Guest Editorial

Architectures, Protocols and Quality of Service for the Internet of the Future

DR. MATTEO D'AMBROSIO, GUEST EDITOR
Networking Dept., CSELT, v. Reiss Romoli 274, 10148 Torino – Italy
matteo.dambrosio@cselt.it

PROF. MOHAMMED ATIQUZZAMAN, GUEST EDITOR
Dept. of Electrical & Computer Eng., University of Dayton, Dayton, Ohio 45469-0226, USA
atiq@engr.udayton.edu

What would we like to see in the Internet at the New Millennium dawn? Well, the answer depends on who we are asking to.

Internet customers want to improve their capacities of interaction with humans and machines, by means of new advanced (but simple to use) applications and tools. They would like Internet to be not only a large container of information, but also an environment where people can move, look, meet, talk, listen, learn, work, sell and buy.

Organisations, industries and commercial companies, are a special kind of customer: They are interested in improving their core business, maximising incomes and minimising costs of their communication and production processes. They not only ask for new applications on their computers, but also for increased capacities (bandwidth) and services from the network, at a lower cost. They would like to see Internet as a chance to maximise their profits.

Corporate networkers would like to cope with stable and performing technologies, with network products which can be clearly and easily understood and integrated in their network environment, managed and upgraded as required from the evolution of the network services. They would like to discriminate into the network market and make choices without taking high risks on their investments.

And what would network operators like to see in the Internet of the future? They have to deal with network technologies that cannot keep the pace of the service demands. Competition requires network operators to be ready to enlarge their service offerings, as soon as new applications and suitable equipment appear on the market and are accessible to the customers. And usually these products are available to the users much before operators can deploy network platforms which are able to dispense services with the necessary levels of performance. Today, designing new networks with advanced service capabilities is a very complex task. Network designers must handle unstable technologies, network products not meant to work in geographical environments with millions of customers. They must deal with new network platforms whose reliability and performance under heavy load are unknown, and manage continuous appearance of hardware upgrades and new releases of control software, heterogeneous devices that hardly interwork, lack of managing tools, and so on. Internetworking, today, is more an art than a pure science.

The widespread availability of Internet, as a global environment in which people meet and communicate in various forms with the assistance of multimedia applications, is in contrast with the real capacity of the present network infrastructures, which cannot sustain such a large trafficburden. But it is not only a matter of bandwidth provisioning at will. Network operators require additional mechanisms for flow control, complex schedulers, policing units, reservation and routing protocols, accounting functions and so on, implemented in the network nodes in order to cope with new levels of grade of service needed by customers. And of course managing tools able to deal with all this complexity.

Recent advances in switching and transmission technologies allow the implementation of very high speed networks that are changing the face of the Internet. In the next Telecommunication Age, it will be possible to support new multimedia applications in a global environment and design new services on flexible platforms without upgrading the physical infrastructure. In order to achieve these goals, many researchersare working on defining the new Network Architecture, which will be capable of offeringtransport and computation services to communication applications with

stringent Quality of Service (QoS) requirements. New protocols and node implementations have to be envisioned with this objective in mind.

The new Service Models (Integrated Services, DifferentiatedServices) being defined in IETF for the future Internet need a flexible network, which is capable of adapting itself to the sudden transformations of the telecommunication market. So next generation nodes shall be open control, open to modifications of their behaviour, programmable by the operators to create new services and not only configurable as they are today.

The idea behind this special issue was to solicit contributions on hot topics related to the future Internet, mainly on the topic of the provision of QoS, but also keeping an eye on the new philosophies on the Network Architecture. The Call for Paper was meant to cover the main research areas from ATM and High speed networks up to the Internet protocols at the network and transport levels. As a result of the call, a large number of very high quality papers have been submitted. After the review process, fourteen papers have been selected for this special issue, which will be published into two separate Issues of ETT, Issue No. 2 and Issue No. 3 (year 1999). Issue No. 2 "Architectures, Protocols and Quality of Service for the Internet of the Future: Advances in ATM Networks" contains a selection of seven papers focussed on the latest research topics concerning the ATM technology, while Issue No. 3 "Architectures, Protocols and Quality of Service for the Internet of the Future: New Concepts and Systems" contains eight papers which are concerned with various advanced topics in Internet research, from IP optical switching to Active Networking.

In Issue No. 2, which is dedicated to the latest advances in the ATM field, all the accepted papers are concerned with ATM control features: from buffer and traffic management to the admission policies and routing protocols. In fact, much of the present work in this field is directed towards all those components that are contained in the ATM control plane.

The first paper by Ajmone Marsan, Bianco, Filippi, Giaccone, Leonardi and Neri, performs an exhaustive comparison of input queueing cell switching architectures which recently appeared in the literature. Some of these queueing schemes have also been implemented in commercial high speed IP routers, as a practical alternative to the classical output queueing design.

Reservation of resources in an ATM network to support multiple traffic classes has been considered in the paper by Altman, Artiges and Traore. They study the performance of an ATM network as a result of application of two different reservation strategies for Best Effort and guaranteed real-time connections, in order to assure a minimum level of QoS even to the Best Effort users. Pricing of services is also a subject touched in this work.

The following paper, by Weijia and Zhao, focusses on CAC algorithms, which select a path with the best possible QoS for adaptive real-time ATM connections. The algorithm is based on a heuristic search technique that maintains the execution time at a reasonable level.

