Connectionless Services in ATM Networks

• ITU-T approach
  – Indirect connectionless service
  – Direct connectionless service

• IETF approach
  – Classical IP over ATM

• ATM Forum approach
  – LAN Emulation

ITU-T Approach
Indirect provision of connectionless service

- CLSF (Connectionless Service Functions)
- B-ISDN customer
- Private connectionless network
- B-ISDN switched capabilities

Symbols:
- ATM: Asynchronous Transfer Mode
- CLSF: Connectionless Service Functions
- SB or TB: Service Boundary or Transport Boundary

Notes:
- Semi-permanent connection
- Call-by-call connection
- ATM
ITU-T Approach
Direct provision of connectionless service

<table>
<thead>
<tr>
<th>Semi-permanent connection</th>
<th>Call-by-call connection</th>
</tr>
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<tbody>
<tr>
<td>ATMI</td>
<td>CLSF</td>
</tr>
<tr>
<td>B-ISDN customer</td>
<td></td>
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<tr>
<td>B-ISDN customer</td>
<td></td>
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<tr>
<td>ATM</td>
<td></td>
</tr>
<tr>
<td>ATM switched capabilities</td>
<td></td>
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<tr>
<td>B-ISDN customer</td>
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Protocol structure for connectionless service

<table>
<thead>
<tr>
<th>Higher layer protocols</th>
<th>ME</th>
</tr>
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<tbody>
<tr>
<td>CLNAP</td>
<td></td>
</tr>
<tr>
<td>CPCS SAR</td>
<td></td>
</tr>
<tr>
<td>ATM</td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td></td>
</tr>
<tr>
<td>CLAI</td>
<td></td>
</tr>
<tr>
<td>CLNI</td>
<td></td>
</tr>
</tbody>
</table>

AAL | ATM adaptation layer
ATM | Asynchronous transfer mode
CLAI | Connectionless access interface
CLNAP | Connectionless access protocol
CLNI | Connectionless network interface
CLNIP | Connectionless network interface protocol
CPCS | Common part convergence sublayer
ME | Mapping entity
PL | Physical layer
SAR | Segmentation and reassembly
Structure of the CLNIP-PDU

- **C**: CRC indication bit
- **CLNIP**: Connectionless network interface protocol
- **HEL**: Header extension length
- **Pad le**: Pad length
- **PDU**: Protocol data unit
- **PP**: Post pad
- **PI**: Protocol identifier
- **QOS**: Quality of service

<table>
<thead>
<tr>
<th>Header extension</th>
<th>Header extension post pad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

User-data

Optional 32 bit CRC

CLNAP-PDU encapsulation

- **AH**: Alignment header
- **BOM**: Beginning of message
- **COM**: Continuation of message
- **CPCS**: Common part convergence layer
- **EOM**: End of message
- **EOM**: End of message
- **PDU**: Protocol data unit
- **SAR**: Segmentation and reassembly
- **SDU**: Service data unit

Mapping entity

AAL ATM adaptation layer

AAL 3/4 CPCS

AAL 3/4 SAR sublayer

CLNIP layer

CPCS-SDU

CLNAP-PDU

CLNAP-SDU

CPCS-SDU

SAR-PDU header

SAR-PDU trailer

SAR-PDU header
Connectionless Services in ATM Networks

Protocol structure for connectionless data service
Connectionless Services in ATM Networks

<table>
<thead>
<tr>
<th>Bit Word</th>
<th>32</th>
<th>1</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Destination address</td>
<td>Destination address</td>
</tr>
<tr>
<td></td>
<td>Source address</td>
<td>Source address</td>
</tr>
<tr>
<td>5</td>
<td>PI 6b</td>
<td>PAD length 2b</td>
</tr>
<tr>
<td>6</td>
<td>Header extension</td>
<td>Header extension post pad</td>
</tr>
<tr>
<td>11</td>
<td>User information</td>
<td>Optional 32 bit CRC</td>
</tr>
</tbody>
</table>

CLNAP-PDU structure.

