will be integrated for validaton purpose as soon as available. A revision cycle will allow to feedback results from the early evaluation into the specifications as well as into the individual developments.

The developments will be finalised by the integration of the full system in line with the common architecture and the demonstration of the functionality of the in-home network as developed by InHoMNet. The fully integrated system will be finally verified by a number of end-users and the participation of an industrial user. Their feedback report will finish the project.

2.4.2 Relation to TEQUILA

TEQUILA is strongly interested in the network layer requirements of the investigated end user applications. The liaison is one of *information exchange potential*.

2.5 GCAP

IST-1999-10504

Title : Global Communication Architecture and Protocols for new QoS services over IPv6 networks

2.5.1 Abstracts & Objectives

ABSTRACT : High performance networking with guaranteed Quality of Service is one of the major challenges of the next decade. It mandates very important efforts to provide multimedia and multicast communications to wide area advanced users, because the limited mechanisms of UDP and TCP cannot adequately support innovative distributed applications. Furthermore, future architectures will involve heterogeneous networks, as new satellite and terrestrial networks having sophisticated services. As a consequence, GCAP aims at developing for the future Internet two new end-to-end multicast and multimedia transport protocols, embedded in a new global architecture to provide a guaranteed QoS to advanced Multimedia Multipeer Multinetwork applications. In order to rapidly experiment the proposed solutions, an efficient deployment of the communication software will be developed over an industrial IPv6 layer by using a programmable active network based technology.

OBJECTIVES : The objectives of the project are : - to define and evaluate a new end-to-end multicast transport protocol and a new end-to-end multimedia multicast transport protocol for supporting dedicated or specialised applications having guaranteed QoS requirements ; - to define and evaluate a new integrated global multinetwork end-to-end architecture for supporting multimedia and co-operative applications needing guaranteed Quality of Service ; - to propose a design approach to rapidly deploy and use such new protocols, that will be developed on top of the new QoS architecture based on IPv6 and DiffServ, by means of an active network based technology ; - to illustrate the feasibility and evaluate the potential of the advocated approach by conducting two experiments using the national research networks and their European interconnection.

2.5.2 Relation to TEQUILA

TEQUILA and GCAP share the intention to work on end-to-end QoS. However, the focus of GCAP lies on IPv6 and multicast. The liaison between both projects is one of *joint meetings potential*, on the subjects of end to end QoS with diffserv.

2.6 6INIT

IST-1999-12383

Title : IPv6 Internet Initiative

2.6.1 Abstracts & Objectives

ABSTRACT: The objective of the 6INIT project is to prove the business case for Euro-IPv6 by defining implementation and set-up procedures for European IP Networks to offer production IPv6-based Internet services.

The primary areas addressed within this project will be to:

- define operational procedures for IPv6 networks and for IPv4 to IPv6 network and application migration
- interconnection of IPv6 native applications and IPv6/IPv4 networks.
- set up IP telephony services
- implement IPv6 applications (Stock Exchange, Remote Newspaper printing, household Internet IP Plug access).
- initiate the implementation of an IPv6 Internet Service Provider.

OBJECTIVES: The objective of the 6INIT project is to validate the introduction of the NEW INTERNET in Europe based on the new Internet Protocol version 6 (IPv6), which offers a solution for current problems in space address limitation, quality of service, mobility and security. The 6INIT project will lead to the set-up of a first European operational platform providing customers with native IPv6 access points and native IPv6 services.

6INIT is a co-ordinated initiative of the major European Telecom companies, equipment manufacturers, solutions / software providers and research labs that will lead to provide production IPv6 transit service to facilitate high quality, high performance, and operationally robust and secure IPv6 networks in view of wider deployment of European E-commerce and convergence.

2.6.2 Relation to TEQUILA

The liaison is one of *joint meeting potential* on the subject of QoS support in IP networks.

2.7 BASS

IST-1999-11956

Title : Broadband Access Services Solution.

2.7.1 Abstracts & Objectives

ABSTRACT: The BASS project will evaluate a Broadband Information Highway designed to European requirements. It will be scalable, manageable and capable of supporting data as well as voice and video. Its main objectives are

- To specify and develop dial-up to broadband networking using ADSL technology for SOHO and residential users
- To bridge voice, data and video networks and thus provide one network capable of transporting the legacy, traditionally circuit-switched, services as well as the new Broadband services
- To develop a Quality of Service Methodology Framework to ensure that the Telecom Operators can meet the QoS demands of both end-users and service-providers.

The project has two sequential pilot stages, with the second adding functionality and building on the results of the first.

OBJECTIVES:

- The precise definition and implementation of the concept of “Dial-up Broadband Networking”, a mechanism that allows the end-user to select which broadband service with its specific QoS he wants (including but not limited to Internet Access), performing authentication, billing and testing for Quality of service :
- To evaluate solutions for the convergence of voice, data and video networks, that can also transport the legacy, traditionally circuit-switched, services, as well as the new, broadband services

- To design and realise an innovative methodology and supporting for assuring the Quality of Service. This methodology will integrate in the same framework formal methods to verify the design of complex network systems and "platform independent" testing methodologies

2.7.2 Relation to TEQUILA

BASS investigates amongst other things the access to IP QoS services. From that perspective, the project has a close affinity with the access studies being performed within TEQUILA. There exists a clustering potential with BASS on the subject of IP QoS access (including SLA negotiation and the related policy architecture, etc…).

2.8 VideoGateway

IST-1999-10160

Title : A video gateway between the next generation Broadband Internet and the current narrowband internet for live and on-demand access.

2.8.1 Abstracts & Objectives

ABSTRACT: The Proposal is for a system that functions as a gateway between the next generation Internet streaming video standards and the narrowband Internet with is own video streaming standards. The proposed video gateway will also serve as a gateway between video sources coming from analogue video, DVB compresssed video, stored MPEG video coming off video servers and DVD video to the narrow-band Internet. Since the world is moving to digital at an accelerated rate, there is a real need to develop such a gateway with capabilities to handle compressed video already in MPEG format and transcode it efficiently with a maximum quality.

OBJECTIVES: While today's Internet is evolving quickly, the next generation broadband Internet will evolve at an even more accelerated pace. Based on evolving technologies such as cable modems, xDSL, Gigabit Ethernet and ATM, it will enable high quality, MPEG-based video communication. This type of broadband network will transport high quality video content that cannot be streamed over today's Internet, so the Internet will be composed of heterogeneous networks with different bandwidth and protocol capabilities. Our video gate will function as a gateway between video streaming standards currently in use on the narrowband Internet and those to be used by the next generation Internet. It will serve as a gateway between different video sources origination from analogue video (DVB compressed video, stored MPEG video and DVD) and the narrowband Internet. The system will perform dynamic bit-rate adaptation and protocol conversion between networks for live and on-demand audio video applications.

2.8.2 Relation to TEQUILA

TEQUILA is interested in the resulting network layer requirements from the digital video, so, the liaison is one of *information exchange potential*.

2.9 LION

IST-1999-11387

Title : Layers Intern working in Optical Networks

2.9.1 Abstracts and Objectives

The goal of LION is to design and test a resilient and managed transport network realised by an OTN carrying different clients (SDH, ATM, IP-based) with interworking between client-server layers and domains. The identified requirements will be validated in a testbed where IP-routers, ATM and SDH equipment will be integrated. The following objectives will be met: define the interworking requirements between client-server layer networks and domains; define the functional requirements of an IP-based transport network; enhance the functional architecture of an OTN to account for new emerging features; implement, integrate and test NNIs and CNIs, and an "umbrella" management system over a testbed; to test strategies for integrated resilience controlled by an overall OA&M and a management system adopting QoS demanding applications; make techno-economic evaluations of an IP-based network over an OTN.

Network Operators expect the OTN to be a client-independent network supporting different layer networks (e.g. ATM, SDH and IP-based); to bring to fulfilment these expectations requires a focus on the interoperability and interfacing aspect of the OTN. The target of the LION project is to develop and test OTN architectures, providing a support for the convergence of different transport networks carrying services and in a multi-domain environments.

The LION project will first define the requirements for interworking between client-server layer networks and domains. The major achievement will be the implementation, integration and testing of 3R domain and client specific interfaces over an OTN testbed. Integrated strategies for resilience in a multi-layer transport network will be investigated and tested over the testbed. Furthermore an integrated multi-layer transport network requires appropriate and practical OA&M with an integrated management system to guarantee an effective network interoperability: in particular, a proper signalling between client-server layer networks and between administrative domains is required. In this context, the LION project will design and test an “umbrella” management architecture that enables integration of TMN, WBEM, and SNMP on the network level management. To complete the design of the multi-client optical transport infrastructure, techno-economical evaluations will be carried out considering also, as an input parameter, the QoS requirements for Network Operators. The activities carried out in LION will allow the project to contribute to a strong European position in support of standardisation activities (OIF, ITU, ETSI, IETF) and in the telecommunication market in the areas of optical network interfaces, interworking, network management, optimised protocol architectures.

2.9.2 Relation to TEQUILA

TEQUILA assumes a modelling technique for subnetwork layer connectivity between layer 3 aware network elements (routers and switch-routers). Amongst the modelled links is certainly the optical network, based on SDH and or ATM subnetwork layer transmission. Therefore, there is a *joint meeting potential* with LION on the aspects of the link modelling approach in TEQUILA.

2.10NETGATE

IST-1999-10905

Title : Advanced Network adapter for the new generation of mobile and IP based networks.

2.10.1Abstracts and Objectives

One of the many challenges posed by the rapid advancement of telecommunication technology and the emergence of novel network architectures (VoIP, IN, GPRS, UMTS etc) is the need to merge different existing networks in interworking schemes and solve interoperability problems between state of the art equipment and older, legacy systems. Taking into account the series of these new technologies, new issues arise including the question whether it is possible to provide a solution that will be able to “combine” the different “traffic” of each network, and make available the interoperability between them.

Currently in the telecom market there are products that enable interworking between different types of networks. However, most of the offered solutions rely on dedicated network elements and mainly address particular inter-working cases, such as bridging PSTN and IP based networks, without providing flexibility and adaptability to new and evolving standards.

The main goal of this project is to design and develop a novel, low cost, flexible, highly efficient and scaleable system able to operate as a high performance protocol gateway, which will bridge the 'compatibility' gap between different backbone telecommunication network technologies such as ISDN, SS7, IN, ATM, GSM, GPRS and also provide interfaces to IP based networks.

The solution that NETGATE suggests will be able to provide interoperability between wireless platforms (GSM, GPRS) and wired platforms (ISDN, ATM, and IP) as well as an open architecture for future technologies. Moreover NETGATE solution is meant to be fully flexible, as it will provide a single node, which combines different interfaces and makes possible, through the adequate hardware and software components, the inter-working between various telecommunication protocol stacks.

Such a system could be used as:

- A protocol gateway (Advanced Network Adapter), connected to commercial high performance switches that would provide protocol conversion capabilities and custom switching and interoperability functions at a low cost and versatile basis.
- A low cost small switch with interworking and protocol conversion capabilities and clear APIs for the implementation of networking applications (QoS, Management, etc.)
- A low cost evaluation platform that would enable the limited deployment and testing of pilot applications that require an interworking infrastructure, providing the means to Operators for migrating their networks to new technologies including IP, GPRs, UMTS, etc.
- An enhanced Voice over IP (eVoIP) gateway for different Switched Circuit Networks (SCN - such as STN/ISDN/GSM) capable of handling mobility and QoS issues not handled by current VoIP solutions.

In more detail the specific project objectives are:

- To design, develop and integrate the software and hardware sub-systems for providing a modular, generic architecture for interworking units between several networking technologies such as classical IP networks, IP real time traffic (voice over IP), X.25, X.75, frame relay 2 Mbps, SS7, INAP/TCAP to support IN services, GPRS – Intranet (access to private networks), GPRS – ATM. The resulting platform will be expandable and upgradable to support future needs and evolving standards.
- To provide a high performance protocol execution engine, which will be based on a robust run-time executive optimised for protocol execution. This innovative approach combines tried and tested methodologies in a unique way in order to reduce the complexity of the protocols' implementation and optimise performance.
- The software platform on which NETGATE builds, will be open, based on telecommunication standards as SDL, allowing the easy incorporation of new protocol layers defined in SDL or other conventional language. A high level programming interface will facilitate development and integration of various S/W modules.
- To integrate different physical interfaces using open and generic NETGATE Device Driver Interface Specification. Thus, the system network interface boards will be plugged-in in a common way so that the system can accommodate further interfaces (ATM, CATV, and Ethernet) in the future without redesign. The NETGATE device drivers will handle the problems associated with external actions from asynchronous systems (interface boards) completely automatically and independently of the protocol execution engine scheduler.
- To integrate different networking protocol stacks and interface with them in live networks.

- To provide generic protocol translation modules for interworking between the different interfaces, and resource management techniques based on standard technologies (Management Information Bases, etc.).
- To design and implement application level functions including Protocol Conversion, QoS Management, Resource Management and Trace and Monitoring.
- To provide all system components in a way allowing the future smooth migration for new types of interfaces and services.
- To assess the migration of telecom operators to the new types of services and networks.

Particular emphasis will be given on emerging state-of-the-art technologies such as the General Packet Radio Service (GPRS) and Voice over IP (VoIP). Under this perspective the NETGATE prototype will provide the network interfaces and application-level functions and system parameter configuration that would support the operational scenarios of using NETGATE (instantiations of the NETGATE platform) as:

- A GPRS Support Node (GSN) that combine the (SGSN and GGSN) functionality
- An Enhanced Voice over IP Gatekeeper

Deriving from these application scenarios the following objectives support the primary ones:

- To employ QoS mechanisms between IP networks and PSTN and GPRS. IP network provides best effort QoS, unless Resource Reservation Protocols such as RSVP, SIP, SRP, IPv6 are used. Due to this fact NETGATE could be used as an Enhanced Voice over IP gateway where QoS issues need to be taken into account.
- Develop and integrate required protocol stacks and network interfaces (SS7, IP, SS7, GSM/GPRS, IP-GPRS, GSM-BSS) based on existing sub-systems from partners.
- Configure and optimise system parameters for the instantiations of the platform for GPRS and VoIP applications

2.10.2 Relation to TEQUILA

Since NETGATE works primarily at the application layer, TEQUILA is again interested in the transport network layer requirements imposed by both the data and control plane layers investigated by NETGATE. Therefore, there is *information exchange potential*.

2.11 MOEBIUS

IST-1999-11591

Title : Mobile extranet based integrated user services .

2.11.1 Abstract and Objectives

The main objectives of the MOEBIUS project are:

- To integrate an IP based, Mobile Extranet platform, exploiting state of the art technologies in the Telecommunication and in the Information Technology areas
- To use the platform for applications in different sectors, i.e. health care, and remote control, in order to demonstrate the benefits for the end users in public health, business and residential environments.
- To verify, on the overall platform, the inter-operations of the different technologies
- To identify the impact on the terminal side protocols and implement the relevant changes;
- To provide of the security infrastructure at both network and application level;

- To contribute to relevant standardisation bodies.

Recent time has witnessed the explosion in the business world of the concept of Intranet and, as a natural evolution, of extranet, i.e. the use of Internet Communication paradigms to allow access to relevant (private) information to closed used groups from the outside world, over the public Internet. Typical extranet application scenario involves employees of a company, or more generally of a structured organisation (e.g. an hospital) that need to access internal information or services, when physically far from the organisation home premises.

In this context, the MOEBIUS proposal seeks to identify an integrated mobile service platform, i.e. the Mobile Extranet platform focusing on a global co-ordination of micro (i.e., Layer 2) and macro (i.e. Layer 3) mobilities provided by the state of the art and future mobile data systems (SMS, GPRS, circuit data, Cellular IP, etc.) with Mobile IP, as well as on the provision of security mechanisms for this service platform supporting a variety of application sectors.

