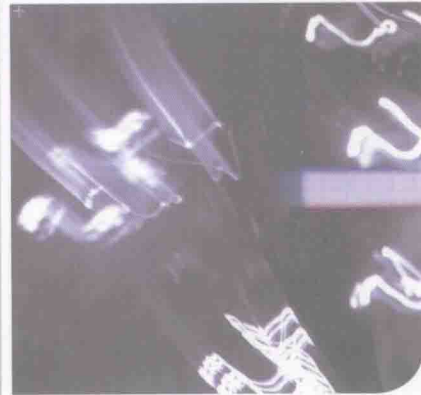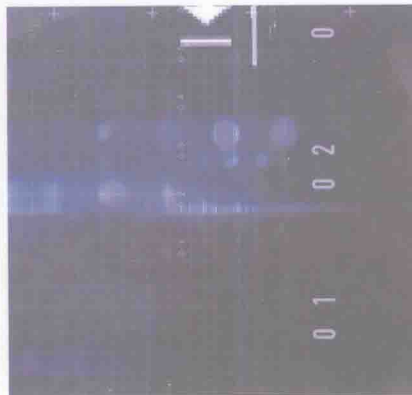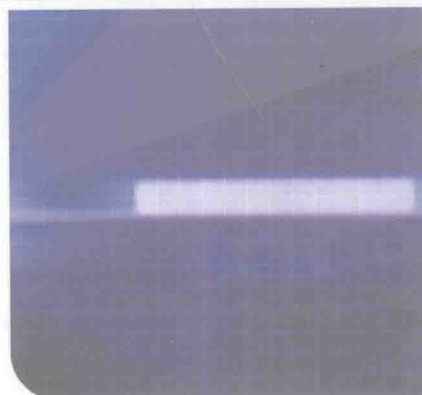# ATM NETWORKS

Concepts and Protocols

SUMIT KASERA

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Concepts and Protocols

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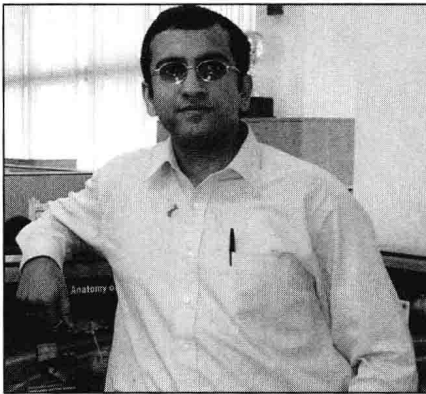
Sumit Kasera is Senior Technical Leader at Flextronics Software Systems (formerly Hughes Software Systems), India. He has a B. Tech degree in Computer Science and Engineering from IIT, Kharagpur, India, and an M.S degree in Software Systems from Birla Institute of Technology and Science, Pilani, India. His current area of interest is software development for GSM, GPRS, and EDGE access network. Sumit is also experienced in software development for networking protocols like ATM, TCP/IP and 3G UMTS. He has been an active participant in various technical forums like ITU-T, ATM Forum and 3GPP, where he has presented papers and conducted seminars; and also participated in the review of 3GPP specifications.

Sumit is the author of books—*ATM Networks: Concepts and Protocols, Communication Networks: Principles and Practice, 3G Networks: Architecture, Protocols and Procedures.*

To

My mother Sneha Lata Kasera
for making me what I am

Sumit Kasera

Preface

Raison d'être

It goes without saying that we now live in a networked world: a world where networking technologies play important roles in our lives. Be it the railway booking counter, or automated banking, be it the ubiquitous Internet or the global wireless telephony systems, a life without networks is inconceivable.

Among the plethora of networking technologies that have emerged in the last two decades, ATM is considered a breakthrough one. The popularity and pervasiveness of ATM lies in the fact that it seamlessly integrates local area network and wide area network—a concept also referred to as single network for desktop-to-the-core. Moreover, ATM provides a single platform for voice, video and data, thereby leveraging the process of network convergence. Apart from this, ATM also provides quality of service. All these factors are considered unique selling points of ATM technology.

When I first became interested in ATM technology and wanted to know more on the subject, I found to my surprise that there were hardly any books that provided a conceptual treatment of ATM. This, despite the fact that ATM technology attracted widespread interest. Most of the books were a shadow of ATM standards, derived from ITU-T and ATM Forum publications. Moreover, they had too many underlying assumptions to provide any insight into the topic. The concepts were shrouded in abbreviations and jargons. It resulted in people being more concerned with whether ATM was a 'telecommunication network' or a 'data communication network', than with understanding what either of them meant. I also observed that authors of technical books wrote with the assumption that technical stuff ought to be complicated because it is technical. I believe however, that everything is more or less simple unless made otherwise.

