Chapter 11
Asynchronous Transfer Mode
ATM

• Multi-speed network environment that provides a variety of complex network services
• Can carry voice, data, video separately or simultaneously
• Can be used in LANs, MANs, or WANs
• Fixed-length packets (cells)
• Allows multiple logical connections to be multiplexed
• Minimal error and flow control capabilities
• Connection-oriented virtual channel
Cell Switched ATM

• Similar to frame relay
• Difference?
  — Frame relay switches variable length frames within frame relay cloud from source to destination
  — ATM switches fixed-length cells (48 byte information field, 5 byte header)
• Based on packet switching (connection-oriented)
  — Cell sequence integrity preserved via virtual channel
  — VCC – virtual channel connection – is set up between end users, variable rate, full duplex
  — VCC also used for control
• Information field is carried transparently through the network, with minimal error control
Protocol Architecture (diag)
ATM Physical Layer

- Transports cells via a communications channel (either optical or electrical)
- LAN support: 25-155 Mbps copper or fiber
- WAN support: SONET rates over fiber
- Physical Medium Sublayer: bit transfer, bit alignment, and copper/fiber conversions
- Transmission Convergence Sublayer: bit/cell conversion at sending and receiving nodes
ATM Layer

• Handles functions of the network layer:

• Connection-oriented without acknowledgements

• Two possible interfaces:
  — UNI – User-Network Interface: Boundary between an ATM network and host
  — NNI – Network-Network Interface: Between two ATM switches
UNI/NNI Interface

CUSTOMER PREMISES EQUIPMENT (CPE)

UNI: Network-Node Interface
UNI: User-Network Interface
ATM Adaptation Layer (AAL)

• Maps higher-layer information into ATM cells to be transported over an ATM network

• Collects information from ATM cells for delivery to higher layers
Virtual Connections

- Virtual Channel Connection (VCC) – Full duplex virtual circuit with logical connection between source and destination – can be PVC or SVC
- Virtual Path Connection (VPC) – Semi-permanent (or customer controlled or network controlled) connection that provides a logical collection of virtual channels that have the same endpoint
- A single virtual path supports multiple virtual channels (analogy – highway = VPC, lane = VCC)
VCI vs VPI

• VPI – Virtual Path Identifier – identified in cell’s header. Cannot establish a virtual channel before virtual path
• VCI – Virtual Channel Identifier – only have local significance – different virtual paths reuse VCIs (but VCIs on same path must be unique)
What is so special about a virtual path?

- ATM is connection-oriented, so circuit must be established before transmission
  - As route established, VPIs and VCIs are assigned
- VPI and VCI info suffices for addressing info
- Simplified network architecture (based on VC or VP)
- Increased network performance and reliability (fewer, aggregated entities because of simplified network architecture)
- Reduces processing and short connection setup time
- User may define closed user group or closed networks of virtual channel bundles
ATM Connection Relationships
Definition of Terms

• COS – Class of Service – sets a priority of data delivery, based upon the class. Higher priority data get delivered before lower priority data (example – which should have higher priority – streaming video or email?)

• QOS – Quality of Service – involves establishing certain parameters for a specific transmission – e.g. amount of bandwidth required for a given priority data transmission, max. amount of latency tolerated, etc

• Both are required to deliver real-time voice and video traffic
Call Establishment Using VPs
VP/VC Characteristics

- Quality of service based on VCC
- Switched and semi-permanent channel connections
- Call sequence integrity – packets arrive in order
- Traffic parameter negotiation and usage monitoring

- VPC only
  - Virtual channel identifier restriction within VPC – some VCCs reserved for network management
ATM Cells

• Fixed size – 53 bytes
• 5 octet header
• 48 octet information field
• Small cells reduce queuing delay for high priority cells
• Small cells can be switched more efficiently
• Easier to implement switching of small cells in hardware
ATM Cell Format

