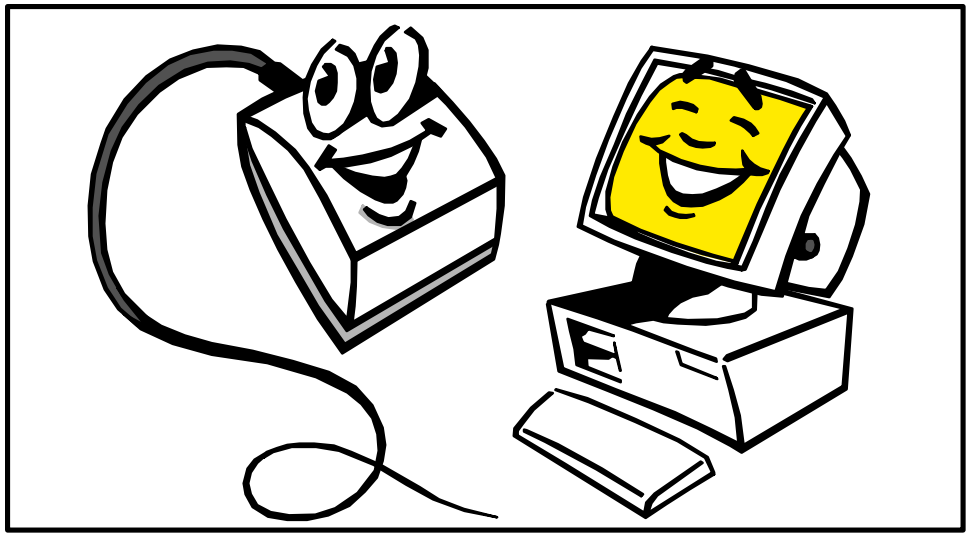
ATM Networks: An Overview



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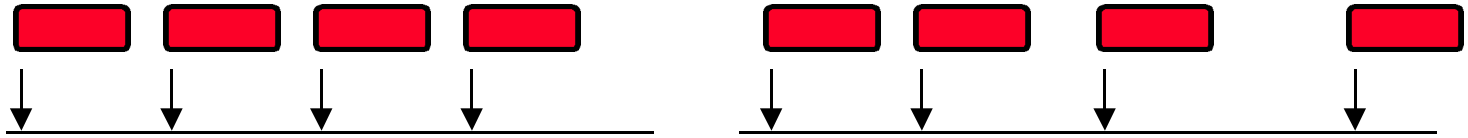
- ATM: Overview
- ATM Protocol Layers
- Adaptation Layers
- LAN Emulation
- Network Interfaces

ATM Networks: Overview

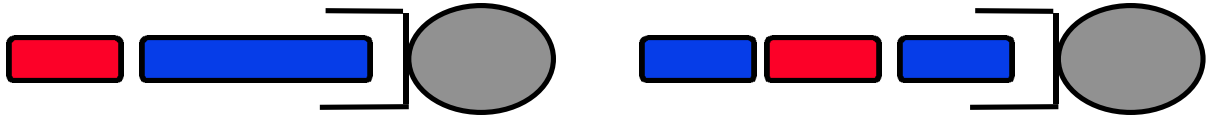
- STM = Synchronous Transfer Mode,
  ATM = Asynchronous Transfer Mode



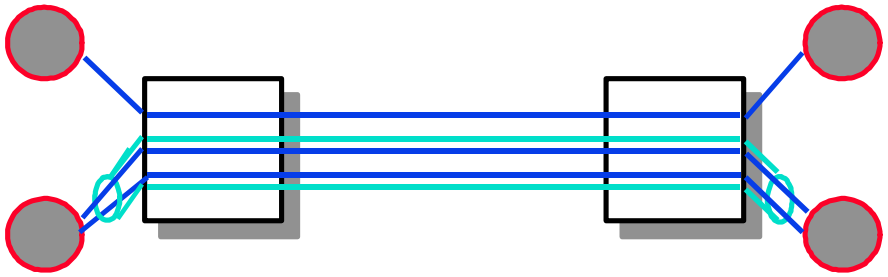
Allows any-speed and even variable rate connection

Broadband = Rate greater than primary rate (1.5 Mbps)

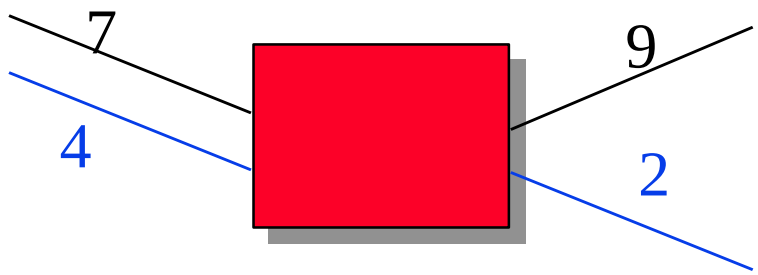
- ATM = Short fixed size 53-byte cells



- Connection oriented ⇒ Virtual Channels (VC)



- Labels vs addresses
  ⇒ Better scalability in number of nodes

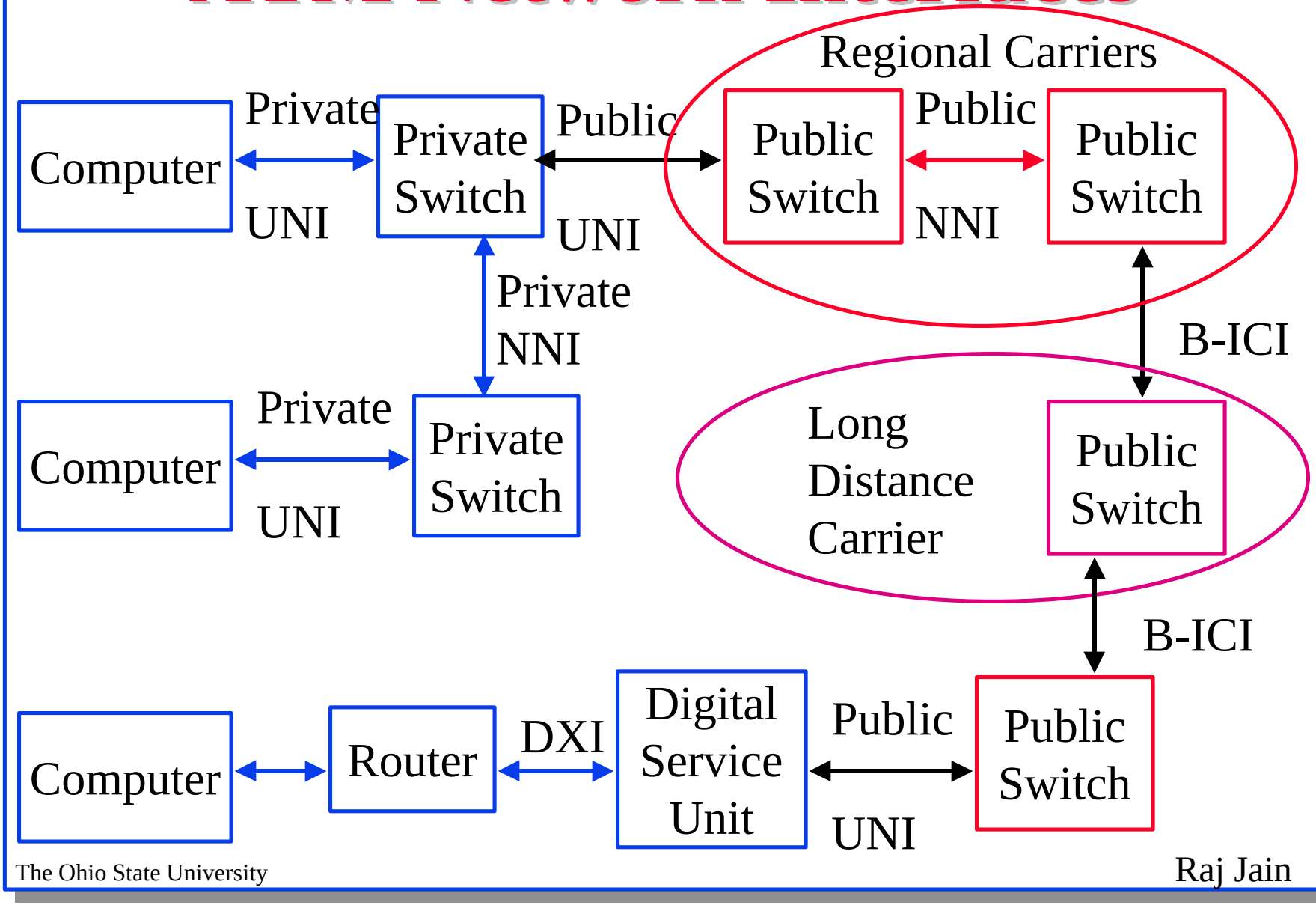


- Slotted system ⇒ Better scalability in distance-bandwidth
- Switches vs routers
  ⇒ Cheaper due to fixed size, short address, simplicity
- Seamless ⇒ Same technology for LAN, MAN, WAN
- Data, voice, video integration
- Everyone else is doing it