GPRS will be mainly considered in the experimental phase of the project for Layer 2 mobility, since it is the most attractive solution in the short-medium term. Nevertheless, the Mobile Extranet concept defined in MOEBIUS will not be confined to the use of GPRS and evolutive solutions, such as Cellular IP and UMTS, will be considered by the system study part of the project from architectural and system engineering points of view.

The Mobile Extranet will be defined as an open platform to be supported by many network operators in a cost effective, competitive environment and the users can move amongst the various areas during their communication in a seamless way.

Project experiments will be mainly performed with applications deriving from one of the most mobile sensitive sectors. i.e. the healthcare sectors. Additional applications will be considered in the business and residential areas to prove the generality of the Mobile Extranet approach.

2.11.2 Relation to TEQUILA

As far as the core aspects of the mobile Extranet are concerned, the application requirements are of interest to the TEQUILA project. As such there is potential for *information exchange*.

2.12 GEOCAST

IST-1999-11754

Title : Multicast over beostationary EHF satellites .

2.12.1 Abstract and Objectives

The objective of the GEOCAST (Multicast Over Geostationary EHF Satellites) project is to support IP multicast services over broadcast geostationary satellites. GEOCAST encompasses a satellite emulator with building blocks (terminals, gateways, and satellite) as well as protocol (network, medium and physical layers) definitions, in order to match the needs of multicast systems. A more evolutionary approach to satellite-based broadband Internet connectivity is possible via geostationary satellites. This is due to two main properties of the geostationary satellite:

- Large amounts of bandwidth are becoming available at high frequencies (Ka band and above) for geostationary use, supplementing the use of the traditional C and Ku bands.
- The ability to broadcast to a large area, making support for broadcast and multicast services more straightforward than with the more complex LEO solution.

The GEOCAST project aims at improving the Global Information Infrastructure by alleviating the network load thanks to an intelligent use of the geostationary satellite as a true multicast node. Multicast can be served in a very efficient way by the geostationary satellite due to the broadcast nature of its wireless links.

2.12.2Relation to TEQUILA

TEQUILA models the Internet access links in order to remain independent of any specific access technology. Therefore, the models used by TEQUILA may include a satellite access. The liaison potential is one of *joint meeting* on the modelling of the access network.

2.13MANTRIP

IST-1999-10921

Title : Management testing and reconfiguration of IP based networks using mobile software agents.

2.13.1Abstract and Objectives

The objective of the MANTRIP (Management Testing and Reconfiguration of IP-based Networks using Mobile Software Agents) project is to design, develop, test, validate and provide a set of novel network management applications based on Mobile Agent Technology (MAT), for the efficient management of IP networks. It will exploit the unique features of mobile agents to provide novel toolkits to enable both users and providers to access information on end-to-end performance, to monitor QoS and audit SLA in terms of throughput, availability and delay. Each of these toolkits will consist of a suite of different management tools integrated in common environment. Using the toolkits both users and providers will be able to access information on end-to-end performance and traffic flows, to monitor QoS and audit SLA in terms of throughput, availability and delay. The toolkits will enable retrieval of management information, beyond the scope of devices controllable by the individual network administrations or users. The delivered measurement tools will provide options for evaluating and comparing services and service quality.

2.13.2Relation to TEQUILA

MANTRIP can be seen as complementary to TEQUILA. While TEQUILA concentrates on the theoretical study and implementation of traffic engineering and management aspects of IP QoS-based networks, MANTRIP can be regarded as providing the necessary tools for fulfilling a subset of this goal.Therefore there liaison potential of joint meetings on the management of the IP network.

2.14DRIVE

IST-1999-12515

Title : Dynamic Radio for IP-Services in Vehicular Environments

2.14.1Abstract and Objectives

The overall objective of the DRiVE (Dynamic Radio for IP-Services in Vehicular Environments) project is to enable spectrum efficient high-quality wireless IP in a heterogenous multi-radio environment and to deliver in-vehicle multimedia-services, which ensure universally available access to information and support for education and entertainment. DRiVE tackles two key issues: Inter-working of different radio systems (GSM, GPRS, UMTS, DAB, DVB-T) in a common frequency range with dynamic spectrum allocation, and the co-operation between network elements and applications in an adaptive manner. The DRiVE project will develop an IP-based mobile that ensures optimised inter-working of cellular and broadcast networks on the IP level. The IP infrastructure will support profiles of different future mobile multimedia services, especially asymmetric communication for up- and downlink, uni-, multi-, broadcast, and interactive real time services (e.g. audio and video streaming). The different classes of the multimedia services will be managed according to a suitable quality of service model. The project will also design and implement value-added services that will make use of standardised co-operation of base services. This will ease the rapid introduction and ad-hoc provisioning of new value added services from a set of base services by the content provider.

2.14.2 Relation to TEQUILA

Areas specific to DRiVE that may be of interest to TEQUILA are IP QoS in mobile environments. Liaison potential of *information exchange*.

2.15 Harmonics

Title : “Hybrid Access Reconfigurable Multi-wavelength Otical Networks for IP-based communication Services”

IST 11719

2.15.1 Abstract & Objectives

The main objective of Harmonics is to stimulate the convergence of access networks; supported by realising:

- a dynamically reconfigurable fibre-based feeder network infrastructure, supporting a wide variety of last-mile customer access networks
- a packet-based WDMA/TDMA MAC protocol, offering capacity-on-demand
- a control plane protocols for a range of QoS classes for IP-based services
- novel optical system modules supporting the WDMA/TDMA system concept
- an evaluation of the key functionality’s of the system in a laboratory testbed
- a demonstration of the viability of the system in a field trial involving real-life IP-based services and real users, and to evaluate the users' experiences
- an assessment of the techno-economical aspects of the system concept and alternatives
- the development of evolution strategies leading to convergence of hybrid access networks
- contributions to standardisation processes

2.15.2 Relation to TEQUILA

There may be some interaction with Tequila concerning QoS provisioning in the access network for an IP on WDM network. While Harmonics focuses on the provisioning of the fibre based access networks, for QoS enabled IP, the latter is the very subject of the TEQUILA project. To that end HARMONICS could derive information from TEQUILA.

2.16 Android

Title : “Active Network Distributed Open Infrastructure Development”

IST -10299

This note outlines some points which might be considered interfaces between Android and Tequila. In particular these points are of interest to exploit by the common partner(s), UCL and NTUA, of these projects.

2.16.1 Android Outline

Android project will concentrate on the management of Application Level Active network technology (ALAN). The active network technology focuses on engineering services *into* an IP based network to facilitate building services which cannot purely be facilitated on the edge of the system. As such, the project focuses on the management of Service Control Plain technology for applications which do not impose a hard state on the networks (*i.e.* are not connection oriented). Target scenarios for the project are services such as: dynamic 'active' cache configuration; 'live' trans-coding for audio / video; and 'active' multi-cast. The resources used by services provided by such a system include: network connectivity, node processing, information sources and code. (Each of these may be provided for by different players). The management of an Active Network system needs to involve all these resources. Android will develop a policy based management system to encompass this. Advanced algorithms for highly distributed adaptive resource management will be explored.

2.16.2 Points of Concentration

1. Active network technology could be used to engineer services on top of a QoS based network *a la* Tequila. This would imply co-management of the Tequila and Android management elements. This can impact on **service level agreements**, and the definition of **policies**.

   How can Android request appropriate network services from Tequila? *(the SLA for a client for which elements are hosted inside the network)*

   Can Android co-optimise between network routing and processing node load? *(provisioning of lower level routing info. Or addition of auxiliary constraints)*

2. Control plain traffic (*SS#7 / INAP as was*) needs to be engineered as much as the service traffic. Thus it should be able to define a SLA for an Active Network. Classical issues need to be tackled such as:

   - Accounting for control communications overheads
   - Signalling Storms – with feed back
   - Service traffic moderation / shaping (was call gapping?)

   What is the SLS of an active network to the transport plain? (*i.e. from Android to Tequila)*

3. Future Test-beds: LEARNet / Jif / Terina RN4. Substantial work is in progress in implementing active networking technologies on existing IPQoS based experimental test beds (*i.e.* LEARNet). It is anticipated that this work will be extended from more than one possible source. The integration of functional components from projects such as Tequila and Android can both enhance this experimentations and development programmes as well as adding substantial added value to work of the individual projects.

4. The active network technology can be used as management middleware. This is a very secondary issue for Tequila (*i.e.* there will be a middle ware selection procedure and research in this area is not central to Tequila). However auxiliary research might include 'mirroring' Tequila functionality in active network type technology where appropriate.

2.17 FORM

IST-1999-10357

Title : Engineering a Co-operative Inter-Enterprise Management Framework - Supporting Dynamic Federated Organisations Management

2.17.1 Overview

FORM aims to develop services, systems and components for managing Inter-Enterprise - or Interprise - Services. Interprise Services aim to exploit emerging security and quality of service capabilities of the IP networks to support dynamically configured, process driven relationships between businesses.

FORM is targeting scenarios where Interprise Services are out-sourced to an Interprise Service Provider. This therefore combines features of today's Application Service Providers and Virtual Private Network Providers.

Interprise Management aims to ensure that the Interprise Service is delivered to all customers at low cost and within agreed performance parameters. FORM is developing an open Interprise Management Framework to provide guidance to industry practitioners on the development of Interprise Management Solutions. This Framework aims to be both open and adaptable so as to support an open market in suitable software components. These software components will be structured in a three-tier architecture. It is an aim of FORM to investigate how the use of such a three-tier component architecture will contribute to the evolution of management specific software architectures such as TMN.

FORM will also investigate the impact on management system development of emerging technologies such as XML, CORBA Components and Enterprise Java Bean. This will include addressing how they might co-exist with existing technologies such as CMIP, SNMP and CORBA.

2.17.2 Relation to TEQULA

TEQUILA and FORM have common areas of interest in the management of IP QoS, in particular an initial discussion between the two projects reveal that the following areas might provide fruitful ground for collaboration:

- Service Level Agreement (SLA) definition and management: FORM is addressing areas of IP QoS management that focus on mechanisms to structure, exchange and negotiate SLA is a manner flexible enough to accommodate a range of services from IP QoS level to application services. As TEQUILA will be covering QoS management of IP diffserv based on SLA there may be a potential for beneficial exchange of information and mutual co-operation on the SLA related concertation activities.

- IP QoS testbed: Both projects are implementing management systems that are broadly targeted at services that use IP QoS capabilities. This may provide an opportunity to exchange practical knowledge and expertise in setting up and operating such a testbed, based for example on a network of diffserv router running on Linux PCs.

- Metering: Both projects are addressing metering of IP QoS to some extent. An exchange and understanding of the different approaches taken may be helpful to both projects in verifying and modifying their metering requirements.

As FORM, at the time of writing, has not yet started, these potential areas of collaboration are conditional on the suitable agreement on a detailed work plan within the FORM consortium. As a result some of the above item may not prove to be practical while other new item of potential co-operation may emerge.

2.18 M3I

IST-1999-11429

Title : Market-Managed Multi-service Internet

2.18.1 Abstract and Objectives

M3I aims to design, implement and trial a next-generation system that will enable Internet resource management through market forces, specifically by enabling differential charging for multiple levels of service. Price-based resource management pushes intelligence and hence complexity to the edges of the network, ensuring the same scalability and simplicity of the current Internet.

A trial system will be designed and experimented with. It will enable ISPs to explore sophisticated charging options and business models with their customers. Measurable improvements for end users are: the ability to instantaneously increase quality of service (QoS) by accepting different charging rates; more effective competition in a differentiated services market; real-time feedback and validation of charges.

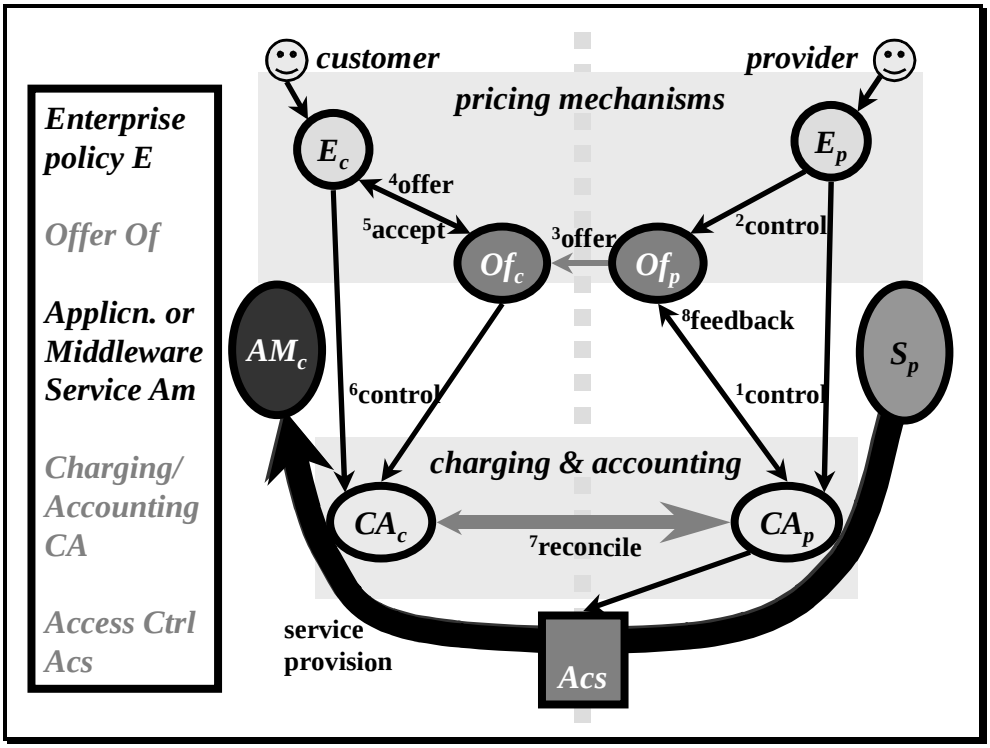
Measurable improvements for ISPs using the M3I system are: the ability to change tariffs and easily communicate them to the end users within seconds; the ability to hold current QoS in the presence of bad congestion effects by communicating price changes in real-time to customers; the ability to charge differentially for applications requiring differing QoS levels, or multicast.

Using the above platform, M3I will show to what extent:

- the demand for Internet services, including various QoS levels can be managed effectively through a pricing mechanism;
- customers can flexibly access both high and low quality services, depending on their particular application needs, instead of being limited to a single best-effort service as in the current Internet;
- end users in corporate organisations can exercise similar choice, but constrained by the policy of the party that is paying;
- ISPs can recover the costs of new services, such as voice and video, that are currently provided by different infrastructures, and hence increase social efficiency by exploiting economies of multiplexing and scale, which in turn will also provide for increased network revenue;
- simple and scalable extensions to current technology can provide the correct incentives for the economically efficient and uncongested operation of the Internet.

Analysis will be performed to show the global stability, fairness and profitability of differential charging and the efficient operation and management of the network, both at the transport and service level.

M3I's initial architecture is shown in the following figure:



Architecture for market managing Internet services

The immediate difference from traditional communications billing architectures is that the customer processes are included on the left of the figure as a mirror image of the provider's on the right. This is because the reaction of the customer's systems is as important as the control of the provider. Also, the customer has an interest in real-time feedback of their account status and in validating that charges are justified.

2.18.2 Relation to TEQUILA

Although TEQUILA is not explicitly considering charging or billing this is clearly an important area for the success of QoS and differential services in the Internet. TEQUILA's functional model and system architecture should be aware of the requirements of charging issues and should leave the required hooks for integration of TEQUILA functionality with charging and billing systems.

