Tutorial B1: Transport layer and QoS issues over satellite

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Quality of Service (QoS) is the object of a great number of tutorials, forums and conferences. Telecommunication companies put effort in driving analysis, specifications and implementations to provide QoS. The real question is: how does QoS fit within heterogeneous networks including satellites? In more detail, which is the impact on the performance if information traverses different network portions that use specific QoS paradigms? What happens if the access or another portion of the overall path implements radio or satellite technology? These questions and corresponding possible answers are the core of this tutorial.

The definition of "heterogeneous network" may assume different aspects. Network portions may be managed by different Service Providers, may use different transmission means such as cable, satellite, radio, and may implement different protocols such as ATM, IP, MPLS. A network may be heterogenous also from the point of view of users, who can require different services and have a different availability to pay for them. This tutorial essentially considers heterogeneity from the point of view of protocols and transmission supports.

The characteristics of the network used are extremely important to provide mechanisms to offer end-to-end QoS guarantee traversing multiple domains to support existing services and to create new dynamic and flexible services. Some types of networks, i.e. ATM ones, have been designed to support QoS for specific traffic flows. On the other hand, the Internet is a "best-effort" network, (for TCP/IP protocols have not been designed to provide guaranteed quality of service) and it only does "its best". Two solutions are available to match the QoS request over IP networks: the Integrated Services approach and the Differentiated Services approach. MPLS (Multiprotocol Label Switching), developed more recently, is a powerful new technology, which may be used as a possible convergence between IP and ATM worlds.

The idea is to have internetworking independent of the technology used to provide QoS. Each portion of the network may use the preferred technology; the only concern is related to the QoS service offered to the neighbour networks. It implies the definition of a common "language" among the networks: i.e. the definition of QoS parameters and of common requests of service to be matched (or not) by the other portion of the network, the definition of a proper architecture, of a communication protocol dedicated to QoS and, in particular, the study of a QoS mapping to implement the translation of QoS among different technologies.

Interworking, on the other hand, involve satellite and radio portions of the network. The peculiarity of the channel has a strong impact on the performance. In particular TCP/IP traffic, which has a main role in telecommunication systems and in this work, is heavily affected. The problem is hidden within the TCP flow control that suffers the effect of a "large delay-bandwidth product", which characterizes GEO satellite and broadband radio environments, and considers each loss as a congestion event so taking countermeasures whose result is performance decrease. A protocol stack, designed in connection with a bandwidth allocation mechanism may be the clue.

This tutorial reports definitions of QoS and widespread technological QoS solutions, describes the general framework and focuses on the QoS mapping solution proposing possible architectures to match the problem. It introduces the problems of the trasport layer over satellite networks, analyses possible solutions and presents issues and problems in other environments as interplanetary communication.

In detail:
Tutorial Program

- QoS Definition
- Introduction to QoS
- QoS Classes
- QoS Structures
- End-to-end Satellite QoS

- QoS Mapping
- QoS at each Functional Layer
- QoS Technologies
- Transport layer over satellite: Scenario and Introduction
- TCP
- TCP over Satellite and Wireless Links
- Possible Solutions
- Testbed
- Experimental Results
- PEPs and New Architectures
- Other Environments (DTN and Interplanetary Communications)

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Mario Marchese was born in Genoa, Italy in 1967. He got his "Laurea" degree cum laude at the University of Genoa, Italy in 1992 and the Qualification as Professional Engineer in April 1992. He obtained his Ph.D. (Italian "Dottorato di Ricerca") degree in "Telecommunications" at the University of Genoa in 1996.

From 1999 to 2004, he worked with the Italian Consortium of Telecommunications (CNIT), by the University of Genoa Research Unit, where he was Head of Research. From February 2005 he has been Associate Professor at the University of Genoa, Department of Communications, Computer and Systems Science (DIST).

His main fields of activity include: Telecommunication Networks, Satellite Communications, Radio Communications, Transport Layer, Quality of Service over ATM, IP and MPLS, emulation and simulation of telecommunication networks and data transport over heterogeneous networks. He is the founder and the technical responsible of CNIT Satellite Communication and Networking Laboratory (SCNL) by the Genoa Research Unit, which contains high value devices and tools and implies the management of different units of specialized scientific and technical personnel. Over the years he acquired a great experience in projects (both concerning technical managing, implementation details, and composing financial and technical plan) funded by national and international entities, dedicated to: design, implementation, installation and validation of telecommunication infrastructures; design and validation of satellite networks for environmental monitoring via radar; performance evaluation of networks oriented to tele-education and multimedia applications; transport protocol and resource management for telecommunications networks; simulation and emulation of components. He was responsible of the “Protocol implementation” work package in many projects, where he acquired the capacity of implementing and configuration setting of TCP/IP protocols at the operating system level so allowing to get efficient prototypes.

Concerning knowledge dissemination and standardization activity: he is the Official Representative of CNIT within the European Telecommunications Standard Institute (ETSI), Vice-Chair of the Satellite and Space Communications Technical Committee of the IEEE COMSOC and Senior Member of the IEEE; he is Member of the Editorial Board of the International Journal of Communication Systems (Wiley) and Member of the Technical Program Committee of various international conferences. He is author and co-author of over 80 scientific works, including international magazines, international conferences and book chapters, in particular concerning novel transport layer implementations over heterogeneous networks, which is an issue where he is an internationally recognized expert. He acted as Guest co-Editor for several international journals and joined many international conferences as Session Organizer, Session Chairman and as Speaker.