Chapter 11. ATM and Frame Relay

- Overview of ATM
- Protocol Architecture
- ATM Logical Connections
- ATM Cells
- ATM Service Categories
- ATM Adaptation Layer (AAL)
- Cell Transmission
- Frame Relay

ATM: a method of packet switching
- A virtual circuit packet switching technique with QoS guarantee.
- Used in both WAN and LAN settings
- Signaling (connection setup) Protocol: Q.2931
- Packets of small fixed size are called cells
  - 5-byte header + 48-byte payload
- Similarities between ATM and other packet switching
  - Transfer data of packets
  - Multiple logical connections over single physical interface

Protocol Architecture

- **User plane**: Provides for user information transfer
- **Control plane**: Call and connection control
- **Management plane**
  - Plane management: whole system functions
  - Layer management: Resources and parameters in protocol entities
- AAL layer: interface between other transfer protocol & ATM

ATM Logical Connections

- Virtual channel connections (VCC): Basic unit of switching between two end users
  - Full duplex; Fixed size cells
- Virtual path connection (VPC): Bundle of VCC with same end points
Advantages of Virtual Paths (VP) & Virtual Channels (VC)

- Two-level hierarchy of virtual connection: many VC are inside one VP, ATM along that VP behave as if there is only one connection. Less connection-state information stored in the ATMs. The VCI is unique locally inside the same VP.
- Simplified network architecture
- Reduced processing & Short connection setup time

Virtual Channel Connection Uses

- Between end users
  - End to end user data
  - Control signals
  - VPC provides overall capacity
  - VCC organization done by end users
- Between end user and network
  - Control signaling
- Between network entities
  - Network traffic management
  - Routing

ATM Cells

- Fixed size: 5 bytes header, 48 bytes data
- Small cells reduce queuing delay for high priority cells
- Easier to implement switching of fixed size cells in hardware

Variable vs Fixed-Length Packets

- Fixed-Length Easier to Switch in Hardware
  - Hardware to do simple jobs: processing packet is simpler if you know their size.
- No Optimal Length:
  - if small: high header-to-data overhead
  - if large: low resource utilization
  - Compromise: 48 bytes = (32+64)/2
Header Format

- Generic flow control (GFC)
  - Only at user to network interface
  - Controls flow only at this point
- Virtual path identifier (VPI)
- Virtual channel identifier (VCI)
- Payload type (PT)
  - e.g. user info or network management
- Cell loss priority (CLP)
- Header error control (CRC-8)

ATM Service Categories

- Real time: Amount of delay & Variation of delay (jitter)
  - Constant bit rate (CBR): e.g., uncompressed audio and video
  - Real time variable bit rate (rt-VBR): e.g. compressed video
    - Can statistically multiplex connections
- Non-real time: overall data transmission rate
  - Non-real time variable bit rate (nrt-VBR): e.g. critical web transaction such as bank trans.
  - Available bit rate (ABR): Application specifies peak cell rate (PCR) and minimum cell rate (MCR); Spare capacity shared among all ABR sources
  - Unspecified bit rate (UBR) -> best-effort service: e.g. text/data/image transfer

ATM Bit Rate Services

ATM Adaptation Layer (AAL)

- Support for information transfer protocol not based on ATM
  - Supported Application types
    - General data service
    - IP over ATM
    - Multiprotocol encapsulation over ATM (MPOA)
- AAL Service
  - Segmentation and re-assembly
  - Handle transmission errors
  - Handle lost and misinserted cells
  - Flow control and timing
Segmentation and Reassembly

- ATM Adaptation Layer (AAL): 4 types by ITU
  - AAL 1 and 2 designed for applications that need guaranteed bit rate: e.g., voice, video
  - AAL 3/4 designed for packet data (connection-oriented such as X.25, or connectionless such as IP)
  - AAL 5 is an alternative standard for packet data

Transmission of ATM Cells

- ATM Data Rate:
  - 622.08Mbps
  - 155.52Mbps
  - 51.84Mbps
  - 25.6Mbps

- Physical Layers for ATM
  - Run over several different physical media & physical-layer protocols (e.g., SONET, FDDI, wireless physical layers).
  - The standard ways of carrying ATM cells inside a SONET/SDH frame have been defined

ATM is in danger?!

- In LAN network, it competes with Gigabit Ethernet
- In WAN network, it competes with IP
- Many of its innovations in high-speed switching, traffic management, and QoS will survive in an IP-networking framework
Frame Relay

- Designed to be more efficient than X.25
- Developed before ATM
- Larger installed base than ATM
- ATM now of more interest on high speed networks

Frame Relay Background - X.25

- Call control packets, in band signaling
- Multiplexing of virtual circuits at layer 3 (routing)
- Both layer 2 and 3 include flow and error control
- Considerable overhead
- Not appropriate for modern digital systems with high reliability (e.g. optical transmission with less errors)

Frame Relay – Differences with X.25

- Call control carried in separate logical connection (recall common channel signaling)
- Multiplexing and switching at layer 2
- No hop-by-hop (link layer) error or flow control
- End to end flow and error control (if used) are done by higher layer (layer 3 or above)
- Single user data frame sent from source to destination and ACK (from higher layer) sent back
- ITU-T recommend frame relay above 2Mbps