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## **Contents:**

- REVIEW OF: Berry Kercheval. TCP/IP Over ATM: A No-Nonsense Internetworking Guide. by Aimee deChambeau
- REVIEW OF: Debra Jones. Exploring the Internet: Using Critical Thinking Skills, A Self-paced Workbook for Learning to Effectively Use the Internet and Evaluate Online Information. by Brad Eden
- REVIEW OF: Andrea L. Ames, David R. Nadeau, and John L. Moreland. VRML 2.0 Sourcebook, 2nd Edition. by Ray Olszewski
- REVIEW OF: Uyles Black. ATM Resource Library. by Michael B. Spring
- About TER

 [ter issues \(/lita/publications/archive/ter\)](/lita/publications/archive/ter)

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**REVIEW OF: Berry Kercheval. TCP/IP Over ATM: A No-Nonsense Internetworking Guide. Upper Saddle River, NJ: Prentice Hall, 1997.**

by Aimee deChambeau

Berry Kercheval has succeeded in providing a succinct and clear discussion of ATM (Asynchronous Transfer Mode) technology as it relates to IP (Internet Protocol). By introducing new concepts and building upon them in short, well-illustrated sections Kercheval has fulfilled his goal of writing a book for those already familiar with networking but unacquainted with ATM.

While the technical details required for actually implementing IP over ATM are not included, this short book provides the background information one needs to get started. One of the richest features of this book is the continual and consistent provision of pointers to further readings for in-depth coverage of the concepts and technologies introduced. TCP/IP Over ATM is suitable for a wide audience as an introductory text for students or technical managers and as a refresher or reference for network professionals--including those already working in the world of ATM.

The book's Introduction covers the OSI (Open Systems Interconnect) reference model and a few networking basics. A wonderful explanation of the most prominent standards bodies involved with TCP/IP and ATM is also included. The discussion of the standards bodies, in conjunction with Appendix A, "How to find standards documents," is a great springboard for anyone interested in who these standards bodies are, what they do, and how to obtain what they produce.

The second chapter discusses the Internet Protocol (IP) and touches upon some of the related protocols such as the Trivial File Transfer Protocol (TFTP) and the Internet Control Message Protocol (ICMP). Kercheval presents the details of Internet addressing and packet formats, the Transmission Control Protocol (TCP), and connection establishment and termination. The User Datagram Protocol (UDP) is discussed in comparison to TCP and the Address Resolution Protocol (ARP) is introduced.

Chapter three describes the way optical fiber media functions and details two of the most popular types of ATM links: SONET (Synchronous Optical Networking) over optical fiber and Unshielded Twisted Pair (UTP) copper wires. Particular attention is paid to the functioning of optical fiber networking, from the way that light travels through optical fibers to how data is packaged for delivery across optical media (SONET).

ATM (Asynchronous Transfer Mode) is introduced at an abstract level in Chapter four. The Broadband Integrated Services Network (B-ISDN) and its corresponding reference model are discussed. ATM concepts are addressed, such as the connection-oriented nature of ATM, ATM network structure, cells, switches, and virtual circuits. ATM Adaptation Layers (AAL) and ATM addressing are introduced and signaling is discussed at length. The Network-to-Network Interface (NNI) is described in enough detail for the reader to understand what occurs in an ATM network. Permanent Virtual Circuits (PVCs) are treated briefly, primarily to explain their drawbacks in medium and large networks.

Chapters five and six introduce and discuss two separate schemes for connecting computers to an ATM network: respectively, the Internet Engineering Task Force's (IETF) Classical IP (CIP) over ATM and the ATM Forum's LAN Emulation (LANE). The beginning of Chapter five briefly differentiates between these two schemes and outlines some assumptions that CIP makes about the network. The remainder of the chapter details the encapsulation of datagrams, address resolution, and signaling rules in the Classical IP scheme.

Chapter six outlines the various components of an emulated LAN (ELAN) using LANE and describes how these components communicate with one another. Kercheval addresses the pros and cons of LANE and indicates that future directions for LANE address drawbacks. The author does mention that, in discussing LANE, he is in fact referring to LANE's Phase One implementation and that Phase Two (LANE v.2) and

MultiProtocol Over ATM (MPOA) were approved by the ATM Forum in July of 1997. The chapter itself remains up-to-date for 1998 as the industry is currently working with LANE v.1 implementations. Note, however, that LANE v2 and MPOA are currently on the market.