Given this, I felt a need to write a book on the subject that was simple, and easy to understand; a book that solved the problems I had faced when I was studying; a book that provided a comprehensive overview of ATM, and a book that offered fewer assumptions. This provided the motivation to write.

The Book

This book tries to cover all the important topics related to ATM. To this end, the book is organized into five parts (as shown in Figure P.1).

Part 1 introduces some of the important topics/concepts to the readers. To start with, Chapter 1 looks at the technological and marketing drivers that impact a given technology. This is useful in the sense that it provides a perspective on why ATM is what it is. Chapter 2 looks at the important concept of transfer mode and explains the benefits of asynchronous mode. Chapter 3 provides an overview of ATM and summarizes contents of the whole book.

Part 2 covers the three layers of ATM protocol reference model. This includes the physical layer covered in Chapter 4, the ATM layer in Chapter 5 and the ATM Adaptation Layer (AAL) in Chapter 6.

Part 3 Details the core concepts of ATM, which include parameterization of traffic and services in ATM networks (Chapter 7), elements of traffic management (Chapter 8), switch design and architecture (Chapter 9), addressing (Chapter 10), point-to-point and point-to-multipoint signalling (Chapter 11), routing based on PNNI protocol (Chapter 12), AAL2 signalling (Chapter 13), ATM Network management (Chapter 14) and ATM Security (Chapter 15).

Part 4 covers the interworking aspects of ATM. Chapter 16 describes the ATM network architecture and important interfaces defined for interworking. ATM in LAN environment and LAN Emulation (LANE) are explained in Chapter 17. Classical IP over ATM provides mechanisms to transfer IP datagrams over ATM networks. This standard also defines the means for address resolution. This technique is explained in Chapter 18. Another technique for IP over ATM is Multiprotocol over ATM (MPoA). The MPOA technique is also explained in Chapter 18.

Part 5 covers the application aspects of ATM. This includes ATM in MPLS Networks (Chapter 19), Voice over ATM (Chapter 20), ATM in DSL Networks (Chapter 21) and ATM in Third Generation (3G) Networks (Chapter 22).

Website

For greater interaction with readers after the publication of the book, the authors have created a website http://atmbook.tripod.com/. This website offers the following:

- Preface
- Table of Contents
- Errata
- Feedback and Review Comments
- References
- Other Related Material

Readers are encouraged to visit the website and use the available material.

FIGURE P.1

Organization of this Book
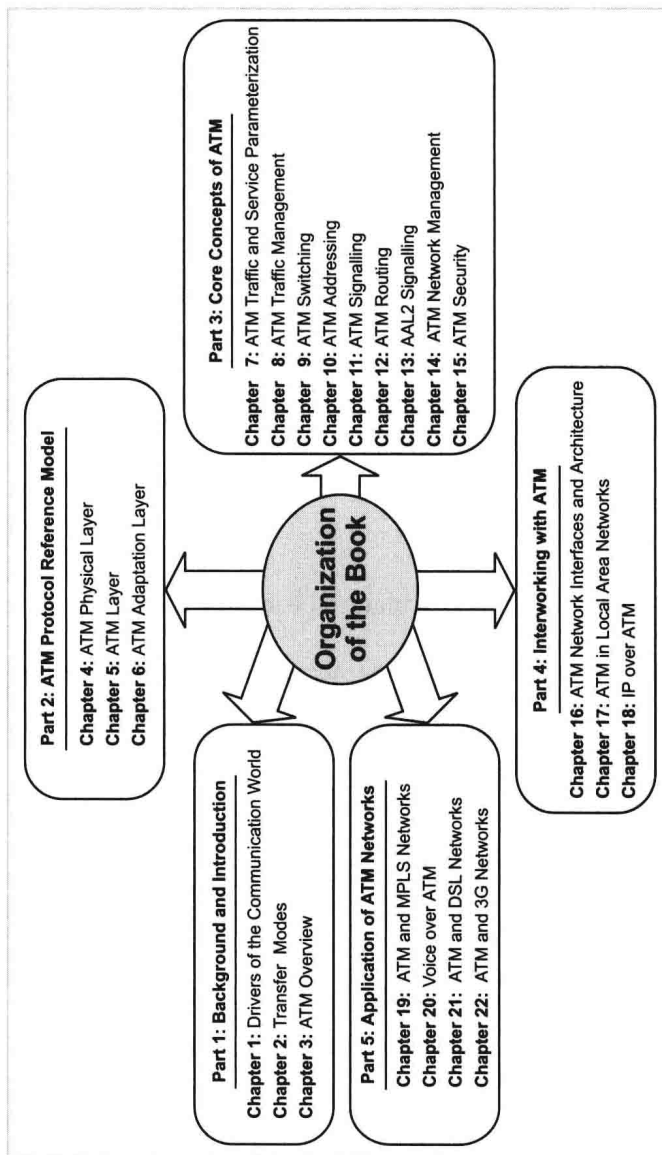
Suggestions

Your comments, feedback and constructive criticism are valuable to me. So, please free to drop an email at s.kasera@lycos.com. I would be glad to incorporate your comments in the subsequent edition of the book.

