CSE/EE 458: Data Communication (ATM)

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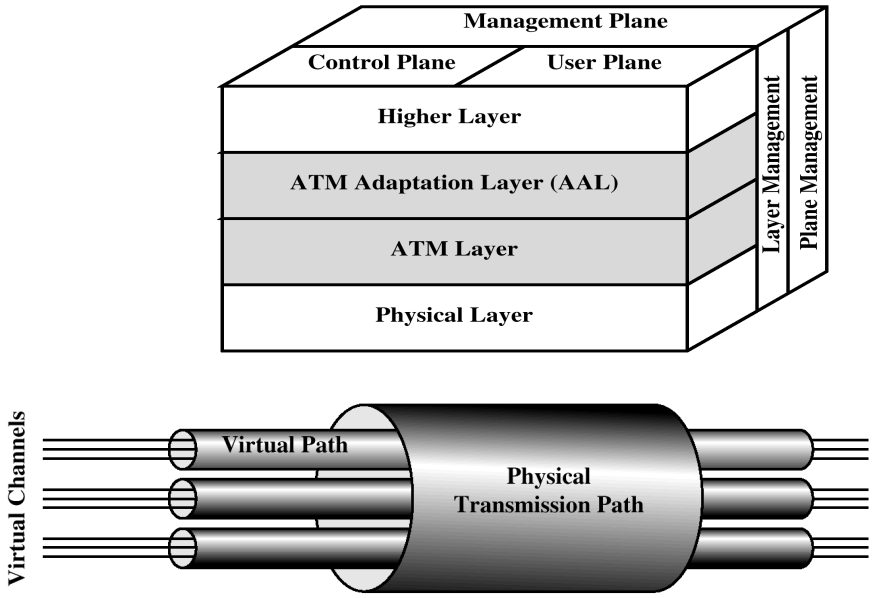
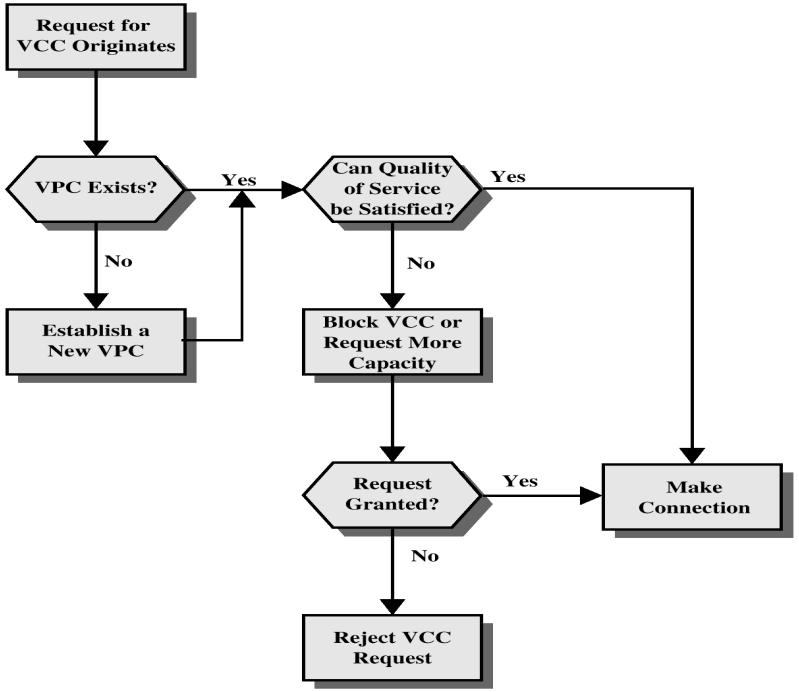
Protocol Architecture

- Similarities between ATM and packet switching
  - Transfer of data in discrete chunks
  - Multiple logical connections over single physical interface
- In ATM flow, packet size is fixed, called cells
- Minimal error and flow control
  - Reduced overhead
- Data rates (physical layer) 25.6Mbps to 622.08Mbps



