ATM

Asynchronous Transfer Mode
Issues Driving LAN Changes

• Traffic Integration
  – Voice, video and data traffic
  – *Multimedia* became the ‘buzz word’
    • One-way batch Web traffic
    • Two-way batch voice messages
    • One-way interactive Mbone broadcasts
    • Two-way interactive video conferencing

• Quality of Service guarantees (e.g. limited jitter, non-blocking streams)

• LAN Interoperability

• Mobile and Wireless nodes
Figure 5.9 Example ATM LAN configuration.
Stallings “High-Speed Networks”

Figure 5.10 ATM LAN hub configuration.
Voice

A/D

\[ s_1, s_2 \ldots \]

Digital voice samples

Video

A/D

picture frames

Compressed frames

Data

Bursty variable-length packets

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Figure 9.3
Asynchronous Transfer Mode (ATM)

Voice

Data packets

Images

Wasted bandwidth

TDM

ATM

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Figure 7.37

Networks: ATM
ATM

- ATM standard (defined by CCITT) is widely accepted by common carriers as mode of operation for communication – particularly BISDN.

- ATM is a form of cell switching using small fixed-sized packets.
ATM Conceptual Model

Four Assumptions

1. ATM network will be organized as a hierarchy.
   User’s equipment connects to networks via a **UNI** (User-Network Interface).
   Connections between provided networks are made through **NNI** (Network-Network Interface).

2. ATM will be *connection-oriented*.
   A connection (an ATM channel) must be established before any cells are sent.
ATM Connections

- two levels of ATM connections:
  virtual path connections
  virtual channel connections
- indicated by two fields in the cell header:
  virtual path identifier VPI
  virtual channel identifier VCI
ATM Virtual Connections

Physical Link

Virtual Paths

Virtual Channels
ATM Conceptual Model
Assumptions (cont.)

3. Vast majority of ATM networks will run on optical fiber networks with extremely low error rates.

4. ATM must supports low cost attachments
   • This decision lead to a significant decision – to prohibit cell reordering in ATM networks.
   ➔ ATM switch design is more difficult.
## UNI Cell Format

<table>
<thead>
<tr>
<th>Field</th>
<th>Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFC</td>
<td>4</td>
</tr>
<tr>
<td>VPI</td>
<td>4</td>
</tr>
<tr>
<td>VCI</td>
<td>4</td>
</tr>
<tr>
<td>VCI</td>
<td>8</td>
</tr>
<tr>
<td>VCI</td>
<td>4</td>
</tr>
<tr>
<td>PT</td>
<td>3</td>
</tr>
<tr>
<td>CLP</td>
<td>1</td>
</tr>
<tr>
<td>HEC</td>
<td>8</td>
</tr>
<tr>
<td>Payload</td>
<td>48 bytes</td>
</tr>
</tbody>
</table>

**Figure 9.7**

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Networks: ATM
ATM Cell Switching

Figure 7.38

Switch

<table>
<thead>
<tr>
<th>25</th>
<th>N</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>1</td>
<td>67</td>
</tr>
</tbody>
</table>

| 32 | 3 | 39 |

N | 2 | 67 |

<table>
<thead>
<tr>
<th>video 25</th>
<th>voice 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>video 32</td>
<td>voice 61</td>
</tr>
<tr>
<td>video 61</td>
<td>voice 75</td>
</tr>
</tbody>
</table>

1 | voice 67 |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>video 67</td>
</tr>
<tr>
<td>3</td>
<td>data 39</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

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Networks: ATM
Digital Cross Connect

*Only switches virtual paths*

Sw = switch

ATM Sw 1

ATM Sw 2

ATM Sw 3

ATM Sw 4

VP1

VP2

VP3

VP5

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Figure 7.39

Networks: ATM
ATM Protocol Architecture

• ATM Adaptation Layer (AAL) – the protocol for packaging data into cells is collectively referred to as AAL.

• Must efficiently package higher level data such as voice samples, video frames and datagram packets into a series of cells.

**Design Issue:** How many adaptation layers should there be?
Networks: ATM

Figure 9.2

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Networks: ATM

Figure 9.4
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Original ATM Architecture

- CCITT envisioned four classes of applications (A-D) requiring four distinct adaptation layers (1-4) which would be optimized for an application class:
  A. Constant bit-rate applications  CBR
  B. Variable bit-rate applications  VBR
  C. Connection-oriented data applications
  D. Connectionless data application
ATM Architecture

An AAL is further divided into:

The **Convergence Sublayer (CS)** manages the flow of data to and from SAR sublayer.