At least 3 areas of M3I work will generate possible points of interaction with TEQUILA and other projects in the area of SLAs.

- Work on modelling of network economics may lead to new results in how to provision, and price for, networks for sets of users with sets of SLA requirements. This work could inform algorithms for admission control, traffic engineering, QoS and Constraint Based Routing, and possibly policing and shaping (generally traffic conditioning) used in differentiated service networks.

- Work on distributed metering in M3I is designed to achieve a very high degree of scaling through efficient sampling and filtering. This will also provide a standard interface both to switching and routing elements, and to the service management system, and long term, to the provisioning system. Work on end-system only implementation of the meter/stamp function *may* lead to a component that M3I can offer to other projects that is re-useable. It is quite like the Congestion Manager component in the IETF.

- Lastly, the infrastructure M3I is preparing for testing its ideas may involve technology selections, which we can share with other projects.

A potential topic for a project proposal for additional funding which would incorporate M3I and TEQUILA results might be: User evaluation of pricing, SLAs, and corresponding quality. This is an important area which has to date been largely overlooked except in some work at Berkeley (the INDEX project) and at UCL in several PhD students work.

2.19FAIN

IST-1999-10561

Title : Future Active IP Networks

2.19.1Abstract and Objectives

FAIN aims to develop an open, flexible, programmable and dependable (reliable, secure, and manageable) network architecture based on novel active node concepts. The network architecture will be validated by deploying and exercising interoperable active IP network nodes, in order to support new business models of network control and management and a wide range of distributed applications as envisioned in the future information society. It proposes a new generic architecture for active networks with an innovative integration of active networking, distributed object and mobile agent technology. The architecture is the core of the work, surrounded by effective solutions for service security and autonomous management that are critical for a realistic business adoption. The architecture will be validated and evaluated in Pan-European trials with international links to USA.

The project will develop a novel:

- Active Node and Network architecture
- interoperable AN solution for flexible and secure service provision in IP networks,
- a programmable solution for flexible management provision in active networks,
- distributed solution for dynamic programming of service and management functions

2.19.2Collaboration Opportunities

There are a number of technical areas, which offer potential opportunities for collaboration:

- SLAs: FAIN will use SLA specifications to drive active node provisioning. In this sense there is an overlap with TEQUILA where SLAs are used as input to network planning and dimensioning. Collaboration could take place in the form of common definitions, templates, technologies and mechanisms.
- FAIN will be using policy-based management techniques for the management of active nodes. TEQUILA is considering policy-based management for the management of SLAs, routing and bandwidth provisioning. There is scope for collaboration on techniques for management policies.
- Because FAIN is considering the deployment of protocols and other router intelligence through active network techniques there is scope for a study on the deployment of TEQUILA functionality - advanced routing protocols, PHB mechanisms, etc. - into active node enabled routers through these technologies. This study would clearly be outside the scope of the exiting TEQUILA workplan but could form the basis of a project proposal for additional funding.

- FAIN is interested in providing QoS in IP, but through added value functionality provided through router programmability than through approaches such as diffserv, intserv, traffic engineering etc. There could be scope for comparing QoS-based IP approaches: pure diffserv, TEQUILA-enhanced diffserv and active network based intelligence. This work could take several forms ranging from a paper study comparing attributes of the various approaches, through a benchmarking project to measure specific performance attributes in selected scenarios, to a large-scale integration project which might consider experiments on interworking between TEQUILA and FAIN.
- FAIN is specifically considering the dynamic provisioning of VPNs in IP. TEQUILA and FAIN could collaborate on the SLA negotiation issues involved with VPN definition and management.

2.20 WINMAN

IST-1999-13305

Title : WDM and IP Network MANagement

2.20.1 Abstract and Objectives

The overall WINMAN aim is to realise and demonstrate an open, flexible and Integrated Management solution offering Configuration, Fault and Performance management for IP over hybrid transport networks and supporting Service Level Agreements for IP connectivity. WINMAN will capture the requirements, define and specify an open, distributed, reliable and scalable management architecture, and implement the Integrated Management System of IP and WDM and the Inter-Domain Network Management System for IP over WDM networks. The requirements will include and the architecture will support multi-vendor/ -technology environments and evolution scenarios for end-to-end IP transport from IP/ATM/SDH/WDM towards IP/WDM. WINMAN will set up an infrastructure including several sites to demonstrate and validate the system with real-life scenarios.

The project will address the Integrated Management of IP/WDM networks, between the Network Management and Network Element Management. This is referred to as Vertical Integration. An Inter-Domain Network Management System (INMS) as a sublayer of the Network Management Layer will be developed to support IP-connectivity spanning different WDM subnetwork. End-to-end management of all these transport networks is referred to as Horizontal Integration. The INMS will implement Configuration, Fault and Performance (CFP) Management functions for IP Service Level Agreements. Development will be carried out in two phases in the project.

The areas to be examined include physical topology resource allocation (network planning), path provisioning functionality (automatically monitoring and optimally fitting the IP traffic needs), IP and WDM optimum two-layer routing interworking (involving wavelength translation and optical cross-connections), path tracing, and capacity management in both the physical and logical domains, fault management and restoration mechanisms including alarm correlation between optical and client layers, alarm localisation and multi-layer survivability, performance management including relation of optical layer performance and the client layer performance, traffic monitoring, and identification of the end-to-end QoS requirements.

2.20.2 Relation to TEQUILA

- WINMAN will be using policy-based management techniques for managing the IP layer. TEQUILA is considering policy-based management for the management of SLAs, routing and bandwidth provisioning. There is scope for collaboration on techniques for management policies.

- WINMAN is not explicitly considering the SLA negotiation process, but is assuming that SLAs have already been defined and will use them as the starting point to derive requirements on connectivity at both IP and WDM levels to meet the agreed SLAs. However the fact that SLAs are used in WINMAN to drive network configuration implies that there is scope for common work on the definition of SLA templates, attributes, etc. as well as on the techniques, algorithms and approaches for converting SLAs to configuration actions through planning and dimensioning functions. An aspect of this work might be on the definition of common management interfaces/APIs between the SLA negotiation and network provisioning functions/processes.

- One of the techniques for IP/WDM interfacing in WINMAN will be based on MPLS to wrap the wavepaths over WDM rings. TEQUILA is considering MPLS as one approach for traffic engineering. There is scope for some common work on the use of MPLS for providing engineered paths between IP routers. WINMAN will focus on the electrical/optical interface issues of packet/flow aggregation while TEQUILA can focus on the layer3/layer2 interactions for engineering MPLS paths between diffserv routers. This issue required further investigation to determine the nature of the possible collaborations - exchange of design ideas, benchmarking of traffic engineering approaches or large-scale experiments and integration of prototypes.

- WINMAN is studying and prototyping configuration, performance, and fault management systems for IP - although QoS issues will not be at the forefront of their work. TEQUILA's planning, traffic engineering and dynamic control systems are also concerned with configuration and performance management. There is scope for exchange of ideas on functional models, system architectures, designs and technologies for such IP management and control systems.

2.21 IST liaison and concertation overview

The TEQUILA project has attended the concertation meeting (organized by the commission in Brussels, early 2000) that has led to the identification of a set of key topics for the next generation networks projects.

As can be seen on the list hereunder, TEQUILA has taken the co-chairmanship of key topic 2. To that end, the TEQUILA project will host the virtual meeting room for projects and interested individuals that want to contribute to advances at the level of "Definition of QoS/CoS and Service Level Agreements/Specifications". The virtual meeting room consists of both a web page and dedicated e-mail list. That is accessible through the projects web site.

For more information see http://www.ist-tequila.org/

Key Topic	Title	Chairmen	Project	Commission Coordination
KT1	Active Services			MGF
KT2	Definition of QoS/CoS and Service Level Agreements/Specifications	Martin Potts Yves T'Joens	CADENUS TEQUILA	PdS
KT3	Multicasting (routing, QoS, bandwidth brokering)	Laurent Claverotte	GEOCAST	PJ
KT4	Common object specifications for IP-WDM network management		(LION tbc)	AH
KT5	Specification of Interface between Home network and Public network			CM
KT6	New network architectures and wavelength-packet conversion	Piet Deemeester	OPTIMIST	AH

KT7	Joint demonstrations and large scale experiments			MGF
KT8	Conformance and performance testing services			AK
KT9	Promotion of IPv6	Latif Ladid	6INIT	PdS
KT10	Satellite interworking with terrestrial Internet infrastructures	Paolo Comforto	SUITED	PJ

Commission Contacts (email):

AH andrew.houghton@cec.eu.int
MG merce.griera-i-fisa@cec.eu.int
PdS paulo.desousa@cec.eu.int
AK alkis.konstantellos@cec.eu.int
PJ pertti.jauhiainen@cec.eu.int
CM colette.maloney@cec.eu.int

Further to the above mentioned IST projects, it is to be envisaged that further projects will start within the IST programme that are operational in the IP domain. Specifically towards the end of the project, the TEQUILA project will be looking for opportunities to test the established architecture and related functionality for the provisioning of end to end QoS/CoS in bigger network configurations. The TEQUILA project is therefore interested in seeing projects being established in the RN (research networks) series of work topics.

The formation and potential liaison with these newly established projects will be an ongoing effort within the TEQUILA consortium.

3 INTERNATIONAL EFFORTS

3.1 Quantum / TF-TANT

3.1.1 Quantum and DANTE

The Quantum project follows on from the successful TEN-34 project. Between February 1997 and December 1998, TEN-34 provided the European academic and research community with a stable IP based pan-European network service. The main objective of the Quantum project is the continuation of this stable IP network service but at access capacities up to 155 Mbps. In parallel with the IP service, the continuation service known as TEN-155, provides a managed bandwidth service to the participating national research networks and other specific groups of users.

More and more cooperative development activities in Europe are based on the use of multi-media services, which are only effective if they can rely on high Quality of Service levels which cannot be provided on a loaded 'best efforts' IP network. Protocol enhancements such as RSVP and IPv6, as well as the Quality of Service management inherent in the ATM technology are addressing these issues. It is apparent that for multi-media services to develop on a pan-European scale a new approach to Quality of Service is required. An important element of the Quantum project is to trial the new protocols and technology developments both in a test and a wide area network environment with view to deploying them in the operational TEN-155 service at a later stage.

A Consortium of 16 national research networks, one regional research network and DANTE as the Coordinating Partner are responsible for the organisation of the Quantum project. DANTE is a not-for-profit company which plans, builds and manages the provision of pan-European Internet connectivity for the European research community.

The Quantum Project is co-funded under a joint initiative by DGXIII (Telematics for Applications, Esprit and ACTS) of the European Commission.

3.1.2 The joint DANTE/TERENA Task Force TF-TANT

The Quantum Test Programme (QTP) has the objective of testing and validating new technologies, products and services with a view to introducing them into the operational TEN-155 service at some future date. The purpose of this page is to summarise and publish the developments of the QTP. To make the QTP a success, as many people from the European research community as well as the Quantum project partners should get involved.

A joint DANTE/TERENA Task Force carries out the experiments of the QTP using the Managed Bandwidth Service (MBS) of Quantum. Experimentation under the label of QTP is co-ordinated by DANTE as part of the Quantum project which is ultimately controlled by the Quantum Consortium.

Additional work items under the control of the Task Force will be included to cover both longer term developments and new networking techniques which might not effect backbone services, but primarily the access networks.

3.1.3 Liaison with TEQUILA

TERENA as mutual partner to the TEQUILA and TF-TANT will provide a bridge between the work done in the TEQUILA project, and the research effort in the TF-TANT community. While TEQUILA today aims at building isolated test networks and simulators, joint experimentation over the Quantum network could be explored in the future (however not in scope today). The very nature of research conducted in TF-TANT provides hooks for technical discussion on a European Platform. To that aim, researchers active within TF-TANT will certainly be invited to the workshops organised by TEQULA. Both aiming at improved IP services, mutual workshops will forward the work in both projects.

3.2 UCAID/Internet2

3.2.1 Introduction

The consortium called Internet2 consists of over 150 (mainly US) universities and industrial partners and is aimed at research on the deployment of next generation networks and advanced applications. This means that research is being done on 4 main areas: advanced applications, necessary middleware, new networking capabilities, and advanced network infrastructures. All of this is put together in an operative, QoS-supporting network called the QBone.

The university-led Internet2 and the federally-led NGI are parallel and complementary initiatives based in the United States. Internet2 and NGI are already working together in many areas. For example, through participation in a NSF NGI program, over 150 Internet2 universities have received competitively awarded grants to support connections to advanced backbone networks such as Abilene and the very high performance Backbone Network Service (vBNS). Internet2 is also forming partnerships with similar advanced networking initiatives around the world.

3.2.2 Liaisons with Tequila

The architecture of internet2's QBone, described in the public document [Qbonearch], is concerned of different areas which will also be addressed in the context of Tequila. This goes from bandwidth brokering over monitoring to low-level diffserv specifications. Some dissemination of Tequila results towards Internet2 might be possible through a member or affiliate partner (TERENA) and through the organization of a workshop on the specific topic of QoS enabled IP networking.

The TEQUILA project will seek concensus with the Internet2 community on these issues that impact cross-domain inter operation.

3.3 CANARIE

3.3.1 Introduction

CANARIE Inc. is Canada's advanced Internet development organization. It was established in 1993 and has been working with government, industry, and the research and educational communities to enhance Canada's advanced Internet infrastructure, applications development and use.

Who's involved?

CANARIE is a private, not-for-profit organization supported by Industry Canada, 120 members and over 500 project partners. It has a 26-member board that represents the private and public sectors equally.

How does it work?

CANARIE's mission is to accelerate Canada's Advanced Internet Development and use by facilitating the development of Canada's communications infrastructure; stimulating next generation products, applications and services. It is a cornerstone of the Connecting Canadians initiative as well as an integral part of Canada's ability to maintain its global competitiveness and leadership in information technology.

Over the next five years, CANARIE will continue to stimulate the development and use of advanced Internet infrastructure in Canada. CANARIE will collaborate with government departments, industry, and research and educational institutions to identify special opportunities to enhance the widespread adoption of new Internet technologies, especially in critical sectors such as lifelong learning and electronic commerce. It will focus on the development of applications to address structural barriers that impede widespread adoption of advanced applications.

CANARIE will continue to develop its world-leading, national R&D optical Internet network, CA*net 3, funded in the 1998 federal budget. This will include working with researchers in universities and industry to develop and demonstrate critical new applications of advanced Internet technology. The project is intended to contribute to the creation of a sustainable research network for Canada's research community, and provide equipment manufacturers, carriers and others in the information and communications technology sector with a unique showcase for their cutting-edge technology.

CANARIE has succeeded in enhancing Canadian research Internet speeds by a factor of almost one million since 1993, and has funded over 200 advanced Internet applications projects that involved more than 500 companies and created over 2250 high technology jobs since 1995.

3.3.2 Liaison with TEQUILA

Next to Quantum TF-TANT and Internet2, CANARIE is deployed for fostering research on advanced IP technology. To that aim, the TEQUILA project will seek interaction with the CANARIE effort in establishing cross domain consensus on topics involved in QoS enabled Internetworking.

3.4 Conclusion

The TEQUILA project seeks to actively interact with both Quantum/TF-TANT and Internet2 communities. For CANARIE, the situation is today more unclear.

The active interaction will consist of visiting and presenting at each others workshops. These workshops could lead to detailed discussion on the end-to-end Cos/Qos picture, its derived network functional model and implementation feedback, amongst many other focussed research topics that are to be identified over the course of the project.

4 STANDARDIZATION BODIES

4.1 IETF

4.1.1 Introduction

The Internet Standards process is an activity of the Internet Society that is organized and managed on behalf of the Internet community by the Internet Architecture Board (IAB) and the Internet Engineering Steering Group (IESG).