(a) User-Network Interface
(b) Network-Network Interface
Header Format

- Generic flow control
  - Only at user to network interface
  - Controls flow only at this point
- Virtual path identifier
- Virtual channel identifier
- Payload type
  - e.g. user info or network management
- Cell loss priority
- Header error control
Generic Flow Control (GFC)

• Control traffic flow at user to network interface (UNI) to alleviate short term overload

• Two sets of procedures
  — Uncontrolled transmission
  — Controlled transmission

• Every connection either subject to flow control or not

• Flow control is from subscriber to network
  — Controlled by network side
ATM Service Categories

• ATM is designed to transfer many different types of traffic simultaneously, including real-time voice, video, and bursty TCP traffic
• Way in which data flow is handled depends on the characteristics of the traffic flow and requirements of the application (ex. Real-time video must be delivered within minimum variation in delay)
• Primary service categories – real time service, non-real time service
ATM Service Categories

• Real time
  — 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)
  — Guaranteed frame rate (GFR)
Real Time Services

- If want to avoid or decrease variation of delay (jitter), use CBR or rt-VBR
- CBR Fixed data rate continuously available
- Commonly used for uncompressed audio and video
  - Video conferencing
  - Interactive audio
  - A/V distribution and retrieval
- rt-VBR Best for time sensitive applications
  - Tightly constrained delay and delay variation
- rt-VBR applications transmit at a rate that varies with time
  - e.g. compressed video
  - Produces varying sized image frames
  - Original (uncompressed) frame rate constant (isochronous)
  - So compressed data rate varies
- Can statistically multiplex connections
Non-Real Time

• Intended for applications with bursty traffic and limited constraints on delay and delay variation

• Greater flexibility, greater use of statistical multiplexing
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
UBR

- Unused capacity of CBR and VBR traffic made available to UBR
- For application that can tolerate some cell loss or variable delays — e.g. TCP based traffic
- Cells forwarded on FIFO basis
- Best efforts service
ABR

- Application specifies peak cell rate (PCR) it will use and minimum cell rate (MCR) it requires
- Resources allocated to give at least MCR
- Spare capacity shared among ABR and UBR sources
- e.g. LAN interconnection
Guaranteed Frame Rate (GFR)

- Designed to support IP backbone subnetworks
- Purpose: optimize handling of frame based traffic passing from LAN through router to ATM backbone
  - Used by enterprise, carrier and ISP networks
  - Consolidation and extension of IP over WAN
- UNI establishes hand shaking between NIC and switch
ATM versus Frame Relay

- Frame relay uses variable length frames
- ATM fixed length cells
- ATM has higher overhead, but faster speed and traffic management (better suited for video and voice)
ATM versus SONET

- SONET is a transport mechanism, transporting data over fiber.
- Can act as a transport carrier for ATM (or FDDI, or ISDN, etc.)
- ATM is a technology and protocol designed to use SONET as its carrier service
Why is ATM so Efficient?

- Minimal error and flow control
  - Reduces overhead of processing ATM cells
  - Reduces number of required overhead bits
- Fixed size simplified processing at each ATM node (can be switched more efficiently – more efficient use of router)
- Small cells reduce queuing delay
- Minimal addressing info on each cell
- Efficient traffic management
Required Reading

• Stallings Chapter 11
• ATM Forum Web site
Chapter 11 Review Questions

• Describe the basic characteristics of ATM
• Explain the relationship between UNI and NNI interfaces
• What is the difference between a virtual channel and a virtual path?
• What are the advantages of the use of virtual paths?
• What are the characteristics of a virtual channel connection?
• What are the characteristics of a virtual path connection?
• Define the following terms: QOS, COS, CBR, VBR, UBR, GFR, PCR, MCR
• Compare and contrast two methods of transmitting ATM cells.
• How does ATM differ from Frame Relay
• What are the relative advantages of ATM compared to frame relay?
• How does ATM differ for SONET?
• Discuss why ATM is so efficient.