Chapter seven addresses network management and administration. The Simple Network Management Protocol (SNMP) data structures, Management Information Bases (MIBs), and information exchange protocol are introduced. The ATM Forum's Interim Local Management Interface (ILMI) and its relationship to SNMP is treated in detail. Firewalls are discussed briefly, and a model for firewall technology in ATM networks is provided.

Chapter eight describes IP Multicast, the sending of packets to a group of hosts on a network. The Multicast backbone, or Mbone, is introduced in detail. ATM hardware and software support for multicast (also known as Point-to-MultiPoint, or PMP) are discussed. In this chapter the author addresses both the IETF's scheme for implementing multicast over ATM and the ATM Forum's LAN Emulation approach to multicast.

Chapter nine introduces traffic management with descriptions of the various classes of traffic found in ATM networking. Traffic degradation is treated briefly, while ATM traffic control is discussed at length, including the credit- and rate-based traffic control algorithms. The ReSource Reservation Protocol (RSVP) is outlined.

Network tuning and performance are addressed in Chapter ten. Two freeware tools for measuring performance, netperf and ttcp, are described and various common reasons for poor performance are summarized.

The last chapter, 11, is a short look at the directions that research and development are taking in the world of ATM. Several large test-bed, academic, and commercial projects are described briefly, with URLs provided for more information.

TCP/IP Over ATM really is a no-nonsense introduction to ATM networking in the context of TCP/IP. Kercheval's informal tone combined with his clarity make this an extremely easy to read book without sacrificing technical content. The fact that the author provides so many recommended readings and pointers to standards documents adds another dimension to this book: one of a short desk reference. TCP/IP Over ATM is a valuable addition to any networking collection.

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[table of contents](#)  ter issues (/lita/publications/archive/ter)

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**REVIEW OF: Debra Jones. Exploring the Internet: Using Critical Thinking Skills, A Self-paced Workbook for Learning to Effectively Use the Internet and Evaluate Online Information. New York: Neal-Schuman, 1998.**

by Brad Eden

As the title suggests, this is a self-paced workbook for learning to explore the Internet. A map of the workbook is included; it is divided into eight lessons. The reader has ample opportunity to explore various sites on the Internet, while answering questions regarding reliability, usefulness, and quality of information. The author provides a number of quality web sites for examination and to assist the reader in assessing quality. Symbols are used throughout the workbook to notify the reader of concepts, definitions, tools, and practice sections. A short glossary and bibliography are given as well.

This book appears to be geared toward serious Internet beginners and perhaps librarians looking for a quick and easy guide to learning the Internet for themselves. The title makes it clear that the purpose of this book is to teach the reader how to use the Internet and to evaluate what it contains. Internet beginners who wish to have a quick and easy guide to Internet use will be disappointed with this workbook, as it spends as much time questioning the quality of the information as finding the information. This is probably why the author has effectively defined the purpose of the workbook in the title. I personally found the Tools icon the most helpful, as the author mentioned some very helpful and interesting Internet sites under this icon.

This book would probably be appropriate for high school and college students as a beginning Internet workbook as well, since many of them are now using the Internet as a sole source for research and assignments. I think that it is well-written and would recommend it as a beginning workbook for serious Internet beginners, high school/college students, and librarians with no Internet experience.

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[table of contents](#)  [ter issues \(/lita/publications/archive/ter\)](#)

---

## **REVIEW OF: Andrea L. Ames, David R. Nadeau, and John L. Moreland. VRML 2.0 Sourcebook, 2nd Edition. New York: Wiley, 1997.**

by Ray Olszewski

VRML, or Virtual Reality Modeling Language, is a language intended to permit the creation of "worlds" that one can view and interact with through a suitably-equipped Web browser (either a custom browser or a plug-in for a standard graphical browser). VRML 2.0 includes tools for the creation of 3-D objects, for "staging" the world (e.g., lighting it, defining the viewer's location), and for controlling the viewer's ability to interact with the objects (e.g., moving the viewing location, changing attributes of objects).

When VRML first appeared over four years ago, it showed some promise of being the "next big thing" on the World Wide Web. Back then, enthusiasm for graphically-rich Web pages was high; plug-ins to enhance Web browsers were the standard way of increasing functionality; and there was as yet no standard for adding interactive capabilities to pages downloaded to a browser.