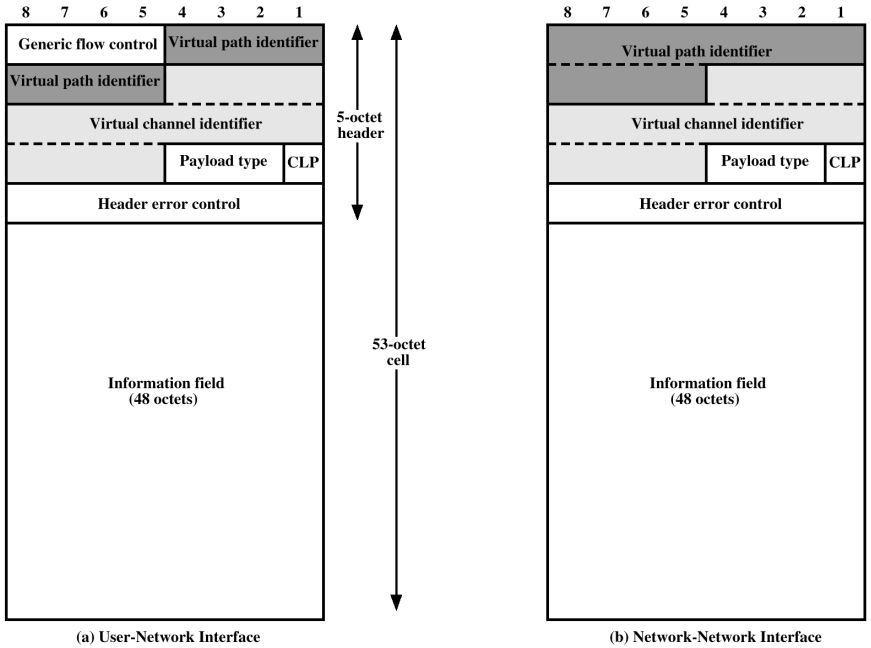
ATM Logical Connections

- Virtual channel connections (VCC)
  - Basic unit of switching
  - Full duplex, fixed size cells
  - Between end users: user data or control signals
  - Between end user and network: control signaling
  - Between network entities:network management, routing
- Virtual path connection (VPC)
  - A bunch of VCCs with the same end points
  - Simplify network architecture
  - Increase network performance and reliability
  - Reduce processing time, short connection setup time



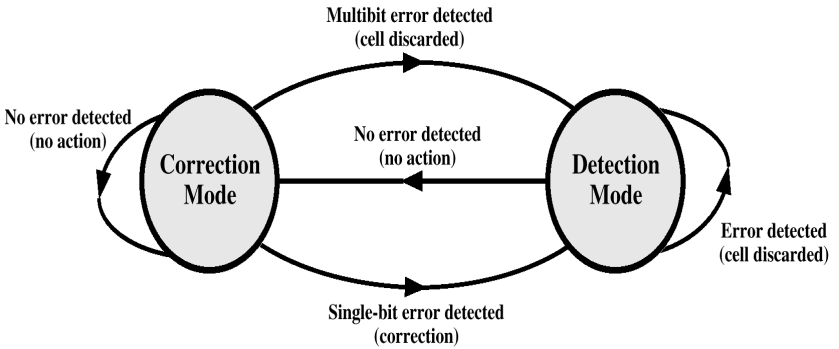
ATM Cells

- Fixed size, 5 octet header, 48 octet information
- Small cells can reduce the queuing delay of high priority cells, can be switched efficiently, easy to implement.
- Generic flow control
  - Only at user to network interface
  - Controls flow only at this point
- Virtual path identifier, virtual channel identifier
- Payload type: user info or network management
- Cell loss priority, header error control



Header Error Control

- 8 bit error control, can correct single error, Calculated on remaining 32 bits of header



