Preface

The enterprise network is a vital component of the infrastructure for any modern firm. What are the chances that a company today does not use e-mail or does not have a LAN, a server or connection to the Internet? The adoption of networks in day-to-day and critical operations has made them indispensable, considering the large volume of information being shared and their penetration in almost every corporate activity and transaction. As it is unlikely than any IT manager has a projection for decreased network capacity, a significant effort is being made to minimize the cost of implementing and maintaining the corporate network infrastructure and to maximize its scalability. Therefore, as bigger and faster networks are inevitable, the network manager needs to be able to support an increasing number of value-added applications for an increasing number of even more powerful workstations.

Technological advances in transmission technologies, wired or wireless, enhanced management capabilities, higher speed networks and distributed data storage locations enable applications such as data mining, multimedia communications and a wide range of value-added applications at a continuously decreasing cost. In addition, while information on these networks is sensitive and mission critical, network security is emphasized more than ever. Applications such as electronic libraries, subscription services, and collaboration sessions would not be feasible without these technologies, which provide reliable and effective communication with high throughput, low latency and low bit error rates. However, many of the technologies involved are still in their infancy, although the advances in transmission technologies and high-speed networks are rapidly progressing. Significant effort is spent in all directions, to provide improved services at all levels, improved abstraction levels and interfaces to end-users; these are key requirements for the wide deployment and acceptance of these new technologies.

Conventional networks, although effective and vital, manage information and provide a basic level of services that does not compare to the promise and expectations of future networks. This originates from the fact that conventional network technology provides efficient solutions only to the problem of moving packets of information. In contrast, future "intelligent" networks will transfer and manage higher levels of information structures, e.g., multimedia sessions, multi-

connection applications, etc. These "information networks" will enable the deployment of a large number of long awaited applications for users at work and at home. A first wave of these applications and services includes multimedia-based teleworking and telecommuting, digital studios, online multimedia processing, and many new e-commerce applications. Such applications require high bandwidth per session, low latency, high reliability, quality of service (QoS), and management of large amounts of information and security. Most importantly, these services have to coexist or to take advantage of the Internet and corporate Intranets, which are part of the landscape and support an exponentially increasing client population.

The improved control over network parameters and the widespread Internet technology have led to significant efforts for research, development and standardization of high-speed communication protocols and value-added services. The result is a wide range of projects and standards that are available or under development today. Additionally, the standardization efforts, often led by real market interests and needs, have resulted in the development and deployment of high-performance communication systems. Reasonably, the first deployment of high-speed communication systems targeted the provision of high-speed data transfer. However, it quickly became clear that the vast bandwidth provided by modern transmission technology couldn't be naively used for the provision of value-added services, such as real-time services (e.g., multimedia). This has led to the current efforts to upgrade the existing infrastructure, so that it supports Quality-of-Service (QoS).

For the design and implementation of high-speed "information networks" that span wide, geographically separated areas, one needs to consider a large number of available protocols and network technologies. Therefore, it is imperative to identify the most important technologies that currently play a critical role and provide a high promise for the future. This book intends to contribute in this direction. It addresses the technologies that have attracted significant attention and provide a promise for the scalability and future use in enterprise "information" networks. More importantly, the book does not only cover these technologies, but also identifies and discusses the open issues that are currently being addressed.

We follow a systematic approach to the presentation of the various topics in order to facilitate the reader to identify the technologies, their problems and the solutions proposed at all protocol and systems levels involved. The book is structured according to the standard OSI layered protocol stack, i.e., we start with issues related to the lower, physical layer and continue with increasingly higher layers and related functionality. At the end, we include issues that span many layers

(e.g., security and applications). To provide a complete, comprehensive collection of chapters, we begin with Chapter 1 describing the OSI protocol stack model. Its author describes the complete OSI protocol stack, identifying the functionality of each layer and providing an overview of protocol switching among protocols in each layer.

Chapter 2 discusses how advanced, multilayer switches can be used to increase the performance of network services. For this discussion, the term "performance" refers to availability, latency, and throughput, since all of these factors affect a user's impression of a site's performance. This chapter is intended for network service providers who must scale their services, network administrators who need to apply policies to their networks, and developers of switches who need to understand what the utility and requirements for these switches are.