But all that was more than four years ago. In 1999, things are different. Now, the dominant reaction to elaborate graphics is concern about how much they increase download times--careful, selective use of graphics is the norm (except for advertising banners, I suppose). Upgrades to the two main browsers in use--Netscape Navigator/ Communicator and Microsoft Internet Explorer-- have incorporated the most common enhancements, reducing the need for plug-ins (and making the usefulness of big ones seem less worth the trouble). Perhaps most important, the Java programming language is, for better or worse, becoming established as the standard for adding interactive features to downloaded Web pages.

As a consequence, VRML is a technology that has become a niche player, of interest mainly to hobbyists, avid gamers, and perhaps some developers of specialized intranet sites. As such, it joins a club of clever, attractive technologies--Smalltalk, APL, and Forth come to mind--that failed to achieve market acceptance for reasons having nothing to do with their intrinsic merits.

VRML 2.0 Sourcebook is thus something of a cenotaph to VRML. Superbly written and loaded with examples of functioning code, it provides all the detail needed to teach the programming component of how to create VRML worlds. The authors, who also maintain the VRML Web site at the San Diego Supercomputer Center (<http://www.sdsc.edu/vrml>), provide a careful, well-ordered introduction to the components of VRML.

Although there are gui-based tools available (freeware, shareware, and commercial) to assist in creation of VRML worlds, the authors opt for the more fundamental approach--writing line-by-line the actual code to create a world. This makes the book tough going for readers used to highly interactive programming tools and methods, but it gives the authors the opportunity to explain clearly and carefully what the actual components of worlds and object are, what properties and capabilities they have, and how worlds can be fine-tuned at a level of detail hard to achieve with visual world-building tools.

The book covers all the main features of VRML and its worlds: predefined shapes (spheres, cylinders, cones, boxes), text shapes, extrusions and other custom shapes, colors, textures, coordinates, positioning and rotating shapes, animation, backgrounds, lighting, fog (controlling the haziness of distant objects), moving the viewpoint, and making objects respond to being "touched."

All of this material is, however, approached from the standpoint of programming, not artistry. As a programmer myself, I found myself understanding clearly how to create visually-simple objects, but also receiving little guidance about how to make the worlds I created look visually attractive. Some of this may reflect the limits of VRML--examples I viewed both in the book and on the Web) were relatively simple, either abstract geometric shapes or the cartoonish, Tron-like images that are common in computer games.

From a programmer's standpoint, some limitations of VRML were surprising. I could find no functional equivalent of the "if" statement in the language, the most serious limitation. While it is possible to assign a name to a complex construction so you can use it again later by referring to it simply by name, it seems that you cannot define a structure prior to its first use--this makes for hard-to-read and -maintain code, compared to languages in which the components being labeled for reuse can be grouped at the start of a program. Objects don't cast shadows. There is no (or no obvious) way to detect a collision between two objects. Predefined shapes have no inside surface; in effect, they are all like one-way mirrors.

At the same time, the actual performance of VRML is somewhat disappointing. The CosmoPlayer browser plug-in I downloaded ( <http://cosmosoftware.com>) had a hard time displaying images well on my computer (a P233mx CPU with a generic video card). This may have been a

configuration problem with my system, or it may be that VRML software demands very high-end clients to work well--but in either case, it was a bad sign for widespread acceptance of VRML, especially given the dominance of low-end computers in recent sales.

These and other VRML limitations are, I suspect, indications that development of the language has been stopped short of full functionality by its lack of acceptance in the marketplace.

The book is now almost two years old. That's not bad for the book itself, but it makes the associated CD-ROM an archival source, not a current one. The CD-ROM provides useful copies of the book's example code and some "sampler" collections of VRML objects and components. The rest of the materials--samples of VRML browsers, VRML creation tools, and a few other applications--however, are old enough that I would urge the interested reader to get more current versions through the authors' VRML Web site.

So in the end, VRML 2.0 Sourcebook is an excellent book about a minor, specialized component of the World Wide Web. A reader with some programming experience will learn a lot here both about VRML in particular and about the underpinnings common to 3-D image creation programs, though readers without much prior programming experience will find the going tough. The clarity of the presentation is exceptional, though, enough so that I hope the authors turn their hands to writing about other, more successful technologies.

