



dcn  
data communications & networks

# ATM

solutions for enterprise internetworking

---

David Ginsburg

 Addison-Wesley

# Contents

---

<b>Preface</b>	<b>xv</b>
<b>1 ATM background and business drivers</b>	<b>1</b>
1.1 ATM: what and why?	1
1.2 Business drivers	4
1.2.1 Applications	4
1.2.2 Hardware	5
1.2.3 Integrated services	6
1.3 Promise and reality	7
1.3.1 Public service providers, consumers, and vendors	8
1.3.2 Costs	9
Equipment costs	10
Operational costs	11
Cost savings	12
1.3.3 ATM end-to-end	13
1.3.4 User acceptance	14
<b>2 Standardization</b>	<b>17</b>
2.1 Decision for ATM versus fast packet and TDM	20
2.2 International Telecommunication Union (ITU)	22
2.2.1 Background	22
2.2.2 Recommendations	23
2.3 ATM Forum	24
2.3.1 Committees	26
2.3.2 Technical Committee working groups: goals and efforts	26
2.3.3 Released works	29
2.3.4 Liaisons with external standards bodies	31
2.4 Internet Engineering Task Force (IETF)	32
2.5 Digital Audio Visual Council (DAVIC)	33
2.6 IEEE	34
<b>3 Architecture</b>	<b>35</b>
3.1 The physical ATM network	36
3.1.1 Interfaces	37
Virtual Paths (VPs) and Virtual Channels (VCs)	39
Private User–Network Interface (P-UNI)	40
Public UNI	40
Residential UNI	40
Network-to-Node or Network–Network Interface (NNI)	41
3.1.2 Physical	41
3 Transmission hierarchies	41

Physical Media Dependent (PHD) and Transmission Convergence (TC) layers	43
SDH over UTP and STP	64
4B/5B (TAXI)	66
25 Mbps	67
8B/10B (fiber channel)	68
Cell-based clear channel	69
Internal system interfaces	69
UTOPIA	69
WIRE	71
3.1.3 ATM layer	72
UNI cell structure	73
NNI cell structure	76
3.1.4 Adaptation	77
AAL1	78
AAL2	79
AAL3/4	80
AAL5	83
ATM error correction including forward error correction	84
3.2 Signaling	86
3.2.1 Connection types	87
3.2.2 Public signaling	89
3.2.3 ATM Forum UNI	92
3.2.4 UNI 3.x/4.x signaling procedures	94
3.2.5 Information elements and signaling for IP over ATM	97
3.2.6 Soft PVCs and SVC tunneling	100
3.3 Trunking and routing	100
3.3.1 PNNI Phase 1	102
Hierarchy	102
Addressing and routing	105
QoS support	109
3.3.2 IISP	110
3.3.3 B-ICI	111
3.4 Addressing	114
3.4.1 ATM End-System (AES): NSAP format	115
3.4.2 E.164	117
3.4.3 Broadcast	117
3.4.4 Multicast	118
3.4.5 Anycasting	118
3.4.6 Addressing plans	120
3.4.7 Mapping E.164 to NSAP	123
3.4.8 Integrated ATM and network addressing	124
3.5 Traffic management	124
3.5.1 Throughput	125

3.5.2	Theory and TCP	125
	Effect of cell loss	128
	Practical experience	131
3.5.3	ATM Forum traffic management	132
	ATM service categories	138
	Congestion avoidance: background and requirements	144
	Preventive congestion control	149
	Reactive congestion control: rate based	153
	ABR service	156
	ABR: protocol operation	157
	ABR: implementation concerns	161
	ABR: effect of mixed (ATM and non-ATM) architectures	165
	Switch buffering and traffic management	166
	Other – credit based	168
	Analysis	169
3.6	Management, security, and directory services	170
3.6.1	Network management framework	172
3.6.2	SNMP	175
3.6.3	CMIP	175
3.6.4	MIBs	176
3.6.5	ILMI	179
3.6.6	RMON	181
3.6.7	OAM flows	182
3.6.8	Public management	186
3.6.9	Testing	187
3.6.10	Network management platforms	190
3.6.11	Security	191
3.6.12	Directory services	194
<b>4</b>	<b>Services</b>	<b>195</b>
4.1	ATM data models	196
4.1.1	Internetworking	200
4.1.2	IETF Classical model	202
	Classical IP and ARP over ATM	203
	Multiprotocol encapsulation over ATM AAL5	209
	Multicasting and broadcasting	212
	Alternatives to MARS	219
	Extending the multicast group	220
	Solutions for broadcasting	221
4.1.3	Optimizing routing	221
	NHRP	223
	Direct connections	227
	Conventional model	231
	Analysis	231
4.1.4	ATM Forum LAN emulation	232
	Background	232

