Suggested reading

The following are synopses of four recent books that may be of interest to readers of the *IBM Systems Journal*, particularly those with an interest in networking. Inquiries should be directed to the publishers cited.

The enormous promise asynchronous transfer mode (ATM) holds for the future of networking, well into the 21st century, means we'll be seeing a spate of books explaining it, dissecting its value, and reporting its progress. The first three books discussed here take up the challenge in different ways that should find general appeal. Each has its own focus and makes its own audience assumptions. The books by Stallings and by McDysan and Spohn have been written for use as texts, although they both should appeal to practicing professionals as well. This use as texts is reflected in their extensive references throughout, with Stallings also discussing his recommended readings and including problem sets at the end of chapters. Goralski's book is directed more at the practitioner, including telecommunications specialists, and network designers, implementers, planners, and support personnel.

ISDN and Broadband ISDN with Frame Relay and ATM, 3rd Edition, William Stallings, Prentice Hall, Englewood Cliffs, New Jersey, 1995. 581 pp. (ISBN 0-02-415513-6). Stallings concerns himself with both the narrowband and broadband integrated services digital network (ISDN and B-ISDN) standards and their key networking technologies—frame relay and ATM. His major emphasis throughout the book is on the logical structure (layering), services, and protocols, mostly as they relate to the user-to-network interface rather than to internal network operation. Following a brief introductory chapter setting the basic context of ISDN and explaining the book's structure, the book consists of five parts. Part 1 presents the basic elements of digital transmission and switching techniques, for the reader lacking background in data communications.

Part 2 covers the ISDN standard in six chapters, perhaps too much for many readers, given the small presence of ISDN in the marketplace. The coverage includes an overview of ISDN and its standards, its interfaces and functions, the physical layer, the data link layer (e.g., the LAPD protocol), the network layer (for out-of-band call control for user-channel traffic), and service capabilities for voice and data applications. An additional chapter describes the Signaling System Number 7 (SS7), a standard for signaling on a separate channel (called *common-channel signaling*) to provide internal control and network intelligence for ISDNs. The author points out the immense scope of SS7 (with its 43 ITU-T standards), embracing all aspects of control signaling for complex digital networks, including the reliable routing and delivery, and application-oriented content, of control messages.

Part 3 covers frame relay, the jewel of the ISDN standardization process. The coverage of frame relay is in two chapters, one on its protocols and service, and one on its congestion control. In the congestion control chapter, Stallings attempts to bring order to what he notes is the most confusing aspect of frame relay, partly because of the number of techniques (which can be used together or alternatively) and partly because of the documentation of the techniques, scattered "through various [standards] documents in no particular order." The approaches he discusses include frame discard strategy, explicit notification of congestion (including usage of the euphonious FECN and BECN bits), and implicit control of congestion (relying on higher layers).

Part 4 then covers B-ISDN: its standards, services, requirements, functional architecture, user-to-network interface, and transmission structure in one chapter; and its basic layering, including how ATM fits in, in another chapter. This second chapter covers details of the optical transmission facility called SDH (or SONET in the United States).

Part 5 covers ATM in two chapters. The first discusses the cell, the virtual channel and virtual path, the operation and maintenance functions, the transmission of the cell over a cell- or SDH-based physical layer, and the ATM adaptation layer (AAL), including its services, protocols, and types. The second chapter on ATM discusses traffic and congestion control, using material gleaned from both ITU-T (I.371, 1992) and ATM Forum (UNI 3.0, 1993) specifications. It treats the basics of the requirements for ATM traffic and congestion control with respect to latency/speed effects and cell-delay variation, the rudimentary functions of traffic control (virtual path management, connection admission control, policing of usage parameters, priority control, and traffic shaping), and the congestion control functions of selective cell discarding and explicit forward indication of congestion.

The book ends with two appendixes, one on flow control and error detection and control, and another on the Open Systems Interconnection (OSI) Reference Model (both for the novice), a mediocre glossary (almost nothing on ATM), a recompilation of all the references cited in the chapters, and a very useful index.

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ATM Theory and Application, David E. McDysan and Darren L. Spohn, McGraw-Hill, Inc., New York, 1995. 636 pp. (ISBN 0-07-060362-6). McDysan and Spohn take a broader perspective on ATM, adding extensive discussions of the applications, business choices, and economics enabling the technology. They also include considerable material on ATM hardware implementations, obtained in a survey of vendors. For some, their pace may be too leisurely; the background topics use up nearly the first 200 pages. However, the newcomer to this area of networking may be well served. The book, which consists of eight parts, begins with a two-chapter discussion outlining the technological, application, and business drivers for ATM, and touching on the history of communications, the revolutionary alteration of business networks from voice to data orientation, and projected data networks for the next century.