Transmission of ATM Cells

- 622.08Mbps, 155.52Mbps, 51.84Mbps, 25.6Mbps
- Cell based physical layer
  - No framing imposed
  - Continuous stream of 53 octet cells
  - Cell delineation is based on the header error control field
- Synchronous digital hierarchy (SDH) based
  - Imposes structure on ATM stream, e.g. for 155.52Mbps
  - Specific connections can be circuit switched using SDH channel
  - SDH multiplexing techniques can combine several ATM streams

ATM Service Categories

- Real time: amount of delay, variation of the delay (jitter)
  - Constant bit rate (CBR)
  - Real time variable bit rate (rt-VBR)
- Non-real time
  - Non-real time variable bit rate (nrt-VBR)
  - Available bit rate (ABR)
  - Unspecified bit rate (UBR)

Real Time Services

- Constant bit rate (CBR)
  - Supports fixed data rate
  - Tight upper delay bound
  - Can support uncompressed audio and video
    - Video conference, interactive audio, A/V distribution, retrieval
- Real time variable bit rate (rt-VBR)
  - Time sensitive application
    - Tightly constrained delay and delay variation
  - The transmission rate varies with time
    - e.g. compressed video, produces varying sized image frames
  - Can statistically multiplex many connections to efficiently utilize the bandwidth.

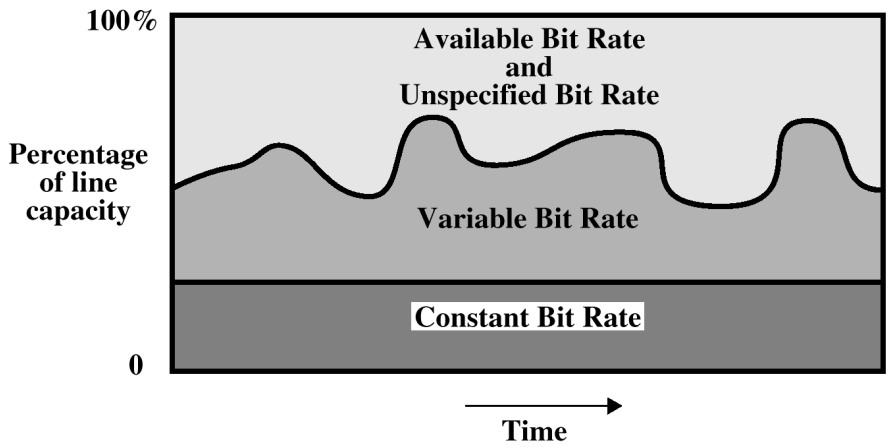
nrt-VBR and ABR

- Nrt-VBR
  - May be able to characterize expected traffic flow
  - Improve QoS in loss and delay
  - End system specifies:
    - Peak cell rate, sustainable or average rate
    - Measure of how bursty traffic is
  - e.g. Airline reservations, banking transactions
- ABR:
  - The application specifies peak cell rate (PCR) and minimum cell rate (MCR)
  - MCR must be satisfied during resource allocation
  - Spare capacity shared among all ABR services
  - e.g. LAN interconnection

UBR

- May be additional capacity left besides the resources used by CBR and VBR traffic
  - Not all resources dedicated
  - Bursty nature of VBR
- For application that can tolerate some cell loss or variable delays
  - e.g. TCP based traffic
- Cells are forwarded on FIFO basis
- Best effort service