Notes to Readers

Since standardization is an ongoing activity, some of the standards quoted in this book have been superseded by newer specifications. Some of these have been explicitly mentioned in the reference section. For others, the reader is advised to cross-check with the appropriate governing body. For ATM Forum specifications, the reader could browse www.atmforum.com. For ITUT recommendations, could go to www.itu.ch. For Internet RFCs, the reader could browse http://www.ietf.org/rfc.html.

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Acknowledgements

Abbreviations

1G	First Generation
2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
AAL	ATM Adaptation Layer
AAL1	ATM Adaptation Layer 1
AAL2	ATM Adaptation Layer 2
AAL3/4	ATM Adaptation Layer 3/4
AAL5	ATM Adaptation Layer 5
ABR	Available Bit Rate/Area Border Router
ACAC	Actual Connection Admission Control
ACR	Allowed Cell Rate
ADR	Average Data Rate
ADSL	Asymmetric DSL
ADT	Assured Data Transfer
ADTF	ACR Decrease Time Factor
ADTR	ACR Decrease Time Rate
AES	Advanced Encryption Standard
AESA	ATM End System Address
AFI	Authority and Format Identifier
AINI	ATM Inter-Network Interface
AIS	Alarm Indication Signal
ALCAP	Access Link Control Application Part
AMI	Alternate Mark Inversion
AN	Access Network
ANS	ATM Name System
ANSI	American National Standards Institute
API	Application Programming Interface
APS	ATM Protection Switching

ARP	Address Resolution Protocol
AS	Autonomous System
ATM	Asynchronous Transfer Mode
ATMARP	ATM Address Resolution Protocol
ATU-C	ADSL Terminal Unit for the Central Office
ATU-R	ADSL Terminal Unit for the Remote site
AuC	Authentication Centre
AvCR	Available Cell Rate
AW	Administrative Weight
BAsize	Buffer Allocation size
BD	Burst Duration
BECN	Backward Explicit Congestion Notification
BER	Bit Error Rate/Bit Error Ratio
BGP	Border Gateway Protocol
BGT	Broadcast and Group Translator
B-ICI	BISDN Inter-Carrier Interface
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network
BLER	Block Error Rate/Block Error Ratio
BLER	Block Error Result
B-NT1	Network Termination 1 for B-ISDN
B-NT2	Network Termination 2 for B-ISDN
BOM	Beginning of Message
BPS	Bits Per Second
BR	Backward Reporting
BRI	Basic Rate Interface
BSC	Base Station Controller
BSI	British Standards Institute
BSS	Base Station Sub-system
BT	Burst Tolerance
B-TA	Terminal Adapter for B-ISDN
B-TE1	Terminal Equipment 1 for B-ISDN
B-TE2	Terminal Equipment 2 for B-ISDN
BTS	Base Transceiver Station
BUS	Broadcast and Unknown Server
CAC	Connection Admission Control
CAM	Content Addressable Memory
CAS	Channel Associated Signalling
CBR	Constant Bit Rate
CC	Country Code
CCITT	Consultative Committee on International Telegraph and Telephony
CCR	Current Cell Rate

CCS	Common Channel Signalling
CDF	Cut-off Decrease Factor
CDM	Code Division Multiplexing
CDMA	Code Division Multiple Access
CDV	Cell Delay Variation
CDVT	Cell Delay Variation Tolerance
CER	Cell Error Ratio
CES	Circuit Emulation Service
CID	Channel Identifier
CLEC	Competitive Local Exchange Carriers
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CLP	Cell Loss Priority
CLR	Cell Loss Ratio
CMIP	Common Management Information Protocol
CMR	Cell Mis-insertion Ratio
CN	Core Network
CNM	Customer Network Management
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
COM	Continuation of message
CPCS	Common Part Convergence Sub-layer
CPCS-UU	CPCS User-to-User Indication
CPE	Customer Premises Equipment
CPI	Common Part Indicator
CPN	Customer Premises Network
CPS	Common Part Sub-layer
CRC	Cyclic Redundancy Check
CRM	Cell Rate Margin
CRM	RM-Cells before Cut-off
CRV	Call Reference Value
CS	Circuit Switched/Convergence Sub-layer
CSI	Convergence Sub-layer Indication
CSMA	Carrier Sense Multiple Access
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CSU	Channel Service Unit
CTD	Cell Transfer Delay
DBCES	Dynamic Bandwidth Circuit Emulation Service
DBU	Dynamic Bandwidth Utilization
DCC	Data Country Code
DCE	Data Circuit-Terminating Equipment
DES	Data Encryption Standard
DFA	DXI Frame Address