Part 2 (Chapters 3–5) begins with the obligatory background on basic OSI layering concepts, along with brief mention of SONET, ISDN basics and history, connection-oriented and connectionless network services, and circuit-switching concepts. Chapter 4 defines the rudiments of network topologies, circuit types, data transmission methods, transfer modes, and principles and examples of multiplexing and switching. Chapter 5 presents a review of data services, giving the origins, structure, basic formats, functions, and other aspects of X.25 packet switching, TCP/IP, frame relay, and the metropolitan area network service called switched multimegabit data service (SMDS).

Part 3 (Chapters 6–9) brings us to ATM. Chapter 6 introduces the relevant standards bodies involved (e.g., the ITU-T and the ATM Forum), the players (users, vendors, and network service providers), the standardization process and results to date, the B-ISDN framework for ATM, and current directions and approaches. Chapter 7 provides a basic introduction to ATM: objectives, the cell, fundamental concepts of cell presentation and switching, and basic building blocks (paths and channels). Chapter 8 delves into the details of the physical, ATM, and ATM adaptation layers of the B-ISDN framework. Among the topics are the differences between the user-to-network interface (UNI) and network-to-network interface (NNI) cell structures, key functions of the ATM layer, and specifics of AAL types 1, 3/4, and 5. Chapter 9 discusses the notions of the user plane and the management plane (details of which appear in later chapters), and the detailed functions of the control plane. (The *plane* is a visual categorization of the components of the B-ISDN framework according to the needs they serve.)

Part 4 (Chapters 10–11) discusses ATM hardware and software. Beginning with brief sections on the blocking characteristics, switch fabrics, and buffering methods of ATM switch technology, and on the basic ATM hardware categories, Chapter 10 has an extensive compilation of vendor hardware characteristics. Although of interest to many, the material will likely have only brief relevance in a fast-paced marketplace. Chapter 11 covers additional concerns for ATM end systems: network addressing and routing, hardware and operating systems, application programming interfaces for ATM, and ATM-based applications.

Part 5 (Chapters 12–16) presents many details on ATM traffic management, congestion control, and traffic engineering. Included are the standards, the algorithms, the many alternative approaches, the mathematical models underlying the authors' insights, and design considerations for switches and networks. Readers will find this part of the book very enlightening.

Part 6 (Chapters 17–18) examines ATM-based protocol interworking and public ATM network offerings. Chapter 17 discusses the ATM Forum's data exchange interface (DXI), multiprotocol support using AAL5, ATM interworking with higher layers (frame relay, SMDS, and IP), and the ATM Forum's broadband intercarrier interface (B-ICI) for connecting two network providers or carriers in the interworking context. Chapter 18 explores public ATM network architectures and looks at decision criteria for selecting ATM-based services.

Part 7 (Chapters 19–21) defines management aspects of ATM. Chapter 19 covers the philosophy of such management; architectures defined by ISO, ITU, IETF (for TCP/IP), and the ATM Forum; and an interface (ILMI) and management information base (AToMMIB) to be used for ATM. Chapter 20 presents ATM layer management and fault management, while Chapter 21 describes the use of performance measurement procedures concerned with checking that quality-of-service (QOS) objectives are met.

Part 8 (Chapters 22–23) compares ATM with other technologies (e.g., X.25, IP, frame relay, SMDS, FDDI), and speculates on future directions involving ATM (the authors are very optimistic). The book ends with an exhaustive list of acronyms, a list of sources of standards throughout the world, and a fair glossary and index.