ATM Bit Rate Services

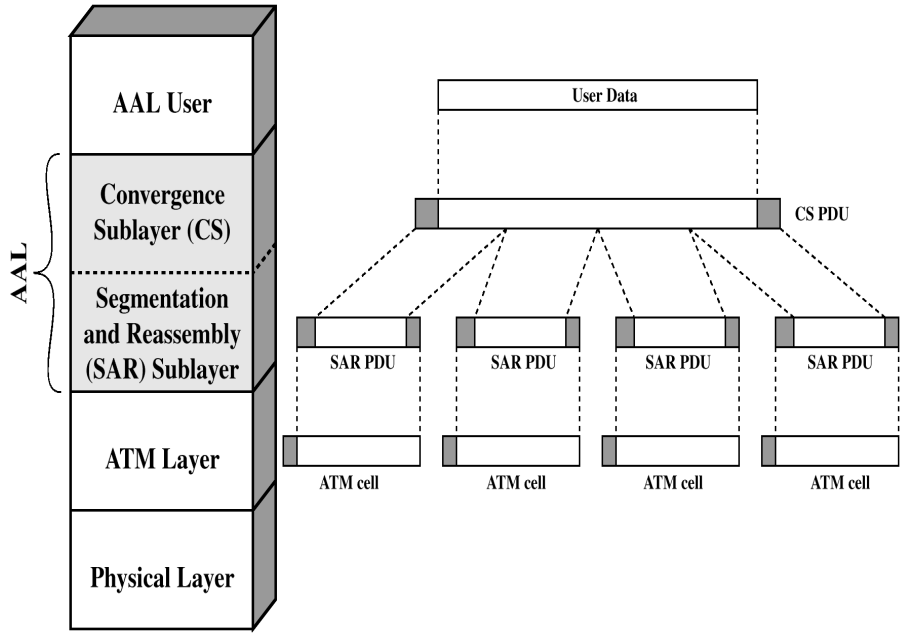


ATM Adaptation Layer

- Support for protocols that are not based on ATM
- PCM (voice)
  - Assemble bits into cells
  - Re-assemble into constant flow
- IP
  - Map IP packets onto ATM cells
  - Fragment IP packets
- Handle transmission errors,
- Segmentation and reassembly
- Handle lost and out-of-sequence cells
- Flow control and timing

AAL Protocols

- Convergence sublayer (CS)
  - Support for specific applications
  - AAL user attaches at SAP
- Segmentation and reassembly sublayer (SAR)
  - Packs and unpacks info received from CS into cells
- Four types
  - Type 1: CBR, circuit emulation, voice over ATM.
  - Type 2: rt-VBR, VBR voice and video
  - Type ¾: nrt-VBR, general data services
  - Type 5: All types, voice on demand, IP over ATM, LAN emulation