Diffserv	Differentiated Services
DIR	Direction
DLCI	Data Link Connection Identifier
DLL	Data Link Layer
DLPI	Data Link Provider Interface
DNS	Domain Name System
DSAID	Destination Signalling Association Identifier
DSL	Digital Subscriber Line
DSLAM	DSL Access Multiplexer
DSP	Domain Specific Part
DSS	Dynamic Structure Sizing
DSU	Data Service Unit
DTE	Digital Terminal Equipment
DTL	Designated Transit List
DTMF	Dual Tone Multiple Frequency
DWDM	Dense Wavelength Division Multiplexing
DXI	Data Exchange Interface
ECF	Establish Confirm
EDGE	Enhanced Data Rates for Global Evolution
EFCI	Explicit Forward Congestion Indication
EIA	Electronic Industries Association
EIR	Equipment Identity Register
ELAN	Emulated LAN
EM	Element Manager/Error Monitoring
EOM	End of Message
EPD	Early Packet Discard
ER	Explicit Rate
ERQ	Establish Request
ESF	Extended Superframe
ERV	End-point Reference Value
ESI	End System Identifier
ETSI	European Telecommunications Standards Institute
FA	Frame Alignment
FAST	Frame-based ATM over SONET/SDH Transport
FATE	Frame-based ATM Transport over Ethernet
FAX	Facsimile
FCAPS	Fault, Configuration, Accounting, Performance and Security management.
FCS	Frame Check Sequence
FDDI	Fiber Distributed Data Interface
FDM	Frequency Division Multiplex
FDMA	Frequency Division Multiple Access
FEBE	Far End Block Error

FEC	Forward Error Correction/Forwarding Equivalence Class
FECN	Forward Explicit Congestion Notification
FERF	Far End Reporting Failure
FIFO	First-in-First-out
FM	Fault Management
FPM	Forward Performance Monitoring
FRS	Frame Relay Service
FRTT	Fixed Round Trip Time
FSM	Finite State Machine
FTP	File Transfer Protocol
FTTC	Fiber-To-The-Curb
FUNI	Frame-based UNI
GC	General Purpose Communication Channel
GCAC	Generic Connection Admission Control
GCRA	Generic Cell Rate Algorithm
GFC	Generic Flow Control
GFR	Guaranteed Frame Rate
GGSN	Gateway GPRS Support Node
GMSC	Gateway MSC
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GTP	GPRS Tunnelling Protocol
HDLC	High-level Data Link Control
HDSL	High-Bit-Rate DSL
HEC	Header Error Control/Header Error Check
HLR	Home Location Register
HO-DSP	High-Order Domain Specific Part
HOL	Head-of-Line
HSSI	High Speed Serial Interface
HTTP	Hyper Text Transfer Protocol
HW	Hardware
IAD	Integrated Access Device
ICD	International Code Designator
ICIP	Inter-Carrier Interface Protocol
ICIP_CLS	ICIP Connectionless Service
ICR	Initial Cell Rate
ID	Identifier
IDI	Initial Domain Identifier
IDP	Initial Domain Part
IE	Information Element
IEEE	Institute of Electrical and Electronic Engineers

IETF	Internet Engineering Task Force
IGRP	Interior Gateway Routing Protocol
IISP	Interim Inter-Switch Protocol
ILEC	Incumbent Local Exchange Carrier
ILMI	Integrated Layer Management Interface
IM	Input Module
IME	Interface Management Entity
IMS	IP Multimedia Sub-system
INE	Internetworking Network Elements
IOTA	Identifiers for Organizations for Telecommunications Addressing
IP	Internet Protocol
IPoA	IP over ATM
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
IPX	Internetwork Packet Exchange
ISDN	Integrated Services Digital Network
ISH	Interworking Specific Header
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union-Telecommunication Standardization
IVR	Interactive Voice Recognition
IWF	Interworking Function
LAG	Local Address Group
LAN	Local Area Network
LANE	LAN Emulation
LAP-B	Link Access Procedure-Balanced
LAP-D	Link Access Procedure for D-channel
LCN	Logical Channel Number
LCT	Last Conformance Time
LD-CELP	Low Delay Code Excited Linear Prediction
LDP	Label Distribution Protocol
LE-ARP	LAN Emulation Address Resolution Protocol
LEC	LAN Emulation Client
LECID	LEC Identifier
LECS	LAN Emulation Configuration Server
LES	LAN Emulation Server
LGN	Logical Group Node
LI	Length Indicator/Indication
LIJ	Leaf Initiated Join
LIS	Logical IP Sub-network
LLC	Logical Link Control
LMI	Local Management Interface
LNNI	LANE Network Network Interface
LOS	Loss of Signal