The **Segmentation and Reassembly Sublayer (SAR)** breaks data into cells at the sender and reassembles cells into larger data units at the receiver.
Original ATM Architecture

Abbreviations
- AAL: Adaptation Layer
- SAR: Segmentation And Reassembly
- CS: Convergence Sub-layer
- PL: Physical Layer
- TC: Transmission Convergence
- PM: Physical Medium

Service Classes for AAL

<table>
<thead>
<tr>
<th>Class</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Constant Bit Rate</td>
</tr>
<tr>
<td>B</td>
<td>Variable Bit Rate</td>
</tr>
<tr>
<td>C</td>
<td>Connection Oriented Data</td>
</tr>
<tr>
<td>D</td>
<td>Connectionless Data</td>
</tr>
</tbody>
</table>

1. Protocol Reference Model in the User Plane. See Section 4.1 for AAL SAP classes (A to D) and values (1 to 4).
Original ATM Architecture

• The AAL interface was initially defined as classes A-D with SAP (service access points) for AAL1-4.
• AAL3 and AAL4 were so similar that they were merged into AAL3/4.
• The data communications community concluded that AAL3/4 was not suitable for data communications applications. They pushed for standardization of AAL5 (also referred to as SEAL – the Simple and Efficient Adaptation Layer).
• AAL2 was not initially deployed.
Revised ATM Architecture
Revised ATM Service Categories

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR</td>
<td>Constant Bit Rate</td>
<td>T1 circuit</td>
</tr>
<tr>
<td>RT-VBR</td>
<td>Real Time Variable Bit Rate</td>
<td>Real-time videoconferencing</td>
</tr>
<tr>
<td>NRT-VBR</td>
<td>Non-real-time Variable Bit Rate</td>
<td>Multimedia email</td>
</tr>
<tr>
<td>ABR</td>
<td>Available Bit Rate</td>
<td>Browsing the Web</td>
</tr>
<tr>
<td>UBR</td>
<td>Unspecified Bit Rate</td>
<td>Background file transfer</td>
</tr>
</tbody>
</table>
QoS, PVC, and SVC

• Quality of Service (QoS) requirements are handled at connection time and viewed as part of signaling.

• ATM provides permanent virtual connections and switched virtual connections.
  – Permanent Virtual Connections (PVC) permanent connections set up manually by network manager.
  – Switched Virtual Connections (SVC) set up and released on demand by the end user via signaling procedures.
(b) CS PDU with pointer in structured data transfer

- AAL 1 Pointer
- 47 Bytes
- Optional

(a) SAR PDU header

<table>
<thead>
<tr>
<th>CSI</th>
<th>Seq. Count</th>
<th>SNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bit</td>
<td>3 bits</td>
<td>4 bits</td>
</tr>
</tbody>
</table>
Figure 9.10

AAL 1

Higher layer

\[ b_1 \quad b_2 \quad b_3 \quad \ldots \]

User data stream

Convergence sublayer

CS PDUs

SAR sublayer

SAR PDUs

ATM layer

ATM Cells

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Networks: ATM  
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### AAL 3/4
CS and SAR PDUs

(a) CPCS-PDU format

<table>
<thead>
<tr>
<th>CPI</th>
<th>Btag</th>
<th>BASize</th>
<th>CPCS - PDU Payload</th>
<th>Pad</th>
<th>AL</th>
<th>Etag</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1 - 65,535</td>
<td>0-3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

(2 bytes) (bytes)

(b) SAR PDU format

<table>
<thead>
<tr>
<th>ST</th>
<th>SN</th>
<th>MID</th>
<th>SAR - PDU Payload</th>
<th>LI</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>10</td>
<td>44</td>
<td>6</td>
<td>10</td>
</tr>
</tbody>
</table>

(2 bytes) (bits) (bytes) (bits)
AAL 3/4

Higher layer

Service specific convergence sublayer

Common part convergence sublayer

SAR sublayer

ATM layer

Information

User message

Assume null

Pad message to multiple of 4 bytes. Add header and trailer.

Each SAR-PDU consists of 2-byte header, 2-byte trailer, and 44-byte payload.

Figure 9.15

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Networks: ATM 30
AAL 5

Convergent Sublayer Format

<table>
<thead>
<tr>
<th>Information</th>
<th>Pad</th>
<th>UU</th>
<th>CPI</th>
<th>Length</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 65,535</td>
<td>0-47</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>(bytes)</td>
<td>(bytes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SAR Format

ATM Header

48 bytes of Data

1-bit end-of-datagram field (PTI)
Networks: ATM

Higher layer

Service specific convergence sublayer

Common part convergence sublayer

SAR sublayer

ATM layer

Assume null

Figure 9.18

PTI = 0

PTI = 0

PTI = 1

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