## x Contents

	A quick review of LAN protocols	233
	The LAN emulation service	235
	Procedures	239
	Data forwarding between VLANs	243
	Source route bridging concerns	244
	VLAN mappings and mobility	246
	Management	249
	Scaling LAN emulation: applicability of multilayer switching to Classical ATM and LANE	250
	Analysis	251
	The LNNI and LANE Version 2	255
	VLAN Architectures	259
4.1.5	ATM Forum Multiprotocol over ATM (MPOA)	260
	Architecture	262
	Operation	265
	Mapping MPOA to physical systems	268
4.1.6	Frame Relay and ATM	269
	ATM as a Frame Relay transport	270
	Frame Relay CPE to ATM CPE interworking	270
	IWF	271
	RFC 1490	274
	Analysis	274
4.1.7	SMDS/CBDS and ATM	275
	ATM as an SMDS/CBDS transport	276
	CLSF	276
	IWF	278
	RFC-1209	278
	Scalability	279
	Analysis	280
4.1.8	Other data service interworkings	281
	ISDN data	281
	X.25	281
4.1.9	Frame-based interfaces	282
	ATM-DXI	282
	FUNI	286
	Analysis	288
4.1.10	Integrated PNNI (I-PNNI) and PNNI Augmented Routing (PAR)	288
4.1.11	Peer model for data and the integrated network	289
4.1.12	Application QoS and resource reservation	294
	The Integrated Services (IS) Internet	296
	Resource ReSerVation Protocol (RSVP)	300
	RSVP versus Q.2931 signaling: disconnects and possible solutions	304
	The Internet Streams Protocol: ST-II	305
	Other possibilities	306

	Deploying QoS and the ATM Programming Interface (API)	307
4.1.13	Evolution of routers	315
4.2	Circuit Emulation Service (CES) and Voice and Telephony over ATM (VTOA)	316
4.2.1	Service types	318
4.2.2	Timing	322
4.3	Voice interworking	324
4.3.1	ATM to non-ATM	324
4.3.2	AAL1 to AAL5	325
4.3.3	ATM to 64 Kbps ISDN	326
4.4	Video coding, conferencing, and distribution	329
4.4.1	Encoding standards	330
	MPEG	331
	CLR and latency	334
	Compression loss	335
4.4.2	Video distribution	335
4.4.3	Video interworking	336
4.5	Residential and small office services	338
4.5.1	Audio Visual Multimedia Service (AMS)	338
4.5.2	IEEE 802.14 and TIA multimedia services	339
<b>5</b>	<b>Implementing ATM</b>	<b>341</b>
5.1	Requirements	341
5.1.1	Service selection	342
5.1.2	Vendor capabilities	346
5.1.3	Detailed requirements	348
5.1.4	PICS and conformance testing	350
5.1.5	Project planning	351
5.2	Infrastructure	351
5.2.1	Role of networking equipment	352
5.2.2	Redundancy	354
5.2.3	Physical media	355
	Fiber	355
	Twisted pair	358
	Wide-area connectivity	359
	Wireless	359
5.2.4	Intermediate systems: ATM switching	360
	Workgroup	365
	Enterprise	367
	Central office edge	368
	Central office	370

