Table of Contents

Preface 10

CHAPTER 1. EVOLUTION TOWARDS AN INTEGRATED BROADBAND COMMUNICATION NETWORK

1.1. Introduction 14
1.2. Current situation in the telecommunication world 15
1.3. Progress in technology : technology push 18
1.3.1. Progress in technology 18
1.3.2. System concept progress 21
1.4. Future service requirements : market pull 24
1.4.1. Residential subscriber expectations 24
1.4.2. Business subscriber expectations 25
1.5. Bibliography 25

CHAPTER 2. TRANSFER MODES

2.1. Introduction 28
2.2. History 29
2.2.1. Telegraphy 29
2.2.2. Telephony 29
2.2.3. Data 30
2.3. Performance requirements 31
2.3.1. Semantic transparency 35
2.3.1.1. Transmission errors 38
2.3.1.2. Switching/multiplexing errors 40
2.3.1.3. Error probability distribution model of the network 41
2.3.2. Time transparency 45
2.3.3. Network conditioning 47

2.4. Description of transfer modes 50
2.4.1. Circuit switching 50
2.4.2. Multirate circuit switching 52
2.4.3. Fast circuit switching 55
2.4.4. Packet switching 56
2.4.5. Fast packet switching – asynchronous transfer mode 58
2.4.5.1. Basic definition 59
2.4.5.2. Performance characteristics 62
2.4.5.3. Definition of the information field length 74
2.4.5.4. Header functionality 84
2.4.5.5. Supportive functions 91
2.5. Bibliography 94

CHAPTER 3. ATM STANDARDS 102

3.1. Introduction 102
3.1.1. CCITT activities 102
3.1.2. ATM Forum activities 103
3.1.3. Overview 103
3.2. Basic principles of ATM 104
3.2.1. Information transfer 104
3.2.2. Routing 104
3.2.3. Resources 105
3.2.4. Signalling 107
3.2.5. Flow control 108
3.2.6. Operation and maintenance 108
3.3. BISDN reference configuration 109
3.3.1. Reference points 110
3.3.2. Functional grouping 111
3.4. BISDN layered model 111
3.4.1. Physical layer 113
3.4.2. ATM layer 114
3.4.3. ATM adaptation layer 115
3.5. The physical layer 116
3.5.1. General 116
3.5.2. Synchronous digital hierarchy based interface 117
3.5.3. Cell based interface 118
3.5.4. Plesiochronous digital hierarchy based interface 120
3.5.5. FDDI based interface 121
3.5.6. ATM specific transmission convergence sublayer functions 122
3.6. The asynchronous transfer mode layer 124
3.7. The ATM adaptation layer 128
3.7.1. Functions and types of adaptation layers 128

3.7.2. Adaptation for constant bit rate services : AAL 1 130
3.7.3. Adaptation for variable bit rate services : AAL 2 132
3.7.4. Adaptation for data services : AAL 3/4 133
3.7.5. Adaptation for data services : AAL 5 138
3.7.6. Adaptation for signalling 140
3.8. Maintenance functions 140
3.8.1. Principles 140
3.8.2. OAM network layering 141
3.8.3. OAM of the physical layer 143
3.8.4. OAM of the ATM layer 144
3.9. Bibliography 145

CHAPTER 4. BROADBAND ATM SWITCHING

4.1. Introduction 147
4.2. Switching requirements 152
4.2.1. Information rates 153
4.2.2. Broadcast/multicast 153
4.2.3. Performance 153
4.3. Basic switching building blocks 155
4.3.1. Queuing disciplines 156
4.3.2. Performance 158
4.3.2.1. Analytical models 160
4.3.2.2. Computer simulation 167
4.3.3. Implementation parameters of basic ATM switching building blocks 168
4.3.4. Knockout switching element 172
4.3.5. Roxanne switching element 181
4.3.6. Coprin switching element 184
4.3.7. Athena switching element 188
4.4. ATM switching fabrics 192
4.4.1. Multistage interconnection networks with internal cell loss 195
4.4.1.1. Roxanne switching fabric 199
4.4.1.2. Athena switching fabric 204
4.4.2. Multistage interconnection networks without internal cell loss 209
4.4.2.1. St. Louis switching fabric 209
4.4.2.2. Batcher-Banyan based MINs 214
4.5. Concluding remarks 220
4.6. Bibliography 221

