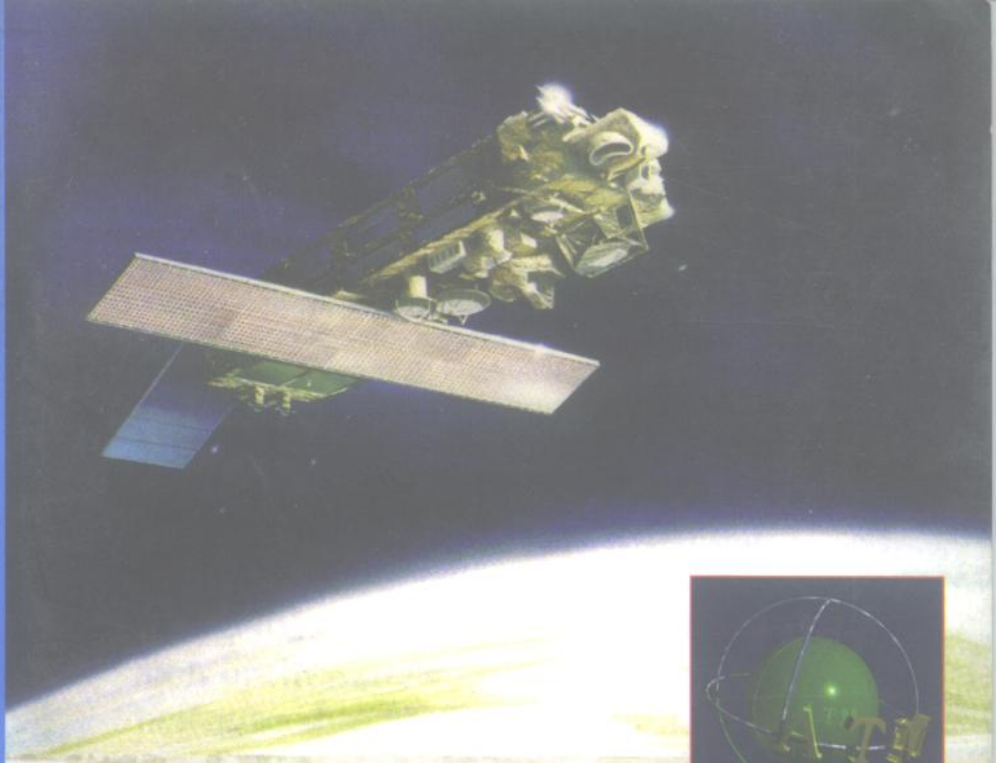

[美] DANIEL MINOLI THOMAS GOLWAY
NORRIS PARKER SMITH

Planning and Managing ATM Networks

ATM网络规划与管理

清华大学出版社
http://www.tup.tsinghua.edu.cn
PRENTICE HALL

Planning and Managing ATM Networks

ATM 网络规划与管理

DAN MINOLI
Teleport Communications Group (TCG)
Stevens Institute of Technology

TOM GOLWAY
Fore Systems

with
Norris Smith

清华大学出版社
Prentice-Hall International, Inc.

(京)新登字 158 号

Planning and Managing ATM Networks/Dan Minoli Tom Golway with Norris Smith

北京市版权局著作权合同登记号:01-98-0182

图书在版编目(CIP)数据

ATM 网络的规划与管理:英文/(美)迈诺利(Minoli, D.)编著 . - 影印版 . - 北京:清华大学出版社,1998.1
ISBN 7-302-02819-2

Ⅰ.A… Ⅱ.迈… Ⅲ.①异步通信网-规划-英文 ②异步通信网-管理-英文 Ⅳ.TN913.2

中国版本图书馆 CIP 数据核字(98)第 01439 号

出版者:清华大学出版社(北京清华大学校内,邮编 100084)
http://www.tup.tsinghua.edu.cn
印刷者:清华大学印刷厂
发行者:新华书店总店北京科技发行所
开 本:850×1168 1/32 印张:10.625
版 次:1998 年 5 月第 1 版 1998 年 7 月第 2 次印刷
书 号:ISBN 7-302-02819-2/TN・93
印 数:4001～9000
定 价:17.00 元

出版前言

90年代中期掀起了信息高速公路的浪潮。宽带综合业务数字网络(B-ISDN)代表着国家信息基础设施的最高网络层次，将在下一世纪发挥非常重要的作用。ATM是B-ISDN的核心技术，已经得到了迅速地发展。广大科技人员和大专院校的师生为了掌握该领域最新发展的知识，迫切需要一套全面、系统地介绍ATM与B-ISDN详细技术的文献，为此我们精选了一些最新英文版图书，组成一套《ATM与B-ISDN技术丛书》，影印奉献给广大读者。