Chapter 3 presents an overview of the technologies that have enabled the spectacular growth in optical networking. The authors discuss various emerging architectures for heterogeneous optical networks. As the management of optical networks has proven to be a challenge, the details on the management and control of optical networks are presented.

The author of Chapter 4 presents Virtual LANs (VLANs) that have become a required feature in any switched LAN solution. This is due to the increasing capacity and performance of switches that has enabled users to dedicate switch ports to every user on the network, increasing the need for control over broadcast and multicasts throughout the network.

Chapter 5 focuses on the current developments of the Internet Protocol (IP) that has fueled the growth of the Web and its widespread usage in the enterprise. Considering the importance of IP switching, many proprietary solutions emerged. The problems that originate from such a large number of different solutions are well known. The author addresses IP Switching and MPLS and explains the circum-stances that led to the development of the MPLS concept and the solutions it offers.

As enterprise websites have become mission-critical resources, Chapter 6 analyzes Web switching, which is executed by extremely fast and "intelligent" LAN switches. These devices switch traffic based on content, rather than just addresses, and integrate the traffic management and control functions that have traditionally run on a number of separate devices.

Chapter 7 deals with the service differentiation that is expected to become

ubiquitous in packet-switched networks. The author highlights four major challenges facing Quality of Service (QoS) in the next few years. Each of these relates to the idea that multiple layers in the protocol stack have to work together in order to deliver the QoS that users expect and are willing to pay to get.

Chapter 8 deals with the Voice over Internet Protocol (VoIP) that refers to the technology that allows transmission of voice over IP networks. With VoIP in place, the Internet will not remain a data-only network, but will become a telephone network as well. The authors discuss several aspects of VoIP: (1) Advanced applications powered by VoIP, (2) the technical challenges and solutions for making VoIP a reality, (3) various VoIP configurations, and (4) the protocols and standards for VoIP.

Chapter 9 continues the discussion on the very important topic of Voice over IP but takes a different perspective. It reviews issues on low bit rate speech compression and silence suppression, voice packetization and encapsulation, sources of packet-voice impairments and methods to mitigate them, and packet-voice transmission engineering.

Network architects recognise that multimedia over IP implementation details will vary from site to site, depending on a combination of internal business requirements and the unique conditions in a network. Chapter 10 will assist those who seek to introduce interactive video to their corporate IP network users as a first step towards network convergence. It will help the reader to benefit from lessons learned in past tests and trials, and to deploy a network with state-of-the-art technologies, capabilities that match user needs but have the ability to evolve over time.

Chapter 11 lays the groundwork for storage or system area networks (SANs) that are supra-high-speed micro- or pico-area (geographically speaking) networks dedicated to moving data between storage devices and users. With their increased speed and Internet-based components, SANs offer a better storage solution to meet data storage needs across the enterprise.

Management of security is one of the most pressing and expensive problems in modern enterprise networks. Chapter 12 attempts to persuade the reader to consider security from an entirely new perspective. The author argues that the current view of security management needs to be modified and proposes a new business-friendly view that treats security as a process that is an integral part of network management and operations. The chapter reviews some of the current

security technologies and methodologies and examines which problems have been satisfactorily addressed and which still need a lot of research, development and operationalization.

Chapter 13 deals with Web caching technologies that attempt to reduce network traffic on the Internet by replicating popular Web pages in strategic places on the network. The performance effect on the user is immediate while web server load is significantly reduced.

Chapter 14 introduces the reader to some of the reasons that Linux is going to play an important role as an Internet/network device in the coming years and why corporate technology strategists should consider it for their own environment. First, the term "Linux" is defined via a brief history lesson, and then examples of Linux deployment at each level of the OSI model are given. The reader will recognize the impetus for its rapid development and the explosive growth in its usage.

Last, but not least we would like to thank the authors for their contributions and for their patience during the completion of this book. We would also like to thank Michele Rossi for her continuous support. Vasilis would like extend his gratitude to his lovely wife and daughter, Roxana and Iliana, that still support and love him despite the long hours he spends at work. Dimitrios would like to thank Loukia and his parents, Nikolaos and Georgia, for their support and patience during this project.

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