History of ATM

- 1980: Narrowband ISDN adopted
- Early 80's: Research on Fast Packets
- Mid 80's: B-ISDN Study Group formed
- 1986 ATM approach chosen for B-ISDN
- June 1989: 48+5 chosen (64+5 vs 32+4).
- October 1991: ATM Forum founded
- July 1992: UNI V2 released by ATM Forum
- 1993: UNI V3 and DXI V1
- 1994: B-ICI V1

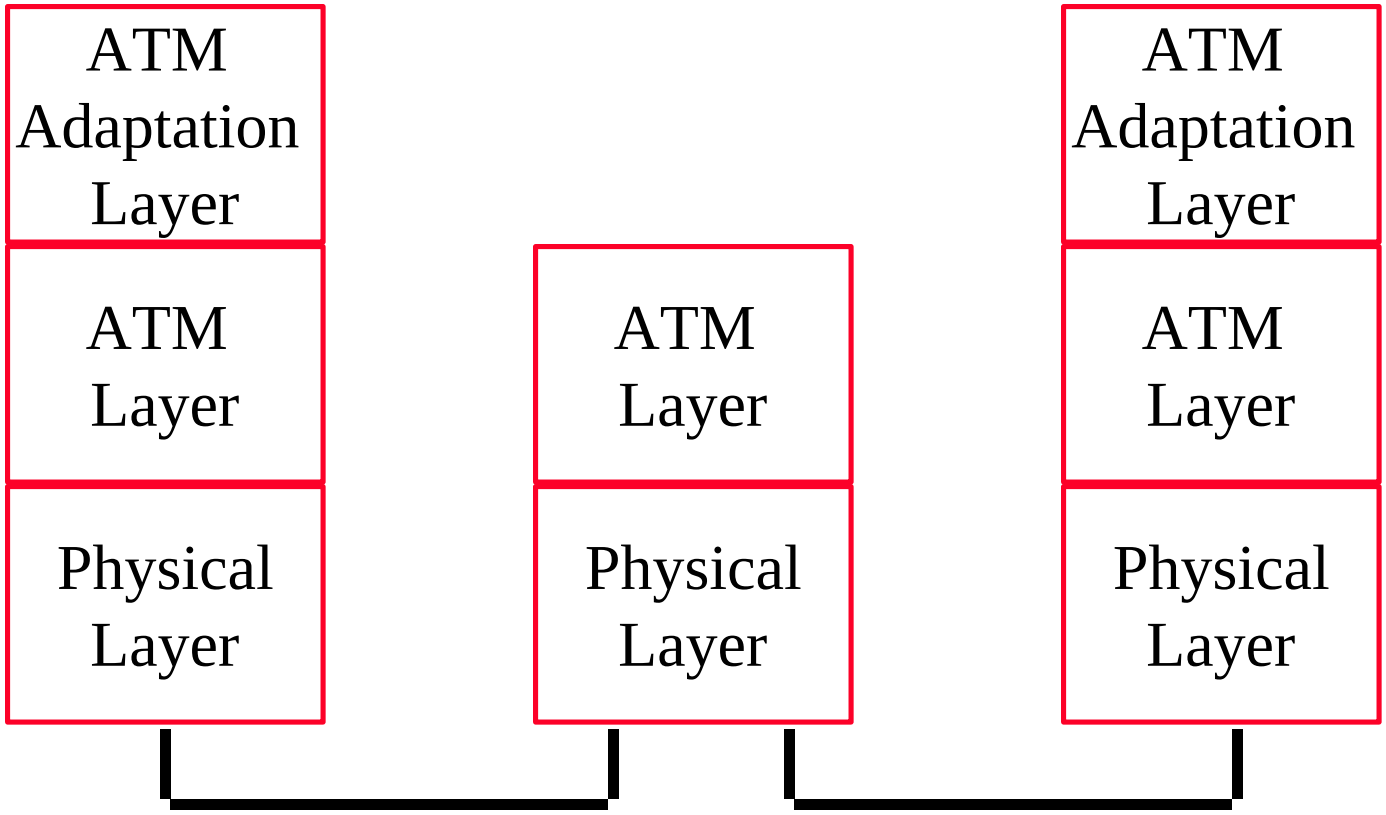
ATM Network Interfaces



ATM Network 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 packet routers and ATM Digital Service Units (DSU)

Protocol Layers

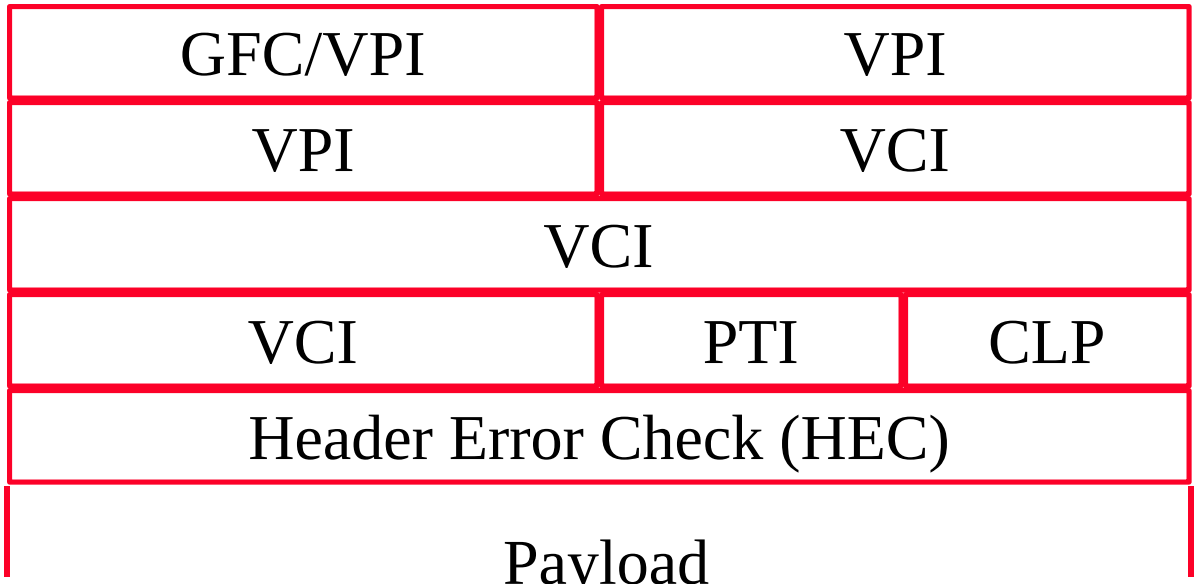


Protocol Layers

- The ATM Adaptation Layer
  - How to break application messages to cells
- The ATM Layer
  - Transmission/Swiching/Reception
  - Congestion Control/Buffer management
  - Cell header generation/removal at source/destination
  - Reset connection identifiers for the next hop (at switch)
  - Cell address translation
  - Sequential delivery