本套丛书既系统全面，又分工明确，各有侧重。在内容安排上包括ATM与B-ISDN技术基础、宽带网信令、宽带网性能分析、ATM网的规划与管理、ATM网与其它网的互通以及ATM网络的应用等技术。希望这套丛书对从事ATM和B-ISDN研究的广大科技人员和大专院校师生有所帮助。

清华大学出版社
Prentice Hall 公司

1998.4

preface

Data processing in the late 1990s and beyond will be established around workgroup computing, whether the workers are in a building, on a campus, around town, around the nation, or around the world. To achieve the desired worker productivity enhancements sought through communication technology, workgroups will increasingly be interconnected over an enterprise-wide high-speed backbone network. Asynchronous Transfer Mode (ATM) technology and cell relay service are likely to play a major role in enterprise networks of the mid and late 1990s. ATM technology not only supports cell relay service, but also other fastpacket services, such as frame relay service, Switched Multimegabit Data Service, circuit emulation service, LAN emulation, and video/multimedia services. It is anticipated that ATM services will transform the enterprise network—from a data-only network to an integrated data, voice, video, image, and multimedia corporate infrastructure.

Specifically, many large corporations now have a growing need to extend high-speed communications beyond key sites, to support applications such as distributed cooperative computing, business/scientific imaging, video conferencing, video distribution, multimedia, (corporate) distance learning, etc. ATM presents itself as a viable, perhaps optimal, approach to meet these evolving corporate needs. However, because of the expense of high-speed networks, and the fact that in an ATM environment, most, if not all, of the corporate information flow may be aggregated over one or a few integrated broadband links, effective network management becomes very critical.

Therefore, such transformation of the enterprise network to an ATM-based infrastructure will result in an ever-increasing need for optimal management

of information processing and communication resources and services, whether these services are locally based or wide-area-based. Users expect rapid reconfiguration of the services they are using, to help them meet market demands on the products they produce, since many of these products utilize, in one way or another, communication and computers. Corporate financial monitors expect cost-effective communication, low outage time, and few work disruptions. Communication and computing expenditures can represent as much as 10% (5% on the average) of the total revenue of a corporation. This can equate to tens of millions of dollars a year. Communications managers want tools to facilitate planning, monitoring, operation, maintenance, administration, and reconfiguration of the enterprise network, to satisfy their customer base.

The purpose of this book is to familiarize ATM and network planners in the user community with the network management challenges, opportunities, and capabilities that ATM presents. The technology is just beginning to be deployed, but as soon as the equipment is taken out of the box and powered up, the question immediately presents itself to the user: "How do we manage—in a cost-effective manner—this thing?" A network technology without a mechanism for the user (and the provider, for that matter) to manage it, is like a car without a steering wheel—of limited or no value.

Detrimentally, there has been a feast of hyperbole about ATM during the past couple of years. Some in the trade press imply that ATM is "magical" in its support of bandwidth on demand, scalability, and other features. These people attribute to ATM features that have never existed and never will exist. The definition used by many neophytes—that ATM will fix whatever significant networking problems you have today, be they staffing; complexity; inability to reach remote exurban, rural, or third-world locations; expenditures; the need to keep up with technology, the need for analytical design; the need for tight operational discipline; or security, is absolutely positively wrong. This book seeks to expunge these misleading accretions. They have no place in a rational discourse of what can be done to next-generation corporate networks.

So what is good about ATM? It is not a panacea. It is only the best technology to come along so far. It can be put to effective use in meeting high-speed connectivity requirements, particularly at the backbone/WAN level, where the tributary bandwidth requirements have been aggregated well beyond the bandwidth needed by a single desktop user. For example, on the assumption that 1.5 Mbps dedicated is adequate to support (e.g., by using MPEG-1) video to each desktop, a company with 100 desktops may see an aggregate requirement of 155 Mbps (if all users must access a remote video server containing some information of interest). As a straight connectivity technology at the WAN level, ATM presents itself as a good candidate, in this example, to support this bandwidth need.

Some also look to ATM to support legacy LAN requirements at the premises level (we don't mean here new ATM services to the desktop, but a hybrid of a premises-based ATM-made-to-look-like-Ethernet suite of transitional equipment). This may or may not occur. In the past, new technologies have failed to win over the *legacy support* market. For example, when satellite links for data applications first appeared, they were not able to support mainframe links; a whole new application (VSAT) had to emerge. When ISDN standards were published (e.g., Q.931), three-quarters of the protocol state machine (as measured by the thickness of the standard) was dedicated to the interworking of traditional packet services over the D-channel (only one-quarter of the standard related to supporting circuit-switched services). This legacy support never occured in ISDN. Similarly, no frame relay service now available is offered in conjunction with ISDN as originally conceived. Numerous other examples can be cited. Naturally, it is the market (but not the vendors) who will decide.