I would recommend this book highly to anyone who needs to learn to program in VRML and to readers with a strong interest in the programming side of 3-D world creation generally. Readers interested in a better understanding of the artistic side of 3-D world creation, or just looking for ways to enhance their Web sites, would do better to look elsewhere.

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[table of contents](#)  ter issues (/lita/publications/archive/ter)

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**REVIEW OF: Uyless Black. ATM Resource Library (Volume 1: ATM: Foundation for Broadband Networks, 1995; Volume 2: ATM Signaling in Broadband Networks, 1998; Volume 3: ATM: Internetworking with ATM, 1998). Upper Saddle River, NJ: Prentice Hall, 1998.**

by Michael B. Spring

This three volume set is a part of the Emerging Communications Technologies collection in the Advanced Communications Technologies Series. Overall, the set will provide a valuable addition to your networking library. ATM is an important new technology and Black does a masterful job of laying out the territory. Even though Volume 1 is now over three years old, it still provides relevant and accurate data about ATM. Overall, this reader found the three volume set to be concise, accurate, and appropriately detailed. There is some

degree of overlap and there are occasional typographic errors (e.g., the back cover of Volume 1 states, "Black examines the B-ISBN model"--interesting substitution "International Standard Book Numbers" for "Integrated Services Digital Networks"!)) While the proofreading oversights are rare and almost always discernible, in the alphabet soup of modern communications acronyms, one tiny slip can send you off in the wrong direction for ten minutes. This can be disruptive, and the reader will need to be prepared for a few.

Black has done his usual fine job of writing to an appropriate level and giving just enough background. This reader welcomed the glossary of acronyms included in Volumes 2 and 3. The glossary should be expanded a bit, or turned into a bookmark and included in all the volumes. About fifty percent of the terms this reader wanted to check in the glossary were not there! The author is not a culprit, rather he is a victim. The telecommunications field is subject to the whims of the engineers developing telecommunications standards. The need for acronyms in standards development is clear. At the same time, the formation and use of acronyms is getting out of control. The use of ATM as an acronym for "Asynchronous Transfer Mode" makes sense--we won't nitpick the fact that Automated Teller Machine had already laid claim to it. I would suggest, however, that AAL which stands for ATM Adaptation Layer might more effectively have been specified as ATMAL. Black has no control over this, and thus he has to struggle with the problem of whether using more consistent acronyms helps by making things more mnemonic or makes things worse by introducing more acronyms and acronyms that are inconsistent with the standards documents.

One final soap box comment, Volume 3 introduces LNNI which stands for LANE Network-Network Interface which stands for LAN Emulation Network-Network Interface which stands for Local Area Network Emulation Network-Network Interface--LANENNI. Short of convincing the engineers that acronyms of acronyms of acronyms are not good for communications, another useful addition to this set might be a mapping of the technical acronyms to the standards in which they are operationally defined.

Volume 1 sets the stage. This reader enjoyed the context setting done by Black in the first four chapters. While chapter two on the nature of digital and analog signals might well be moved to an appendix, chapter four on emerged technologies provides an exquisite overview of communications technologies from T1 to SS7. Black's concise examples and quick review of the history serve to put ATM, SONET, and SS7 in just the right context. Black's mastery of the field is clear in the simplicity of his treatment.

Chapter six provides an overview of ATM addressing the layered nature of ATM and its relationship to the OSI reference model. It includes a worthwhile discussion of the rationale for the 53 byte cell size of the ATM protocol data unit (PDU) with simple examples of the delay and overhead values for varying cell sizes. Header error detection and error handling are clearly outlined and explained. The relationship between channel noise and the probability of packet discard is also set out. This chapter, along with chapter seven, which addresses the ATM Adaptation Layer (AAL), serve as the core of the volume. The discussion of the adaptation layer, which consists of the convergence and the segmentation and reassembly sublayers is quite clear and thorough. The discussion of how various data types (voice, data, video) are handled by the various AAL types, and in particular how the issues of quality of service and dropped packets are dealt with, is quite good.