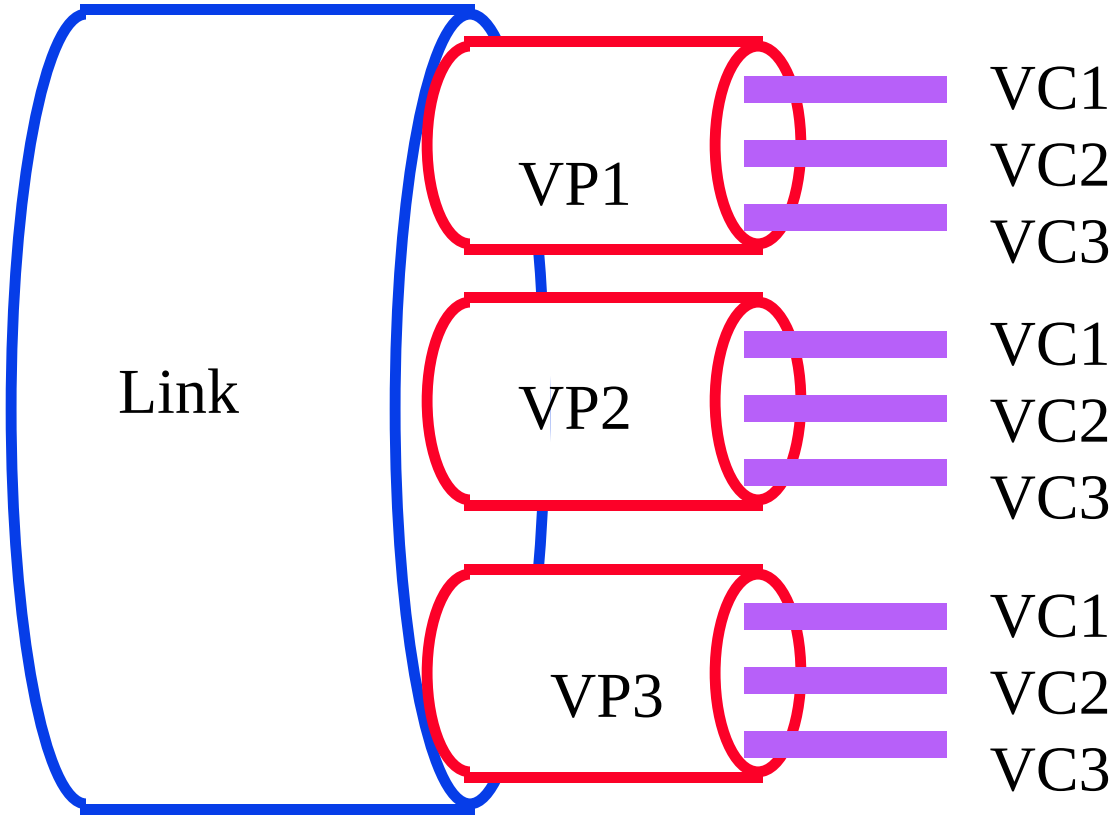
ATM Cell Header Format

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



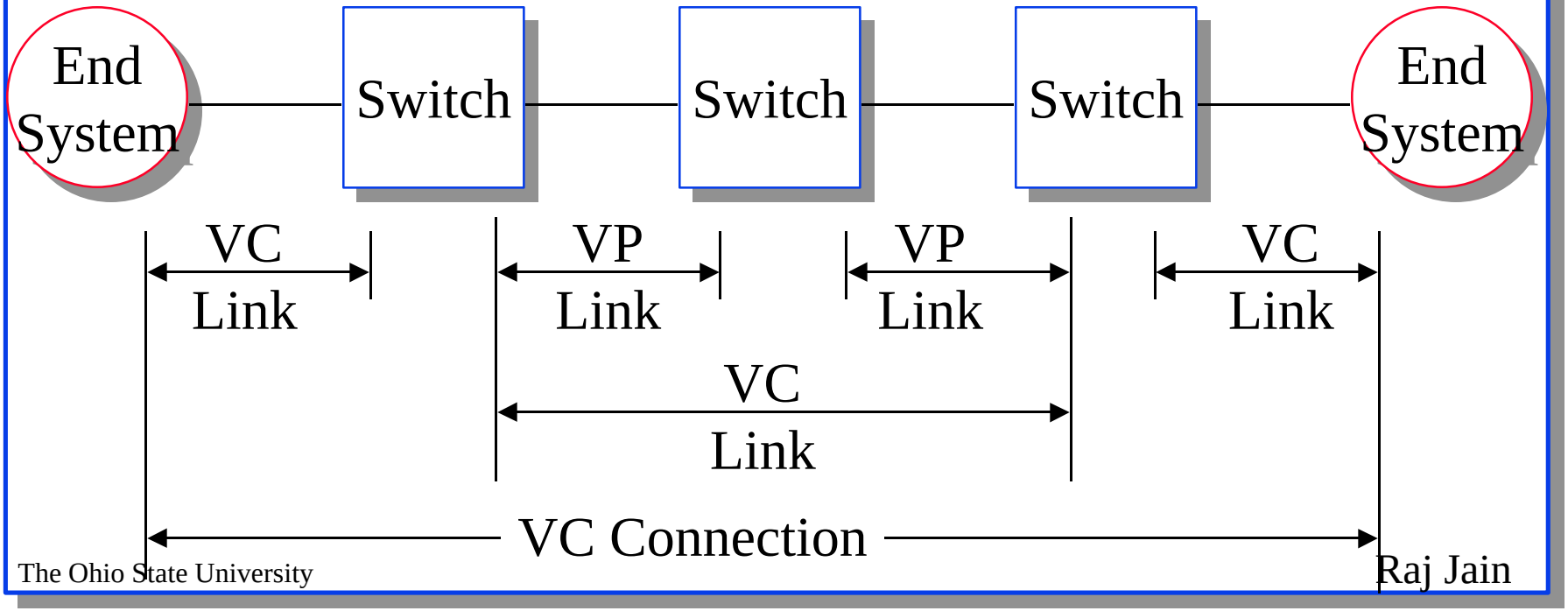
Connection Identifiers

- Each cell contains a 24/28-bit connection identifier
  First 8/12 bits: Virtual Path, Last 16 bits: Virtual Channel
- VP service allows new VC's w/o orders to carriers

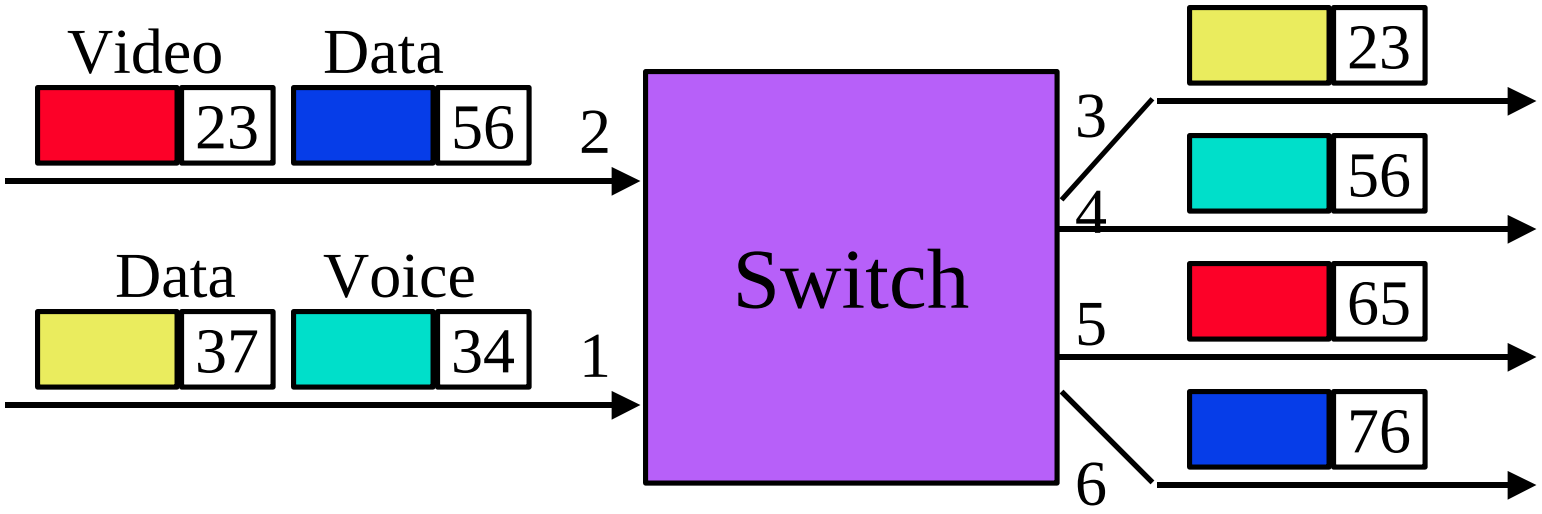


Connections Vs Channels

- VP connections (VPCs) = Series of VP Links
- VC connections (VCCs) = Series of VC Links to make an end-to-end link
- VC = VCL or VCC, VP=VPL or VPC
- Call = Multiple connections