The Internet Engineering Task Force (IETF) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual.

The actual technical work of the IETF is done in its working groups, which are organized by topic into several areas (e.g., routing, transport, security, etc.). Much of the work is handled via mailing lists. The IETF holds meetings three times per year.

The IETF working groups are grouped into areas, and managed by Area Directors, or ADs. The ADs are members of the Internet Engineering Steering Group (IESG). Providing architectural oversight is the Internet Architecture Board, (IAB). The IAB also adjudicates appeals when someone complains that the IESG has failed. The IAB and IESG are chartered by the Internet Society (ISOC) for these purposes. The General Area Director also serves as the chair of the IESG and of the IETF, and is an ex-officio member of the IAB.

The Internet Assigned Numbers Authority (IANA) is the central coordinator for the assignment of unique parameter values for Internet protocols. The IANA is chartered by the Internet Society (ISOC) to act as the clearinghouse to assign and coordinate the use of numerous Internet protocol parameters.

4.1.2 How can the TEQUILA project benefit from working in the IETF ?

Two different types of liaison with the IETF are envisaged.

Information Use: Make use of the information produced by the workgroup (i.e., I-Ds and RFCs).

Contribution : Document TEQUILA work in Internet Drafts (I-Ds), and distribute them in the necessary working groups.

The IETF is known to start and stop workgroups at a frequent basis, as work topics come up and are finished, therefore, the following list of TEQUILA related workgroups should be under constant revision. Below is a set of workgroups that are active today (March 2000).

4.1.3 Workgroups presently active in the IETF

The IETF specification process is distributed over 8 distinct areas :

Application Area, General Area, Internet Area, Operations and Management Area, Routing Area, Security Area, Transport Area, User Services Area.

The following workgroups are of interest to TEQUILA.

See http://www.ietf.org for further information and workgroup charters.

4.1.3.1 Application Area

none

4.1.3.2 General Area

None

4.1.3.3 Internet Area

4.1.3.3.1 Dynamic Host Configuration (dhc)

The working group has developed DHCP for automated allocation, configuration and management of IP addresses and TCP/IP protocol stack parameters. DHCP is currently a "Draft Standard". Today, the group sees to the progress of DHCP to full standard, reviews new options, defines a new option syntax and sees to the usage of the present option space. It further develops DHCP for IP version 6.

Within the context of host auto configuration for the access to the tequila system. e.g. DHCP may be use to download the SLS.

4.1.3.3.2 Layer Two Tunneling Protocol Extensions (l2tpext)

The Layer 2 Tunneling Protocol (L2TP), defined in RFC2661 is a protocol for tunneling PPP sessions over various network types. The group provides a forum for discussion and development of extensions to L2TP, and actively advances the L2TP base protocol to Internet Standard.

One of the extensions currently under study is the support of diffserv over PPP over L2TP access links. In the context of user roaming, this WG may be of interest for the tequila project.

4.1.3.3.3 Point to point Protocol Extensions (pppext)

The Point-to-Point Protocol [PPP] is a mature protocol with a large number of subprotocols, encapsulations and other extensions. This working group actively advances PPP's most useful extensions to full standard, while defending against further enhancements of questionable value.

In the context of SLS negotiation protocol, this WG may e of interest for tequila. Indeed, as mentioned in the <draft-declercq-ppp-ds-sla-negotiation-00.txt> document, the PPP protocol may be extended to handle the negotiation of SLSs according to a specific formal format (here using IPCP TLVs).

This WG is the place where the standardisation of PPP extensions are made.

4.1.3.4 Operations and Management Area

4.1.3.4.1 Authentication, Authorization and Accounting (aaa)

This working group focuses on development of requirements for Authentication, Authorisation and Accounting as applied to network access.

The purpose behind this is to create a base protocol applicable to a number of specific network access models, including Network Access Server AAA, Mobile IP, and roaming. By creating an architecture and set of base protocols, the amount of work to create specific network access AAA protocols will be reduced. Once the requirements documents had been completed, the working group re-chartered to include work regarding the base protocol. Collecting and satisfying application-layer requirements is not in the current set of AAA WG milestones.

The tequila system has policy enforcement as related to QoS enabled network access as working item. In this context, authentication and authorisation are relevant to the project. Tequila does not have accounting as a primary work item but as AAA will be tackled by the project, this last topic may also be of interest.

4.1.3.4.2 Configuration Management with SNMP (snmpconf)

One the goals of the Configuration Management with SNMP Working Group is to create a Best Current Practices document which outlines the most effective methods for using the SNMP Framework to accomplish configuration management [SNMP]. The scope of the work will include recommendations for device specific as well as network-wide (Policy) configuration. The group is also chartered to write any MIB modules necessary to facilitate configuration management. More specifically a MIB module will be written, which describes a network entities capabilities and capacities which can be used by management entities making policy decisions at a network level or device specific level. As a proof of concept, the working group will also write a MIB module, which describes management objects for the control of differentiated services policy in coordination with the effort currently taking place in the Differentiated Services Working Group.

This WG was announced in January 2000 and has not produced any output yet (as of March 2000). Given that configuration management will be one of the main architectural components of the Tequila framework, it is expected that the work of this WG will need to be closely monitored. Potential contribution is possible within this WG.

4.1.3.4.3 Distributed Management (disman)

The Distributed Management Working Group is chartered to define an initial set of managed objects for specific distributed network management applications and a framework in which these applications and others can be consistently developed and deployed [DISMAN]. A distributed network manager is an application that acts in a manager role to perform management functions and in an agent role so that it can be remotely controlled and observed. Distributed network management is widely recognized as a requirement for dealing with today's growing internets. A manager application is a good candidate for distribution if it requires minimal user interaction, it would potentially consume a significant amount of network resources due to frequent polling or large data retrieval, or it requires close association with the device(s) being managed.

The working group limits its work to distributed network management applications where the main communication mechanism for monitoring and control is SNMP. Future work (and other working groups) may be chartered to investigate other distribution techniques such as CORBA or HTTP. The objects defined by the working group are consistent with the SNMP framework. The working group especially keeps security considerations in mind when defining the interface to distributed management.

Although this WG does not seem to have retired, its main scheduled tasks have been completed. The RFCs produced by this WG (Definitions of Managed Objects for Scheduling Management Operations - RFC 2591 - and Definitions of Managed Objects for the Delegation of Management Scripts (RFC 2592) can be consulted if Tequila is to follow an SNMP-based monitoring and control for distributed network management. It is not clear whether a contribution could be done within this WG.

4.1.3.4.4 Internet Traffic Engineering (tewg)

The *tewg* working group of the IETF aims at defining, specifying and developing principles, techniques and mechanisms for providing traffic engineering capabilities in the Internet. The primary focus of the working group consists in focusing on the intra-domain traffic engineering, which includes control features pertaining to intra-domain routing and resource allocation. The tracks of investigation which will be considered by the working group include MPLS (Multi-Protocol Label Switching), as well as traffic engineering techniques in *diffserv* environments. The *tewg* working group may also consider solutions to address inter-domain traffic engineering, although the official charter remains unclear about the work to be done by the working group on this subject.

The *tewg* working is co-chaired by E. Kern and D. Awduche (UUNet). The relevant documents to consider are described in the following table.

[DRAFT-TE-FRAME-00] A Framework for Internet Traffic Engineering, D. O. Awduche et al., draft-ietf-tewg-framework-00.txt, January 2000.

[DRAFT-TE-OCT-02] Orchestrally Conducted Traffic (OCT), H. Hummel, draft-hummel-te-oct-02.txt, April 2000.

[DRAFT-TE-SURVIVE-00] Network Survivability Considerations for Traffic Engineered IP Networks, K. Owens et al., draft-owens-te-network-survivability-00.txt, March 2000.

[DRAFT-TE-CONCEPT-00] Concept of IP Traffic Engineering, K. Takashima, draft-takashima-te-concept-00.txt, October 1999.

[DRAFT-TE-QOS-00] Traffic Engineering & QoS Methods for IP-,ATM-,& TDM-Based Multiservice Networks, G. Ash, draft-ash-te-qos-routing-00.txt, March 2000.

Traffic engineering is obviously one of the key components of the TEQUILA project, and, from this standpoint, the ongoing specification effort of the tewg working group deserves a careful attention. Nevertheless, the tewg working group appears to be one of the most appropriate place for the TEQUILA project to actually contribute to the standardisation effort, and this would be an excellent opportunity for the members of the project to adopt a leading role in the conduction of such an effort, by producing requirements as well as specifications.

4.1.3.4.5 Network Access Server Requirements (nasreq)

The purpose of this group is to gather and process the requirements of modern Network Access Servers (NAS) with respect to user-based service Authentication, Authorization, and usage Accounting. Services being considered go beyond simple dial-in access, and include Virtual Private Network support, smart authentication methods, and roaming concerns. The common thread is demand-based dynamic services requested within a user authentication model, viewing the NAS as a tool for implementing network policy and security.

While the majority of users passes a Network Access Server, this device is seen as a key component of the TEQUILA system to enforce policy on individual users with regard to QoS enabled access to the TEQUILA system.

4.1.3.4.6 Policy Framework (policy)

The Policy Framework Working Group has three main goals. First, to provide a framework that will meet the needs to represent, manage, share, and reuse policies and policy information in a vendor-independent, interoperable, and scalable manner. Second, to define an extensible information model and specific schemata compliant with that framework that can be used for general policy representation (called the core information model and schema). For now, only a directory schema is defined. Third, to extend the core information model and schema to address the needs of QoS traffic management (called the QoS information model and schemata).

The viability of the framework will be proven by demonstrating that high-level policy information can be translated into device configuration information for network QoS applications. This requires the coordination of the core and QoS schemata, the PIB and MIB being developed in DiffServ, and possibly extensions to COPS provisioning, which is being developed in RAP. A secondary goal of this framework is to show that this general development process can be extended to other application domains. The charter specifically excludes protocol definition and schema attributes or classes that are vendor-specific (although the schema defined in this group will be defined in a way that is extensible by specific vendors).

A policy system will be designed and implemented in Tequila. It is therefore necessary to follow closely the activities of this WG. Its current output, such as the policy framework and its information model and schema, are expected to influence the design of the Tequila system. Potential contributions are possible to this direction.

4.1.3.4.7 Remote Dial In User Service (RADIUS)

The original specification for and implementation of RADIUS was written by Steve Willens of Livingston Enterprises in response to a need outlined by the earlier NASREQ working group, and has been deployed by multiple vendors over the past years. Today, RADIUS is by far the most used policy protocol for the remote access to IP based networks.

Within the context of TEQUILA, updates to policy control protocols will be necessary, it is however unclear as of today if RADIUS will further be pursued within the context of the IETF.

4.1.3.4.8 Remote Network Monitoring (rmonmib)

The RMON MIB Working Group defines SNMP managed objects for remote network monitoring. The objects will monitor multiple network layers and provide fault, configuration, and performance management. Current work includes:

- Application performance measurements – response time and availability of applications (rather than network and computing resources) aiming at capturing user experiences of applications.
- Diffserv statistics collection – to aid DS deployment and performance tuning.
- New support for quickly determining the congested physical ports and links.
- The Token Ring RMON MIB.

SNMP is one of the likely candidates for management protocols and interfaces in the TEQUILA prototypes. TEQUILA needs to monitor the network for many reasons, including: measurements of performance data to monitor SLSs; measurements of traffic load to build up statistics on network usage and to inform network dimensioning and dynamic control of routing and resource management algorithms. For that reason this WG is of interest to TEQUILA for its general network monitoring MIBs but also specifically in its work towards diffserv statistics gathering MIBs. There is already an Internet-Draft on RMON extensions for diffserv (draft-ietf-rmonmib-dsmon-mib-00.txt). TEQUILA may be in a position to contribute to this WG as the TEQUILA system design work on management interfaces progresses.

4.1.3.4.9 Resource Allocation Protocol (rap)

In an open and public Internet (as well as large intranets), maintaining service differentiation inherently depends on mechanisms capable of enforcing (or reporting) operational policy constraints. Towards this end, RSVP message formats contain a place-holder for policy data elements, which may contain information relevant to the network's decision to grant a reservation request. Certain network elements may require assistance in the processing of these policy-data elements and, therefore, may communicate with one or more policy servers, entities specialising in the making of policy decisions.

The purpose of the RAP (Resource Allocation Protocol) working group is to establish a scalable policy control model for RSVP. The working group specifies a protocol for use among RSVP-capable network nodes and policy servers. This work also requires documentation of any extensions to RSVP, which may be necessary in support of this policy control. In addition, the working group defines usage directives for use of the COPS base protocol to support policy information exchange transactions within the framework being standardised in the Policy Framework working group.

In pursuit of the above goals, the working group must expressly avoid specifying policy behaviour. The judgement of specific policies is similarly beyond the scope of the working group. The working group will, however, specify mechanisms that allow for a wide variety of possible policies to be carried out.

The work of the RAP working group is of high interest to TEQUILA. The provisioning of differentiated services based on SLSs, the ultimate objective of the project, requires that certain policies regarding network operation are in-place and enforced. In TEQUILA such policy controls must be provided at the network edges for SLS-based service provisioning. Further, policy controls may exist at the level of traffic engineering for network resource dimensioning. The project will utilise the results of this working group in terms of policy control model specifications and related protocols for basing the architecture of its system. Results from the project will also be fed back as appropriate.

4.1.3.4.10 Roaming Operations (roamops)

The purpose of this group is to develop or adopt procedures, mechanisms and protocols to support user roaming among groups of Internet service providers (ISPs). This is different from, but related to, the work of the IP Routing for Wireless/Mobile Hosts Working Group (mobileip) in that the roamops group is not concerned with the movement of hosts or subnets, but of users. Thus far, the group has produced an architectural document describing the basic mechanisms required to support user roaming, a description of several existing roaming implementations and defined a standard username syntax to support roaming. A repository for documentation describing current roaming implementations is also maintained.

The group further addresses interoperability among ISPs and roaming users by standardizing such items as network usage data exchange (including the content, format and protocols involved), phone book attributes and exchange/update protocols, authentication and authorization mechanisms and exploring in depth the security issues involved with roaming. This work is expected to consist mainly of new or revised procedures and application-layer protocols, in addition to recommendations for the fulfillment of the Internet roaming requirements.

Although the roaming work group is today dormant, they have produced the architecture for dial in roaming. It is to be expected that extensions to support QoS enabled Internet access for roaming users, as defined within the scope of the TEQUILA project will take this architecture as a prerequisite.

4.1.3.4.11 SNMP Agent Extensibility (agentx)

The goal of the SNMP Agent Extensibility Working Group is to define standards-track technology for SNMP Agent extensibility [AGENTX]. The resulting technology specification allows independently developed sub-agents to communicate with a master-agent running on an Internet device.

The technology specification consists of:

- a platform-independent protocol which supports intra-agent communication within a device or local area network (mandatory);
- a MIB module, which, when implemented by a master-agent, allows an SNMP-based management application to monitor and control the intra-agent communication service (optional); and,
- a programmatic interface to the services offered by that protocol (optional).

The working group is explicitly directed to develop a solution which is adequate to achieve transparency with respect to whether a SNMP request is processed by a master-agent and/or one or more sub-agents; simultaneously, the working group is further directed to use good engineering judgement is developing an approach with the smallest reasonable “footprint” to achieve intra-agent communication.

This WG is at the stage where it will be decided whether a new charter proposal will be submitted or the WG be retired. Further investigation is needed to decide if this WG will be useful in Tequila. No potential contribution is foreseen in the context of this WG.

