APPENDICES

APPENDIX A: ATM Adaptation Layer Protocol Type

	Services Provided	Overall Functions	SAR Functions	CS Functions
AAL 1	• Transfer of SDUs with constant bit rate (CBR) • Transfer of timing information between source and destination • Transfer of structure information between source and destination • Indication of lost or error information not recovered by AAL 1	• Segmentation and reassembly • Handling of cell delay variation • Handling of cell payload assembly delay • Handling of lost and misinserted cells • Source clock frequency recovery at destination • Recovery of the source data structure at the receiver • Monitoring and handling of PCI bit errors • Monitoring of user information for bit errors and possible corrective action	• Mapping between CS-PDU and SAR-PDU • Indication of existence of CS function • Sequence numbering • Error protection	• Handling of cell delay variation • Handling of lost and misinserted cells • For some services, clock recovery at the receiver • Transfer of structure information • Forward error correction for high quality video and audio • Reporting of end-to-end performance status
AAL 2	• Transfer of SDUs with variable bit rate (VBR) • Transfer of timing information between source and destination • Indication of lost or error information not recovered by AAL 2	• Segmentation and reassembly • Handling of cell delay variation • Handling of lost and misinserted cells • Source clock frequency recovery at destination • Recovery of the source data structure at the receiver • Monitoring and handling of header and trailer bit errors • Monitoring of user information for bit errors and possible corrective action	• For further study	• For further study
AAL 3 / 4	• Message mode service • Streaming mode service • Assured operation • Non-assured operation		• Segmentation and reassembly • Error detection • Sequence integrity • Multiplexing	• Error detection and handlling • Indication of buffer allocation size
AAL 5	• Message mode service • Streaming mode service • Assured operation • Non-assured operation		• Segmentation and reassembly • Handling of congestion information • Handling of loss priority information	• Error detection and handlling • Padding • Handling of congestion information • Handling of loss priority information

SDU = Service Data Unit, CS = Convergence Sublayer, SAR = Segmentation And Reassembly Sublayer, PDU = Protocol Data Unit

APPENDIX B: ATM Layer Service Categories

Attribute	CBR	rt-VBR	nrt-VBR	UBR	ABR
PCR and CDVT	Specified				
SCR, MBS, CDVT	N/a	Specified		n/a	
MCR	Specified		Unspecified		
Mean CTD	Unspecified		Specified	Unspecified	
Maximum CTD	Specified		Unspecified		
CLR	Specified			Unspecified	Specified
Feedback	Unspecified				Specified

APPENDIX C: Congestion Scheme

In this section, some proposal that were presented and discarded early at the ATM Forum will briefly describe.

Fast Resource Management

Proposed by France Telecom [17] requires sources to send a resource management (RM) cell requesting the desired bandwidth before actually sending cells. If a switch cannot grant the request it simply drops the RM cell; the source times out and resends the request. If a switch can satisfy the request, it passes the RM cell on to the next switch. Finally, the destination returns the cell back to the source, which can then transmit the burst.

Delay-Based Rate Control

Made by Fujitsu [18] requires that the sources monitor the round trip delay by periodically sending resource management (RC) cells that contain timestamp. The destination returns the RM cell to source. The source measure the roundtrip delay and to deduce the level of congestion.

Backward Explicit Congestion Notification (BECN)

Presented by N.E.T. [19][20][21] consist of switches monitoring their queue length and sending a RM cell back to source if congested. The sources reduce their rates by half on the receipt of RM cell. If no BECN cells are received within a recovery period, the rate for that VC is doubled once each period until reaches the peak rate.

Early Packet Discard

Presented by Sun Microsystems [22] is based on the observation that a packet consist a several cells. It is better to drop all cells of one packet then to randomly drop cells belonging to different packet.

Link Window with End-to-End Binary Rate

Presented by Tzeng and Siu [23]. It consists of using window flow control on every link and to use binary (EFCI-based) end-to-end rate control.

Fair queuing with Rate and Buffer feedback

Proposed by Xerox and CISCO [24]. It consists of sources periodically sending RM cells to determine the bandwidth and buffer usage at their bottlenecks. The switches compute fair share of VCs and monitor each VC's queue length. The minimum of the share and the maximum of queue length at this switch and those from the previous switches is placed in the same RM cell.

Credit-Based Congestion Scheme

This was one of the two leading approaches. Originally proposed by Professor H.T. Kung, it was supported by Digital, BNR, FORE, Ascom-Timeplex, SMC, Brooktree, and Mitsubishi [25][26]. The approach consists of per-link, per-VC, window flow control. Each link consists of a sender node (an end system or a switch) and a receiver node (an end system or a switch). Separate queue for each VC is maintains by each node. The receiver monitors queue of each VC and determines the number of cells that the sender can transmit on that VC.

Rate-Based Congestion Scheme

Mike Hluchyj proposed this approach. Originally consists of rate-based version of the DECbit scheme [27], which consists of end-to-end control using a single-bit feedback from the network. The switch monitor their queue lengths and if congested set EFCI in the cell headers. The destination monitors these indications for a periodic interval and sends an RM cell back to the source. The sources use an additive increase and multiplicative decrease algorithm to adjust their rates.

MIT Scheme

Proposed by Anna Charny [28]. This scheme consists of each source sending an RM cell every n^{th} data cell. The RM cell contains the VC's current cell rate (CCR) and a "desired rate". The switches monitor all VC's rates and compute a fair share. The destination returns the RM cell back to the source, which then adjusts its rate to the indicated in the RM cell.

Enhanced PRCA (EPRCA)

Enhanced PRCA is evolving from PRCA with explicit rate scheme [29][30]. In EPRCA, the sources send data cells with EFCI set to 0. After every n data cells, they send an RM cell. The