Connectionless Services in ATM Networks

CLNAP-PDU

Alignment header

Mapping entity

CLNIP-PDU

header

CLNIP layer

CPCS

header

AAL 3/4

CPCS layer

BOM segment

COM segment

EOM segment

AAL 3/4

SAR layer

Encapsulation of a CLNAP-PDU within a CLNIP-PDU
IETF Approach

- IP over ATM

Classical IP over ATM

- RFC 1577 Classical IP and ARP over ATM
- "direct substitution of cables, LAN segments, dedicated circuits, etc.
- AAL5 (best performance)
- ATM-ARP and In-ATM-ARP
- VCCs between pairs of WS within a LIS
- ATM-ARP server (well known address)
Classical IP over ATM

- RFC 1483 Multiprotocol Encapsulation over ATM AAL5
- LLC/SNAP (SubNetwork Attachment Point)
- LLC header indicates the protocol
- Several protocols (LAN bridging, LAN routing exist on a single VCC)

Classical IP over ATM

- RFC 1626 Default IP MTU for use over ATM AAL5
- Maximum Transmission Unit (IP segment):
  TCP, UDP, LLC, RPC/XDR: 8300 bytes
  NFS: 8192 bytes
  SMDS: 9180 bytes
- Default MTU: 9180 bytes
Multicast IP

- RFC 1112
- Encapsulation of multicast IP datagrams into IP datagrams
- “tunneling”
- IP multicast address: Class D
  224.x.y.z - 239.x.y.z
  session address (not host address)

Multicast IP over ATM

- IP over ATM
- Multicast IP
- Two alternatives
  - Full mesh of VCCs
  - Multicast server
- ATM switches with point-to-multipoint connections (replication of cells)
Multicast mesh vs Multicast server

Multicast mesh

Multicast server
ATM Forum Approach

• LAN Emulation over ATM
  – LANE v1, January 1995
  – LANE v2, July 1997
  – UNI 3.0, UNI 3.1, UNI 4.0

LAN Emulation over ATM

KEY ISSUES:

• Complete Multivendor Interoperability
• Scalability
• Seamless Connectivity
• Transitional Support for “Current LAN's”
• Provide a complete long term solution for “Current LAN technology” integration & support
• Robustness & Redundancy
• Coherent Integrated Multivendor Network Management
Business case issues. Why LANE/ATM?

- **Virtual work groups**: The ability to create virtual workgroups using workstations, fileservers & other equipment regardless of location.

- **Virtual networks**: The ability to create virtual networks using a common infrastructure.

- **Manageable bandwidth**: The ability to provide a certain quality of service and bandwidth.

- Reduced operations cost through simplified moves & changes process.

User Site Requirements Rationale

- Provide a transitional path for existing deployed workstations, fileservers, and network equipment.

- Replace the existing Campus MAN FDDI backbone with an ATM enterprise network infrastructure.

- Migrate the existing corporate WAN to an ATM enterprise network infrastructure.

- Increase throughput and performance & reduce latency for applications such as desktop video conferencing.
LAN Characteristics

- Connectionless Service
- Multicast MAC Address
- MAC driver Interface (APPN, NETBIOS, IPX, AppleTalk, IP)
- Standardized MAC interfaces:
  - NDIS (Network Driver Interface Specification)
  - ODI (Open Data-Link Interface)
  - DLPI (Data Link Provider Interface)

Emulated LANs over ATM

- Several emulated LANs (ELANs) within an ATM network
- Multiple ELANs over a single ATM network are logically independent
- Interconnection with existing LANs (bridging mechanisms: Transparent Bridging and Source Routing Bridging)
LAN emulation over ATM

Configuration 1: ATM and a legacy LAN station

LAN emulation over ATM

Configuration 2: legacy LAN to legacy LAN over ATM
LAN emulation over ATM

Configuration 3: ATM to ATM

LANE Service

• Types:
  – Ethernet / IEEE802.3
  – IEEE802.5 (Token Ring)

• Components:
  – Set of LANE Clients (LECs)
  – LAN Emulation Service (LE Service)
    • LECS (LE Configuration Server)
    • LES (LE Server)
    • BUS (Broadcast and Unknown Server)
LAN Emulation over ATM

