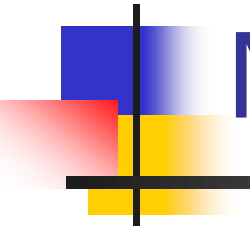

Multicast

รศ.ดร. อนันต์ ผลเพิ่ม

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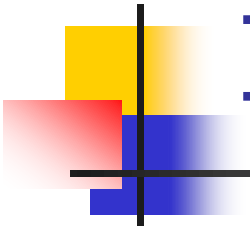
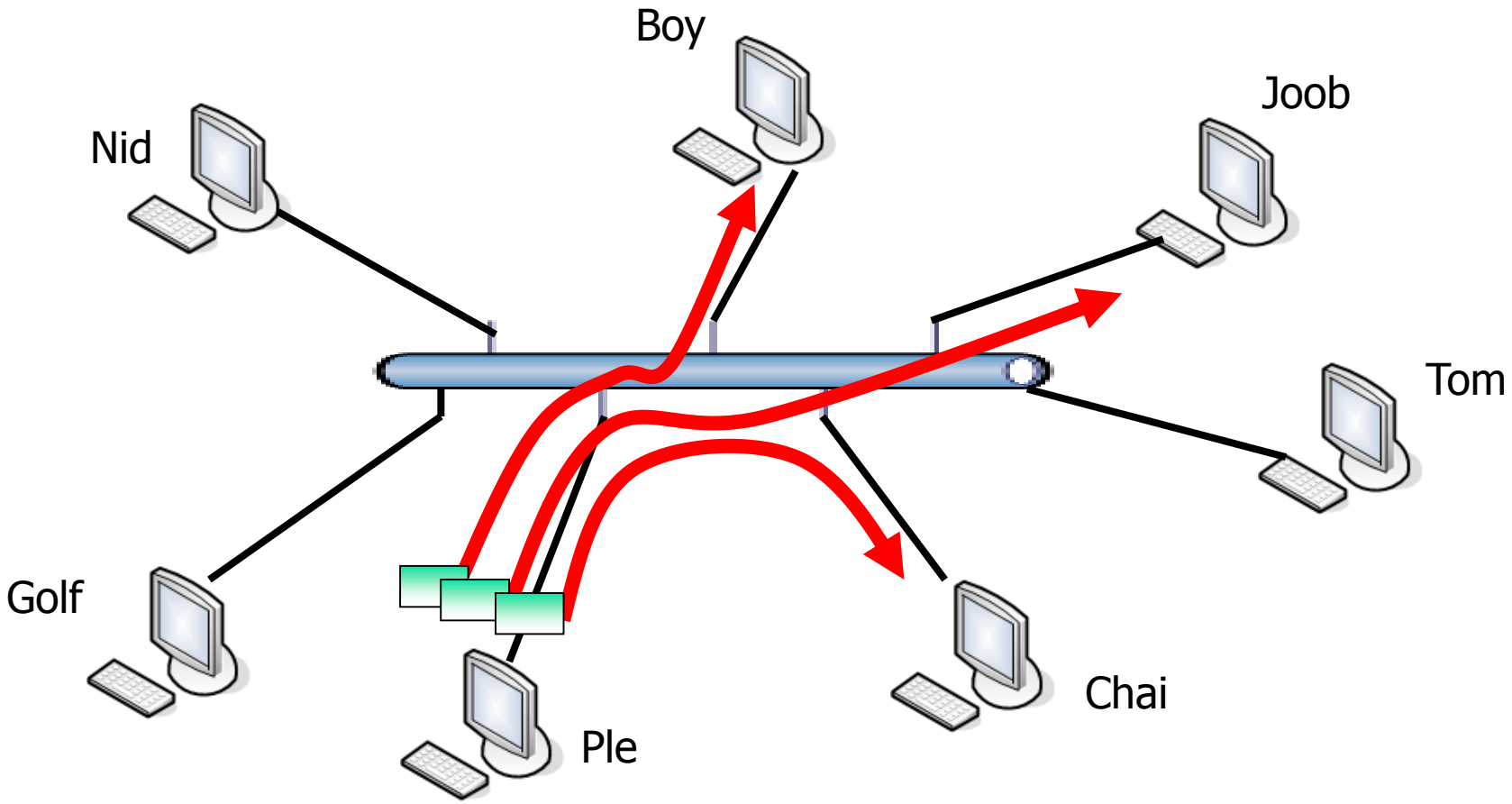
Kasetsart University, Bangkok, Thailand