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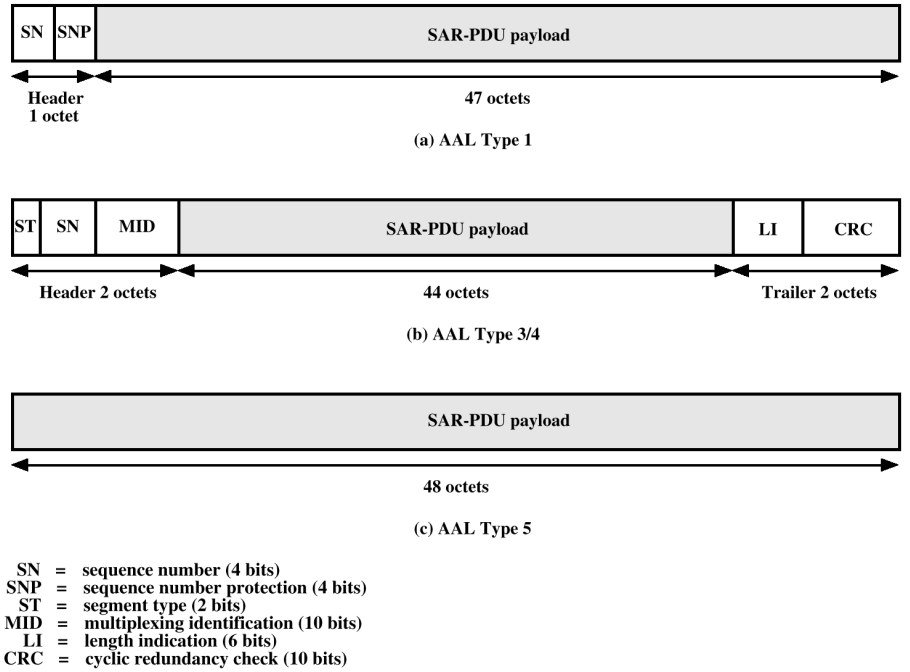
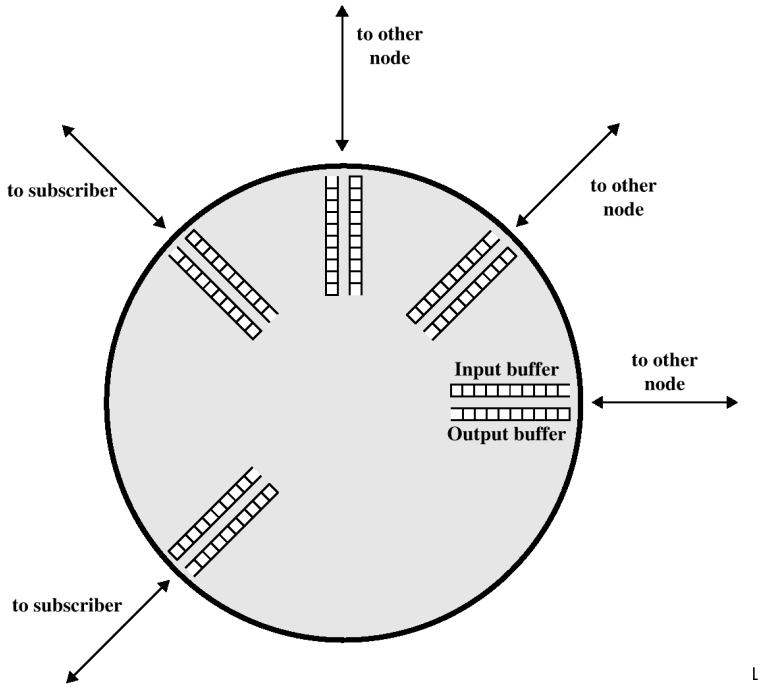


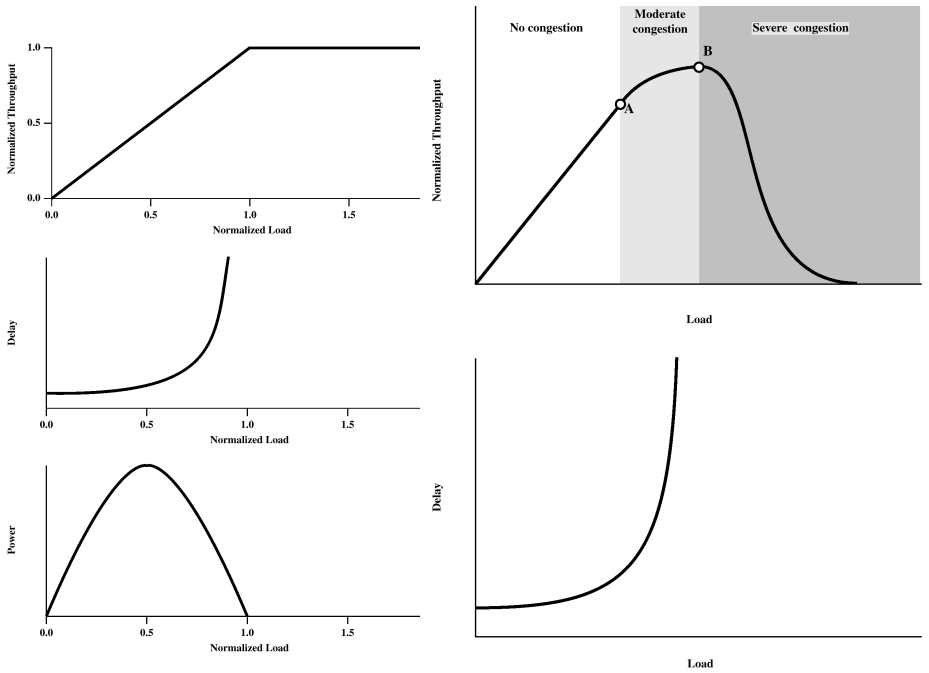
What Is Congestion?