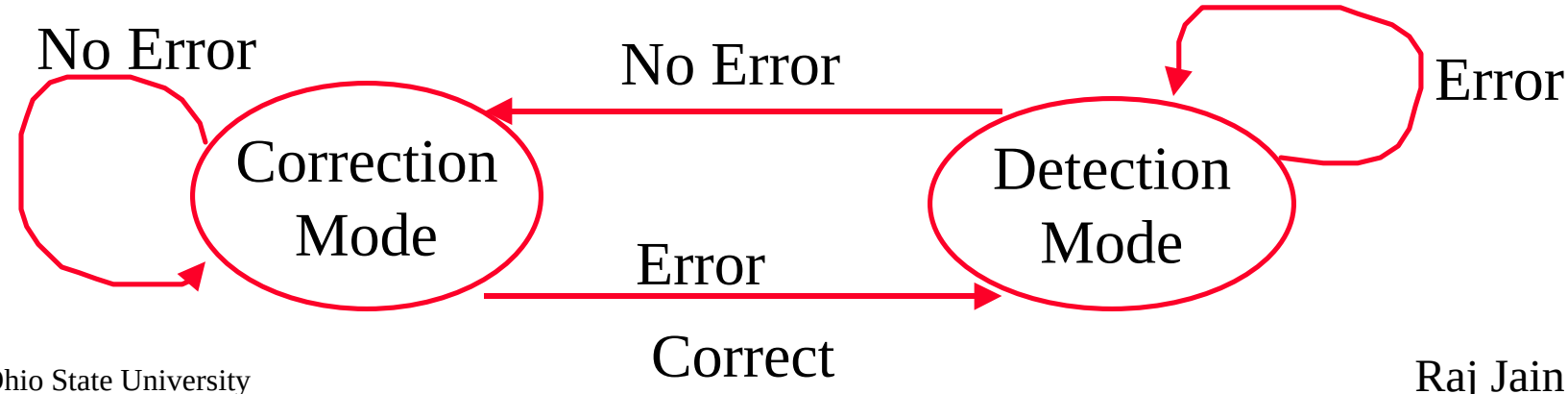
VP/VC Assignment/Use



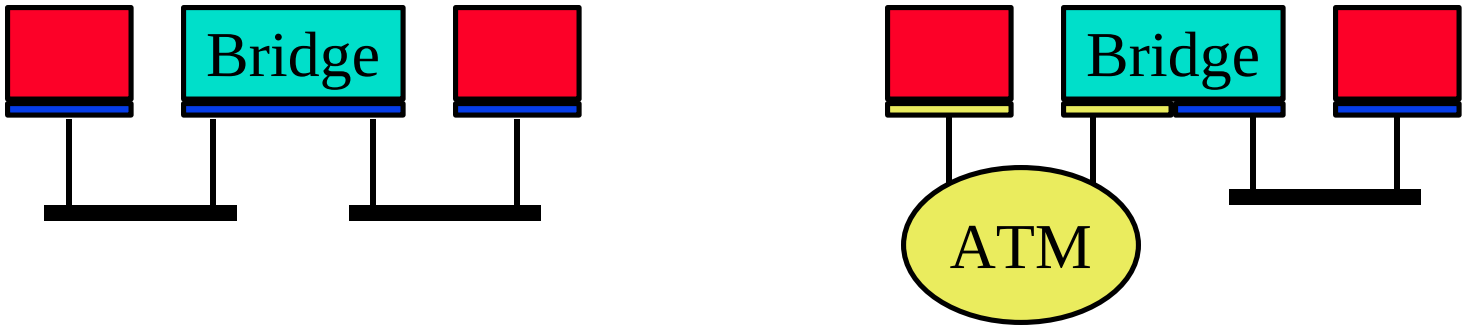
In		Out	
Port	VPI/VCI	Port	VPI/VCI
1	0/37	3	1/23
1	0/34	4	0/56
2	0/23	5	0/65
2	0/56	6	4/76

Header Error Check (HEC)

- Protects header only
- Optional Correction mode: Correct one bit errors if no earlier errors
- Discard cells with bad HEC
- Used for cell delineation in SONET
- Recalculated on each hop

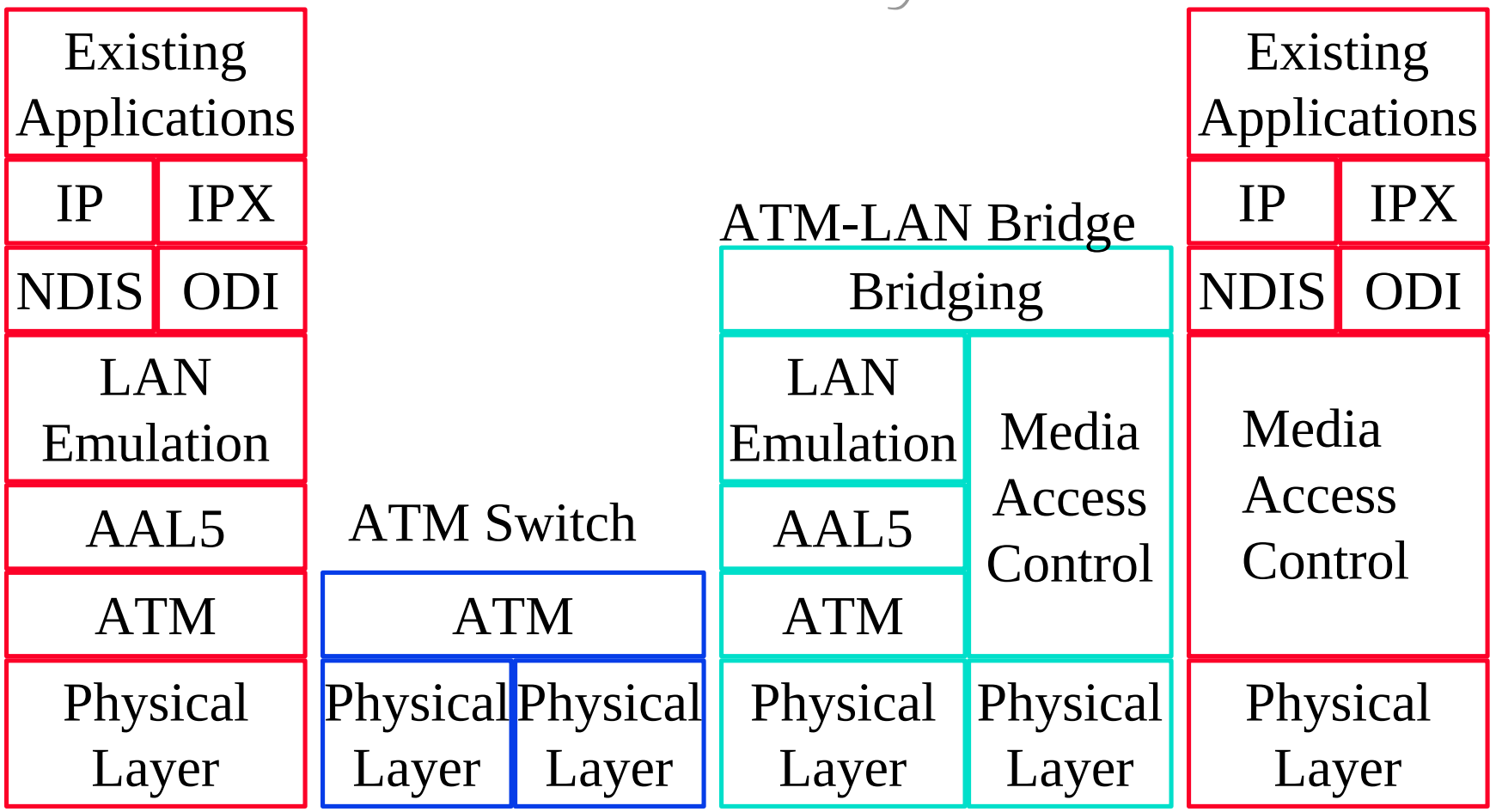


LAN Emulation



- Problem: Need new networking s/w for ATM
- Solution: Let ATM network appear as a virtual LAN
- LAN emulation implemented as a device driver below the network layer

Protocol Layers



- NDIS = Network Driver Interface Specification
- ODI = Open Datalink Interface

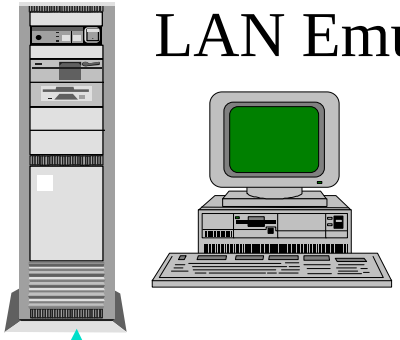
Features

- One ATM LAN can be multiple virtual LANs
- Logical subnets interconnected via routers
- Need drivers in hosts to support each LAN
- Only IEEE 802.3 and IEEE 802.5 frame formats supported
- Doesn't allow passive monitoring
- No token management (SMT), collisions, beacon frames

LE Header (2 Bytes)	Standard IEEE 802.3 or 802.5 Frame

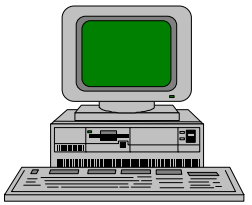
LAN Emulation

1. Clients get receipient's address from LES and setup a VC.



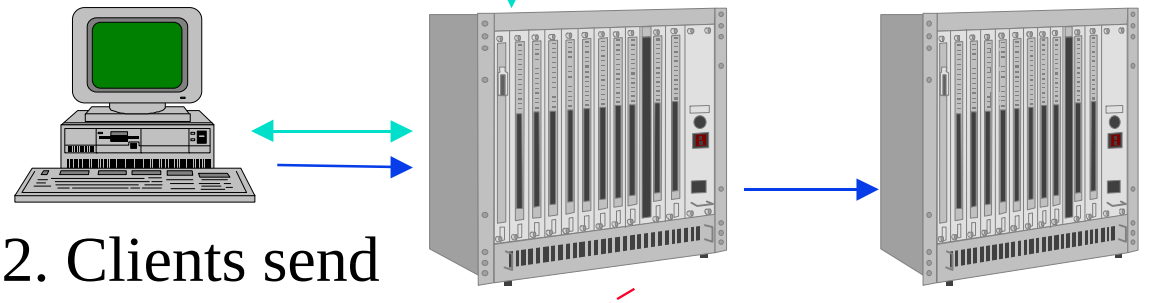
LAN Emulation Server (LES)