5.2.5	End-systems: the office and home	371
	LAN switching	372
	Routers	372
	Multilayer switching	374
	PCs and workstations	375
	Service multiplexers	376
	Video-on-demand and set-top	377
	Desktop area networks	378
5.2.6	Future cores: the convergence of ATM switching and routing	379
5.3	Applications	380
5.3.1	Classical	381
	Terminal access	381
	File transfer	381
	Locators and resolvers	382
	Multicasting	382
	Information retrieval	382
5.3.2	ATM-enabled	383
	Server farms	383
	Collaboration	384
	Residential	385
5.4	Implementation examples	385
5.4.1	Classical ATM: PVCs, SVCs, the ATM-DXI, and the FUNI	388
	Classical 1: campus multiprotocol backbone	388
	Classical 2: campus IP backbone	395
	Classical 3: SVC tunneling in an ATM WAN	404
	Classical 4: frame-based connectivity to ATM	406
	Classical 5: NHRP in an ATM WAN	408
	Classical 6: video multicasting application	411
	Classical 7: RSVP and ATM	414
	Classical 8: SNA integration and APPN	419
5.4.2	LAN emulation	421
	LANE 1: single port-based ATM Forum virtual LAN	421
	LANE 2: filtering	423
	LANE 3: multiple port-based ATM Forum virtual LANs	426
	LANE 4: multiple virtual LANs per port	432
	LANE 5: LAN emulation to Classical model interworking	435
5.4.3	MPOA and route distribution	438
5.4.4	Frame Relay transport and interworking	440
	Frame Relay service interworking	440
	ATM as Frame Relay transport	442
5.4.5	SMDS/CBDS transport and interworking	442
	SMDS 1: SMDS across the ATM-UNI	442
	SMDS 2: interworking between ATM and DQDB-based SMDS	444

5.4.6	Circuit Emulation Service (CES)	445
5.4.7	Residential services	447
	Residential 1: Video on Demand (VoD)	447
	Residential 2: data overlay	449
5.4.8	Customer case studies	450
	Medical school	450
	Brokerage house	450
	Commercial bank	451
	Automobile manufacturer	452
	Insurance company	453
	Cable provider	453
	PTT/Telco	454
<b>6</b>	<b>ATM and other technologies</b>	<b>455</b>
6.1	Local area	456
6.1.1	Wither FDDI?	458
6.1.2	Ethernet and Token Ring switching	460
6.1.3	High-speed Ethernet alternatives	463
	Fast Ethernet: 100Base-T	464
	Demand priority: 100VG-AnyLAN	465
	Gigabit Ethernet	466
6.1.4	Fiber channel	466
6.1.5	Others	468
	Integrated Services LAN (ISLAN)	468
	Isochronous Ethernet	469
	Extensions to FDDI	469
	Wireless	470
6.1.6	Analysis	470
6.1.7	Virtual LAN interoperability	471
6.2	Wide area	472
6.2.1	64 Kbps ISDN	473
6.2.2	Frame Relay	474
6.2.3	Distributed Queue Dual Bus (DQDB)	474
6.2.4	Layer 1 technologies	477
	PDH	477
	SDH/SONET	478
6.2.5	Analysis	479
6.2.6	Experimental	480
<b>A</b>	<b>Technical</b>	<b>485</b>
<b>B</b>	<b>Rollouts</b>	<b>501</b>
	North America	501
	Europe	
	Early trials	502
	European MOU	503

## **xiv** Contents

Tariffed services	505
Pacific Rim	506
Multinational service providers	507
<b>C Sources</b>	<b>509</b>
International standards organizations	509
Technology-specific vendor and standards organizations	510
Standards bodies and professional organizations	512
Interoperability and performance test laboratories	513
Some representative network contacts	513
ATM-related corporate Web servers	514
Telecom Web servers	516
Other on-line resources	517
Web search lists	517
ATM-related	517
Telecom-related	518
Internet-related	518
Bookstores	519
Periodicals and newsletters	519
Internet mailing lists	520
Obtaining organizational names	521
United States	521
Canada	521
United Kingdom	521
<b>Glossary (ATM from A to Z)</b>	<b>523</b>
<b>Acronyms</b>	<b>537</b>
<b>Bibliography</b>	<b>543</b>
<b>Index</b>	<b>557</b>