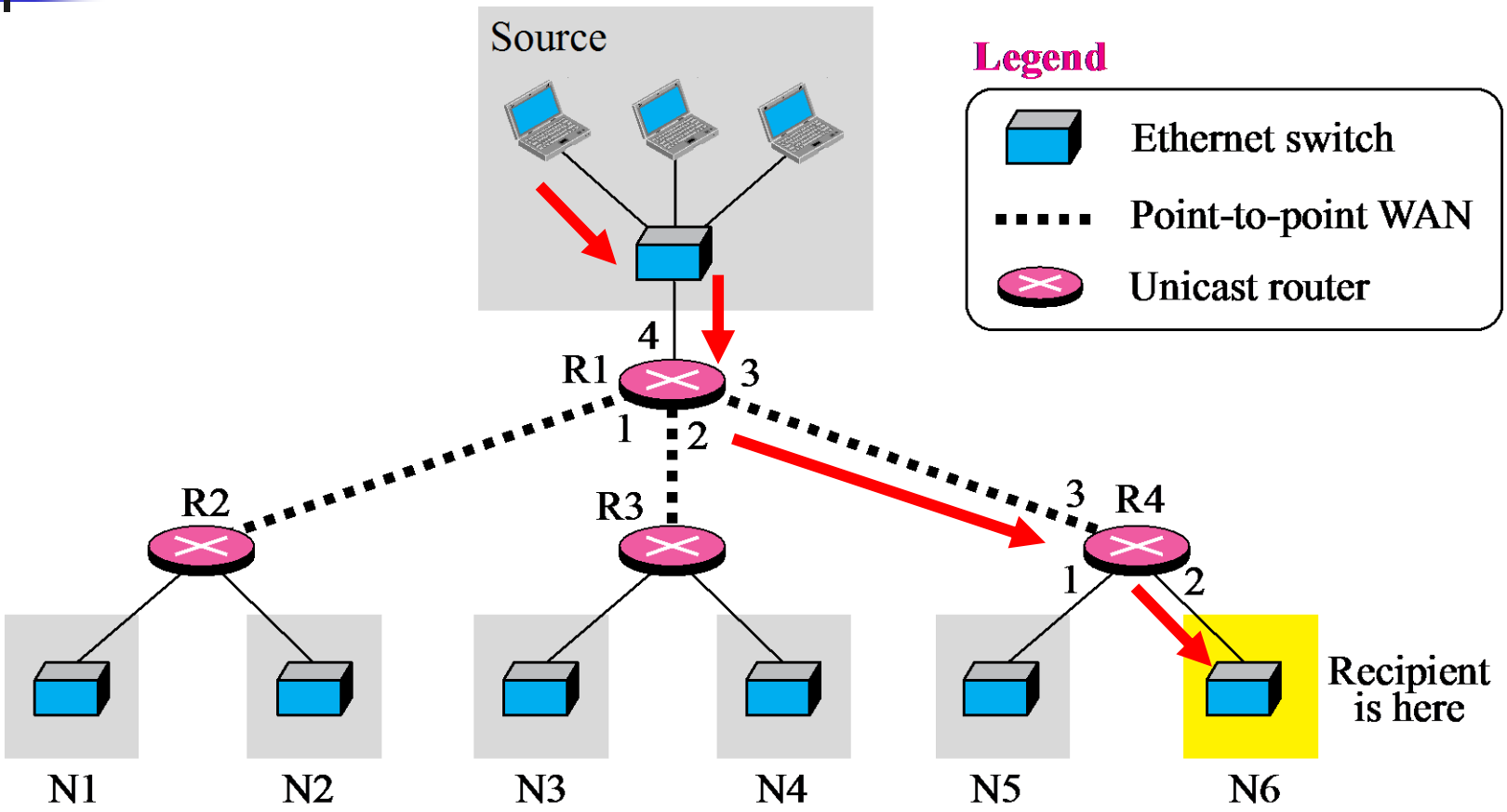
IP Datagram delivery

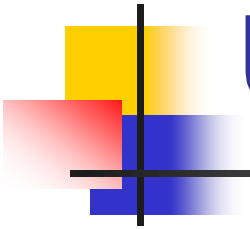
- Unicast
- Broadcast
- Multicast

Unicast



Unicast

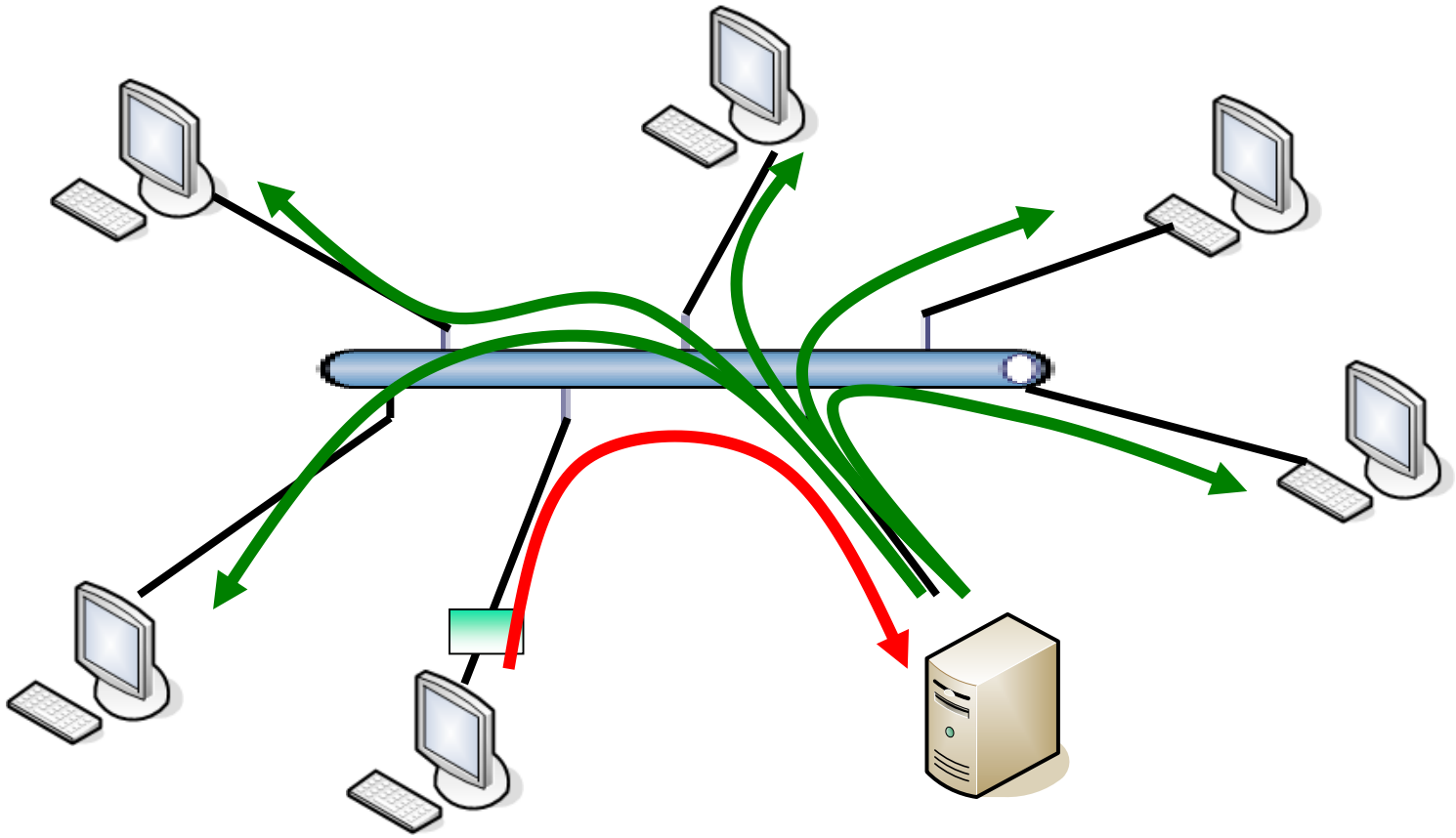

Source
Legend
Ethernet switch
Point-to-point WAN
Unicast router
R1
R2
R3
R4
4
3
1
2
3
1
2
N1
N2
N3
N4
N5
N6
Recipient is here