3. Messages for ATM clients are delivered directly.



ATM client B

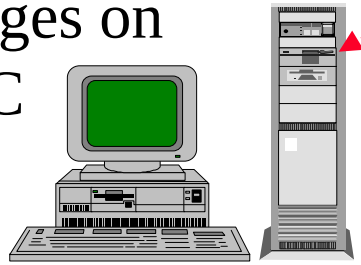
ATM Switches



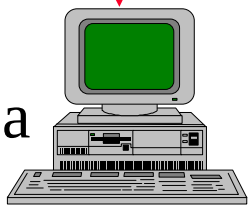
Bridge

2. Clients send messages on the VC

4. Messages for non-ATM clients are forwarded through a bridge



Broadcast/Unknown Server (BUS)

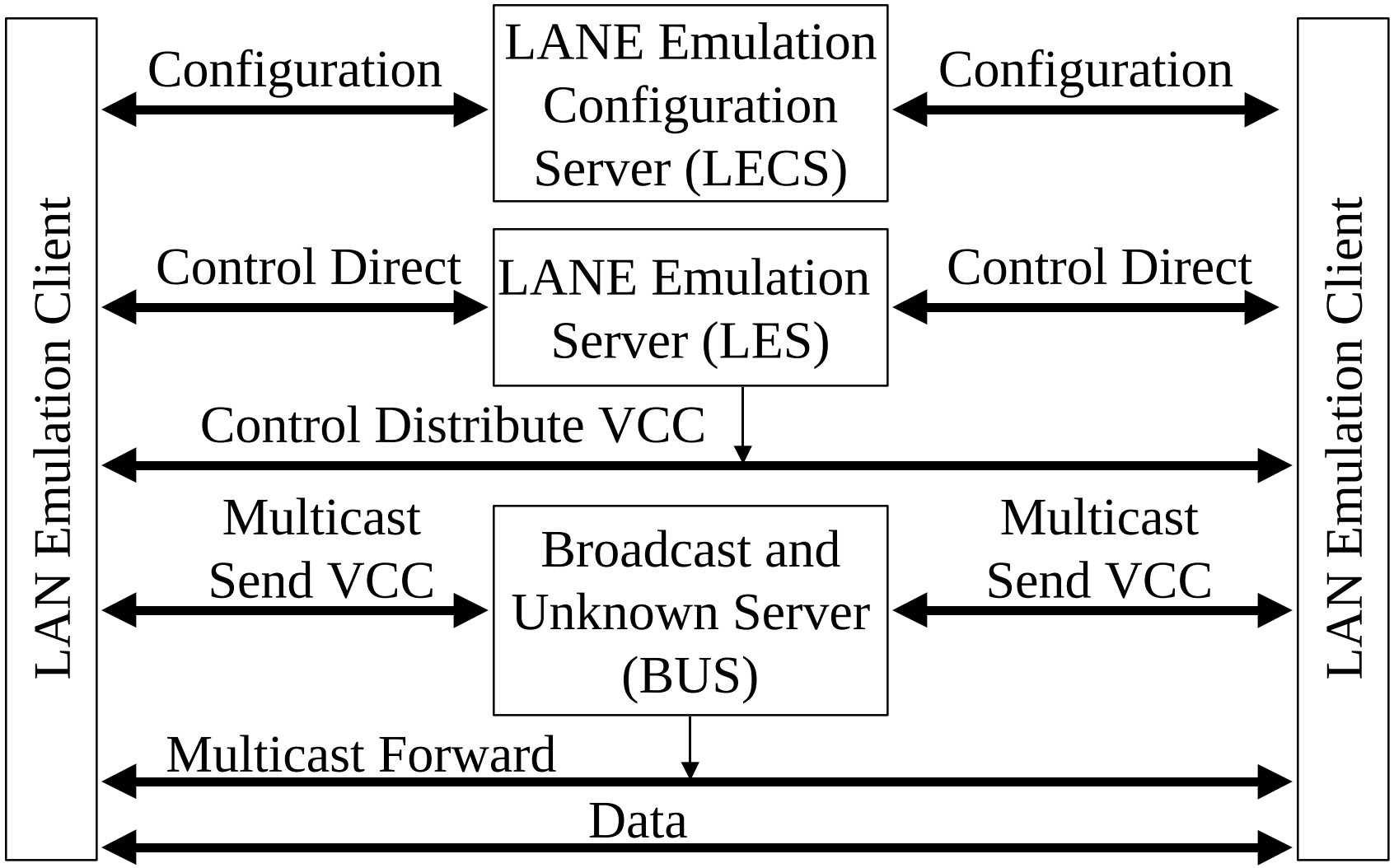


Non-ATM client

Operation

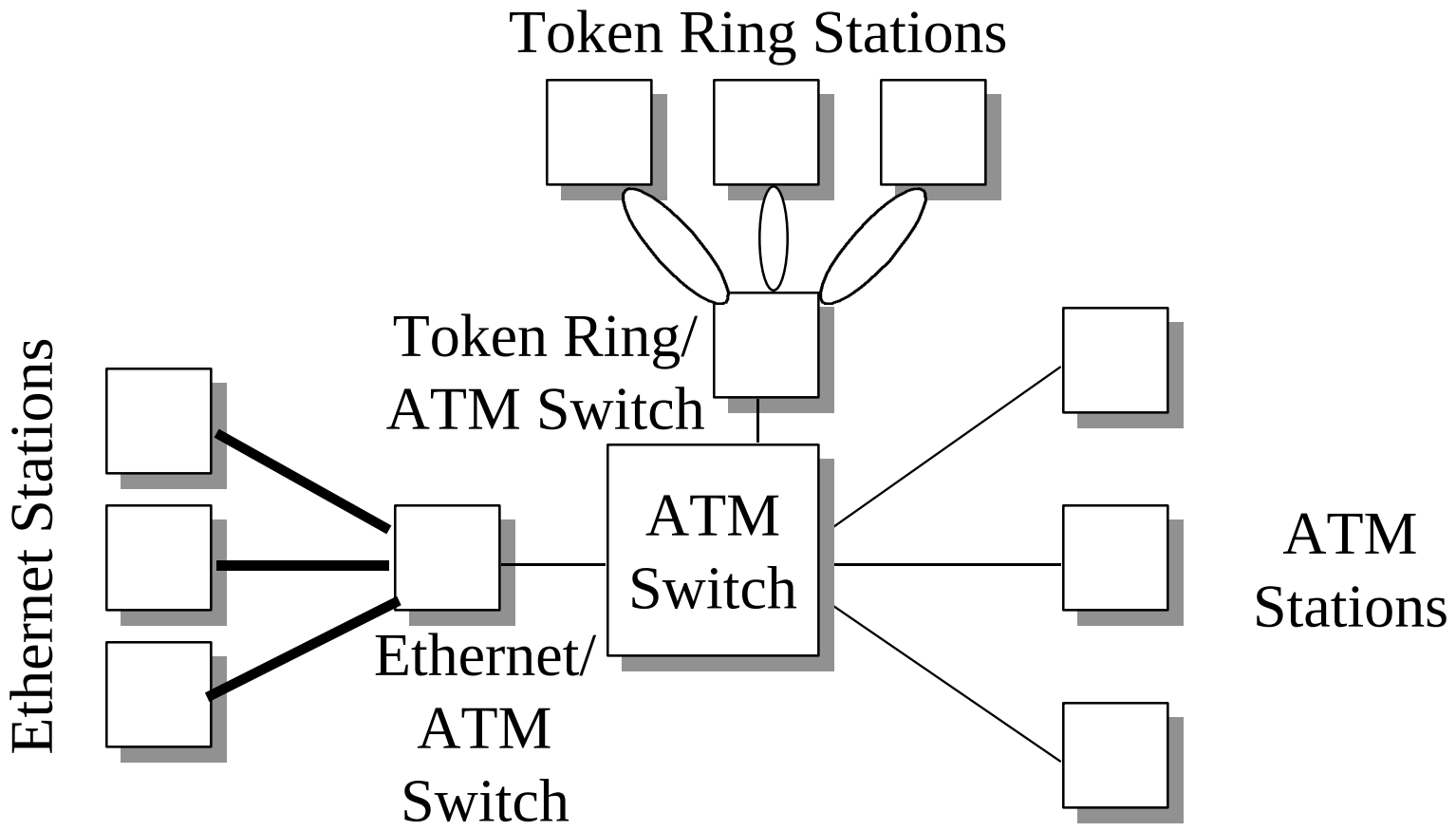
- Initialization: Client gets Server's address from a well known ATM address
- Registration: Client sends a list of its MAC addresses to Server
- Address Resolution: Client sends ARP request to Server
  - Server, Clients, Bridges answer ARP
  - Client setups a direct connection
- Broadcast/Unknown Server (BUS): Forwards multicast traffic to all members

