

ATM

THE BROADBAND TELECOMMUNICATIONS SOLUTION

**L G Cuthbert
and
J-C Sapanel**

Contents

	<i>Page</i>
Preface	xi
Acknowledgements	xii
Abbreviations	xiv
1. Introduction	1
1.1. What is broadband?	1
1.2. Why ATM?	2
1.3. Transfer mode	5
1.4. CCITT standardisation of B-ISDN	5
2. Asynchronous Transfer Mode (ATM)	7
2.1. Basic principles of ATM	7
2.2. Protocol reference model	8
2.3. ATM layer	10
2.3.1. Cell structure	11
2.3.2. Types of cell	13
2.4. ATM objects	13
2.4.1. Virtual channels	14
2.4.2. Virtual paths	16
2.5. ATM adaptation layer	19
2.5.1. AAL principles	19
2.5.2. AAL type 1	24
2.5.3. AAL type 2	25
2.5.4. AAL types 3/4	25
2.5.5. AAL type 5	28
2.5.6. Service timing/synchronisation aspects	30
2.6. Physical layer	31
2.6.1. Principles	31
2.6.2. Transfer capacity	32
2.6.3. Physical layer for cell-based interface	32
2.6.4. Physical layer for SDH-based interface	33
2.6.5. Header error control	34
2.6.6. Cell delineation and scrambling	35
2.6.7. Scrambler operation	36

3. Applications and Services	37
3.1. Applications	37
3.2. Classification of services	39
3.3. Teleservices	40
3.4. Bearer services	42
3.4.1. Definition	42
3.4.2. Information transfer mode	43
3.4.3. Information transfer rate: bit-rate parameters	43
3.4.4. Information transfer capability of VC and VP	44
3.4.5. Structure of VC and VP	44
3.4.6. Establishment of communication	44
3.4.7. Symmetry	44
3.4.8. Communication configuration	44
3.4.9. Access channel and rate	45
3.4.10. Access protocols	45
3.4.11. Supplementary services	45
3.4.12. Grade of service for the set-up and clear-down of VCC	45
3.4.13. Performance of an established connection	46
3.4.14. Interworking possibilities	46
3.5. Mapping of services onto attributes	47
4. Networks and Network Elements	48
4.1. Network structure and elements	48
4.2. Interfaces	50
4.2.1. Basic characteristics at S and T reference points	50
4.2.2. Interfaces for distribution services	51
4.3. Customer equipment	52
4.3.1. Business customers	53
4.3.2. Residential customers	53
4.4. Access network	54
4.4.1. NT1	54
4.4.2. Access link	54
4.5. Switching nodes	55
4.5.1. Switching functions	55
4.5.2. Remote unit	56
4.5.3. Local exchange	57
4.5.4. Transit exchange	58
4.6. Transmission	58
4.6.1. PDH transmission	59
4.6.2. SDH transmission	59
4.6.3. Cell-based transmission	59
4.7. Signalling	60
4.7.1. Requirements for B-ISDN signalling	60
4.7.2. Signalling evolution	61
4.7.3. Call control and bearer control functions	62

5. Network Performance	64
5.1. Introduction	64
5.2. Delay	64
5.2.1. Components of delay	64
5.2.2. Delay in the physical layer	66
5.2.3. Delay in the ATM layer	66
5.2.4. Delay in the AAL	66
5.2.5. Consequences of delay	67
5.2.6. Errors	68
5.2.7. Errors in the physical layer	68
5.2.8. Errors in the ATM layer	69
5.2.9. Errors in the AAL layer	69
6. Network Evolution	70
6.1. General technical aspects of network evolution	70
6.2. Substitution/island/overlay introduction approaches	72
6.3. Customer groups	72
6.4. Fibre in the access network for business customers	73
6.4.1. Separate access for broadband	74
6.4.2. Multiplex access system	75
6.4.3. Target access	76
6.5. Residential customers and distribution traffic	77
6.5.1. Fibre to the kerb	79
6.5.2. Passive optical networks	80
6.5.3. Direct fibre / logical star	82
6.5.4. Influence of existing CATV systems	83
6.6. High-speed LANs and B-ISDN	84
6.6.1. Early interconnection of high-speed LANs	84
6.6.2. Interconnection through the ATM cross-connect network	85
6.6.3. Connectionless data service over the ATM network	86
6.7. Frame relay and B-ISDN	87
6.8. Mobility and B-ISDN	87
6.8.1. Problems introduced by mobility	88
6.8.2. How ATM could influence existing mobile networks	89
7. Interworking	90
7.1. Interworking with existing networks	90
7.1.1. Background to interworking	91
7.1.2. Network interworking	91
7.1.3. Service interworking	92
7.1.4. Location of interworking functions	92
7.1.5. Gateways handling unlike calls	93
7.1.6. Impact of ATM on interworking	94
7.2. Interworking with high-speed data networks	95
7.2.1. High-speed LANs and MANs	95
7.2.2. Frame relay	97

7.3. Interworking with mobile networks	98
8. Numbering and Charging	99
8.1. Numbering schemes	99
8.2. Impact of ATM on existing numbering schemes	100
8.3. Numbering and addressing interworking	101
8.4. Charging	102
8.4.1. General issues	102
8.4.2. ATM specific issues	102
8.4.3. Charging parameters	103
9. Routing Techniques	104
9.1. Implications for the network structure	104
9.1.1. Routing of customer access	105
9.1.2. Routing between exchanges	105
9.1.3. <i>Distribution of traffic over the network</i>	106
9.2. Route modification methods	107
9.3. The routing plan	107
10. Traffic Control and Resource Management	109
10.1. Network resource management	110
10.2. Connection admission control	111
10.3. Usage parameter control and network parameter control	113
10.3.1. UPC functions	113
10.3.2. UPC algorithms	115
10.4. Traffic shaping	118
10.5. Priority control	119
10.6. Fast resource management	120
10.7. Congestion control	120
10.7.1. Selective cell discard	120
10.7.2. Explicit forward congestion indication	121
11. Intelligence in the Network	122
11.1. Operations and maintenance principles	122
11.2. Network management	124
11.2.1. OSI functional groups	124
11.2.2. Configuration & name management	124
11.2.3. Performance management	126
11.3. Intelligent networks	127
11.4. Relationship between TMN and IN	129
12. Traffic Engineering	132
12.1. Traffic modelling	133
12.1.1. Traffic sources and their behaviour	135
12.1.2. Traffic parameters and source models	139
12.1.3. Traffic mixes	141

12.2. Performance measures	141
12.2.1. Network traffic performance	142
12.3. Performance evaluation	142
12.4. Network dimensioning	143
12.4.1. End-to-end traffic	144
12.4.2. ATM logical network	145
12.4.3. Physical transmission network	147
Appendix: Summary of Standards	148
References	151
Index	156