CHAPTER 5. IMPACT OF ATM ON TERMINALS AND SERVICES

5.1. Introduction 232
5.2. Variable bit rate video coding 232
5.3. Statistical multiplexing 237

5.4. Service multiplexing 240
5.5. Cell loss protection 244
5.6. Service synchronization 245
5.7. Bibliography 247

CHAPTER 6. ATM LAN, HIGH SPEED LOCAL AND METROPOLITAN AREA NETWORKS

6.1. Introduction 252
6.2. ATM LAN 253
6.2.1. Physical layer 256
6.2.2. AAL and signalling 256
6.2.3. Network management 258
6.2.4. Quality of service parameters 259
6.3. Definition of a MAN 259
6.4. MAN relation with BISDN and ATM 261
6.5. FDDI 264
6.5.1. Layered structure 265
6.5.2. FDDI-II 269
6.5.3. Performance of FDDI 271
6.6. DQDB 273
6.6.1. DQDB topology 273
6.6.2. The DQDB protocol 274
6.6.3. Performance of DQDB 279
6.7. Orwell 282
6.7.1. Orwell description 282
6.7.2. Slot structure 284
6.7.3. Performance of Orwell 285
6.8. Bibliography 286

CHAPTER 7. TRAFFIC CONTROL IN ATM NETWORKS

7.1. Introduction 289
7.2. Basic ATM traffic control functions 289
7.2.1. Connection admission control 290
7.2.2. Usage / network parameter control 290
7.3. Traffic parameter specification 291
7.3.1. Definitions 291
7.3.2. Characteristics of traffic parameters 291
7.3.3. Statistical versus operational traffic specification 291
7.3.4. Generic cell rate algorithm 292
7.4. Traffic contract specification 294
7.4.1. Connection traffic descriptor 294
7.4.1.1. Peak cell rate 294

7.4.1.2. Cell delay variation tolerance 295
7.4.1.3. Sustainable cell rate 295
7.4.1.4. Burst tolerance 296
7.4.2. Requested quality of service class 297
7.4.3. Definition of a compliant connection 297
7.5. Granularity of traffic contract parameters 297
7.6. Bounds on cell delay variation and burst tolerances 298
7.6.1. The simulation model 298
7.6.2. The reference model 300
7.6.3. Some key results 300
7.6.4. Bounds for CDV tolerance 302
7.7. UPC/NPC performance meters 303
7.7.1. UPC location 303
7.7.2. UPC/NPC actions 304
7.7.3. UPC performance metrics 304
7.8. Additional control functions 305
7.8.1. Priority control 305
7.8.2. Traffic shaping 306
7.8.3. Network resource management 306
7.9. Bibliography 307

CHAPTER 8. INTRODUCTION STRATEGIES FOR ATM

8.1. Introduction 309
8.2. ATM in the private network 310
8.2.1. The evolution of intelligent hubs 310
8.2.2. Initial application of ATM hubs 311
8.2.3. The use of ATM LANs 312
8.3. ATM in the access network 313
8.3.1. FITL with PON technology 315
8.3.2. High capacity point-to-multipoint transport system 315
8.3.2.1. Transport system 316
8.3.2.2. Enabling techniques 317
8.3.3. Modular equipment at the subscriber side 320
8.3.4. Expandable interworking unit at the central office 321
8.3.5. Evolution capabilities 322
8.4. ATM in the switching network 323
8.5. Conclusion 326
8.6. Bibliography 326

Index 328