After debunking the hype, users will deploy ATM services for those (new) applications that really need it. Several studies have shown that network management can take as much as 40% of the total communication budget. To ensure that the network management methodology, and the tools that may be selected by an organization, provide for efficient network operations, several issues need to be addressed:

- Is it easy to manage ATM?
- How does the organization define ATM network management?
- What ATM network management services are provided? By whom?
- What are the ATM performance metrics and objectives?
- What are the requirements for the support staff in charge of ATM?
- How does one integrate the management of the new ATM technology with existing LAN/WAN network management systems?
- What features are available in commercial ATM network management products? How easy is it to extend these products if needed?
- Are there standards for ATM management?
- Can one use SNMP for ATM management?
- How does one go about supporting an integrated ATM data, voice, video, image, and multimedia corporate infrastructure?

These and other issues are treated in this text. We hope it will assist corporations early on, in making the necessary decisions about ATM. The text takes

a pragmatic approach. It is aimed directly at communication professionals and corporate network managers and planners.

After an overview of the field (Chapter 1), an assessment of the importance of ATM in enterprise networks is provided (Chapter 2). This is followed by a primer on key ATM technologies that will play significant roles in the near future and which corporations expect their communication planners to manage (Chapter 3).

Chapter 4, provides a detailed technical analysis of ATM network management capabilities. Chapter 5, discusses the management of the protocol stack at the physical and ATM level. Chapter 6, looks at models to support Customer Network Management of ATM services. Chapters 7,8, and 9 cover the Open Systems Interconnection Network Management Specific Management Functional Areas (fault management, accounting management, configuration management, performance management, and security management) in the ATM context. Chapter 10, covers some of the network management issues faced by carriers offering ATM services, as they contemplate managing their own ATM networks.

The chapters that follow look at specific user environments, and assess the issue of managing ATM overlays to these embedded networking architectures—which clearly organizations cannot obsolete overnight in favor of an all-ATM enterprise network. Chapter 11, looks at emerging computing environments and the specific management requirements these impose on ATM. Chapter 12, examines the issue of establishing corporate network management goals. Chapter 13, addresses the predecision issues related to technology assessment for the deployment of ATM. Chapter 14, assesses management issues in Virtual LANs. People-related issues are covered in Chapter 15, along with a description of other collateral tools for effective network management. Finally, Chapter 16, provides an assessment of the industry in terms of commercial tools that have emerged and are expected to emerge in the next couple of years. Typical features and functions are discussed.

In addition to its professional market target, we believe that the book can be used for an undergraduate or graduate course, particularly from an enterprise network perspective. This material has, in whole or in parts, been used for teaching ATM technology at Stevens Institute of Technology to students already familiar with fastpacket communications.

The authors hope that this book will be of value to early adopters of ATM in selecting an appropriate network management strategy that provides a path of cost-effectiveness that goes beyond technical innovation. In the experience of the authors, corporations seek technology for productivity enhancement rather than pure academic pursuit of abstract technical advancement and sophistication.

acknowledgments

For Mr. Minoli, some portions of the material (specifically, Chapters 5–8 and 16) were originally done while at Bell Communications Research (Bellcore). Mr. Minoli also wishes to thank McGraw-Hill for allowing him to expand a network management chapter in the book *Cell Relay Service and ATM in Corporate Environments*, 1994, by Mr. Minoli and M. Vitella, into this more inclusive treatment.

Mr. Minoli wishes to thank Dr. Roy D. Rosner, Vice President and General Manager Data Service and Private Line LOB, Teleport Communications Group Incorporated (TCGI) for the support provided in the development of this treatise, based on the high-quality ATM services offered by TCGI.

Mr. Golway wishes to thank his clients for providing the opportunity to build advanced networks such as those described in the book. He also wishes to thank Ed, Mike, Bob, Domminic and Vinnie for their encouragement and freedom to go beyond conventional wisdom and push the envelope.

contents

Network planning and operations managers find that their networks are entering a period of significant transformation in the latter part of the 1990s. A network technology called Asynchronous Transfer Mode *(ATM) will be in the forefront of this transformation and the ensuing corporate and public infrastructure transition. The need for change is evident. During the early decades of data networking, complicated, expensive, and often duplicative solutions were created in isolation. Strenuous efforts led to some form of network interoperability. Increasing adoption of standards and open systems philosophies have reduced, to some extent, the interworking complications. Nevertheless, these solutions are barely adequate to meet evolving requirements for integrated, ubiquitous, and cost-effective connectivity.*

This chapter explores the motivations, opportunities, and challenges faced by this evolving technology for corporate networks.