Introduction to ATM Networking, Walter J. Goralski, McGraw-Hill, Inc., New York, 1995. 383 pp. (ISBN 0-07-024043-4). Goralski's objective is to offer a complete technical introduction to ATM, dedicated to the topic and as up-to-date as possible. His perspective emphasizes the technology, with economic factors brought in "as a side issue." He cites the social acceptability as problematic for ATM, as it is for any new technology, and sets it aside as an unknown (although he discusses some of its aspects). In describing ATM, he relies on the standards of the ATM Forum, the large international vendor consortium that, since its formation in October 1991, has been blazing the ATM trail. His book *is* the most up-to-date of the three discussed here. (All the authors will need to keep their editions flowing to stay timely.) Goralski is an exceptionally engaging author, whose prose has a compelling flow. He weaves personal insights and opinions regularly into his exposition, and explains related technologies as needed, but only to the extent they are relevant to his primary focus. Moreover, he crafts very succinct and able definitions throughout. Following an introduction that sets forth the book's purpose, basis, and direction, Part 1 (Chapters 1–2) gives some brief background. Chapter 1 traces the historic progression from older "transfer mode" networks—the "optical telegraph" network in the late 1700s, the electrical telegraph network in the mid-1800s, and the telephone network beginning in the 1880s—to the modern era, where ATM represents the culmination of the application of computer technology to digital telephone networks. Chapter 2 presents the basic capabilities of ATM, its *synchronous* technology, the problems it addresses, how it overcomes the limitations of its predecessor *channelized* networks, and how its multiplexing technique gives acceptable performance in mixing voice, video, and data.

Part 2 (Chapters 3–6) forms the core of the text, telling how ATM works. Chapter 3 introduces the major concepts of ATM

networks. First it shows how ATM is positioned in the OSI Reference Model compared to its forerunners: router-based networking, X.25 packet-switched networking, and frame-relay networking. Citing the "six necessary cell functions," the author shows how these map into ATM's layers, comparing ATM with the SMDS cell-based service for these same functions. Showing how ATM fits into the B-ISDN framework, he then points out the benefits of defining more carefully in the standards how this should fit into the OSI stack. The chapter proceeds with an overview of ATM functions and layers, the virtual connections and paths, basic switching, signaling principles, performance parameters, traffic control, operation and management (OAM) functions, and the network components and interfaces defined by the ATM Forum. Chapter 4 deals with details of the physical layer of the ATM protocol stack. The focus here is on fiber optics media and SONET (Synchronous Optical Network), explained in some detail. Mentioned also are the other media defined by the forum—while "waiting for SONET." The chapter concludes with a detailed discussion of the ATM transmission convergence sublayer, which is the upper part of its physical layer. This sublayer is concerned with the basics of cell exchange with its lower transport service and with cell header error control. Goralski devotes much space to this topic compared to the other authors. Chapter 5 covers the ATM layer (having the same name as the architecture itself). Covering the basic functions of this more briefly than McDysan and Spohn (and ignoring some aspects, such as traffic shaping), the chapter instead devotes much space to the basic switching principle of ATM, citing the crucial issues affecting the performance, reliability, and price of ATM switches, and defining the primary architectures for the switch fabric itself. For concreteness, the chapter examines a leading vendor's actual switch; it concludes with details of OAM functions and aspects of signaling, such as those for setting up and releasing ATM connections. Chapter 6 discusses the ATM adaptation layer (AAL), its AAL types (including the problems in defining AAL2), and its major services, such as accommodating earlier technologies.

Part 3 (Chapters 7–9) considers issues in actually building ATM networks. Chapter 7 defines the network considerations that are basic: performance issues, network management, and interoperability. The chapter concludes with a discussion of "myths," caveats, and some significant unanswered questions. Chapter 8 looks at the future of ATM, exploring some of the technologies viewed by some as rivals to ATM. One technology examined at some length is *packet transfer mode*, offered in IBM's Networking BroadBand Services (NBBS) architecture, with advantages for data the author readily concedes. Other protocols include those for local and metropolitan area networks and SMDS and frame relay. The chapter shows generally how these "rivals" can be interworked with ATM. Chapter 9 closes out the book, looking at issues in building private ATM networks, and also presenting the author's view of the various players and products—inevitably a dated version of the developing scene.

The book appends a useful list of selected ATM and related standards, a brief bibliography of related books, an exhaustive acronym list (at the front of the book), no glossary (contrary to the claim on the book's back cover), and a minimal index. Simply extending the table of contents by additional levels of the existing headings could have aided the searching reader where the index does not.