4.1.3.4.12 SNMP Version 3 (snmpv3)

The SNMPv3 Working Group is working towards the next generation of SNMP. The previous work on SNMPv2 did not converge, it ended with two approaches: V2u and V2*. This WG will try to bring together these two approaches into a single SNMP standard to be endorsed by the IETF.

One of the main differences between SNMPv3 and SNMPv1 is security. For most practical reasons, where security is not a major issue the community still uses SNMPv1. Security is not a core issue in TEQUILA so the project will probably stick to SNMPv1.

4.1.3.5 Routing Area

4.1.3.5.1 IS-IS for IP internets (isis)

IS-IS is an ISO IGP standard protocol incorporating extensions to support IP. The IS-IS WG is to work on a set of documents describing current protocol implementation practices and improvements, as well as to propose further extensions to be used within the scope of IS-IS and IP routing. There are two RFCs proposed by this WG:

- "Use of OSI IS-IS for Routing in TCP/IP and Dual Environments" (RFC 1195)
- "Dynamic Hostname Exchange Mechanism for IS-IS" (RFC 2763).

There has been an IS-IS WG Internet Draft on "IS-IS Extensions for Traffic Engineering" (May 1999). This draft extends the IS-IS protocol by specifying new information that an Intermediate System (router) can place in Link State PDUs (LSP). This information describes additional information about the state of the network that is useful for traffic engineering computations. The goals of these extensions is to add more information about the characteristics of a particular link to an IS-IS's LSP, increase the dynamic range of the IS-IS metric, and improve the encoding of IP prefixes.

As Tequila intends to address Traffic Engineering using layer 3 techniques, it is likely that Tequila will want to contribute to this WG.

4.1.3.5.2 Interdomain Routing (idr)

The *idr* working group is in charge of standardising (and promoting the use of) the BGP4 (Border Gateway Protocol, version 4), as well as the ISO (International Standards Organisation) IDRP (Inter-Domain Routing Protocol) protocol for exchanging network reachability information between autonomous systems. From this perspective, BGP-IV has been seen as the protocol designed for TCP/IPv4 networks, whereas IDRP aims at supporting both versions of the IP protocol, so that the *idr* working group has also been chartered to specify a smooth transition strategy between BGP-IV and IDRP.

In practice, the standards documents which have been produced by the *idr* working group so far (RFC and Internet drafts) mainly focus on the specification and the use of the BGP-IV protocol, including the recent extensions to the protocol which clearly allow the support of any other type of network reachability information than strict IPv4 unicast type-of information. Besides, the BGP4 protocol (and its extensions) is the EGP (Exterior Gateway Protocol) which has been massively deployed in the Internet for years: there are no operational deployments of the IDRP protocol (some people claim the IDRP protocol has been abandoned…).

The *idr* working group is co-chaired by S. Hares (Merit) and Y. Rekhter (Cisco Systems), and the following table describes the Internet drafts currently being discussed.

[DRAFT-BGP-09]	A Border Gateway Protocol 4 (BGP-4), Y. Rekhter, T. Li, draft-ietf-idr-bgp4-09.txt, September 1999 (expired).
[DRAFT-BGPEXTv2-05]	Multiprotocol Extensions for BGP-4, T. Bates, R. Chandra, Y. Rekhter, D. Katz, draft-ietf-idr-bgp4-multiprotocol-v2-05.txt, March 2000.
[DRAFT-CAPNEG-06]	Capabilities Advertisement with BGP-4, R. Chandra, J. Scudder, draft-ietf-idr-bgp4-cap-neg-06.txt, March 2000.
[DRAFT-REFRESH-01]	Route Refresh Capability, E. Chen, draft-ietf-idr-bgp-route-refresh-01.txt, April 2000.
[DRAFT-RRv2-03]	BGP Route Reflection : An Alternative to Full Mesh IBGP , T. Bates, E. Chen et al., draft-ietf-idr-route-reflect-v2-03.txt, December 1999.

As far inter-domain traffic engineering is concerned, the enforcement of a BGP4-based routing policy is typically one of the basic topics that will be addressed by the TEQUILA project, and, from this perspective, the engineering tasks which are related to the use of the [DRAFT-BGPEXTv2-05] (e.g. for the deployment of MPLS-based VPNs) and the [DRAFT-CAPNEG-06] (e.g. to advertise traffic engineering capabilities to BGP peers) documents (among others), together with the release of applicability statements documents, fully justify a close look at the idr ongoing specification effort.

4.1.3.5.3 Multiprotocol Label Switching (mpls)

The use of label-swapping based forwarding ("label switching") in conjunction with network layer routing has attracted much attention. Several vendors have proposed techniques based on this paradigm (Cisco Systems Tag Switching, IBM's Aggregated Route based IP Switching (ARIS), Toshiba's Cell Switch Router (CSR) and NEC's Ipsofacto, now renamed to Lcatm). In order to standardise all these IP switching techniques a new IETF working group came to life in 1997. The MPLS working group has since then been working on forming a common technology for IP switching.

Since it's BOF the working group has produced a large number of drafts. First of all there's an architecture and framework document. A group of documents describe MPLS over a number of different link layer technologies: ATM, Frame Relay, LAN media, PPP and more recently an initial approach at supporting optical and SDH equipment. Another group of documents describe the signalling protocols that may be used to distribute labels in a MPLS network. The working group has developed LDP (Label Distribution Protocol). LDP is mandatory for non-traffic engineered LSPs in an IGP. Another document describes to use of BGP to distribute labels. Currently CR-LDP (constrained routed-LDP) is under development. CR-LDP and M-RSVP are considered as signalling protocols for traffic engineering with MPLS.

Currently at lot of interest exist in the usage of MPLS for both traffic engineering and recovery (fast re-routing and protection). Possible contributions of the Tequila project are traffic engineering and recovery techniques that use MPLS technology.

4.1.3.5.4 Open Shortest Path First IGP (ospf)

The OSPF WG is to work on a set of standards improving current SPF-based IGP, as well as proposing further extensions to be used within the scope of IP routing.

RFC 2676 describes QoS routing mechanisms and propose extensions to the OSPF protocol (RFC 2328) to support QoS routes. This RFC is not the work of OSPF WG. The efforts towards the deployment of Constraint-based Routing for intra-domain routing are reflected in this document. The goal of this document is to identify a framework and possible approaches to allow deployment of QoS routing capabilities with the minimum possible impact to the existing routing infrastructure. The focus of this document is on the algorithms used to compute QoS routes and on the necessary modifications to OSPF to support this function. Aspects related to how QoS routes are established and managed are also discussed.

Current works include the following Internet Drafts listed as individual submissions:

- *"OSPF Sub-Areas" (Oct. 1999)*
- *"Traffic Engineering Extensions to OSPF Summary LSA" (March 2000)*
- *"Traffic Engineering Extensions to OSPF" (Oct. 1999)*
- *"Multiple Metrics for Traffic Engineering with IS-IS and OSPF" (March 2000)*
- *"Extensions to IS-IS/OSPF and RSVP in support of MPL(ambda)S" (Feb. 2000)*
- *"Extensions to OSPF/IS-IS for Optical Routing" (Feb. 2000).*

As Tequila intends to address Traffic Engineering using layer 3 techniques, it is likely that Tequila will want to contribute to this WG.

4.1.3.5.5 Routing Information Protocol (rip)

The RIP WG was formed from the RIP Version 2 WG, which was originally chartered to create the RIP-2 standard in order to handle all RIP-related efforts. The RIP WG is chartered to guide and develop the proposals related to RIP-2. Additionally, the RIP WG handles the RIPng protocol, which contains the minimum modifications to RIP-2 necessary to handle IPng.

As RIP is a distance vector protocol, it is unlikely that Tequila will contribute to this WG.

4.1.3.6 Security Area

None identified

4.1.3.7 Transport Area

4.1.3.7.1 Differentiated Services (diffserv)

The Differentiated Services (diffserv) Working Group investigates the differentiated services approach to provide quality of service in networks. It has standardised a common layout for the DS field and has produced RFCs 2474 and 2475 which define the architecture, and the general use of bits within the DS field. The WG has also standardised a small number of specific per-hop behaviours (PHBs), the Expedited Forwarding (EF) PHB and the Assured Forwarding (AF) PHB Group.

The WG has investigated the additional components necessary to support differentiated services, including such traffic conditioners as traffic shapers and packet markers that could be used at the boundaries of networks. The WG will define a general conceptual model for boundary devices, including traffic conditioning parameters, and configuration and monitoring data. The group will also define a MIB and a PIB for diffserv nodes, and an encoding to identify PHBs in protocol messages. It will document issues involving diffserv through tunnels.

The WG will develop a format for precisely describing various Behaviour Aggregates (BAs). The description of a BA contains the specific edge rules and PHB type(s) and configurations that should be used in order to achieve specified externally visible characteristics. In addition, specific descriptions of BAs will be developed and reviewed by a design team. The group will continue to analyse related security threats, especially theft of service or denial of service attacks, and suggest counter-measures.

The objective of TEQUILA project is to provide a complete solution for end-to-end QoS in the Internet through careful planning, dimensioning and dynamic control of scaleable and simple qualitative traffic management techniques within the Internet. Of all emerging QoS frameworks, the Differentiated Services (DiffServ) framework, as specified by the diffserv WG, is considered to be the most scaleable approach towards QoS provisioning in the Internet. By itself, DiffServ cannot guarantee end-to-end communication properties, it is limited to relative characteristics of aggregate flow behaviours at each network hop. In order to provide quantitative service guarantees, the DiffServ architecture should be augmented with intelligent network dimensioning, operational and management functions. Today, this is a wide-open research topic. The main aim of TEQUILA is to make progress in this area and to disseminate our work to standards bodies such as the IETF diffserv WG.

4.1.3.7.2 IP Performance Metrics (ippm)

The IPPM WG has develop a set of standard metrics that can be applied to the quality, performance, and reliability of Internet data delivery services. These metrics have been designed such that they can be performed by network operators, end users, or independent testing groups. It is important to note that the metrics not represent a value judgement (i.e. define "good" and "bad"), but rather provide unbiased quantitative measures of performance.

The IPPM WG defines specific metrics, cultivates technology for the accurate measurement and documentation of these metrics, and promotes the sharing of effective tools and procedures for measuring these metrics. It also offers a forum for sharing information about the implementation and application of these metrics, while actual implementations and applications are understood to be beyond the scope of this working group.

The TEQUILA project will base itself as much as possible on the metrics and measurement methodologies prescribed by this workgroup.

4.1.3.7.3 Integrated Services (intserv)

The transport of Integrated Services - audio, video, real-time, and classical data traffic- over a single packet switching based network infrastructure is the main theme of this working group. Specifically, the purpose of the INTSERV (Integrated Services) working group is to specify the Internet enhanced service model and then to define and standardise certain interfaces and requirements necessary to implement the new service model.

The INTSERV working group focuses on defining a minimal set of global requirements which transition the Internet into a robust Integrated-Service communications infrastructure. Enhancements to individual protocols (e.g., adding additional routing information to routing protocols, or choosing IP queueing disciplines for routers) are left to other working groups, except in those rare cases where detailed definitions of behaviour are critical to the success of the enhanced architecture.

Extending the Internet service model raises a series of questions. The working group focuses on the three problems listed below:

- Clearly defining the services to be provided.
- Defining the application service, router scheduling and (general) subnet interfaces.
- Developing router validation requirements, which can ensure that the proper service is provided.

The work of the INTSERV working group is of interest to TEQUILA, especially the work related to the definition of service requirements. These requirements must be taken into account by TEQUILA for specifying its SLS template. Furthermore the Integrated Service network architecture and capabilities need to be taken into account in the design of the TEQUILA traffic engineering solutions. This is required for ensuring that the developed traffic engineering solutions do not contradict and/or duplicate Integrated Services traffic management functions and for ensuring that service requirements as specified by the Integrated Services service model can indeed be satisfied.

4.1.3.7.4 Integrated Services over Specific Link Layers (issll)

The ISSLL (Integrated Services over Specific Link Layers) working group defines specifications and techniques needed to implement Internet Integrated Services capabilities within specific network technologies.

The Internet Integrated Services design, developed within the IETF by working groups such as INTSERV and RSVP, specifies extensions to the IP architecture which allow applications to request and receive a specific level of service from the internetwork, as alternatives to the current IP best-effort service class. The work of these groups has resulted in technology-independent protocols and specifications. Focused engineering work to define the mapping of these universal specifications onto specific subnetwork technologies is now required. At minimum, the following points must be addressed for each candidate technology:

- Service mappings, defining the way that the link layer technology is used to provide a particular IntServ traffic management service, such as controlled-load or guaranteed-delay.
- Setup protocol mappings, defining how an internet- level setup protocol such as RSVP is implemented or mapped onto the link layer technology.
- Adaptation protocols, used to augment the native capabilities of the link-layer technology, when this is necessary to support required Integrated Services functions.
- Statements of non-applicability, describing which Integrated Service capabilities are not supported by the link layer technology under consideration.

The work of the ISSLL working group is of interest to TEQUILA, especially the aspects related to the operation and service mappings of Integrated Services over and to Differentiated Service networks. The work in the project will enable a Differentiated Service network to look as a link for transporting services ala Integrated Services model. These results will be fed to this working group as appropriate.

4.1.3.7.5 Resource Reservation Setup Protocol (rsvp)

RSVP is a resource reservation setup protocol for the Internet. Its major features include: the use of ‘soft state’ in the routers, receiver-controlled reservation requests, flexible control over sharing of reservations and forwarding of subflows, and the use of IP multicast for data distribution.

The primary purpose of the RSVP working group is to evolve the RSVP specification and to introduce it into the Internet standards track. The working group also serves as a meeting place and forum for those developing and experimenting with RSVP implementations.

Although RSVP is largely independent of the service model, its design does depend upon the overall integrated service architecture and the requirements of real-time applications.

The work of the RSVP working group is indirectly of interest to TEQUILA. The project must include in its assumptions that RSVP requests may reach the network at its edges conveying (individual application or aggregate) QoS requirements. Of increasing interest to the project is the application of RSVP in the traffic engineering context, which is investigated under other working groups. The project may rely on RSVP for signalling and further negotiating QoS requirements at the network edges and for bandwidth reservations for aggregate traffic in the network core as required by the project traffic engineering approach. Extensions to RSVP may also be identified and fed back as a result of project technical achievements.

4.1.3.7.6 Transport Area Working group (tsvwg)

The Transport area receives occasional proposals for the development and publication of RFCs dealing with Transport topics, but for which the required work does not rise to the level where a new working group is justified, yet the topic does not fit with an existing working group, and a single BOF would not provide the time to ensure a mature proposal. The tsvwg will serve as the forum for developing these types of proposals.

The tsvwg mailing list will be used to discuss the proposals as they arise. The working group will meet if there are one or more active proposals that require discussion.

The working group milestones will be updated as needed to reflect the proposals currently being worked on and the target dates for their completion. New milestones will be first reviewed by the IESG. The working group will be on-going as long as the ADs believe it serves a useful purpose.

Today, this workgroup mainly discusses TCP improvements. TEQUILA is aims specifically at the IP layer, without actively investigating the transport layer. To that end the project will follow from a distance the findings of this group.

4.1.3.7.7 Explicit Congestion Management (ecm)

The *ecm* (Explicit Congestion Management) working group was created after a BOF (Birds Of Feather) which has been held in Oslo, during the corresponding IETF meeting, back in July '99. The working group aims at providing a set of congestion control algorithms, and at developing mechanisms for unifying congestion control across appropriate domains.

Such objectives fit pretty well into the scope of a service provider, but the ongoing work appears to be at its very first stage, being conducted by research entities like the MIT (Massachusetts Institute of Technology), so that practical applicability of the ongoing *ecm* effort may not be foreseen before long.