The Volume addresses the issues of traffic management, signaling, operations, administration, and management. Returning to a full-blown OSI type of connection oriented protocol is going to be quite a shock for many network managers. Black's discussion of the ATM provisions for quality of service in terms of the various measures of accuracy, dependability, and speed is quite good. He carefully lays out the generic cell rate algorithm used in many user/network service contracts. The volume has a brief chapter on internetworking which is also covered in Volume 3 in more detail. Finally, the volume concludes with a discussion of the physical layer protocols and interfaces used by ATM with a focus on SONET and the

shared responsibility with SONET for operation, administration, and maintenance. While the focus here is on SONET, a brief discussion of other physical layer interfaces is also provided--FDDI, DS3, and category 3 unshielded twisted pair.

Volume 1 has aged well in terms of the technology. Black will need to go back in the next edition and consider moving a few chapters around in the context of the series as it is fleshed out. The technology sections will need to incorporate new developments in the standards, but these will be more natural refinements rather than major changes. It will be interesting to see how kind the year 2000 is to the chapter 15 predictions about the size of the ATM market. While ATM was viewed at one point as the most natural solution, increases in switched Ethernet speeds (100 Mb and 1 Gb) have provided alternatives for many segments of the market. While it is still probable that ATM will be the internetworking technology of choice, the brief vision of a unified network architecture (desktop to desktop) is fading.

Volume 2, *Signaling in Broadband Networks*, review the various primitives at a number of different interfaces used in ATM related signaling. The first couple chapters review material covered in Volume 1. This allows the book to serve as a stand alone acquisition for the reader only interested in the signaling aspects. It repeats material previously covered, however, which serves as a minor irritation.

Chapters five through nine provide the core of the signaling message. Chapter five covers the ATM addressing scheme and explains the service access points and service definitions in the context of the OSI model. Some time is spent explaining the most commonly used address form to date--E.164. Chapter six covers the specific primitives that are exchanged between the sublayers of the signaling ATM adaptation layer. Black lays out the services, primitives, and peer-to-peer exchanges in a clear graphical form. He clarifies the sublayer exchanges between the service-specific coordination function and the service-specific connection-oriented protocol. The presentation and explanation are as clear as these details can ever be, short of sitting down to construct the finite state machine that complies with the standard.

Chapters seven and eight address the user network interface and the network node interface respectively. Black focuses on how connections are set up on demand between the user and the network. The Q.2931 Recommendation of the ITU-T is used to organize Chapter seven. The network node interface is defined in the Broadband ISDN user part (B-ISUP). Chapter eight explores the relationship between B-ISUP and Signaling System 7 (SS7). The chapter provides a clear explanation of what B-ISUP does and doesn't do. The B-ISUP messages and parameters are laid out conceptually and defined at a reasonable level of detail. Chapter appendices provide additional detail on the actual messages and primitives. Finally, chapter nine details the sequences of primitives that are exchanged end-to-end in operations.

Volume 2 in this series provides valuable insight into the nature of the signaling in the ATM connection-oriented world. The level of the presentation sits nicely between the overly simplistic and the level needed to build software. It serves as a gentle introduction to the task of grappling with the relevant standards and specifications.

Volume 3, *Internetworking with ATM*, provides the culmination of the series at the current point. While an additional volume is planned on network management, for this reader at least, Volume 3 provides a very important perspective on the future of ATM as an internetworking technology. The first two chapters set the context providing a very nice and concise comparative analysis of ATM and various LAN protocols, ATM and Frame Relay, and ATM and the Internet Protocol (IP). Chapter two provides an extensive review of address resolution and encapsulation. The chapter introduces the ATM address resolution protocol

(ATMARP) and explains the roles and interactions between ATMARP servers and clients. The chapter concludes with an overview of how ATM handles the multicast connections that are becoming more common over LANS and the Internet via a Multicast Address Resolution Server (MARS).

Chapters three through six deal with Frame Relay over ATM and Frame Relay to ATM interworking. This reviewer must admit that these chapters presented tough going. Black has done a good job of presenting the material, but lacking any personal interest in frame relay, this reader tended to wander mentally during the reading--a dangerous activity in this type of material. Chapter three provides an overview of models for interworking functions-- based on where adaptation occurs. The relevant standards are introduced, and the services and protocol data units are defined. Specifically, the frame relay service-specific convergence sublayer is defined and specified.