- Congestion occurs when the number of packets being transmitted through the network approaches the packet handling capacity of the network
- Congestion control aims to keep number of packets below level at which performance falls off dramatically
- Data network is a network of queues
- Generally 80% utilization is critical
- Finite queues mean data may be lost

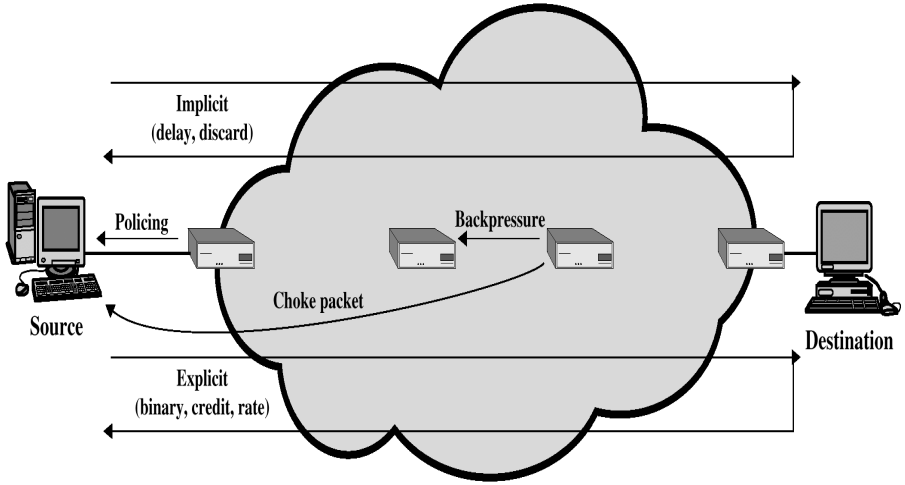
Effects of Congestion

- Packets arriving are stored at input buffers
- Routing decision made, packet moves to output buffer
- Packets queued for output are transmitted ASAP
  - Statistical time division multiplexing
- If packets arrive too fast to be routed, or to be output, buffers will fill
- Can discard packets, can use flow control
  - Can propagate congestion through network
- Ideal performance assumes infinite buffers and no overhead
- Buffers are finite, overheads occur in exchanging congestion control messages





Mechanisms for Congestion Control



Backpressure

- If node becomes congested (no buffer), it can slow down or halt flow of packets from other nodes
- Propagates back to source
- Used in connection oriented that allow hop by hop congestion control (e.g. X.25)
- Not used in ATM nor frame relay
- Only recently developed for IP

Choke Packet

- Control packet
  - Generated at congested node
  - Sent to source node
  - e.g. ICMP source quench
    - From router or destination
    - Source cuts back until no more source quench message
    - Sent for every discarded packet, or anticipated

Implicit Congestion Signaling

- Transmission delay may increase with congestion
- Packet may be discarded
- Source can detect these as implicit indications of congestion
- Useful on connectionless (datagram) networks
  - e.g. IP based
    - (TCP includes congestion and flow control - see chapter 17)

Explicit Congestion Signaling

- Network alerts end system of increasing congestion
- End systems take steps to reduce offered load
- Backwards: congestion avoidance in the opposite direction to packet required
- Forwards: congestion avoidance in the same direction as packet required
- Binary: a bit set in a packet indicates congestion
- Credit based
  - Indicates how many packets source may send
  - Common for end to end flow control
- Rate based: supply explicit rate limit; e.g. ATM