Jos Gerrese

Managing Quality of Service in an IP Infrastructure Environment

This article explains that quality of service (QoS) depends on the type of services, the construction of networks and the requirements of different customer groups. A brief historical overview is given on the developments and transitions happening in transporting electronic information over cable systems, with major changes in the areas of transmission protocols and analogue/digital conversion. An explanation is given on the new converged networks concept, highlighting some consequences, an important one being the fact that converging means compromising and possible sub-optimisation.

The actors, the network, the services and the customers are each further analysed. The consequences of increased QoS requirements are investigated. The conclusions indicate that costs will increase compared to today's IP pricing level and that a lot more attention needs to be paid to QoS supporting technical and administrative facilities.

Jos Gerrese:
AUCS Communications Services
E-mail: jos.gerrese@aucs-europe.com

Introduction

Moving from the well-organised world of the public switched telephone network (PSTN), integrated services digital network (ISDN), X.25 and private leased lines into the wilderness of Internet protocol (IP) networking creates a number of issues. This together with the fast-increasing demand for applications based upon Internet/browser technology makes quality management in IP networks a real challenge.

This article describes some of the background, some of the major issues and ways in which they can be brought to a solution.

Brief Historic Overview

Looking from the early days of telecommunications to current practice we see a development starting a long time ago with analogue voice networks; telex and telegraph entered the world as the first digital forms of data, running over analogue circuit-switched voice networks; and about 30 years ago we saw the first data modem traffic, running on the analogue voice network. Later on we saw data using its own infrastructure facilities like X.25 packet-switched networks, evolving into frame relay, some asynchronous transfer mode (ATM) and now transmission control protocol/Interet protocol (TCP/IP).

In the meantime, voice has transformed largely into a digital format. The growth in volume of data networks and the totally different cost structure of those networks make it feasible and attractive to run digital voice on the back of digital data networks. This is called *convergence* in modern jargon.

Over time we have seen a complete turn-around from all traffic over a circuit-switched network to all traffic over packet-switched networks. Will this be the end?

Present Situation

The developments as we see them over the last few years show an incredible growth of data traffic with recently a strong focus on IP, mainly supporting public Internet usage. The main suppliers state that network facilities are doubling every 3–6 months. This has resulted in a frenzy of contruction of new transatlantic cable facilities.

Another important effect of the Internet explosion is that huge numbers of people are familiar with browser-based applications, fast access to all sorts of information and global networking. It is no wonder that the business community wants to benefit from those developments and opportunities, to carry out their existing business better and create new ways to perform new business.

However, rightfully they require the same sorts of service and quality assurances as they are used to with the traditional communication networks, like voice, telex, X.25, frame relay etc. Furthermore, we see that, because of new types of applications and business, demands for various types and levels of security services are emerging. Also we see an increasing need to integrate services at the desktop level, resulting in a flow of digital data originating from voice, data, and multimedia applications. The problem, however, is that although it is all digital data, the characteristics and therefore the quality requirements from the various applications and sources are very different. Real-time and on-line services like voice and video have different critical quality parameters than X.25 or TCP/IP data.

The Challenge

The challenge is how to bring law and order into a network so that individuals and corporations can perform their businesses in a way that is reliable and sustainable, supported by service level agreements, while keeping the flexibility which makes the IP so attractive to an increasingly large part of the world population.

Directions of Solutions

A number of various service, network and customer characteristics need to be addressed to reach a situation as described above.

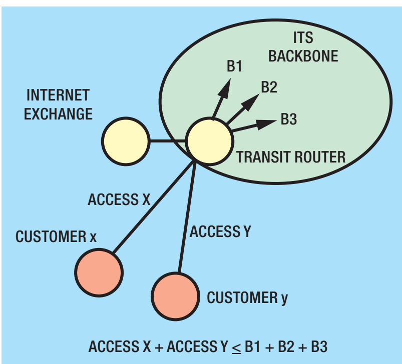
The Network

IP networks and the TCP/IP protocol are of the 'send and pray' type. Packets will find their way through the network up to their address destination. This may go fast but it could also take a very long time before a packet arrives at the destination and the response back is received.