1.1 Asynchronous Transfer Mode

An explosion in demand for enterprise-wide connectivity is now taking place. It is certain to accelerate in coming years. The networks that have been glued together over the years are not capable of meeting this demand adequately. In addition, it is becoming increasingly difficult for network managers to maintain cost efficiency and respond fully to their customers' requirements. Some view data networking as an unloved stepchild of a telecommunications establishment that has been preoccupied with voice transmission. Perhaps this has been justifiable, until now, when one considers that voice represents a yearly US expense of over $200 billion. Nevertheless, the data portion of many telecom budgets continues to increase significantly. Networks to support high-speed transmission of images—broadcast television and cable—have remained, at the practical level, in a separate domain.

No single technology can resolve all interworking, integration, and network simplification issues. It seems certain, however, that ATM will play a central, strategic role in the networks of the future. ATM is an open solution, based on international and industry standards. ATM technology provides the following capabilities:

- Much higher transmission capabilities than existing packet or frame-based technologies. From the start ATM will support LAN speeds 10 to 20 times faster than current systems. By the late 1990s, ATM will be able to operate at gigabits per second.

- Flexibility and versatility. Voice, data, video, and images can be transmitted simultaneously over a single, integrated corporate (or carrier) network.
- The ability to meet the needs of each segment of the corporate network, supplementing and eventually supplanting the different networking solutions that now prevail at the work group, at local area networks (LAN), at campus or metropolitan area networks (MAN), and at the wide-area networks (WAN).
- Adaptability to a wide variety of physical media, from ordinary twisted-pair wire to high-capacity optical fiber.
- The ability to support qualitative as well as quantitative changes in the corporate landscape. ATM will change how networks are used. Specifically, it will enable new applications that could transform the entire computer/network/user environment.
- Universality. ATM technology has the potential to become a ubiquitous, multiservice platform handling a range of traffic types.
- Support of virtual networks, leading to independence with respect to physical topology and decreasing user-perceived dependence on specific pieces of hardware.

On the negative side, ATM has been the subject of much hyperbole and many overwrought vendor claims. On another level, vendors who in the past decade have concentrated on legacy equipment, such as routers, seem to have a hard time grasping the principles and benefits of ATM; often they trivialize, undervalue, or bad-mouth the technology. In fact, ATM is already a working reality, serving the real-world requirements of many kinds of users. At press time one already finds hundreds of users who are in various stages of ATM pilots, early deployments, and initial production use.

ATM implies far-reaching institutional as well as technological changes. Such changes do not propagate through an organization as rapidly as some would think or hope. To be honest, ATM is not yet a fully mature technology, specifically in regards to a commodity status of the various constituent components. Effectively, ATM is today where LANs were in 1984: standards had been developed, and some basic equipment was available, but all the equipment breakthroughs, especially in the areas of high-performance cost-effective bridges, routers, hubs, switches, and Network Interface Cards (NICs), were still several years away. In fact, it took about a decade to achieve a commodity status. Standards-making bodies are still resolving some details of ATM specifications, particularly in support of video, voice, and multimedia. Data WAN technol-

ogy is well-advanced, while LAN-based ATM technology is nearing completion of standardization. Timing is, thus, a crucial dimension of ATM evaluation, adoption, and implementation. Corporate network planners and managers must be conscious of the immediate realities of the next couple of years, as well as ATM's long-term potential. Specifically it appears that large-scale ATM deployment will take place first in the MAN/campus context, followed by WAN implementations and, eventually, at the work group and desktop level.

1.2 About this Book

This book aims to provide readers with the background, concepts, and strategies that they need to prepare for ATM technology deployment in their corporations. It focuses upon network planning and management as it pertains to ATM. Most observers recognize that the planning process will be the key to successful operation of ATM-based networks.

The book assumes that the reader has some basic familiarity with ATM technology, including the references. There are now a number of books on the market focusing on ATM technology, including Ref. [1]. This text covers other topics related to the effective management of ATM equipment, services, quality of service, traffic, and carriers' offerings.

Management, as used here, includes:

- Decisions and broad oversight by a corporation's senior executives.
- Planning and management of the structure, applications, procedures, and future course of the network.
- Operational management of day-to-day functions at the network's logical and physical levels.

This book addresses the needs of readers concerned with these and other dimensions of network management. Particular emphasis is given to corporate networks. Early implementers include major governmental and academic organizations, as well as Fortune 100 companies.

The content of the book is also relevant for small businesses and others that obtain ATM services from common carriers. This situation will become increasingly important as many more carriers in Europe and Canada, as well as the United States, adopt and implement ATM technology. In the US, service is already available from a number of alternative access providers, interexchange carriers, and regional Bell operating companies.

Special attention will be given in this text to the far-reaching changes that ATM technology and principles will bring about in network design, deploy-