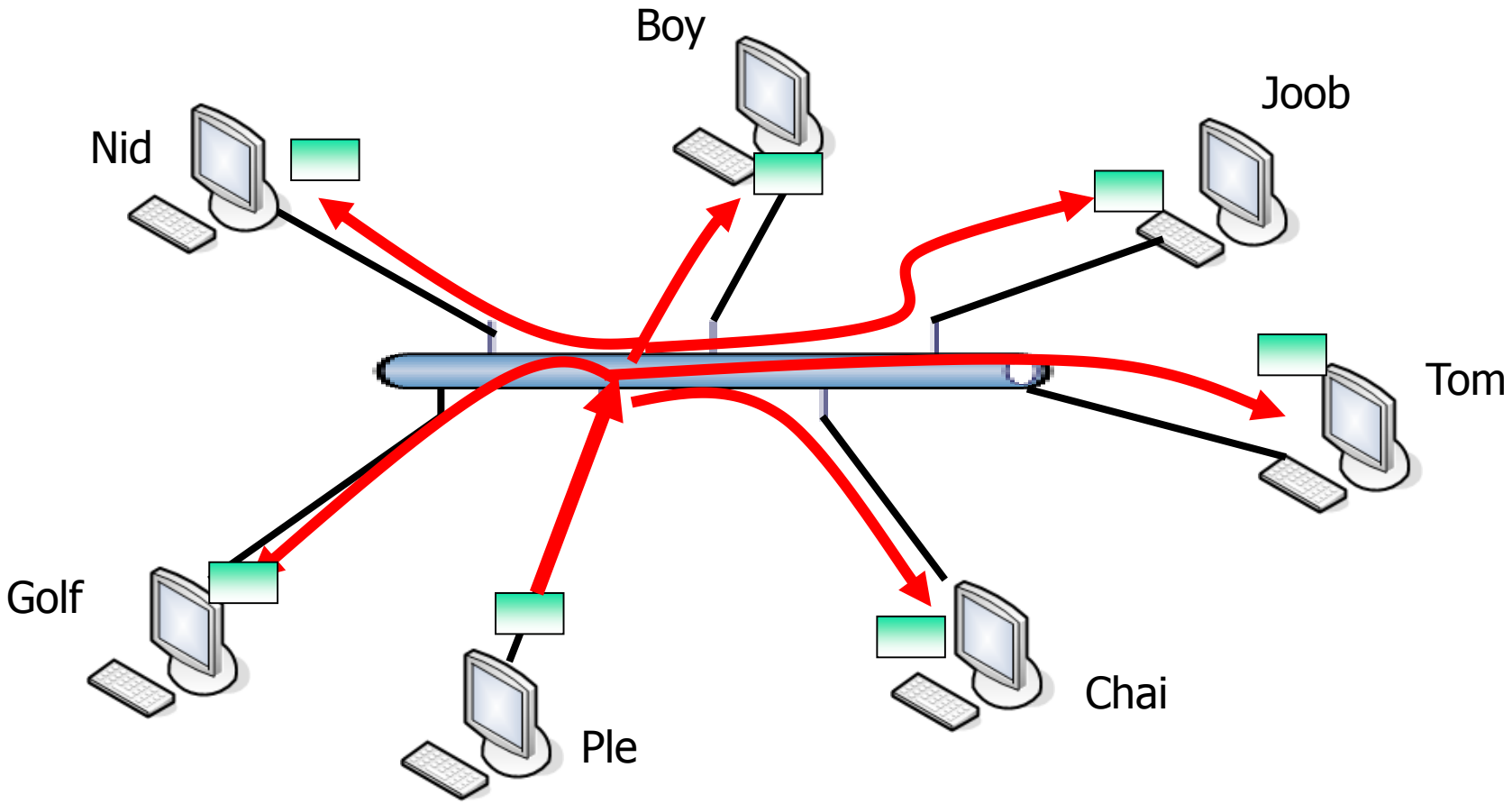
Unicast

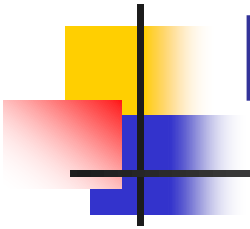
- One-to-one delivery
- Each datagram to single destination
- Need additional buffer
- Large amount of data traffic
- Secure (Only to specified destination)

