ATM Networks: 
An Overview

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Overview

- ATM vs Phone Networks and Data Networks
- ATM Protocol Layers
- Cell Header Format, AALs
- Physical Media
- Traffic Management: ABR, UBR, GFR
ATM

- ATM Net = Data Net + Phone Net
- Combination of Internet method of communication (packet switching) and phone companies’ method (circuit switching)
ATM vs Phone Networks

- Current phone networks are synchronous (periodic). ATM = Asynchronous Transfer Mode
- Phone networks use circuit switching. ATM networks use “Packet” Switching
- In phone networks, all rates are multiple of 8 kbps. With ATM service, you can get any rate. You can vary your rate with time.
- With current phone networks, all high speed circuits are manually setup. ATM allows dialing any speed.
ATM vs Data Networks

- Signaling: Internet Protocol (IP) is connectionless. You cannot reserve bandwidth in advance. ATM is connection-oriented. You declare your needs before using the network.
- PNNI: Path based on quality of service (QoS)
- Switching: In IP, each packet is addressed and processed individually.
- Traffic Management: Loss based in IP. ATM has 1996 traffic management technology. Required for high-speed and variable demands.
- Cells: Fixed size or small size is not important.
Old House vs New House

- New needs:
  Solution 1: Fix the old house (cheaper initially)
  Solution 2: Buy a new house (pays off over a long run)
ATM Interfaces

- Computer
  - Private UNI
  - Private Switch
- Router
  - DXI
  - Digital Service Unit
- Public Switch
  - Private NNI
  - Carriers Public NNI
- Public Switch
  - B-ICI
  - Public Switch
- Carrier
  - Public Switch

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ATM Interfaces

- User to Network Interface (UNI):
  - Public UNI, Private UNI

- Network to Node Interface (NNI):
  - Private NNI (P-NNI)
  - Public NNI = Inter-Switching System Interface (ISSI)
    - Intra-LATA ISSI (Regional Bell Operating Co)
    - Inter-LATA ISSI (Inter-exchange Carriers)
      ⇒ Broadband Inter-Carrier Interface (B-ICI)

- Data Exchange Interface (DXI)
  Between routers and ATM Digital Service Units (DSU)
Protocol Layers

End System
- ATM Adaptation Layer
  - ATM Layer
  - Physical Layer

Switch
- ATM Layer
  - Physical Layer

End System
- ATM Adaptation Layer
  - ATM Layer
  - Physical Layer

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Protocol Layers

- The ATM Adaptation Layer
  - How to break messages to cells
- The ATM Layer
  - Transmission/Switching/Reception
  - Congestion Control/Buffer management
  - Cell header generation/removal at source/destination
  - Cell address translation
  - Sequential delivery
Cell Header Format

- GFC = Generic Flow Control
  - (Was used in UNI but not in NNI)
- VPI/VCI = 0/0 ⇒ Idle cell; 0/n ⇒ Signaling
- HEC: $1 + x + x^2 + x^8$

<table>
<thead>
<tr>
<th>GFC/VPI</th>
<th>VPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPI</td>
<td></td>
</tr>
<tr>
<td>VCI</td>
<td></td>
</tr>
<tr>
<td>VCI</td>
<td>PTI</td>
</tr>
<tr>
<td>Header Error Check (HEC)</td>
<td></td>
</tr>
<tr>
<td>Payload</td>
<td></td>
</tr>
</tbody>
</table>
Path vs Channels

- 24/28-bit connection identifier
  First 8/12 bits: Virtual Path,
  Last 16 bits: Virtual Circuit
- VP service allows new VC's w/o orders to carriers
VP/VC Assignment/Use

<table>
<thead>
<tr>
<th>Port</th>
<th>VPI/VCI</th>
<th>Port</th>
<th>VPI/VCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/37</td>
<td>3</td>
<td>1/35</td>
</tr>
<tr>
<td>1</td>
<td>3/34</td>
<td>4</td>
<td>2/56</td>
</tr>
<tr>
<td>2</td>
<td>5/33</td>
<td>5</td>
<td>4/65</td>
</tr>
<tr>
<td>2</td>
<td>2/56</td>
<td>6</td>
<td>4/76</td>
</tr>
</tbody>
</table>
# Original Classes of Traffic

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Sync</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Bit Rate</td>
<td>Constant</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Connection -Oriented</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Examples</td>
<td>Circuit Emulation</td>
<td>Comp. Video</td>
<td>Frame Relay</td>
<td>SMDS</td>
</tr>
<tr>
<td>AAL</td>
<td>AAL1</td>
<td>AAL2</td>
<td>AAL3</td>
<td>AAL4</td>
</tr>
</tbody>
</table>
- Designed for data traffic
- Less overhead bits than AAL 3/4
  - Simple and Efficient AAL (SEAL)
- No per cell length field, No per cell CRC

**AAL 5**

<table>
<thead>
<tr>
<th>User Payload</th>
<th>PAD</th>
<th>Control</th>
<th>Length</th>
<th>CRC-32</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-64kB</td>
<td>0-47</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

PTI bit indicates last cell

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AAL2

- Ideal for low bit rate voice
- Variable/constant rate voice
- Multiple users per VC
- Compression and Silence suppression
- Idle channel suppression

![Diagram of AAL2 payload and headers]
Physical Media

- Multimode Fiber: 100 Mbps using 4b/5b, 155 Mbps SONET STS-3c, 155 Mbps 8b/10b
- Single-mode Fiber: 155 Mbps STS-3c, 622 Mbps
- Plastic Optical Fiber: 155 Mbps
- Shielded Twisted Pair (STP): 155 Mbps 8b/10b
- Coax: 45 Mbps, DS3, 155 Mbps
- Unshielded Twisted Pair (UTP)
  - UTP-3 (phone wire) at 25.6, 51.84, 155 Mbps
  - UTP-5 (Data grade UTP) at 155 Mbps
- DS1, DS3, STS-3c, STM-1, E1, E3, J2, n × T1
Service Categories

Standby
Joy Riders

Guaranteed
Confirmed
Service Categories

- **ABR** (Available bit rate): Source follows network feedback. Max throughput with minimum loss.
- **UBR** (Unspecified bit rate): User sends whenever it wants. No feedback. No guarantee. Cells may be dropped during congestion.
- **CBR** (Constant bit rate): User declares required rate. Throughput, delay and delay variation guaranteed.
- **VBR** (Variable bit rate): Declare avg and max rate.
  - **rt-VBR** (Real-time): Conferencing. Max delay guaranteed.
  - **nrt-VBR** (non-real time): Stored video.
ABR or UBR?

- Intelligent transport or not?
ABR vs UBR for TCP/IP

**ABR**
- Queue in the source
- Pushes congestion to edges
- Good if end-to-end ATM
- Fair
- Good for the provider

**UBR**
- Queue in the network
- No backpressure
- Same end-to-end or backbone
- Generally unfair
- Simple for user

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Guaranteed Frame Rate (GFR)

- UBR with minimum cell rate (MCR) ⇒ UBR+
- Frame based service
  - Complete frames are accepted or discarded in the switch
  - Traffic shaping is frame based. All cells of the frame have the same cell loss priority (CLP)
  - All frames below MCR are given CLP = 0 service. All frames above MCR are given best effort (CLP = 1) service.
Summary

- ATM Overview: History, Why and What
- Protocol Layers: AAL, ATM, Physical layers, Cell format
- Interfaces: PNNI, NNI, B-ICI, DXI
- ABR, CBR, VBR, UBR, GFR
ATM : Key References

- See http://www.cis.ohio-state.edu/~jain/refs/atm.refs.htm