The two main goals of the *ecm* working group are:

- Provide a set of congestion controls algorithms which may be gracefully activated in end systems;
- Develop mechanisms for unifying congestion control across domains.

As far as the deliverables are concerned, the following milestones have been identified:

When ?	What ?
February 2000	Informational RFC on congestion principles (based upon the draft currently being edited by S. Floyd – [FLOYD]).
February 2000	Standards track RFC describing behavior of the congestion manager, possibly based upon the draft currently being edited by H. Balakrishnan – [CM].
February 2000	Standards track RFC describing the API (Application Programming Interface) for communication between CM (Congestion Manager) clients, CM server and scheduler.
May 2000	Informational RFC giving example of one or more schedulers.
June 2000	Working group is disbanded or re-chartered.

The *ecm* working group is chaired by V. Paxson (ACIRI), and the following documents are currently being discussed, although they are not referenced as an officially chartered specification effort.

Documents	Reference	Expiration date
`draft-balakrishnan-cm-01.txt`	[CM]	April 2000
`draft-floyd-cong-00.txt`	[FLOYD]	April 2000

An ECN-capable IP network may improve transactional type of TCP-based traffic, because less retransmits happen with ECN, thus yielding less traffic in the network and a subsequent improvement of the "good-put", upon which an SLA could be defined between the customer and the service provider.

ECN could also be used for diffserv purposes, where the end user has the ability to probe for its target rate faster, so that the ECN end system could help in probing the network faster to reach an optimal/desired bandwidth.

From these perspectives, it could be worth using the network simulator (NS) equipped with the ECN capability within the context of the WP2/WP3 TEQUILA work packages.

4.1.3.8 User Services Area.

None

4.2 IRTF - Internet Research Task Force

The IRTF (http://www.irtf.org/) mission is to promote research of importance to the evolution of the future Internet by creating focused, long-term and small Research Groups working on topics related to Internet protocols, applications, architecture and technology.

The Building Differentiated Services Group (BuDS) [http://www.irtf.org/charters/buds.html] was formed in early 2000 out of the series of Decides BOFs at the IETF. The goal of the group is to identify major issues and investigate solutions for building, deploying and managing predictable, robust, intra- and inter-domain services based on various architectures and per-hop behaviours including those defined by the Differentiated Services IETF WG.

The goals of BuDS are very similar to those of TEQUILA: what services can be built from existing PHBs? Investigation of static vs. dynamic provisioning. Studies of per-domain network characteristics (delay, bandwidth, etc.). Studies into characterisation and measurement of service performance. Interoperability issues across domains. End-to-end service specification. Traffic engineering/capacity management. Network calculus for diffserv. Inter-domain issues for QoS delivery.

One of the main results expected from the group is progress on network calculus for diffserv. The idea is to derive mathematical equations to characterise the network considering SLAs and PHBs. The resulting equations will be used in network provisioning to meet the contracted SLAs.

The WG is not considering routing issues, neither is it considering the deployment issues from an operator's perspective - these are areas where TEQUILA could add value to the WG.

There is clearly scope for collaboration in some form between the BuDS WG and TEQUILA at the level of system designs for deployment; modelling of services; algorithms for network provisioning.

The group is closed with around 15-20 members but two TEQUILA partners are already represented. UCL (Jon Crowcroft) is co-chair of the group and France Telecom is represented through Jim Roberts. Collaboration mechanisms between TEQUILA and BuDS could be through the common members with exchange of documents, presentations, etc. In addition, although IRTF WGs are closed, experts are often invited to specific meetings to present related work. The next meeting is still to be announced but is likely to take place in April/May. TEQUILA plans, foreseen technical issues and initial results (functional model) could be presented at that meeting when plans for further collaboration could be made.

4.3 W3C

http://www.w3c.org/

The W3C was founded in October 1994 to lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability. Initially, the W3C was established in collaboration with CERN, where the Web originated, with support from DARPA and the European Commission. W3C currently has more than 270 commercial and academic Members worldwide, including hardware and software vendors, telecommunications companies, content providers, corporate users, and government and academic entities.

For the moment the W3C is jointly hosted by the Massachusetts Institute of Technology Laboratory for Computer Science [MIT/LCS] in the United States; the Institut National de Recherche en Informatique et en Automatique [INRIA] in Europe; and the Keio University Shonan Fujisawa Campus in Japan. Services provided by the Consortium include: a repository of information about the World Wide Web for developers and users; reference code implementations to embody and promote standards; and various prototype and sample applications to demonstrate use of new technology.

4.3.1 W3C Domains

Leading the evolution of technology as dramatically in flux as the World Wide Web is a challenging task indeed. W3C is a unique organization, well adapted to today's fast-paced environment. Its mission is to realize the full potential of the Web: as an elegant machine-to-machine system, as a compelling human-to-computer interface, and as an efficient human-human communications medium. In order to achieve these goals, W3C's Team of experts works with its Members to advance the state of the art in each of the four Domains: User Interface, Technology & Society, Architecture, and the Web Accessibility Initiative. Each Domain is responsible for investigating and leading development in several Activity Areas. Activity areas include the DOM: Document Object Model, HTML, HTTP, Metadata (RDF, PICS), Multimedia, XML Extensible Markup Language and many others. In the XML activity area the XML Schema specification is of main interest for Tequila and will be considered if XML is to be used in the description of SLS's.

4.3.2 Recommendation Process

Specifications developed within the Consortium must be formally approved by the Membership. Consensus is reached after a specification has proceeded through the review stages of Working Draft, Proposed Recommendation, and Recommendation. Below there is a list describing the various documents that the W3C produce.

- **Notes**. Note is a dated, public record of an idea, comment, or document. A Note does not represent commitment by W3C to pursue work related to the Note.
- **Working Drafts**. A Working Draft represents work in progress and a commitment by W3C to pursue work in this area. A Working Draft does not imply consensus by a group or W3C.
- **Candidate Recommendations**. A Candidate Recommendation is work that has received significant review from its immediate technical community. It is an explicit call to those outside of the related Working Groups or the W3C itself for implementation and technical feedback.
- **Proposed Recommendations**. A Proposed Recommendation is work that (1) represents consensus within the group that produced it and (2) has been proposed by the Director to the Advisory Committee for review.
- **Recommendations**. A Recommendation is work that represents consensus within W3C and has the Director's stamp of approval. W3C considers that the ideas or technology specified by a Recommendation are appropriate for widespread deployment and promote W3C's mission.
- **Relation to TEQULA**

4.4 Distributed Management Task Force (DMTF)

The Distributed Management Task Force is a non-profit corporation dedicated to developing, promoting and facilitating collaborative industry technical standards and interoperability in desktop and enterprise management for hardware and software. DMTF focuses on the development, adoption and unification of management standards and initiatives for desktop, enterprise and Internet environments.

DMTF changed its name from Desktop Management Task Force to Distributed Management Task Force in May 1999. After the development of the Desktop Management Interface (DMI) standard for desktop management, the DMTF has evolved its mission to address distributed management through the use of its Common Information Model (CIM) standard. Over the last year, the DMTF has taken on enterprise focused industry initiatives and standards such as the Web Based Enterprise Management (WBEM) initiative, the Directory Enabled Networks (DEN) initiative and pioneered the use of eXtensible Markup Language (XML) as the transport encoding for WBEM. The basis for this collaboration and integration is due in large part to the DMTF's CIM standard, which facilitates the common understanding of management data across different management systems. CIM is an implementation neutral schema for describing overall management information. CIM serves as the basis for the IETF Policy Working Group's core model, the starting point for the design of their core policy schema. There is also a lot of work underway in many working groups of the DMTF like the DEN WG, the SLA WG and the Networks WG, which fits nicely with the intent of the Policy WG of the IETF.

It is within TEQUILA's intentions to study existing policy frameworks and distributed management standards for possible use in the project. It is, therefore, expected that the work of DMTF will have an impact on relevant TEQUILA choices.

4.5 ADSL forum overview

4.5.1 What is the ADSL Forum?

The forum [ADSL] was formed in 1994. The creation of this forum has as intention to help telephone companies and their supplier to realise the vast market the DSL technology represent.

Indeed, copper telephone lines are everywhere and they are nowadays nearly one billion lines. Today they connect telephones, fax machines and computer at the low speed of 56K for modems, 128K for ISDN line. With the DSL technology these data rate transfer will speed up to 9 megabits per second, 300 times faster than modems, 70 times faster than ISDN, removing the last bottleneck to high speed access for the Internet, corporate LANs, video on demand and numerous of high speed consumer applications.

4.5.2 Objectives of the forum.

The assistance provided by the forum is twofold: technical and marketing.

4.5.3 Marketing program

The purpose of the marketing program is to attempt to un-complicate DSL's inherent technical complexity and distribute the information. To achieve this, the forum produces public output which mixes the tutorial with the promotion of the DSL technology.

As an example the forum's public website offers, on one hand, short explanations of all DSL technologies, the system environment for DSL, and the basic features of the DSL market. Whereas, on the other hand, it also follows market dynamics such as service deployments and trials worldwide. Moreover it tries to provide an opinion on the market's general frame.

4.5.4 Technical program

The purpose of the technical program is to focus on the system features, without which the DSL technology could not perform its high transmission data rate.

Some of those features are protocols, connections for terminals, home networks but also for access networks that concentrate traffic, network management to install, configure and maintain but also migration towards DSL systems.

Currently, the Forum's formal technical work is divided into seven areas; each dealt with in a separate working group within the technical committee:

- ATM over ADSL (including end-to-end architecture and transport aspects)
- Voice over DSL (VoDSL)
- Operations & Network Management
- Testing and Interoperability
- Symmetrical DSLs
- Support to the Emerging DSLs Study Group (incl. VDSL)

Each area develops T*echnical Reports* (TR) through a working technique called *Working Texts* (WT) which are 'web documents' that capture and organise work in progress. As work completes, the Working Text becomes a Technical Report.

These TRs are subject to membership approval, which is then made public (dissemination of the information) and distributed by the forum to interested parties. In many cases, the forum identifies a particular requirement for DSL, and then advises another standard body of this requirement, in the hopes that it will take appropriate actions.

4.5.5 Liaisons with Tequila

The interaction between the forum and Tequila may be twofold. From one side, Tequila may have to take ADSL forum architectures and recommendations into consideration. And from the other side, Tequila may feed the ADSL forum concerning CoS/QoS, SLS specification and negotiation for the access network and even Policy and Accounting or network management.

Currently, they are already a couple of documents that are issued by the forum and which may be of interest as described below.

In relation with the Service Network Architecture Group (SNAG). The SNAG considers the most likely applications for ADSL services as Internet access and remote LAN access. It has defined a list of generic requirements of an end-to-end ADSL network. These requirements are described and then broken down in terms of how the requirement specifically affects the User, the Network Access Provider (NAP), the Network Transport Provider (NTP) and the Network Service Provider (NSP).

> E.g., TR 10 [TR010] outlines architectural requirements and reference models for ADSL services and service providers

In the context of ADSL access networks. Indeed, the forum defines several ADSL based access architecture and a set of technical recommendations concerning those architectures.

E.g., TR 12 [TR012] specifies an interoperable end-to-end architecture (based on PPP/ATM /ADSL model) to support broadband service over ADSL systems. It also discusses End-to-end Service Requirements. TR12 has classified those requirements in two categories: access configurations and functional requirements. Access configurations address the types of destinations to which the network provides connectivity. Functional requirements are specific capabilities provided by the network to support applications. TR12 also points out the fact that some deployment scenarios may see the access network provider as a different entity from the service provider.

In the context of the customer premises, the forum defines means of connecting end-user's PCs (or other device) and end-user's LAN to the Internet through high-speed networks. As TEQUILA has as objective to offer end-2-end QoS and depending on its definition, it may be of interest to interact with the users network environment.

E.g., TR 18 [TR018] provides a framework which examines different CPE network architecture. It presents a set of requirements to clarify the network architecture issues and the needs of the CPE network architecture. TR 18 presents requirements for extending the high-speed access provided by ADSL through a home distribution network. This home distribution network extends the ADSL access system to the end-user's PC and is critical to enable users to take advantage of high-speed link offered by the ADSL technology.

In the context of Core Network Architectures which support broadband service over ADSL systems.

E.g., TR 25's [TR025]scope is to specify recommendations to the Core Network infrastructure, its associated protocols and interfaces to support the customer premises for application to access the legacy network. By Core Network, TR 25 means one or more network entities inter-working together to provide the differential transport services between the customer premises and the service providers. In section 5 of TR 25 introduces without naming it the notion of service contract (SLS) between end-user and service provider.

"The Core Network operator **MUST** be equipped with effective tools to support the service provisioning and selection between the Service Provider and the user as depicted in Figure 1. The service provisioning **MUST** exist between Service Provider and end user. The mechanism of transporting the service provisioning information to a user **SHOULD** be automatic without the user's intervention, so that user can access a service offered by an NSP based upon the received service provisioning information."

In the context of broadband services (e.g. Voice over DSL) closely bound with the notion of CoS/QoS and end-to-end using ADSL technology.

E.g., WT 43 [TR043] specifies an interoperable end-to-end architecture to support broadband voice and data service over DSL systems.

In the context of CPE auto-configuration.

E.g., WT 48 [TR048] defines a set of parameters to be used for configuring and/or provisioning of ADSL customer premise equipment (CPE) connection parameters, and recommends protocols for the transport of these parameters. WT 48 also describes an initial, but not complete, set of DSL service deployment scenarios from which the parameters are partially derived.

4.6 ITU-T

4.6.1 Abstract

The ITU-T is getting more and more involved in the Internet standardisation area. Some Study Groups such as SG8 and SG16 that are in charge of service definition (such as fax or multimedia applications) already developed a fruitful cooperation with the IETF. Subjects such as telecommunication networks management and interoperability, numbering and addressing, traffic engineering or quality of service definition in connection oriented networks has a long tradition within ITU-T. The explosive growth of Internet has induced the SG13 in charge, among other subjects, of the standardization of B-ISDN and Global Information Infrastructure "GII" to start the "IP project" and coordinate the activities of ITU-T on IP-based networks. Draft Recommendations that may be considered as an input to the Tequila project are already on the track. Conversely, the results of the Tequila project may be an input thanks to the contributions of the project partners who are members of ITU-T.

The IP Project prefigures an important increase of the efforts of ITU-T in the IP standardization area that will be taken into account for the next 4 year Study Period which starts on year 2001. It is too early to forecast the outcome of the World Telecommunication Standardization Assembly "WTSC" that will take place in October 2000. Nevertheless, there is no doubt that the efforts put on the Global Information Infrastructure in line with previous B-ISDN activities will shift towards IP-based networks and services.

Thus, the ITU-T will be a good place to disseminate the results of the Tequila project either:

- Indirectly through the transfer of the results gained in IETF working groups towards the ITU-T
- Directly through the contributions of the Tequila partners who are also members of the ITU-T,

once the list of Questions will be established and allocated to the Study Groups set up for the next 2001-2004 Study Period.

4.6.2 ITU-T Present Status

ITU-T has a more than one-century background in the standardization of telecommunication. As an example, in the networking area, Recommendations such as:

- E.600 - Terms and definitions of traffic engineering,
- E.701 - Reference connections for traffic engineering,
- E.801 - Framework for service quality agreement,

are considered as a valuable input within the relevant traffic engineering working groups of IETF. However, these Recs. are restricted to ISDN (or more generally connection oriented networks) and were delivered respectively in 1993, 1992 and 1996. Thus, they don't address IP networks and there was no more work on these subjects during the current 1997-2000 study period.

The explosion of IP-based network and services has induced the ITU-T either to take into account the IETF output or to progressively shift from ISDN or B-ISDN related activities to IP-based ones.