Conference Server



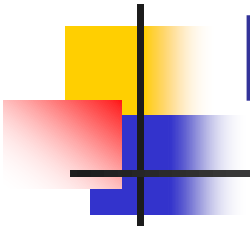
Broadcast





Broadcast

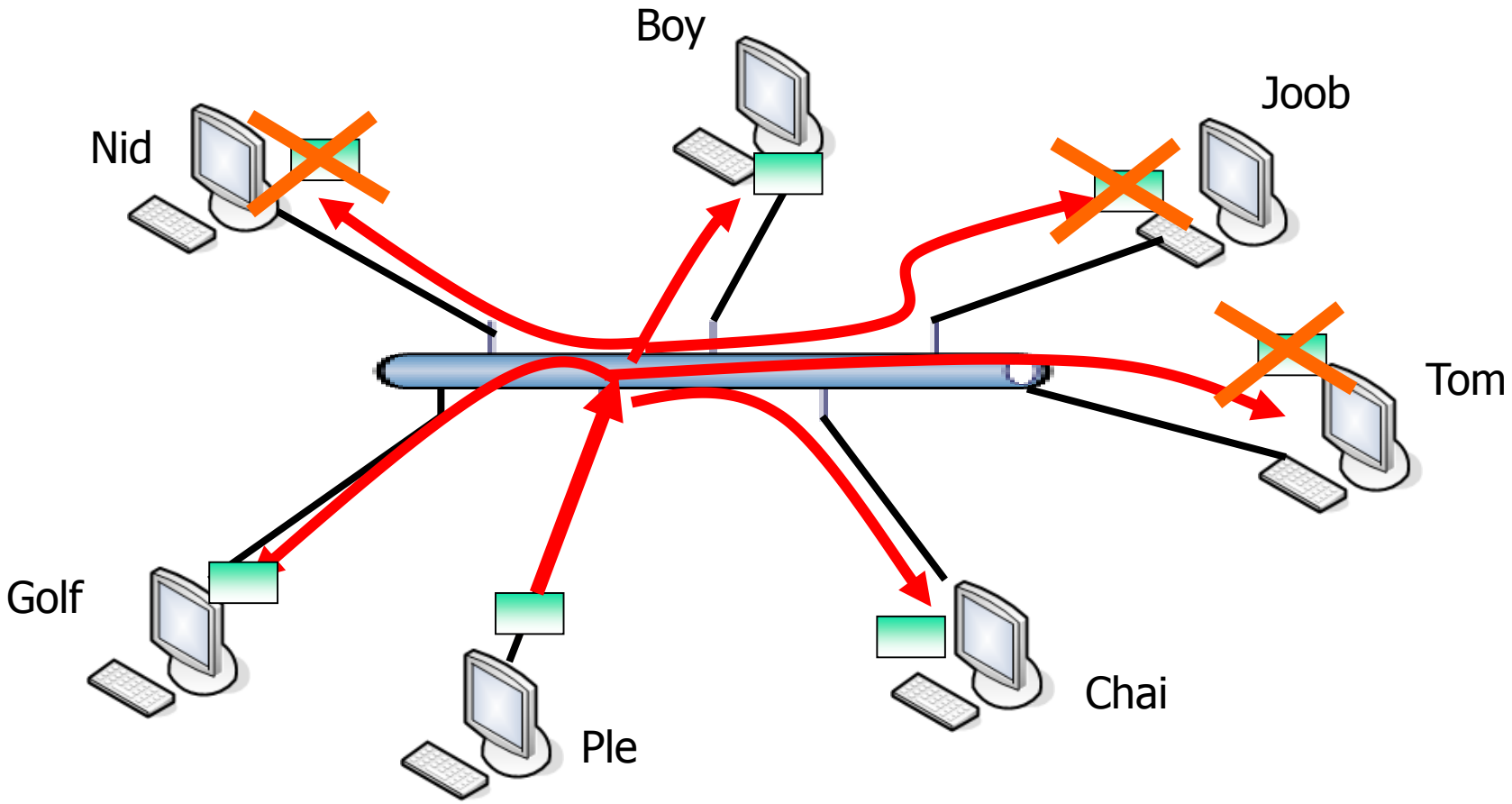
- One-to-all
- Data-Link implementation
  - Broadcast Add. FF-FF-FF-FF-FF-FF
- Each Frame to all nodes
  - Less Data Traffic