Network and Distributed Systems Management, Morris Sloman, Editor, Addison-Wesley Publishing Co., Reading, Massachusetts, 1994. 666 pp. (ISBN 0-201-62745-0). A reference on current practice and future directions for managing networks and distributed systems, this book is targeted at system managers, network and system management vendors, students and computing professionals, and researchers. Divided into 25 chapters, the book has contributors drawn about equally from industry on the one hand, and universities and consultancies on the other. The book begins with an introductory chapter on the "what and why" of management, and concludes with a chapter that summarizes the main trends, the most pressing problems, the remaining research problems, and the future directions for management of networked environments. The content and structure of the intervening chapters reflect the book's theme that management is a distributed processing system, one that can itself be managed with the same techniques and tools used for other distributed applications. These middle chapters are organized into six parts.

Chapters 2–3 deal with technologies and principles that enable communication systems and distributed processing systems to be built. Chapter 2 focuses on local, metropolitan, and wide area networking technologies and on internetworking issues related to addressing, network layer structure, and routing—using TCP/IP and the Open Systems Interconnection (OSI) protocol suite as examples. Chapter 3 defines in some detail a central focus of the book: distributed systems—what they are; the services they provide; how they are constructed and function; and some major issues in their use, such as naming, synchronization, error control, and resource management.

Chapters 4–9 discuss models and standards for management. OSI concepts and standards are a primary topic of several chapters and underlie various others in the book. Chapters 4–6 explain the OSI management model, its object-oriented approach, and guidelines for defining OSI managed objects. Reflecting the reality of its marketplace success, Simple Network Management Protocol (SNMP), which originated in TCP/IP, is accorded ample treatment in Chapter 7, including its origins, its most recent standardized version (called SNMPv2), its major concepts and functions, and its newest security-related services for privacy, authentication, and access control. Chapter 8 draws a comparison between the OSI Common Management Information Protocol (CMIP) and SNMP, essentially contrasting the generality, flexibility, complexity, and cost of CMIP with the simplicity, limited function, and current market ubiquity of SNMP. Chapter 9 defines the Telecommunications Management Network (TMN) architecture, an evolving standard used by public carriers, and one that uses OSI standards as its basis.

Chapters 10–15 dwell on specific management functions. Chapter 10 is concerned with name management and directory services, their evolution, current trends, issues in deploying and managing naming spaces, and the X.500 directory standards, which the author views as a potential basis for a unifying and open-ended naming strategy for global networks. Chapter 11 deals with a topic of great interest to the environment underlying this issue of the *IBM Systems Journal*: management of quality of service (QOS) in distributed systems. Indeed this issue of the *Journal* is a useful counterpoint to the chapter's comment (albeit constructed some two years ago) that the notion of QOS has been dealt with "barely at all in commercial systems." (I cannot resist also pointing out that the long-available

SNA and APPN* concept of *class of service* should readily map to the ATM QOS notion, allowing existing SNA applications to exploit the newer facility using their current interfaces unchanged.) Chapter 12 discusses the monitoring of distributed systems, including generation, processing, dissemination, and presentation of monitoring information, along with implementation issues and examples. Chapter 13 delves into network planning and performance engineering, including service criteria, measurement methods, modeling and analysis, and configuration and capacity planning. Chapter 14 examines administration and accounting functions in networks, concentrating on commercial distributed systems, especially the pan-European digital cellular telecommunications system. Chapter 15 explores security issues in networks and distributed systems emphasizing security management aspects.

Chapters 16–17 address management policy. Chapter 16 introduces the notion of a *domain* as a means of grouping objects in order to specify a common policy and access rules that apply to their management. Chapter 17 shows how management policies for distributed systems may be modeled, using the example of "discretionary" access control—the manager-controlled sharing of managed resources among managers. The work reported in these two chapters stems from research funded in the United Kingdom that "involved Imperial College, Sema Group, and BP."

Chapters 18–21 cover various implementation issues of management. Chapter 18 looks at techniques and tools for constructing distributed applications from context-independent software components, including for running systems. Chapter 19 reviews the application of commercial databases to management. Chapter 20 describes essential features of a graphical management interface for management applications. Chapter 21 speculates on how artificial intelligence techniques can help automate control, problem solving, and decision-making in distributed network management; the author reports on work that has been conducted in several projects at GTE Laboratories.

Chapters 22–24 provide three case studies: Digital Equipment Corp.'s Enterprise Management Architecture, the Open Software Foundation's Distributed Management Environment framework and design, and MetaAccess Inc.'s METAWINDOW** environment for developing and managing communication protocols and distributed systems applications.

This book breathes real life into a topic that is complex and often neglected by network professionals. Its breadth and depth, organization and integrated content, editorial excellence, and extensive references throughout are particularly welcome.

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