LANE Components



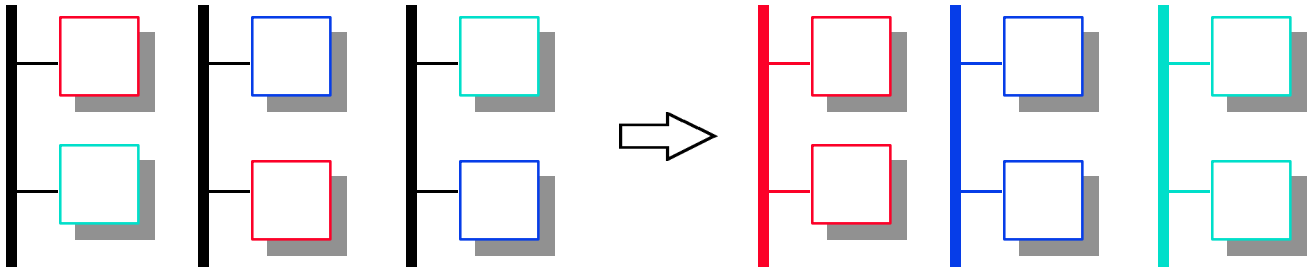
LAN Emulation Configuration 1

- LAN/ATM switches provides bridging functions



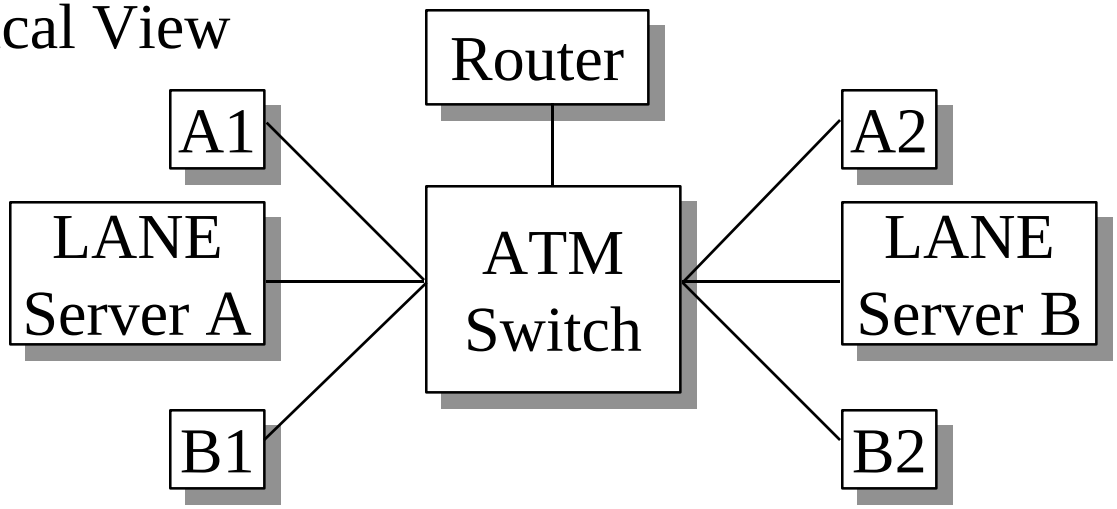
Virtual LANs

- Group of users that appear to be interconnected by one LAN
  One LAN = One broadcast domain
- They may be on physically different LANs
- Stations can be grouped by:
  - All stations that have the same IP subnet address
  - All stations that are connected to the same switch port
  - Stations whose specific addresses are specified