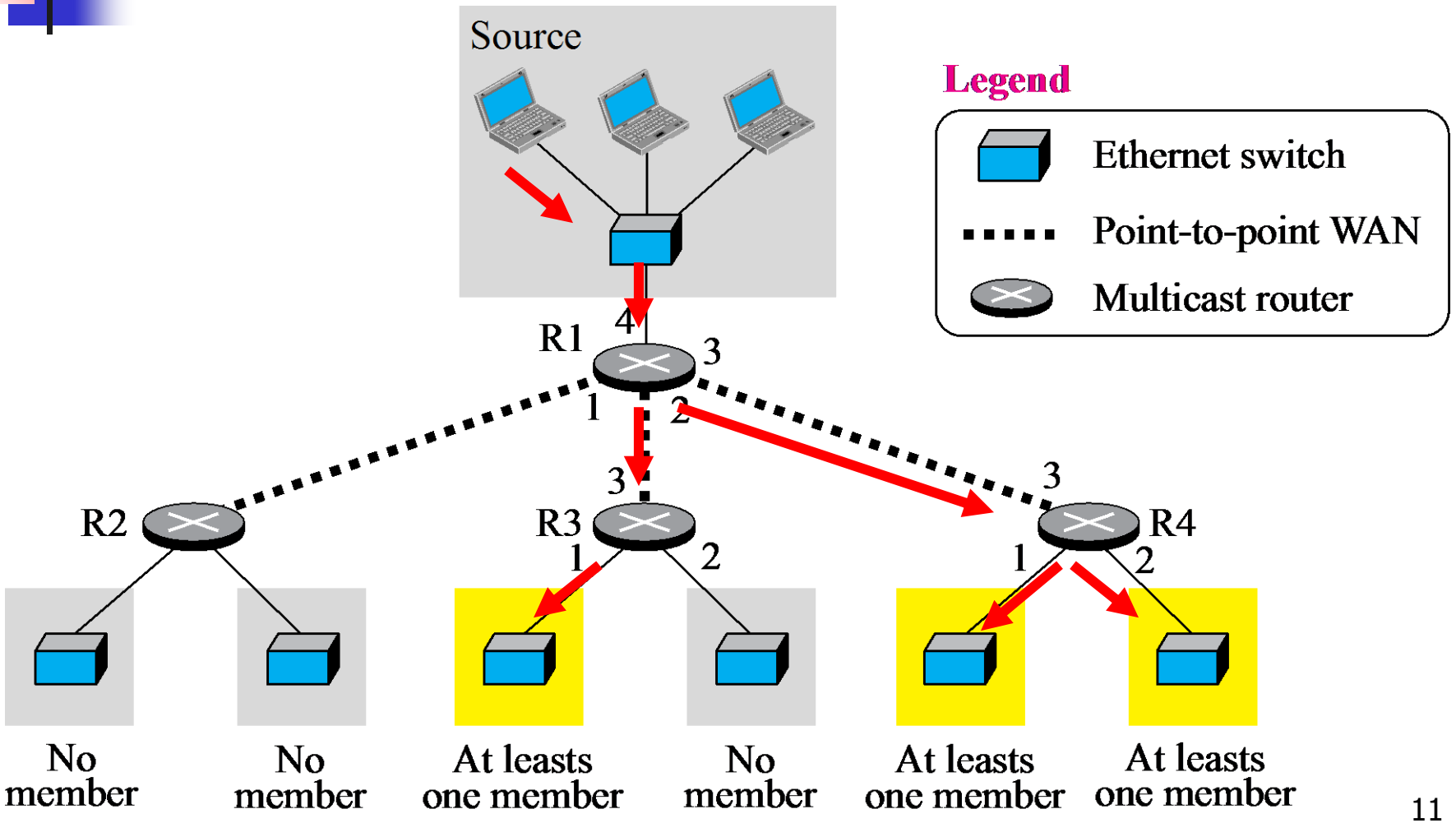
Broadcast Problem

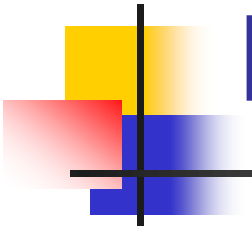
- If not all nodes want the data
  - Higher Layer needs to be involved
  - Unacceptable processing overhead
  - Security vulnerability