Jacqueline and Pierre Boyer, Dugeon, Guillemin, and Mangin propose an accelerated signalling capability for the ATM network, which allows association of cell streams generated by an Internet connection with DBR connections at the ATM level.

The following two papers are concerned with the issue of routing in ATM networks. The work by Matta, Bestavros and Krunz compares different path selection strategies, and show the inadequacy of Load Balancing and Load Packaging techniques. They propose as an alternative a so called Load Profiling Routing technique.

Routing in ATM networks with dynamic multicasting is the subject of the work by Debasish and Gontam Chakraborty, Pornavalai and Shiratori. They propose a heuristic centralised routing algorithm and compare their method with other common techniques.

The last paper, by Burrell and Papantoni-Kazakos, proposes and analyses an on-line learning algorithm useful to dynamically update the control parameters of a traffic monitoring system, which is utilized to allocate channel capacities dynamically to heterogeneous traffics with time-varying characteristics.

Issue No. 3 opens with a paper by Bostica, Burzio, Callegati, Casoni, Raffaelli and Torné, Pareta, dedicated to the analysis of an advanced Optical Packet Network architecture, providing different levels of QoS, considered as a backbone infrastructure for a network of high speed routers.

The second paper by Lin and Chang proposes a new multicast routing protocol based on PIM (Protocol Independent Multicast). This new protocol shows a performance improvement against the classical PIM protocol, thanks to a reduction of the PIM message and resource overhead and an improved load balancing technique.

Antoniou and Stavrakakis in their paper study and compare different scheduling policies for data units delivered at the Network level, with the aim of maximising the number of Application-level Data Units with real-time requirements that are delivered by their respective deadlines.

The issue of protocol configuration is considered in the work by Thomas Plagemann. Dynamic protocol configuration is meant to combine fine granular software and hardware building blocks at runtime in order to fulfil requirements and needs of an application with the minimum resources. The method is based on a formal model.

The fifth paper, by Borella, Upadhyay and Sidhu, is a good survey of recent differentialservices and pricing proposals and introduces a pricing framework for a differentiated-services network. They focus on flat-rate, per-time and usage-based pricing, where users can change their service level, in the current heterogeneous Internet environment.

The last three papers are concerned with the most recent advances in the networking research. This area includes open network architectures, active networks, programmable nodes. In this new philosophy, users (operators mainly, but also customers) are given the potential of creating, customising and controlling the network services according their expectations, by employing switches and routers capable of executing user supplied programs and performing computation on user data in transit.

The paper by Fan and Mehaoua is a tutorial on the active networking concepts. Differentapproaches to the realisation of active networks are described and potential applications of this novel technology are outlined.

Törö and Leung review the capabilities of active networks, and discuss the issues of implementing universal personal computing by means of active network platforms. They propose this new advanced technology as an effectiveapproach for realising universal personal computing services.

The final paper by Azcorra, Calderón, Sedano and Moreno proposes an application of the active network paradigm to provide a congestion control mechanism in a multicast network environment. The advantages of this novel mechanism are described.

In conclusion, the editors wish to thank all the authors that have contributed to this issue, and all those that have enthusiastically responded to the call. As well, it is a great pleasure to thank all those reviewers whose invaluable work has permitted to obtain such result. The editors are also confident that this issue will serve to promote further research in the Networking Area.

Matteo D'Ambrosio received his degree in Computer Science from University di Torino, Torino, Italy, in 1989 and joined CSELT (the telecommunications research laboratory of the Telecom Italia Group) in the same year. From 1989 to 1996 he worked in the field of B-ISDN. He was involved in the research areas of performance evaluation of ATM switching systems, ATM traffic characterisation, and performance evaluation of software open platforms for telecommunication systems. His current research interests are in the field of Internetworking, particularly in the area of IP routing and Differentiated Services network architectures. In such a area, he is now working on the design of new IP WAN networks which can support advanced applications and services (Voice over IP, Videoconference, VPN) requiring appropriate and differentiated QoS levels. He is co-author of several papers, and holds one patent in the ATM field. He can be contacted at matteo.dambrosio@cselt.it.

Mohammed Atiquzzaman received the M.Sc and Ph.D. degrees in electrical engineering and electronics from the University of Manchester Institute of Science and Technology, U.K. Currently he is faculty member in the department of Electrical & Computer Engineering at University of Dayton, Ohio. He is a senior editor of the IEEE Communications Magazine and also serves on the editorial boards of Computer Communications journal and Telecommunication Systems journal. He has guest edited many special issues of various journals including special issues "Traffic Management and Switching for Multimedia" and "Optical Networks, Communication Systems and Devices" in the IEEE Communications Magazine, ATM Switching and ATM Networks of the International Journal of Computer Systems Science & Engineering, and "Enterprise Networking" of the Computer Communications journal. He has also served in the technical program committee of many national and international conferences including IEEE INFOCOM, IEEE Globecom and IEEE Annual Conference on Local Computer Networks. His current research interests are in Broadband ISDN and ATM networks, multimedia over high speed networks and switching. He has over 90 refereed publications.
He can be contacted at atiq@ieee.org and his home page is http://www.engr.udayton.edu/faculty/matiquzz/