The "IP project" has been recently launched by the SG13. Extracts of the present works and goals of ITU-T [IP-NET] are given below:

Interoperability of networks and of applications is becoming an increasingly important aspect. The interaction of IP based networks and telecommunications networks for the purpose of gaining access to Internet, or other IP network applications, and the need for the interoperability of IP-based services and telecommunication services means providing real time Internet or other IP based multimedia services with the speed, capacity, ease of use, reliability and integrity of the public telephone networks in use around the world. These are aspects of telecommunication network standardization in which the ITU-T has an excellent track record.

Although the ITU-T and the Internet Engineering Task Force (IETF) are collaborating in a number of areas, given the new industry emphasis on Internet and IP structured signals, it is our view that this collaboration must be strengthened within the context of changes in work emphasis and direction within the ITU-T on IP based networks. Both the ITU-T and the IETF will play key roles. However, in our view neither the IETF nor the ITU-T will be able to adequately address this area independently. For example, the IETF strength lies in the protocol and application areas, whereas the ITU-T has a great deal to offer in the areas of architectural, network interworking and network evolution.

These aspects have been considered by PP98 in adopting Resolution COM 5/14 (Internet Protocol (IP)-based networks). The PP98 Resolution considers:

- that studies have already started in ITU-T on IP-based network issues, including service interoperability with other telecommunication networks, numbering, signaling requirements and protocol aspects, security and infrastructure component costs; and

- that general cooperation arrangements between ITU-T and the Internet Society (ISOC) and its Internet Engineering Task Force (IETF) have recently been established which encourage the ITU-T continue its collaborative activities on IP-based networks with ISOC/IETF.

In this respect the next WTSA will be in the year 2000 at which time the ITU-T will review its work priorities, direction and structure. However, it is TSAG's view that by the year 2000 the telecommunications environment will have already moved significantly towards making IP based technology a key part of the network infrastructure. Therefore, the ITU-T cannot wait until 2000 to change its work directions in order to maintain its leadership role in the development of global standards, as part of the inevitable network evolution.

The following twelve work areas have been identified as being of current major concern to the ITU-T.

Area 1 - Integrated architecture

Area 2 - Impact to telecommunications access infrastructures of access to IP applications

Area 3 - Interworking between IP based network and switched-circuit networks, including wireless based networks

Area 4 - Multimedia applications over IP

Area 5 - Numbering and addressing

Area 6 - Transport for IP-structured signals

Area 7 - Signalling support, IN and routing for services on IP-based networks

Area 8 - Performance

Area 9 - Integrated management of telecom and IP-based networks

Area 10 - Security aspects

Area 11 - Network capabilities including requirements for resource management

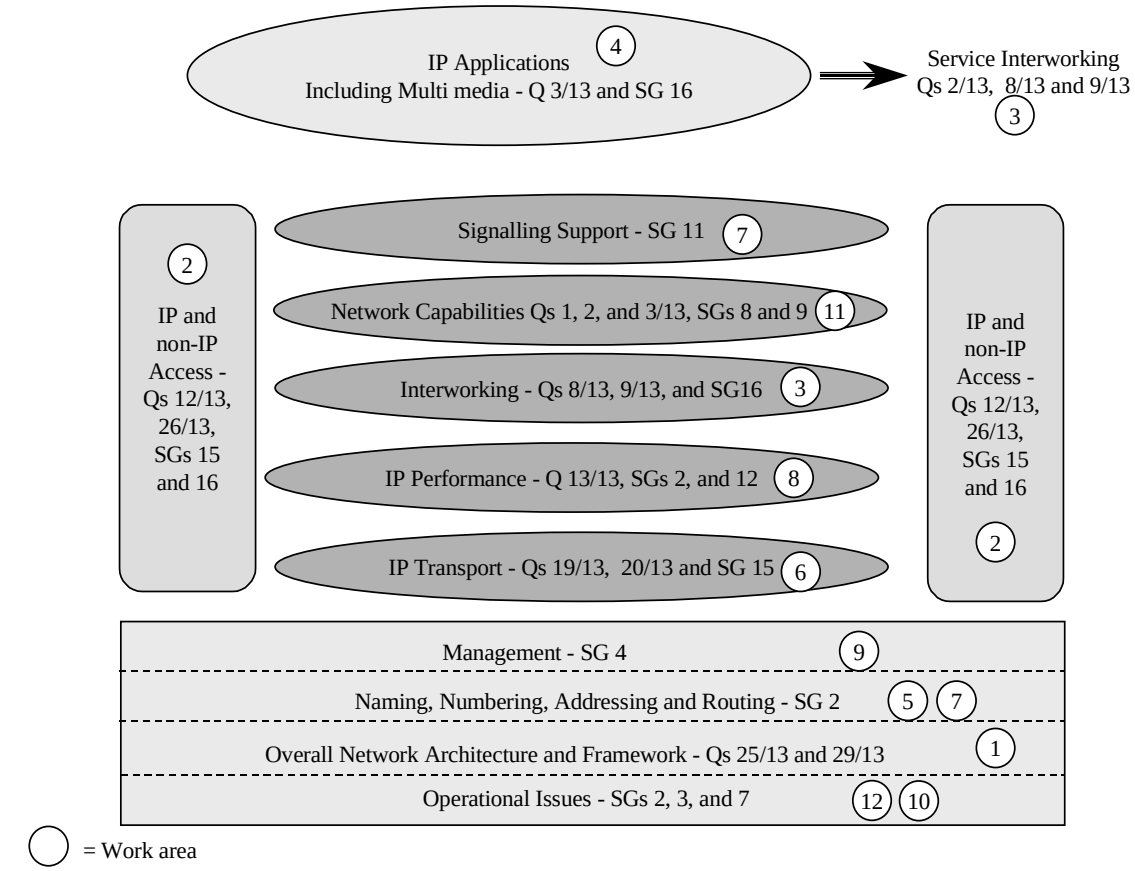
Area 12 - Operations and Maintenance (OAM) for IP

For each of these areas the project describes the scope and focus of the work area, the issues, the current work in the ITU-T Study Groups and related work in the IETF. In some cases the information is not yet complete and further work is necessary to expand the information. Particularly in relation to the IETF work an analysis of the IETF Working Group Charters is currently being undertaken to identify areas of potential overlap and areas where the ITU-T could collaborate with the IETF. The ITU-T Web site contains a detailed description of the project. An outline of the scope of the project areas so far defined is attached as Annex 1.

Study Groups will continue to study IP-related aspects in accordance with their respective responsibility and mandates, as established in Resolution No. 2 of WTSC-96. In accordance with the request made by TSAG the Study Groups have updated their Questions by including IP-related aspects. TSAG, at the meeting in April 1999 has reviewed the report of the leading Study Group, as well as the liaisons received by the various ITU-T Study Groups and will prepare further actions to WTSA-2000 in order to positively respond to this priority item in the Sector Strategic Plan. A summary of information so far provided by Study Groups, both to Study Group 13 as inputs to the IP Project and in response to the TSAG request, is attached in Annex 2.

/.../

The following is a schematic representation of the scope of the Project.



Scope of the ITU-T IP Project

4.6.3 Work in progress

The table below is an extract of the publicly available present work program of ITU-T [ITU] on subjects related to the TEQUILA project.

Rec.	Ques	Timing	Liaison	References	Subject
Q.ip21	21/4	2001			Access IP and IP over ATM
M.23ip	9/4	2001			Performance limits for bringing-into-service and maintenance of IP services
I.5ipatm [Y.310]	20/13	2000-03	SGs 11, 15; ATMF; IETF	COM 13 R-50 [com 13 R62]	IP over ATM
Y.ip-frwk	25/13	2000-03	ITU-T, R SGs; IETF, ATMF, ISO/IEC	COM 13 R-46	IP Framework
I.73ip	10/15	2000-10	SG 13	COM 15-R 30	IP NE Functions and IP over ATM mechanisms

This list is non exhaustive, at least two Recommendations addressing Question Q13/3 on "IP Performance", a subject closely related to Tequila, are at Draft stage :

- ITU-T Draft Recommendation I.380: Internet Protocol Data Communication Service – IP Packet Transfer and Availability Performance Parameters
- ITU-T Draft Recommendation I.381: Internet Protocol Communication Service – IP Performance Objectives and Allocations, whose summary is:

  "This Recommendation specifies provisional objectives for Internet Protocol network performance parameters, some of which depend on the user's selection of Quality of Service (QoS) class. The Recommendation includes the definitions for those QoS classes. Finally, each performance objective is allocated to the individual network portions involved in providing the end-to-end connection."

Furthermore, SG13 is currently working on two Recommendations that still remain unnumbered:

- "Information Communication Architecture" Y.ICA [becomes Y.130]
- "IP Access Network Architecture Y.IPAN"

4.6.4 Future Work

The tables below, compiled from [2, 3], give a list of Questions currently handled by various SGs that are:

- Not closed;
- Explicitly dealing with IP services and networking or being redirected to address IP issues;
- In line with the Tequila activities.

The tables are organized into technical areas, according to their identification in the "IP Project". The IETF working groups marked in bold were not identified by the SG13 as working on topics close to the ITU-T question but it seems that there may exist some relationship.

It is too early to state now how these questions will be handled during the next Study Period. The new:

- List of questions;
- Allocation of Questions among Study Groups;
- Study Groups work program.

will be elaborated during the next World Telecommunication Standardization Assembly in October 2000.

4.6.4.1 Area 1 - Integrated architecture

Question/SG	Deliverable	Timing info	Related IETF

			activity
25/13 GII principles and framework	IP Framework	March, 2000	none
28/13 Vocabulary for general network aspects	Terms/Definitions	Not yet	
29/13 Telecommunications architecture for an evolving environment	TAEE/ICA	1st Ph. : March 2000 2nd Ph. : Not yet	none

4.6.4.2 Area 2 - impact to telecommunications access infrastructures of access to IP applications

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.2/15 Characteristics of optical systems in local access networks for transport and distribution	G.982 G.983.1	1999	pppext ipcdn ipfc
Q.12/13 Access network architecture principles and the interfaces functional characteristics			
Q.13/16 Packet switched multimedia systems and terminals	H.323 Ann. H & I on Mobile		
Q.31/9 Requirements and methods for sound-programme and television "webcasting" services	J.web	2000	
Q.21/4 Management models for ANT and ATM network elements, including the support of access signalling and IP			

4.6.4.3 Area 3 - Interworking between IP based network and switched-circuit networks, including wireless based networks

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.20/13 Support of broadband connectionless data services on B-ISDN	I.ipatm	10/03/2000	ion pint
Q.21/15 Transport Network Equipment for Interconnecting GSTN and IP Networks			

4.6.4.4 Area 4 - Multimedia applications over IP

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.13/7 End-to-end multicasting	X.ectp X.multi		Rmt pilc
Q.3/10 Software platforms and middlewares for the telecom domain	Z.600	Determ. 99/11 Decis. ?/2000	

4.6.4.5 Area 5 - Numbering and addressing

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.1/2 Applications of numbering and addressing plans for fixed and mobile services			nat **dhc, mobileip, manet**
Q.2/2 Routing and interworking plans for fixed and mobile networks	E.mm		

4.6.4.6 Area 6 - Transport for IP-structured signals

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.20/13 Support of broadband connectionless data services on B-ISDN	I.ipatm	10/03/2000	
Q.10/15 ATM and IP and NE functions			
Q.19/13 Transport network architecture and interworking principles (Access architecture)			
Q.9/15 Transport equipment and network protection / restoration			
Q.10/15 ATM and Internet Protocol (IP) Network Element (NE) Functions			ion ipfc
Q.11/15 Signal structures, interfaces and interworking for transport networks			
Q.13/15 Management functions and services of transport systems and equipment			
Q.14/15 Management of transport equipment from the element level view			
Q.20/15 Characteristics of optical networking			

4.6.4.7 Area 7 - Signaling support, IN and routing for services on IP-based networks

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.5/11 Intelligent network capability sets	Q.1231 IN CS-3	Decision 1999	pint, pin (primary activity) megaco sigtran diffserv, mpls, policy, iptel, mmusic (secondary activity)
Q.22/11 Intelligent Network Application Protocol (INAP)	Q.1238 IN CS-3 INAP	Decision 1999	pint, pin (primary activity) megaco sigtran diffserv, mpls, policy, iptel, mmusic (secondary activity)

4.6.4.8 Area 8 - Performance

Question/SG	**Deliverable***	**Timing info****	**Related IETF activity**
Q.3/2 Service quality of networks	E.QOS-VOIP		**diffserv,** intserv**, issll**
Q.6/2 Traffic engineering: performance objectives	E.GOSIP		mpls
Q.2/7 Network performance and quality of service in data communication networks			Ippm rtfm
Q.31/9 Requirements and methods for sound-program and television "webcasting" services			**lsma**
Q.18/12 Interconnection of the public ISDN/PSTN with other networks (e.g. private networks, Internet) - Transmission quality aspects	G.108, G.109, G.177	Recently determined	None **pint**
Q.23/12 Transmission performance considerations for voice-band services carried on networks that use Internet Protocol (IP)			None **pint, megaco** ?
Q.13/13 General performance issues	I.380	February '99	ippm
Q.15/13 Availability performance			
Q.16/13 Transmission error performance			ippm
Q.17/13 Call processing performance			**pint ? pilc ?**
Q.20/13 Support of broadband connectionless data services on B-ISDN	I.ipatm		
Q.9/15 Transport equipment and network protection / restoration			
Q.10/15 ATM and Internet Protocol (IP) Network Element (NE) Functions			**ion**
Q.21/15 Transport Network Equipment for Interconnecting GSTN and IP Networks	G.TIGIN		

4.6.4.9 Area 9 - Integrated management of telecom and IP-based networks

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Q.4/2 Network management	E.41IP Network management for IP services		aaa agentx atommib adslmib disman policy radius **(radius WG is closed)** snmpv3
Q 12/4 Methodology and Quality assurance for TMN specifications	M.3020rev	Feb 2000	
Q 13/4 TMN Principles and Architecture	M.3010 rev M.3013	Feb 2000	
Q 15/4 Service management and generic network element information models for TMN interfaces			
Q 18/4 Generic network level management of transport networks			
Q 19/4 Protocols to support operation, administration and maintenance at the F, Q3 and X interfaces			
Q 20/4 Protocols for the remote operation of management applications			
Q 21/4 Management models for ANT and ATM network elements, including the support of access signaling and IP			
Q 23/4 Technology Specific Network level management of transport networks			
Q 25/4 Framework for unified management of integrated circuit-switched and packet-based networks (with an initial emphasis on IP-based networks)			
Q 13/15 Management functions and services of transport systems and equipment			
Q 14/15 Management of transport equipment from the element level view			
Q 20/15 Characteristics of optical networking			

4.6.4.10 Area 10 - Security aspects

Question/SG	**Deliverable**	**Timing info**	**Related IETF activity**
Question 20/7 - Security services, mechanisms and protocols (Continuation of Q.20/7 studied during 1993-1996)	X.sio X.ttp1 X.ttp2	All: Determ. 99/6 Decis. 00/3	tls

4.6.4.11 Area 11 - Network capabilities including requirements for resource management

Question/SG	Deliverable	Timing info	Related IETF activity
Q.6/2 Traffic engineering: performance objectives			**mpls, tewg**
Q.7/2 Traffic engineering: engineering: measurement and modeling			**mpls, tewg, policy**
Q8/2 Traffic engineering: dimensioning and control			**mpls, tewg, policy**
Q.6/3 Development of charging and accounting principles for B-ISDN services, telecommunication services of a multimedia nature, including those supported by the ATM or offered in conjunction with Global Information Infrastructures			**aaa**

4.6.4.12 Area 12 - Operations and maintenance (OAM) for IP

Question/SG	Deliverable	Timing info	Related IETF activity
Q.6/13 OAM and network management in B-ISDN			
Q.9/15 Transport equipment and network protection/restoration			
Q.11/15 Signal structures, interfaces and interworking for transport networks			

4.6.5 ITU-SG4

The ITU-T Study Group 4 (SG4) is responsible for developing and evolving the TMN architecture (M.3010 recommendation). The latter provides the architectural framework within which other related recommendations are developed. A key aspect of the current TMN architecture is the hierarchical separation of management responsibilities to element, network, service and business management. This is a generic separation, applicable to networks and associated management systems which support Quality of Service and provide Service Level Agreements to customers.