Multicast



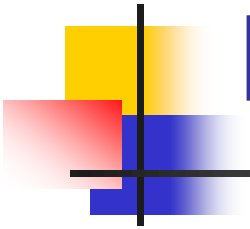
Multicast


Source
Legend
Ethernet switch
Point-to-point WAN
Multicast router
R1
R2
R3
R4
4
3
1
2
3
3
1
2
1
2
No member
No member
At leasts one member
No member
At leasts one member
At leasts one member



Multicast

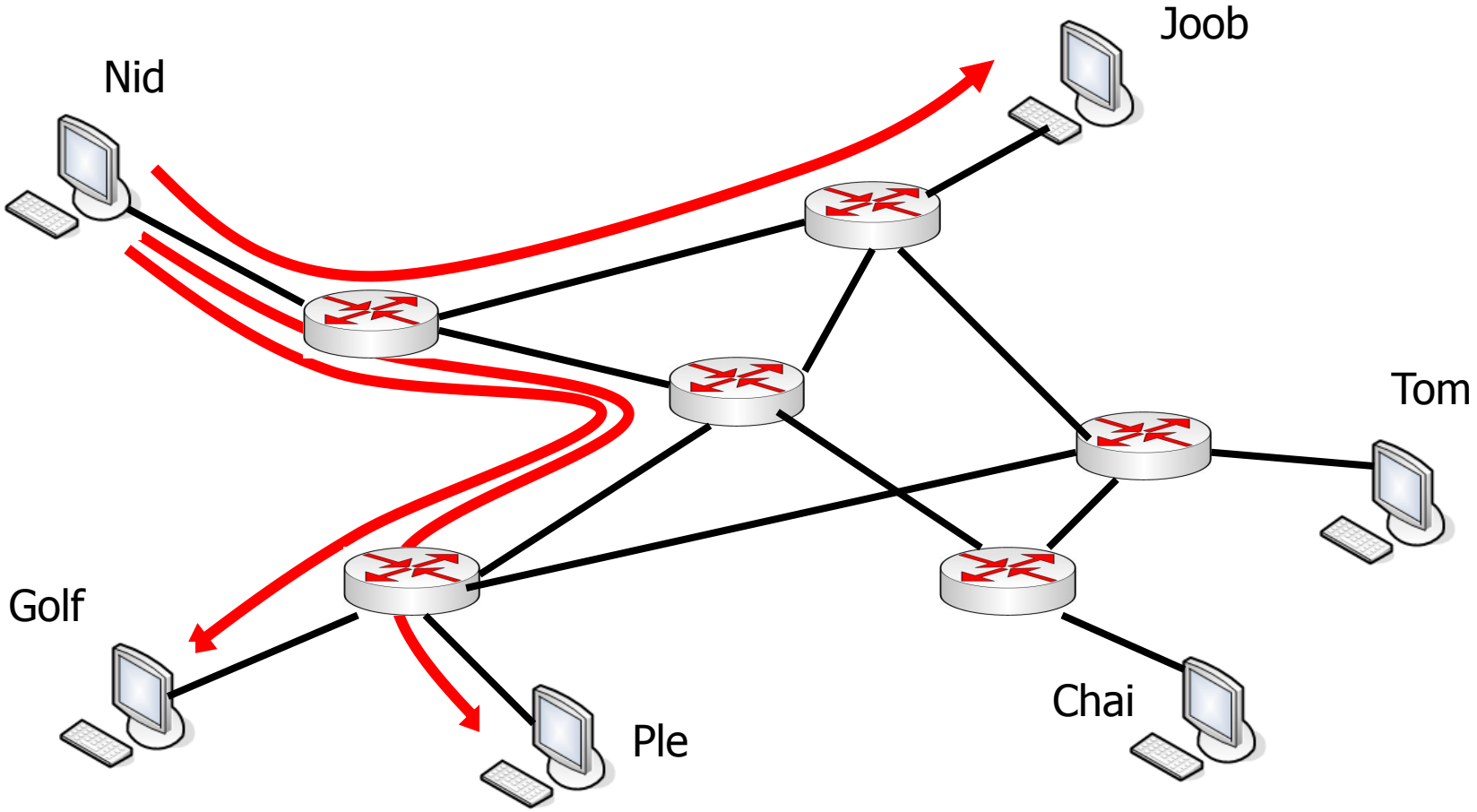
- One-to-many (Not to all)
- Need special address for the group
- Actually broadcast
  - Still have processing overhead
  - Non-participate stations only look and throw away → Less overhead
- Can Reduces more ?
  - Possible to map IP multicast to MAC multicast