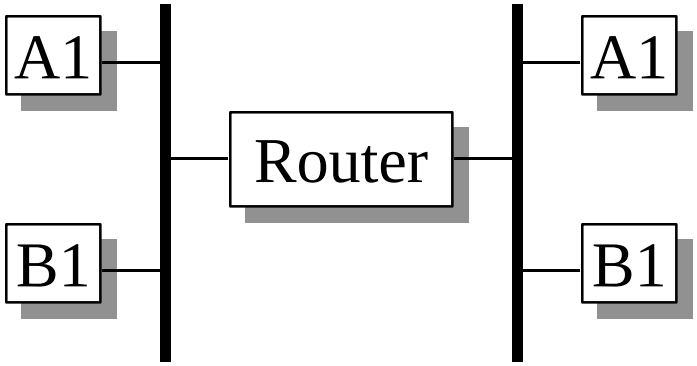


ATM Virtual LANs

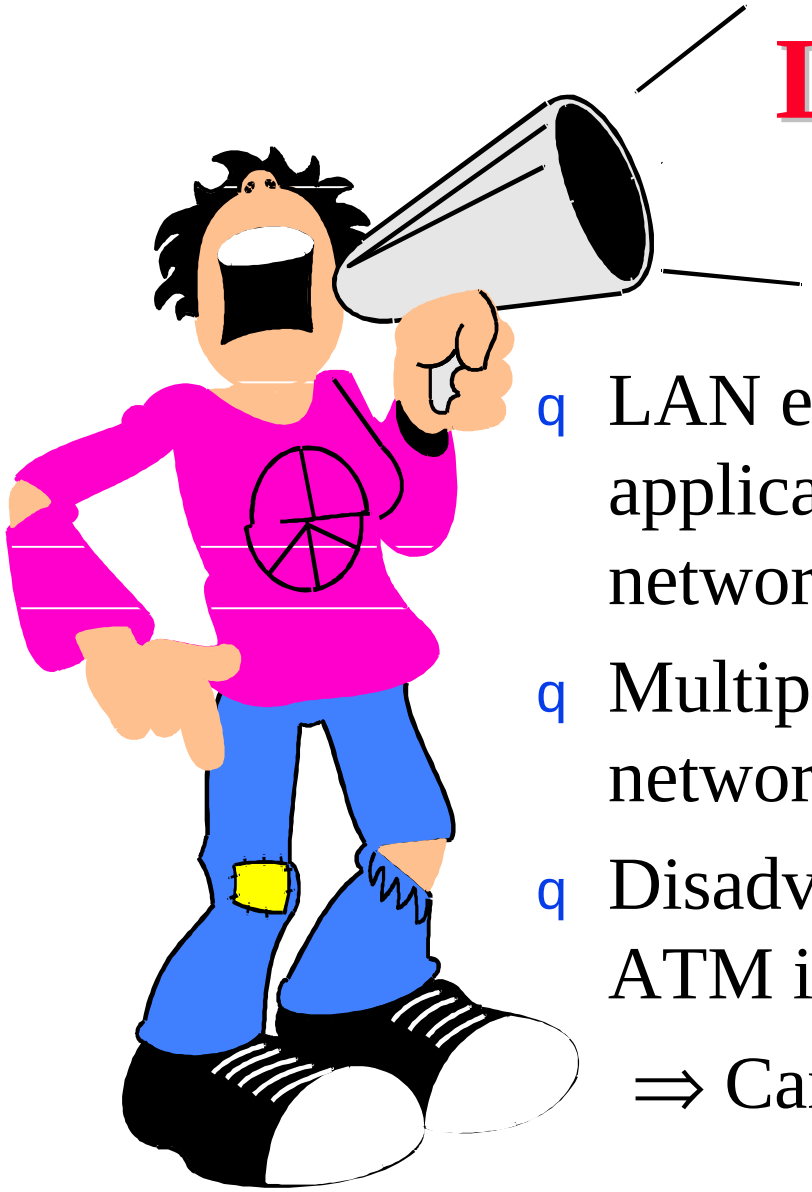
- Physical View



- Logical View



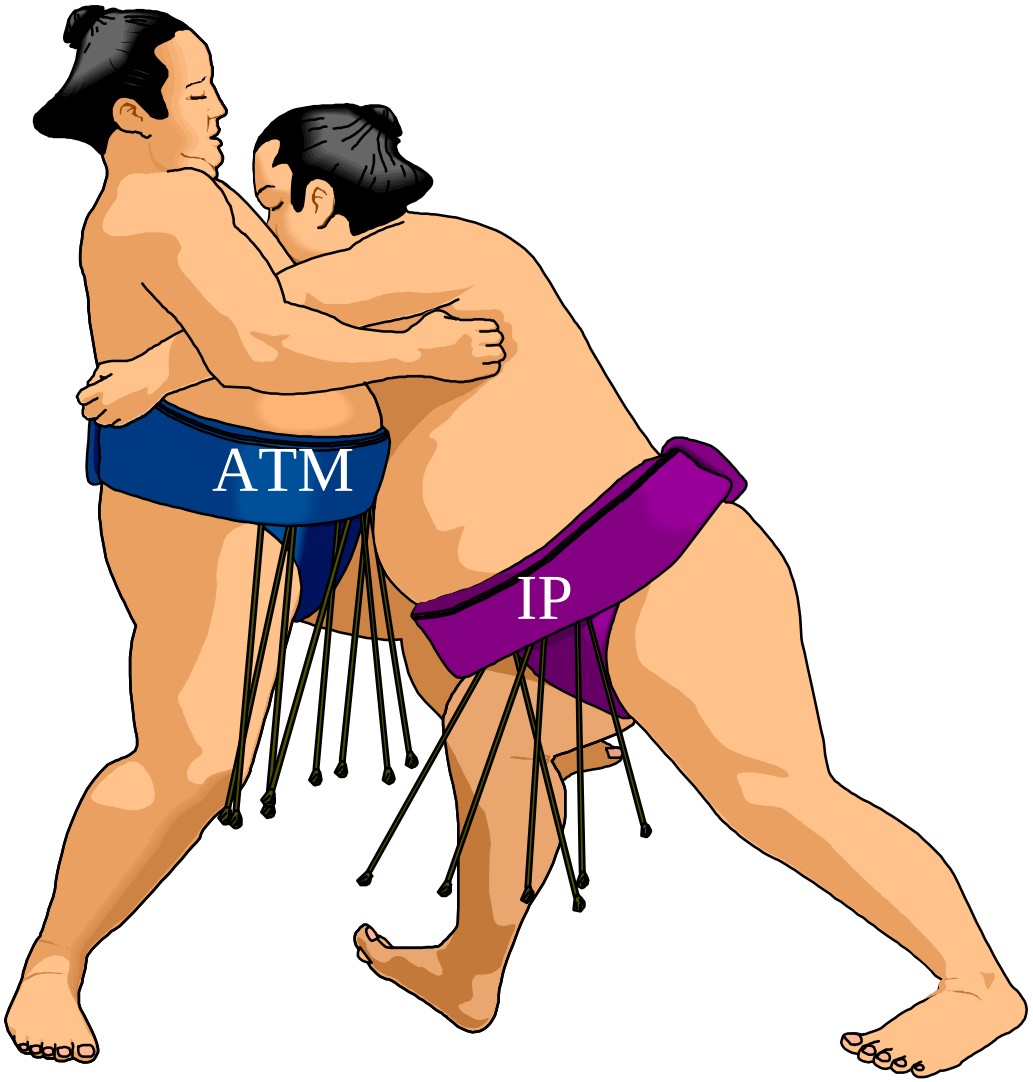
LAN Emulation: Summary



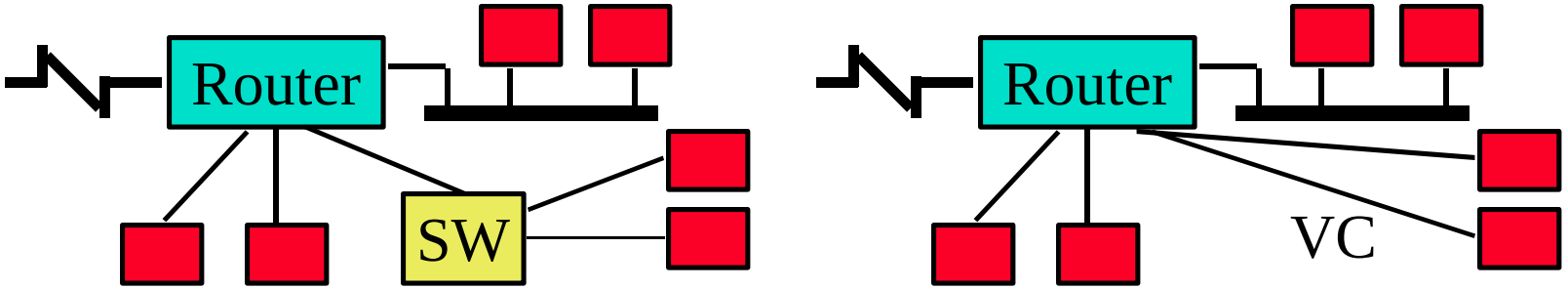
- LAN emulation allows current applications to run on ATM networks without changes
- Multiple virtual LANs on one ATM network
- Disadvantage:
  ATM is hidden from applications

  $\Rightarrow$ Can't use new ATM services

IP Over ATM

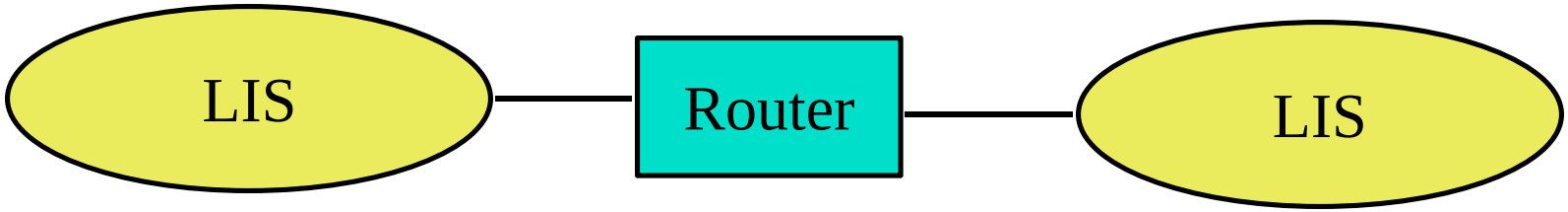


IP Over ATM



- ATM similar to point-to-point WANs.
  Simpler than LAN emulation
- IP address:123.145.134.65
  ATM address:…1-614-999-2345-…
- Issue: IP Address ⇔ ATM Address translation
  - Address Resolution Protocol (ARP)
  - Inverse ATM ARP: VC ⇒ IP Address
- Solution: Logical IP Subnet (LIS) Server
- Ref: RFC 1577

IP Over ATM



- Clients within LIS use direct VCs
- All traffic between LIS passes through a router
- ATM AAL5 PDU size = 9180 + 8 LLC/SNAP header
- Problem: Need router even if ATM connection between LIS
- Solution: Routing Over Large Clouds (ROLC)

ARP Over ATM

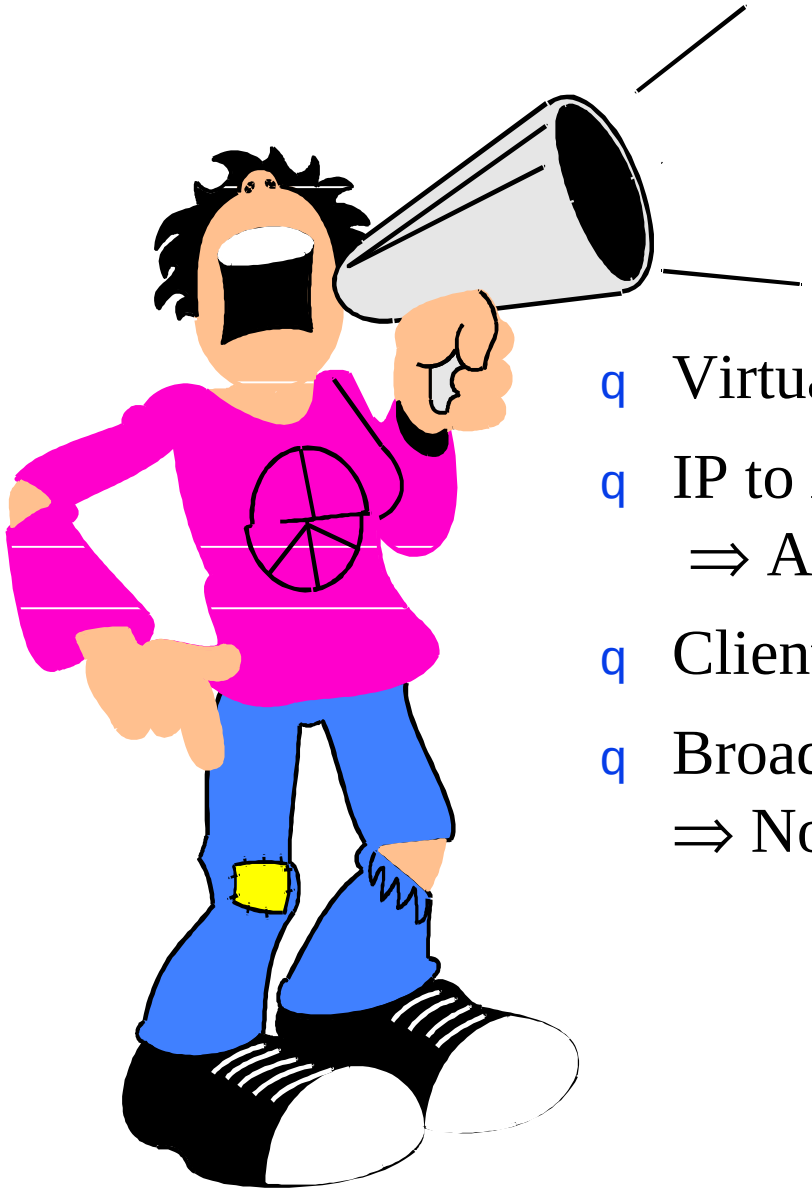
- Only one ATM ARP server per subnet
  $\Rightarrow$ No database synchronization issues
- Clients are configured with server's ATM address
- Clients setup a VC with the server
- Server sends an inverse ARP request
  (What's your IP Address?)
- Client responds with its IP Address
- Clients ask server by ARP request
  (What's ATM address of 123.145.134.65?)
- Server replies with ATM address
- Server sends NAK if not in table
- ARP requests are NOT broadcast to all LIS members