While the TMN was developed initially as the management framework for telecommunication networks, with technology specific recommendations for PSTN, ATM, SDH/SONET and GSM among other, the emerging importance of the Internet and its potential evolution to an infrastructure that will support Quality of Service in a large scale has led SG4 to study its impact and relationship to TMN. This work is currently in progress but the use of SNMP and of other Internet protocols is considered as a valid alternative for TMN interfaces. In addition, the applicability of TMN to QoS-enabled IP networks is examined, together with the arising new requirements.

TEQUILA could monitor developments in SG4 regarding TMN applicability to the Internet and could possibly contribute its architecture as background to SG4.

4.7 ETSI

Today, IP related work in ETSI, can be broadly categorized as work on the TIPHON and MIP projects. TIPHON addresses specifically voice over IP architectures and related standards, while MIP (Management of IP Networks) addresses the management of future IP networks.

As of this writing, work in TIPHON remains out of scope of the TEQUILA project, while the specific task list for the MIP project is not yet completed. It is expected however, that work in MIP will be a joint effort by ETSI, ANSI (NM) and ITU-SG4. Early indications show that work involved would be concerning routing, charging, traffic management and customer recommendations.

TEQUILA will closely follow the progress in these groups, and see if any specific TEQUILA related technical areas would be covered over time.

4.8 ATM Forum

4.8.1 Introduction

The ATM Forum is an international non-profit organization formed with the objective of accelerating the use of ATM (Asynchronous Transfer Mode) products and services through a rapid convergence of interoperability specifications. In addition, the Forum promotes industry cooperation and awareness.

Since its formation in 1991, The ATM Forum has generated very strong interest within the communications industry. Currently, The ATM Forum consists of over 600 member companies, and it remains open to any organization that is interested in accelerating the availability of ATM-based solutions.

The ATM Forum consists of a worldwide Technical Committee, three Marketing Committees for North America, Europe and Asia-Pacific as well as the User Committee, through which ATM end-users participate.

4.8.2 The Technical Committee

The ATM Forum Technical Committee works with other worldwide standards bodies selecting appropriate standards, resolving differences among standards, and recommending new standards when existing ones are absent or inappropriate.

The Technical Committee was created as one, single worldwide committee in order to promote a single set of specifications thereby ensuring interoperability between all vendors as ATM products and services become available.

The Technical Committee consists of several working groups, which investigate different areas of ATM technology.

The ATM Forum launched a major strategic initiative, the Anchorage Accord, guaranteeing a stable platform as the basis for real network implementations. In addition to designating a set of foundation and expanded feature specifications, it also establishes criteria to ensure interoperability of ATM products and services between current and future specifications.

4.8.3 The Market Awareness Committees

- Asia-Pacific (APMAC)

- Europe (EMAC)

- North America (AMAC)

The ATM Market Awareness Committees provide marketing and educational services designed to speed the understanding and acceptance of ATM technology.

The Market Awareness Committees coordinate development of educational presentation modules and technology papers; facilitate exchange of information and requirements between the Enterprise Network Roundtable and the Technical Committee; publish 53 Bytes, The ATM Forum newsletter, and coordinate publicity of Forum activities; and coordinate demonstrations of ATM at trade shows, highlighting ATM's ability to solve today's business problems.

4.8.4 The User Committee

The User Committee, formed in 1993, consists of ATM end-users. This group interacts regularly with the Market Awareness Committees to ensure that ATM Forum technical specifications meet real-world end-user needs.

In this rapidly-growing organization, topics of discussion are varied, including issues such as interoperability among vendors and migration of the installed base to ATM.

Ambassador Program

ATM Forum Ambassadors provide informative presentations to the networking and telecommunications community regarding the Forum and ATM technology. Ambassadors attend ATM Forum meetings regularly, and present material in a non-vendor-specific manner.

4.8.5 Present Status

Today, the ATM Forum has a number of activities that have as objective to better support IP services on top of ATM networks. A first initiative provides indications on how to best support both IP differentiated services and IEEE802.1D QoS classes over ATM networks. To that end, some extensions to the UBR service categories are defined to allow for a service called differentiated UBR. (see : "Addendum to TM 4.1: Enhancements to Support IP Differentiated Services and IEEE 802.1D over ATM Draft**"**,ATM Forum / BTD-TM-DIFF-01.03, February 2000.)

Further the ATM Forum is presently engaged in defining (service) interworking between MPLS and ATM networks. Aspects under consideration are signalling and routing interworking.

(see : "MPLS/CR-LDP and ATM UNI/AINI/PNNI service interworking aspects Living List ", ATM FORUM / ltd-aic-ATM-MPLS-service-01.00, February 2000)

In first instance none of this material is relevant to the TEQUILA project. Only MPLS as forwarding layer for traffic engineering purposes is envisaged, TEQUILA is not interested in the 'horizontal' interworking between ATM networks and MPLS networks.

4.9 The TeleManagement Forum

4.9.1 Introduction

This section outlines the core activates of the TeleManagement Forum (TMF) [TMF-www] and to suggest or outline ways in which the work of TEQUILA might be related to this work. Exact details of possible concertation or association between TEQUILA and the TMF is not seen as being *core*. However the possibility of some lesion exists through the partners who are members of the TMF (UCL), The focus of important TMF activities for TEQUILA discussed here derive from the TMF "Telecoms Operators Map" [TMF-TOM]. In particular the role of the Service Level Agreement (SLA) in various processes of the FAB (Fulfilment, Assurance, Billing) model is discussed. The work on management 'middle ware' derived in the "Technology Integration Map" [TMF-TIM] is *not* discussed as this is not a central issues for TEQUILA.

4.9.2 The FAB Business Model

The Telecoms Operators Map (TOM) document and derivative work develops the and operational support processes required to manage a telecommunications system – without out it being specific to any particular technology or service. This model develops around a business model divided into 6 plains; Customer, Customer Interface, Customer Care, Service Development and Operations, Network and Service Management, Network Elements and Physical System. In each of these planes, a number of processes are defined and elaborated as part of the TOM. For example, Sales, Development, Order handling, Problem Handling *etc*. These process are grouped ve*rtically* through the business model into three broad views of service chains or strings, these being: Fulfilment, Assurance and Billing – or FAB as a mnemonic. The central three planes of this business model with the core processes and the vertical divisions is illustrated in Figure 1.

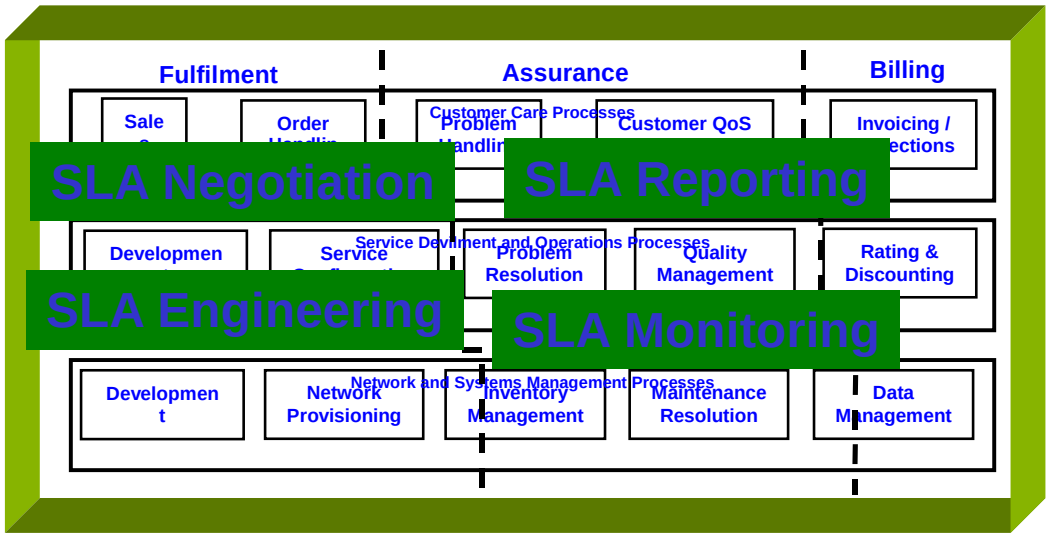


Figure 1. The TMF "3-D" Approach to Mapping--Service Level Agreements [TMF-TOM]

This key business model and grouping of processes is extended into a '3-d' model to accommodate specific engineering activities. Central to both TEQUILA and TMF is the development processes to engineer the support of SLAs. In the figure, four SLA areas are illustrated:

- SLA Negotiation: as being part of the outcome from the Sales & order handling processes in relationship with the service configuration processes
- SLA Engineering: as part of the fulfilment processes linking the Service to the Network activities – and through to the element management.
- SLA Monitoring: relates the specifics of how a services was engineered into the network and network equipment to the service definition.
- SLA Reporting: finally closing the loop between the SLA negotiation / service contract phases to the verification of that / those contract(s).

4.9.3 Processes

In the TOM documents and else where, the processes of the FAB model are elaborated. These processes interlink each other and define sequenced operations required by those processes. The details not only show interfaces between processes of individual operators but between co-operating operators. Finally, the process elaboration also contains locations of the impat of things such as SLAs in the various roles (negotiation, engineering, monitoring *etc*.). An illustration of such a process is given in Figure 2.

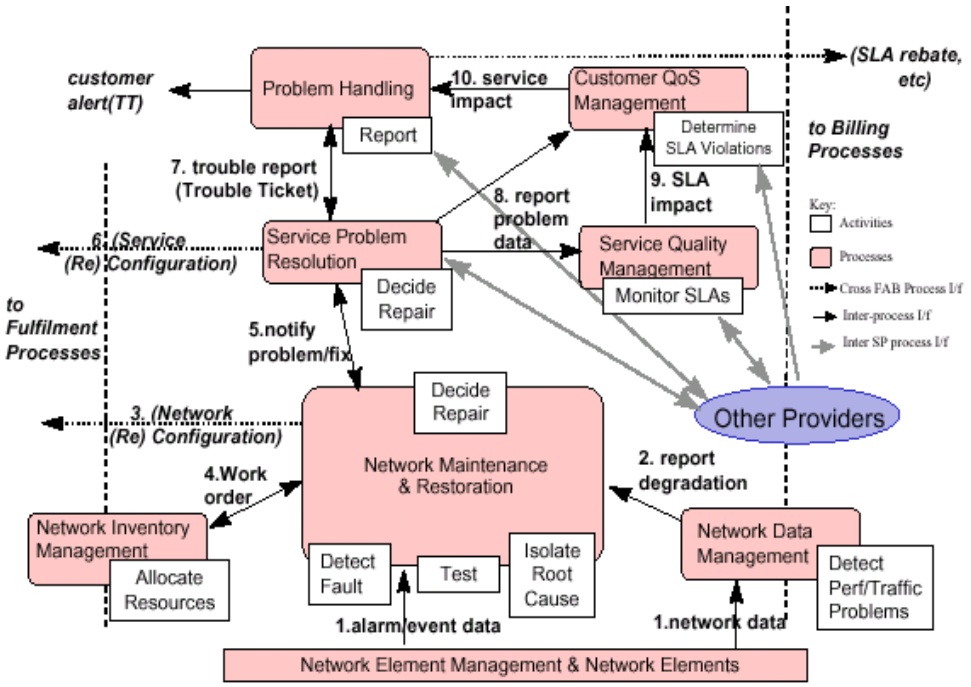


Figure 2. Rough Example of Service Assurance Process Flow [TMF-TOM]

More specific elaborations and diagrams in the TOM details the inputs and outputs between processes. And the activities with the processes.

The point, in part, of this work is to develop a commonly accepted semantics for process naming; and, indeed, to develop a common understanding of the roles of auxiliary information – such as the SLAs – in their various roles. In the words of the TOM document:

1. Internal and external discussion (reduce debate)
2. Identifying and showing needs, developing requirements
3. Developing interface requirements and information models
4. Negotiating automated interfaces with partners
5. Asking suppliers “where they fit on the map”

The TMF efforts may, thus, be used in part as a sort of illustrated dictionary of management processes. These are *generic* to management operations and should, as said above, be applicable for the purposes of TEQUILA.

4.9.4 TMF and TEQUILA

It is not clear, *prima face*, that there is a need for close collaboration between the project and the forum. There is good reason to use the TOM documents for – more or less – their intended purpose. *I.e.* the development of the TEQUILA system might try to appropriately fill in the functional areas as developed in the TOM. This is not a specific requirement on the work of TEQUILA; rather an exercise that should be done on a more or less continuous basis. This would aid in ensuring that there are no 'holes' in the TEQUILA functional model.

4.10 The MPLS forum

4.10.1 Purpose of the MPLS Forum

The primary purposes of the MPLS Forum are:

TECHNICAL

- To serve as a meeting ground for companies that are creating or deploying products that implement MPLS, or services that depend on the capabilities introduced by MPLS and its associated technologies.
- To promote world wide compatibility and interoperability between different implementations
- To facilitate interoperability testing
- To facilitate the support of a wide range of applications enabled by the technology
- To identify, select, augment as appropriate, and publish MPLS implementation agreements drawn up from the appropriate international standards
- To provide input to appropriate national and international standards bodies

Where appropriate the MPLS Forum will work with standards setting bodies such as the IETF, the ITU and The ATM Forum.

The MPLS Forum views its role as entirely complimentary to that of the existing standards bodies such as IETF, the ITU and The ATM Forum. It only intends to develop implementation agreements in such areas of the technology where no other existing standards body has activity and then with full collaboration with them.

EDUCATIONAL

- To provide information on MPLS standards and implementations
- To help users develop strategies and evaluation criteria for deploying MPLS in their IP networks
- To increase market and user awareness of the benefits of deploying MPLS based solutions
- To act as a central reference of resources useful to those with an interest in MPLS.

4.10.2 Relation to TEQUILA

This very newly created forum, might over time address a number of technical domains covered by the TEQUILA project. While Alcatel is member of this forum, TEQUILA will be in a position to see whether the work programme of this forum evolves to where TEQUILA can contribute. Today however, TEQUILA aims primarily at the IETF for MPLS related standardization.

5 REFERENCES

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[IP-NET] internet protocol (IP)-based networks (Contribution to the Secretary-General's Report to the Council)

[ITU] http://www.itu.int

[SG13-R57] Study Group 13 - Report R57 "Report of the IP Experts Meeting (Geneva 31 August – 9 September 1999)"

[TMF-www] http://www.tmforum.org/

[TMF-TOM] "SMART TMN™ Telecom Operations Map" TBD
[TMF-TIM] "SMART TMN™ Technology Integration Map". TBD

6 ABBREVIATIONS

ANT	Access Network Transport
B-ISDN	Broadband - Integrated Service Digital Network
GII	Global Information Infrastructure
GSTN	General Switched Telephony Network
ICA	Information Communication Architecture
IN	Intelligent Network
ISDN	Integrated Service Digital Network
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
OAM	Operation Administration and Maintenance
PSTN	Public Switched Telephony Network
SG	Study Group
TAEE	Telecommunication Architecture for an Evolving Environment
TMN	Telecommunication Management Network
TSAG	Telecommunications Standardization Advisory Group
WTSA	World Telecommunication Standardization Assembly