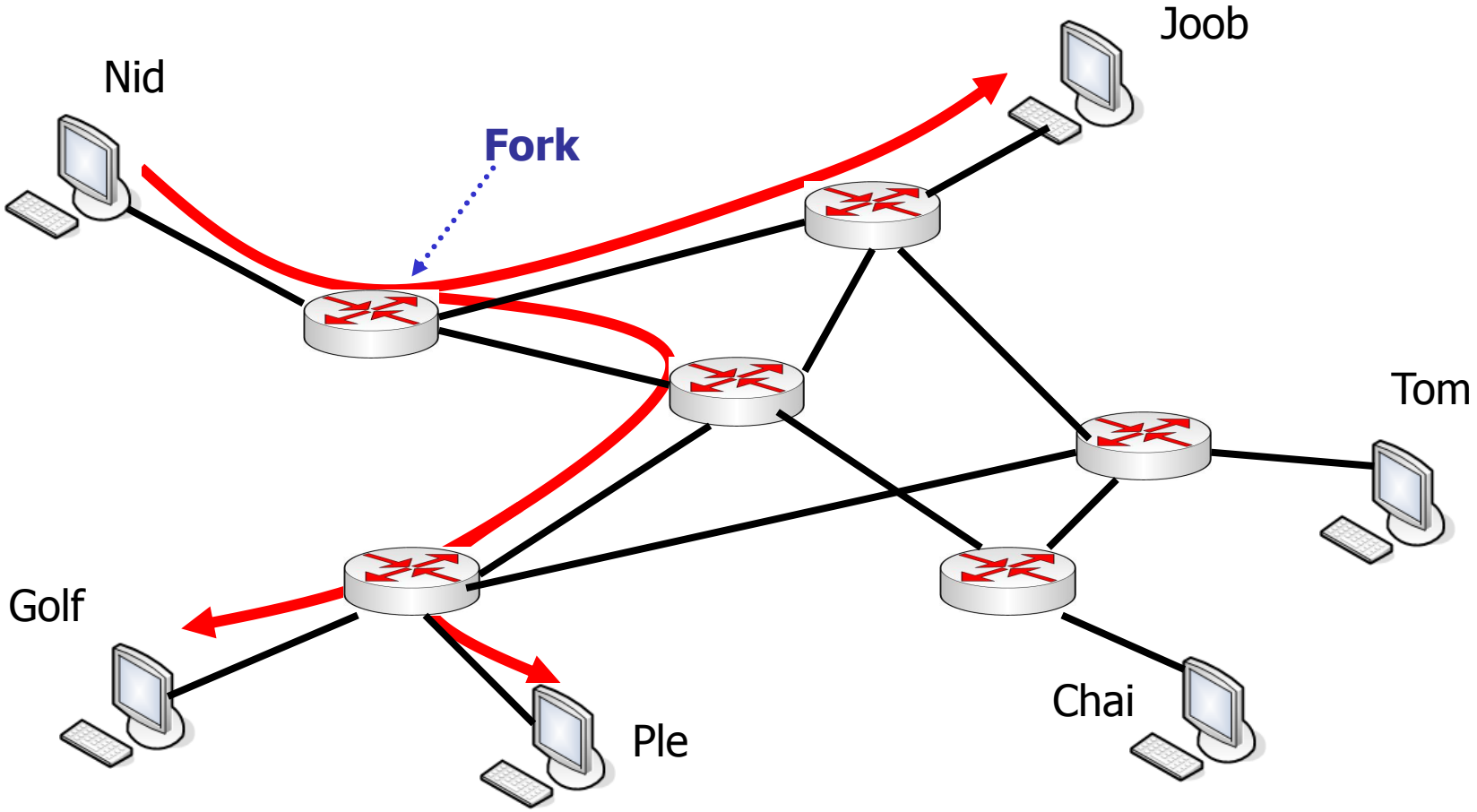
Multicast

- Data-Link Layer broadcast frames are not forwarded across routers
- IP Broadcast packets are also not forwarded across routers
- Multiple copies