Layered Architecture of LAN Emulation Client

LEC Interfaces

- (1) Higher Layers (user data frames)
- (2) AAL5 (user data frames)
- (3) Connection Management (VCCs)
- (4) Initialization and control
- (5) LLC-multiplexed frames (LANEv2)
- (6) LLC-multiplexed flows management
LANE UNI (LUNI)

• LUNIv2 provides enhanced capabilities (LLC multiplexing, support for ABR, enhanced multicast and MPOA support)
LANE Server (LES)

- Control for ELAN
- Registering and resolving unicast and multicast addresses and/or route descriptors to ATM addresses (ATMARP)
- One LEC is connected with one LES

LE Configuration Server (LECS)

- Assign individual LECs to different ELANs
- Configuration DB
- LECS gives the LES ATM address to LECs
- LECs obtain information from an LECS
Bcast and Unkn Server (BUS)

- Provides the connectionless service:
  - Handles MAC Broadcast Addresses
  - Handles multicast data
  - Handles initial unicast data sent by an LEC before the target ATM address has been resolved
- BUS serializes frames (avoid AAL5 frame interleaving)
- Participates in LE_ARP so that a LEC may locate its BUS

LANE Components

- LECs are typically implemented in ATM end stations
  - ATM Host, ATM PC, ATM WS
  - Bridges, Routers (ATM interfaces)
- LE Service may be implemented in ATM switches and ATM end stations
LAN Emulation over ATM

Basic LAN Emulation Client Connections across LUNI

LAN Emulation over ATM

Configuration Direct VCC

LE Client to LAN Emulation Configuration Server (LECS) Control Connection
Bi-directional VCC.
Obtain configuration information and LES address
LAN Emulation over ATM

LAN Emulation Client to LAN Emulation Server (LES) Control Connections

LAN Emulation Client to Client Data Connections
LAN Emulation over ATM

LAN Emulation Client to BUS Connections

Les does address lookup

Host

BUS does broadcasting

© UPC DAC JDP
LAN Emulation over ATM

LAN Emulation Non-multiplexed Data Frame Format for IEEE 802.3/Ethernet Frames

LAN Emulation LLC-multiplexed Data Frame Format for IEEE 802.3/Ethernet Frames

LAN Emulation over ATM

Control Frame

<table>
<thead>
<tr>
<th>Address</th>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>MARKER</td>
<td>X’FF00’</td>
</tr>
<tr>
<td>4</td>
<td>OP-CODE</td>
<td>STATUS</td>
</tr>
<tr>
<td>8</td>
<td>TRANSACTION-ID</td>
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<tr>
<td>12</td>
<td>REQUESER-LECID</td>
<td>FLAGS</td>
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<tr>
<td>16</td>
<td>SOURCE-LAN-DESTINATION</td>
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<tr>
<td>24</td>
<td>TARGET-LAN-DESTINATION</td>
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<tr>
<td>32</td>
<td>SOURCE-ATM-ADDRESS</td>
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<tr>
<td>52</td>
<td>LAN-TYPE</td>
<td>MAXIMUM-FRAME-SIZE</td>
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<td>56</td>
<td>TARGET-ATM-ADDRESS</td>
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<tr>
<td>76</td>
<td>ELAN-NAME</td>
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<tr>
<td>108</td>
<td>TLVs BEGIN</td>
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</tr>
</tbody>
</table>

LANE Control Frame
Three approaches to converting Legacy LANs to ATM Emulated LANs

- “ATM Workgroup”
  Attach End Systems to ATM Network
- “ATM Backbone”
  Attach Hub/Bridge/Routers to ATM Network
- Hybrid (ATM Workgroups & Backbone)

Small & Large Networks

- “Small Network”
  - 50 or less users
  - Usually one site
  - LAN & dial-up public WAN
- “Large Network”
  - 500 or more users
  - Many sites
  - LANs, private WAN & public dial-up WAN
Symbols

- End system
- Dial-up WAN
- LAN-WAN Edge device (Remote LAN Access)
- Private WAN
- ATM Switch (A-A, A-L)
- Private WAN
- LAN Router (L-L)
- Shared media LAN

Small Network LAN Emulation

Before
ATM Backbone Solution

ATM Workgroup Solution
Large Network

Before

Private WAN

Large Network: ATM Backbone Solution

After

Private WAN (Possibly ATM)