Chapter four addresses the Data Exchange Interface (DXI) and the Frame User Network Interface (FUNI). The DXI specifies the interface between a router or other end user device and a data service unit attached to an ATM switch. The FUNI allows for a direct connection between a router and an ATM switch. The various DXI and FUNI modes and interfaces are described. Black makes clear how both of these interfaces offload some of the more complex ATM adaptation layer functions from the user.

Chapter five shows how ATM can be used to support the transmission of traffic between frame relay systems. Chapter six describes the use of ATM to support the transmission of traffic between frame relay and ATM systems. In particular, it addresses the transmission and conversion of frames and cells in both directions; the negotiation of Quality of Service across the connection; and the detection and reporting of transmission, format, and operational errors.

Chapters seven through nine address the use of ATM as a LAN backbone. Essentially, these chapters cover the use of ATM to bridge a LAN--chapters ten and eleven address internetworking. For this reader, these chapters were of the greatest personal interest. Thus, with greater attention and focus, it is not surprising that I found Black to be clear, well organized, and concise in his explanations. Chapter seven sets out the basic structure required to bridge a LAN which includes a LAN Emulation Client (LEC) for each set of workstations connected to the ATM network, a LAN Emulation Server (LES) for each emulated LAN, and a LAN Emulation Configuration Server (LECS) for each ATM network-- which might serve to bridge more than one emulated LAN. The LEC informs the LES of the MAC addresses of workstations it is responsible for and services requests from those workstations for getting information to other workstations. The LES keeps track of the location information for all the workstations on the ELAN, registers the information from the LECS, and responds to workstation requests for information about where other workstations are located. The LECS is responsible for assigning LECs to LESs. Black demonstrates each of the various operations carefully and clearly. He provides a very concise overview of the LAN emulation user to network interface (LUNI).

Chapter eight details service specifications and the protocol data units associated with them. The author carefully lays out and distinguishes the application interface, the ATM adaptation layer interface, and the connection and layer management interfaces. Chapter nine completes the overview backing up to address the overall initial configuration of the system--how LECs interact with the LECS and the LESs to register themselves and their addresses. Black demonstrates how address resolution is done. He concludes with a very brief description of the LAN Emulation Network-Network Interface (LNNI) which supposedly provides some relief for the single point of failure liability represented in the LEC and the LECS. This reader was unclear as to how LNNI, as described, addressed the LECS single point of failure, but then Black's description was very brief.

Chapters ten and eleven address two important extensions of ATM as a backbone. Chapter ten covers the Next Hop Resolution Protocol (NHRP) which provides a partial alternative to the ARP in that NHRP can locate layer three address, such as IP addresses, that are located on a Non-Broadcast Multi-Access subnetwork. In addition, NHRP can identify the egress router--next hop--using its own mechanisms. Like the LAN Emulation protocols, NHRP is designed to operate using a client server model. Black provides appropriately detailed examples of NHRP operations and messages. He provides a well reasoned analysis of the pros and cons of NHRP. Basically, because NHRP operates by resolving layer three addresses--IP and ATM, it provides the first step toward internetworking with ATM.

The final chapter on Multiprotocol over ATM (MPOA) discusses the use of ATM for internetworking--as a backbone for intersubnetwork traffic. Black reviews the ATM Forum specification for MPOA being careful to identify the tentative nature of the standard--it had not yet received final approval. He covers the ingress and egress caches used to determine how datagrams are to be encapsulated and forwarded. In a well-presented review of the interfaces between the MPOA clients and servers, he explains the configuration, discovery, target resolution, connection management, and data transfer operations. He shows clearly how MPOA builds upon both LANE and NHRP and how it retains the advantages of both the layer two bridging offered by LANE and the layer three routing offered by NHRP. The last few pages of Volume 3 read like the end of a good novel in some ways. It is with some level of anticipation that all the pieces fall into place as Black lays out the full functionality and the advantages provided by ATM backbones.

For some readers, Volume 3 will provide all the information they will need to interface to and use ATM as a backbone infrastructure technology. For this reader, Volume 2 was the least informative of the volumes, but this in part simply reflects the focus of my interest in ATM. Readers responsible for implementing the ATM backbone will feel very different. Volume 1 has aged well in this rapidly changing field, but would benefit from a second edition. Overall, the three volume series on ATM by Black is a worthwhile acquisition.

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[table of contents](#)  ter issues (/lita/publications/archive/ter)

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## About TER