Basic QoS has three key parameters:

- network availability—up-time of the facilities;
- round-trip delay—how long does it take for a package to arrive and to receive a response; and
- packet loss—if no transmission path is available the service will drop packets, which is registered as such, but they do not reach their destination.

Figure 1—Basic quality through non-overbooking



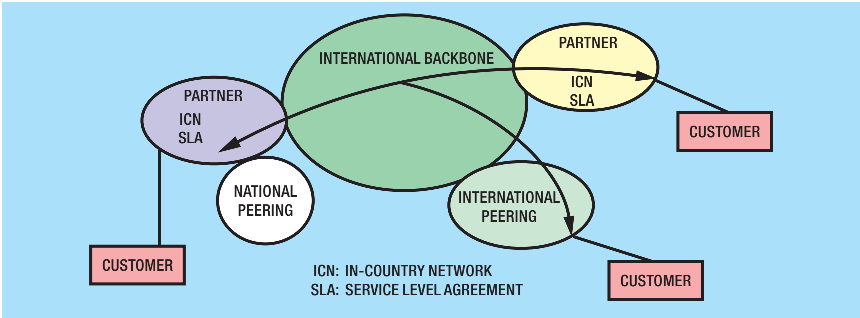


Figure 2—Quality reach extension through peering and interconnects

As long as traffic flows in a network which, up to its boundaries, is controlled by one network provider or IP service provider it is possible to have strong controls in place through network design, network management and traffic observations. As soon as packets start hitting other network domains which are beyond controlled reach, QoS can no longer be managed. One fully depends on management levels applied by the other network supplier(s).

Even when the other networks are managed with the same QoS across all connected networks, then still the final quality is determined at the end address by the design and performance of information servers, home pages etc. There is very little opportunity to enforce quality at the very end of the service.

The optimum quality arrangements can be obtained by building QoS agreements across networks. This can be achieved:

- first and foremost by expanding the reach of the direct controlled network as far as possible through IP backbone structures; and
- secondly, through peering and interconnect negotiations it is possible to expand the QoS reach in an indirect manner by agreeing QoS parameters and values to be respected by the interconnect partners (Figure 2).

Interconnection of IP networks takes place on three layers:

1 *Peering† in public Internet exchanges* Peering in public Internet exchanges like in Amsterdam, Stockholm, Paris, Geneva and London is the most simple way to connect IP domains. In generally there are no QoS objectives or guarantees.
2 *Peering in commercial Internet exchanges* Commercial interconnect exchanges like Telehouse in London can apply at least a certain level of quality requirements for those participating.
3 *Bilateral interconnect arrangements* These are by far the best instrument to get QoS across IP networks.

The Services

A most common split in IP services is based on the level of accessibility:

- *Internet World Wide Web (WWW) traffic*, which is fully open and public. No special quality measures are in place and quality is largely determined by the various Internet service providers (ISPs).
- *Intranet traffic*, which is fully IP/browser based but access is limited to a defined closed user group through firewalls, filters and passwords. This is mostly used by corporations to run their internal workflow and reporting processes.
- *Extranets*, which are intranets with wider access facilities, creating a virtual business community to exchange information, to run critical processes and especially to support logistic processes: the order to delivery chain.

From a different angle we see for all those types the rise of electronic commerce in various stages of sophistication. Security is the key issue for this type of applications.

Services can further be divided into: network services, communication services, information services, transaction services (Figure 3). They

† Peering is a form of interconnect based on the peer principle. There is no accounting and no exchange of money ('peer' = equal).