ARP Database Maintenance

- Clients register with the server at startup
- Can use ARP requests to update entry for requester
- Entries at clients age out after 15 minutes
- Entries at servers age out after 20 minutes
- Server sends inverse ARP on active VC before aging out
- Otherwise clients resend registration every 20 minutes

IP Multicast/Broadcast

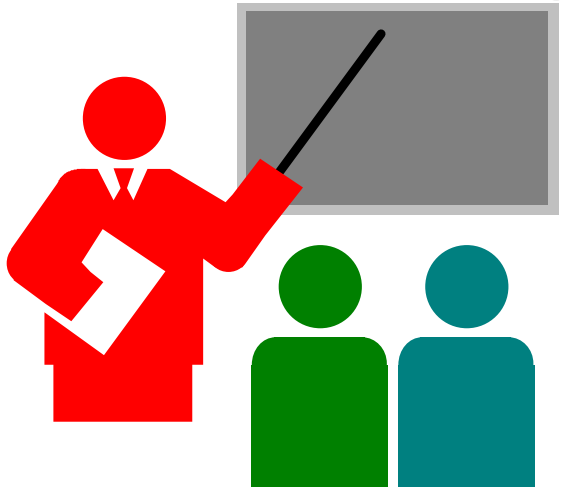
- No broadcast or multicast in LIS
- IP multicast/broadcast packets handled as in WAN
- Clients must process broadcasts/multicasts as if addressed to them
- No mappings from IP multicast to ATM multicast services
- MBONE and IP tunneling operate over ATM as if on WAN



IP Over ATM: Summary

- Virtual circuits in place of real circuits
- IP to ATM address translation
  ⇒ ARP and inverse ARP
- Clients register addresses with server
- Broadcasts are expensive
  ⇒ Not used

Summary



- ATM Overview: History, Why and What
- Interfaces: PNNI, NNI, B-ICI, DXI
- Protocol Layers: AAL, ATM, Physical layers, Cell format
- LAN Emulation
- IP over ATM

ATM Books

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- RFC1755, "ATM Signaling Support for IP over ATM" by M. Perez, F. A. Mankin, E. Hoffman, G. Grossman, A. Malis, 02/17/1995, 32 pp.
- RFC1754, "IP over ATM Working Group's Recommendations for the ATM Forum's Multiprotocol BOF Version 1" by M. Laubach, 01/19/1995, 7 pp.
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- Internet Draft, "Using the MARS to support IP Unicast over ATM," 06/14/1995, <draft-armitage-ipatm-mars-unicast-01.txt>
- Internet Draft, "Issues surrounding a new encapsulation for IP over ATM.," 06/26/1995, <draft-armitage-ipatm-encaps-02.txt>
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- Internet Draft, "Router Architecture Extensions for ATM : Overview," 03/03/1995, <draft-katsube-router-atm-overview-00.txt>
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- Internet Draft, "Support for Multicast over UNI 3.1 based ATM Networks.," 05/31/1995, <draft-ietf-ipatm-ipmc-05.txt>
- Internet Draft, "IP Multicasting over ATM: System Architecture Issues," 07/07/1995, <draft-ietf-ipatm-arch-00.txt>
- Internet Draft, "Definitions of Supplemental Managed Objects for ATM Management," 07/06/1995, <draft-ietf-atommib-atm2-02.txt>
- Internet Draft, "Definitions of Textual Conventions for ATM Management," 07/06/1995, <draft-ietf-atommib-atm2TC-00.txt>

B-ISDN Recommendations

- I.113 Vocabulary of Terms for Broadband Aspects of ISDN, 1991
- I.121 Broadband Aspects of ISDN, 1991
- I.150 B-ISDN ATM Functional Characteristics, 1993
- I.211 B-ISDN Service Aspects, 1993
- I.311 B-ISDN General Network Aspects, 1993
- I.321 B-ISDN Protocol Reference Model and Its Application, 1993
- I.327 B-ISDN Functional Architecture, 1993
- I.361 B-ISDN ATM Layer Specification, 1993

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- I.362 B-ISDN ATM Adaptation Layer (AAL) Functional Description, 1993
- I.363 B-ISDN ATM Adaptation Layer (AAL) specification, 1993
- I.364 Support of Broadband Connectionless Data Service on B-ISDN, 1993
- I.371 Traffic Control and Congestion Control in B-ISDN, 1993
- I.413 B-ISDN User-Network Interface, 1993
- I.414 Overview of Recommendations on Layer 1 for ISDN and B-ISDN Customer Access, 1993

B-ISDN Recommendations

- I.432 B-ISDN User-Network Interface Physical Layer Specification, 1993
- I.555 Frame Relay and ATM Interworking
- I.580 General Arrangements for Interworking Between B-ISDN and 64 kbps Based ISDN, 1993
- I.610 B-ISDN Operation and Maintenance Principles and Functions, 1993
- Q.2931 B-ISDN Call Control
- Q.SAAL Signaling AAL

ANSI Standards

- T1.624, "Broadband ISDN User-Network Interfaces: Rates and Formats Specification."
- T1.627, "Broadband ISDN - ATM Layer Functionality and Specification."

ATM Forum Specs (Approved)

- *User-Network Interface Specifications, V3.0*, Prentice-Hall, September 10, 1993., (515)-284-6751
- ATM UNI 3.1, July 21, 1994.
- ATM B-ISDN Intercarrier Interface (B-ICI), V1.0, June 1, 1993.
- ATM DXI Specification, V1.0, August 1993, ATM Forum, (415)-578-6860
- ATM DS1 PHY V1.0 specs
- ATM 52 Mbps Category 3 UTP
- ATM 155 Mbps Category 5 UTP V1.0 Specification
- LAN Emulation over ATM V1.0 Specification

ATM Forum Specs (Approved)

- Interim Inter-Switch Signaling Protocol (IISP) V1.0 Specification
- 6312 kbps UNI V1.0 Specification
- Introduction to ATM Forum Test Specifications V1.0
- PICS Proforma for the DS3 Physical Layer Intervade V1.0 Specification
- PICS Proforma for the 100 Mbps Multimode Fibre Physical Layer Interface V1.0 Specification
- PICS Proforma for the SONET STS-3c Physical Layer Interface V1.0 Specification

ATM Forum Specs (Final)

- Conformance Abstract Test Suite for ATM Layer of Intermediate Systems
- Interoperability Abstract Test Suite for the ATM Layer
- Interoperability Abstract Test Suite for the Physical Layer
- PICS Proforma for the DS1 Physical Layer Intervace
- PICS Proforma for the UNI ATM Layer
- E3 Public UNI
- LAN Emulation Client Managent Specification

Documents listed above have been sent for final vote (7/95)

Information Sources

- ATM Forum (415)578-6860 info@atmforum.com
  - Fax on Demand: (415)-688-4318
  - http://WWW.ATMFORM.COM
  - Paris: +33 1 46 39 56 26 cguyot@interop.com
  - Tokyo: +81 3 3438 3694 kyb01621@niftyserve.or.jp
- Internet Engineering Task Force
  - IP over ATM: atm-request@hpl.hp.com
  - Routing over Large Clouds: rolc-request@nsco.netcom.com
  - atommib-request@thumper.bellcore.com
  - RFCs: mail-server@nisc.sri.com (Send Help in message)
  - Draft RFC's: Internet-Drafts@cnri.reston.va.us

Information Sources

- Internet News: cell-relay-request@indiana.edu
  - comp.dcom.cell-relay@indiana.edu
- Frame Relay Forum: frf@interop.com
- Switched Multimegabit Data Service (SMDS): sig@interop.com

Quiz

T F Please check True/False

1. ❑ ❑ ATM cells always arrive periodically at the same time.
2. ❑ ❑ ATM cells are always of the same size (bytes) at all speeds
3. ❑ ❑ ATM cells are always of the same time (seconds) at all speeds.
3. ❑ ❑ Each ATM cell contains 4 bytes of destination address
4. ❑ ❑ A VP switch uses only the VP field for switching
5. ❑ ❑ A VC switch uses only the VC field for switching
6. ❑ ❑ The VP field in the cell is changed at each hop
7. ❑ Whenever a cell arrives with errors, HEC will correct it.
8. ❑ ❑ The ATM switching is done in the AAL layer
9. ❑ ❑ The ATM layer is responsible for segmenting user messages into fixed size cells.

Quiz

T F Please check True/False

1. ❑ ❑ LANE allows ATM stations to talk to existing Ethernet stations
2. ❑ ❑ FDDI is not supported by ATM LANE
3. ❑ ❑ ATM stations can not talk to stations on FDDI
3. ❑ ❑ On an emulated Ethernet, you can monitor collisions
4. ❑ ❑ In LANE, all broadcasts are sent to BUS
5. ❑ ❑ LES broacasts unknown querries to all members of the emulated LAN via BUS
6. ❑ ❑ All traffic between LIS's passes through routers
7. ❑ ❑ You will not need a router, if all hosts of an IP network are on a single ATM network.
8. ❑ ❑ Unknown ARP requests are broadcast to all LIS members