



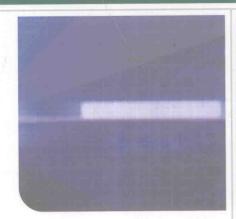


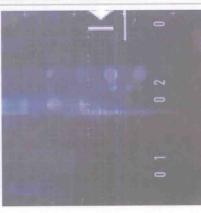
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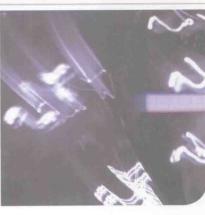
ATM NETWORKS

Concepts and Protocols









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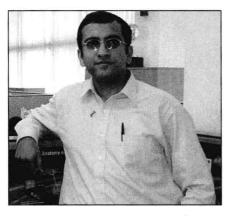
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ATM NETWORKS

Author's Profile



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.

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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.

Chapter 7: ATM Traffic and Service Parameterization Part 3: Core Concepts of ATM Chapter 14: ATM Network Management Chapter 15: ATM Security Chapter 8: ATM Traffic Management Chapter 10: ATM Addressing Chapter 13: AAL2 Signalling Chapter 9: ATM Switching Chapter 11: ATM Signalling Chapter 12: ATM Routing Chapter 16: ATM Network Interfaces and Architecture Part 2: ATM Protocol Reference Model Part 4: Interworking with ATM Chapter 17: ATM in Local Area Networks Chapter 6: ATM Adaptation Layer Chapter 4: ATM Physical Layer Organization of the Book Chapter 5: ATM Layer Chapter 18: IP over ATM Chapter 1: Drivers of the Communication World Part 1: Background and Introduction Chapter 19: ATM and MPLS Networks Part 5: Application of ATM Networks Chapter 21: ATM and DSL Networks Chapter 22: ATM and 3G Networks Chapter 20: Voice over ATM Chapter 2: Transfer Modes Chapter 3: ATM Overview

FIGURE P.1

Organization of this Book X

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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SUMIT KASERA

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I thank Nishit Narang again for contributing three chapters of this book, viz. 'ATM and MPLS Networks', 'ATM and DSL Networks' and 'ATM Network Architecture and Interfaces'.

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Then, I would like to thank the entire team at Tata McGraw-Hill for helping in producing and marketing this book.

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In addition, I would like to acknowledge the role of my family in making this book a reality. Among all the family members, my mother Sneha Lata Kasera's contribution stands out and hence the dedication. I would also like to thank my father J. P. Kasera, wife Manisha, baby Raj (who is unaware of the happenings in this world!), sister Smita, brother-in-law Gaurav and brother Rajiv for their continued support.

SUMIT KASERA

Abbreviations

1G First Generation2G Second Generation3G 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

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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

Abbreviations

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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

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

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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

IADIntegrated Access DeviceICDInternational Code DesignatorICIPInter-Carrier Interface ProtocolICIP_CLSICIP 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

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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

IPv4Internet Protocol Version 4IPv6Internet Protocol Version 6IPXInternetwork Packet ExchangeISDNIntegrated Services Digital NetworkISHInterworking 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