TRANSACTION SERVICES	ELECTRONIC DATA INTERCHANGE (EDI)/WEB EDI, ELECTRONIC PAYMENT SERVICES, TRUSTED THIRD PARTY/CERTIFIED AUTHORITY, CALL CENTRE PLATFORM
INFORMATION SERVICES	WEB HOSTING, DIRECTORY SERVICES
COMMUNICATION SERVICES	400NET, IP MAIL, IP FAX, MANAGED VOICE, UNIFIED MESSAGING, GROUPWARE
NETWORK SERVICES	MANAGED INTERNET SERVICES, IP-VIRTUAL PRIVATE NETWORK, IP-DIAL, MANAGED FIREWALL SERVICES
TRANSPORT SERVICES	WHOLESALE ACCESS/INTERNET TRANSIT SERVICES TRADITIONAL: FRAME RELAY, MANAGED BANDWIDTH SERVICES, X.25

Figure 3—The IP services value stack

each have their different quality requirements.

The Customers

The users of IP facilities can be split roughly into three categories:

1 private and residential users;
2 business-oriented users, small businesses and corporations; and
3 professional Internet companies like ISPs, application builders, and information providers.

The main difference between categories 1–2 and 3 is that 1 and 2 are users of the IP facilities but it is not their core business. They use it as a support facility to run their business. Businesses in category 3 depend on IP for their core business.

It is clear that these categories have different requirements with respect to IP quality. Cost is the most important issue for some customers, with not too much emphasis on quality, while for corporations that run mission-critical applications reliability and security are the most vital points.

Consequences of Increased and Differentiated Quality

It is not possible to discuss QoS and SLAs without the proper measuring, reporting and management facilities in place. These are in fact new to the IP environment and will therefore have related effects on costs, operational staff, customer care, etc.

It can safely be stated that the cheap IP Internet has to become more expensive when all sorts of quality measures and management are added. At this point in time it is still hard to quantify those increased cost effects but they will be there for sure.

As an example we can look at the requirements from a voice-over-IP perspective, if we require a quality level that matches with today's voice virtual private network (VPN) facilities:

- We need to implement guaranteed and delay-less throughput. In IP this can be done fundamentally in two ways:

  —make sure there is always and everywhere an abundance of bandwidth capacity so that congestion never occurs; and
  —create special pre-reserved (like circuit switching) facilities in the network like RSVP, MPLS etc.

- We need to implement the necessary operations and management tools.
- We need to implement the required administrative facilities that can measure and invoice the usage of special quality services within the network and across its boundaries.
- It may be necessary to build more resilience in the network itself

It may be clear that each of those four mentioned points will increase costs.

Conclusions

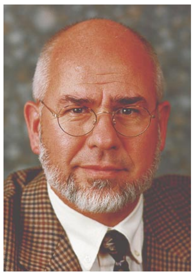
Because of the increasing need for functionality and QoS it is most likely that IP will not be the final network stage and some new converging structure with a mix of packet- and circuit-switched elements will be developed.

As soon as QoS needs to be delivered the costs of service provision will rise sharply above the current prices as now applied for the public IP Internet environment.

Through the fundamentally different cost structure and more efficient usage of the IP type networks the total costs of converged services networks may still be lower than in the traditional network environment.

QoS depends on the requirements of the various user groups and at the same time on the functional requirements of the various service types that run over the network. It is therefore a complex mix of influences which all need to be valued and priced to reach and maintain a profitable business.

Biography



Jos Gerrese
AUCS Communications Services

Jos Gerrese graduated with a Masters Degree in Telecommunications from Technical University of Delft, Telecommunications in 1973. From 1973–1984 he undertook various technical, commercial and management functions in PTT Telecom, Netherlands. From 1984–1989 he was Director of the consultancy organisation NEPOSTEL for South East Asia, stationed in Jakarta. From 1989–1993 he was General Manager of International Services in PTT Telecom, Netherlands. From 1993–1996: he was Director of International Services Portfolio for AUCS and in 1996 became Director of AUCS Internet Business Services, responsible for wholesale access and transit IP services and IP offers. He has been president and chairmain of various consortia, responsible for building multinational broadband networks in the European territory (EBIT, GLOBAND). He is a frequent speaker at conferences and seminars around the world.