Data Across the Internet

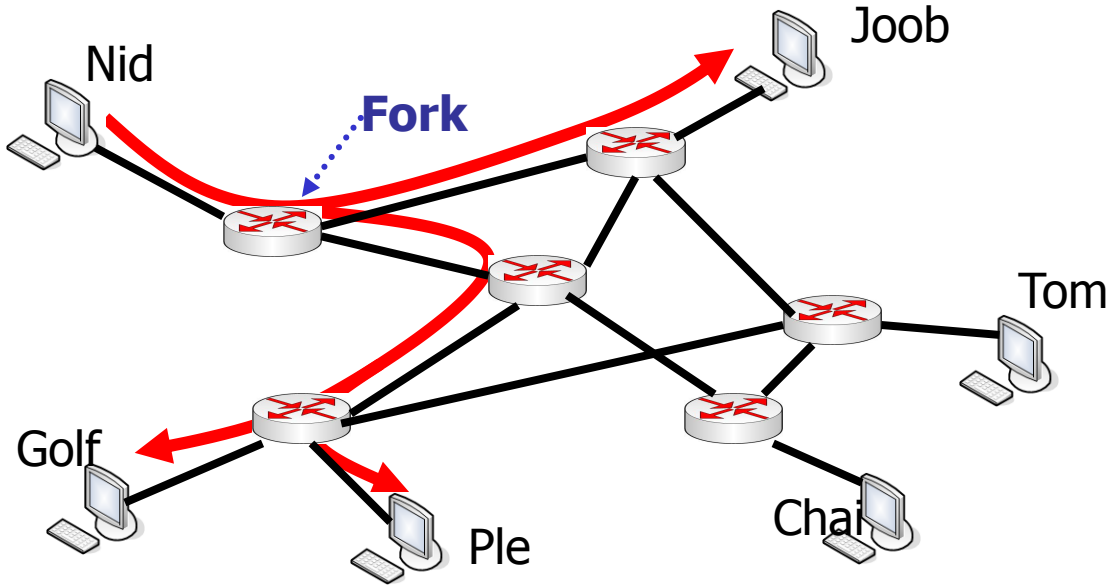


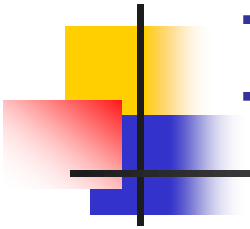
IP Multicast



IP Multicast Challenge

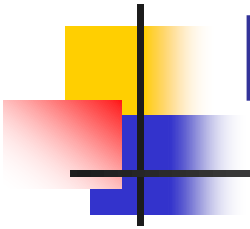
- Determine joined stations
- Locations to fan-out the traffic





IP Multicast

- Additional overhead
  - Control / Join / Leave
- Special routing protocol
- Scalability
- Security concerns
- Retransmission process

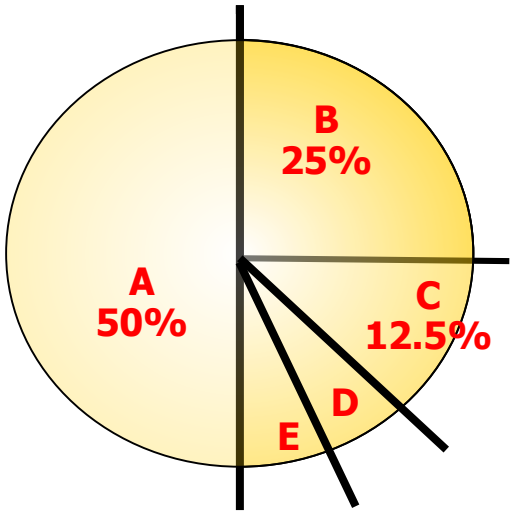


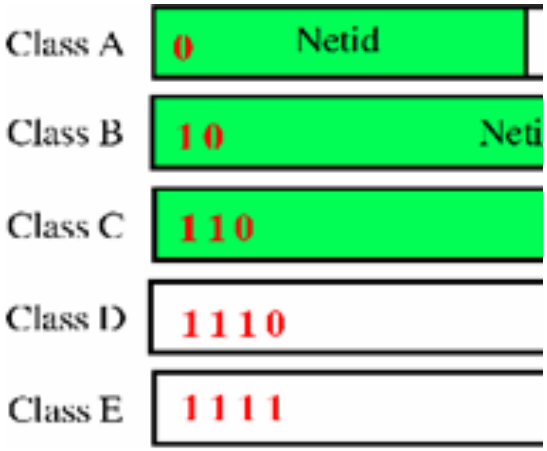
Multicast Applications

- Chain Store
  - Stock distribution / update
- Data Streaming
  - Trader / exchange rate update
  - Video / Audio streaming
  - Multimedia conferences

IP Multicast Address

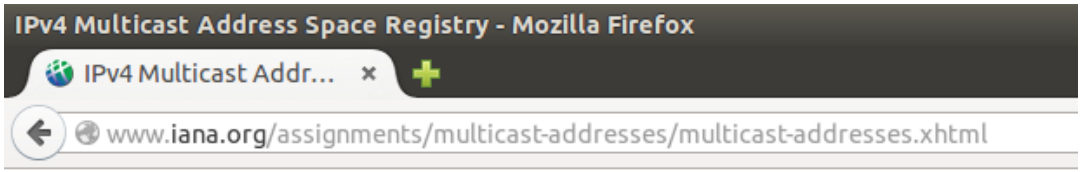
- Class D
- 224.0.0.0 – 239.255.255.255
- Each for Multicast Group





IP Multicast Ranges

Address Range	Usage
224.0.0.1	**All Systems (host + router)**
224.0.0.2	**All Routers**
224.0.0.5 – 224.0.0.6	OSPF routing protocol
224.0.0.1 – 224.0.0.255	Local segment (not across router)
239.192.0.0 – 239.195.255.255	Admin. scope for organizations



http://www.iana.org/assignments/multicast-addresses/multicast-addresses.xhtml

IPv4 Multicast Address Space Registry

Last Updated

2014-12-17

Expert(s)

Stig Venaas

Note

Host Extensions for IP Multicasting [RFC1112] specifies the extensions required of a host implementation of the Internet Protocol (IP) to support multicasting. The multicast addresses are in the range 224.0.0.0 through 239.255.255.255. Address assignments are listed below.

The range of addresses between 224.0.0.0 and 224.0.0.255, inclusive, is reserved for the use of routing protocols and other low-level topology discovery or maintenance protocols, such as gateway discovery and group membership reporting. Multicast routers should not forward any multicast datagram with destination addresses in this range, regardless of its TTL.

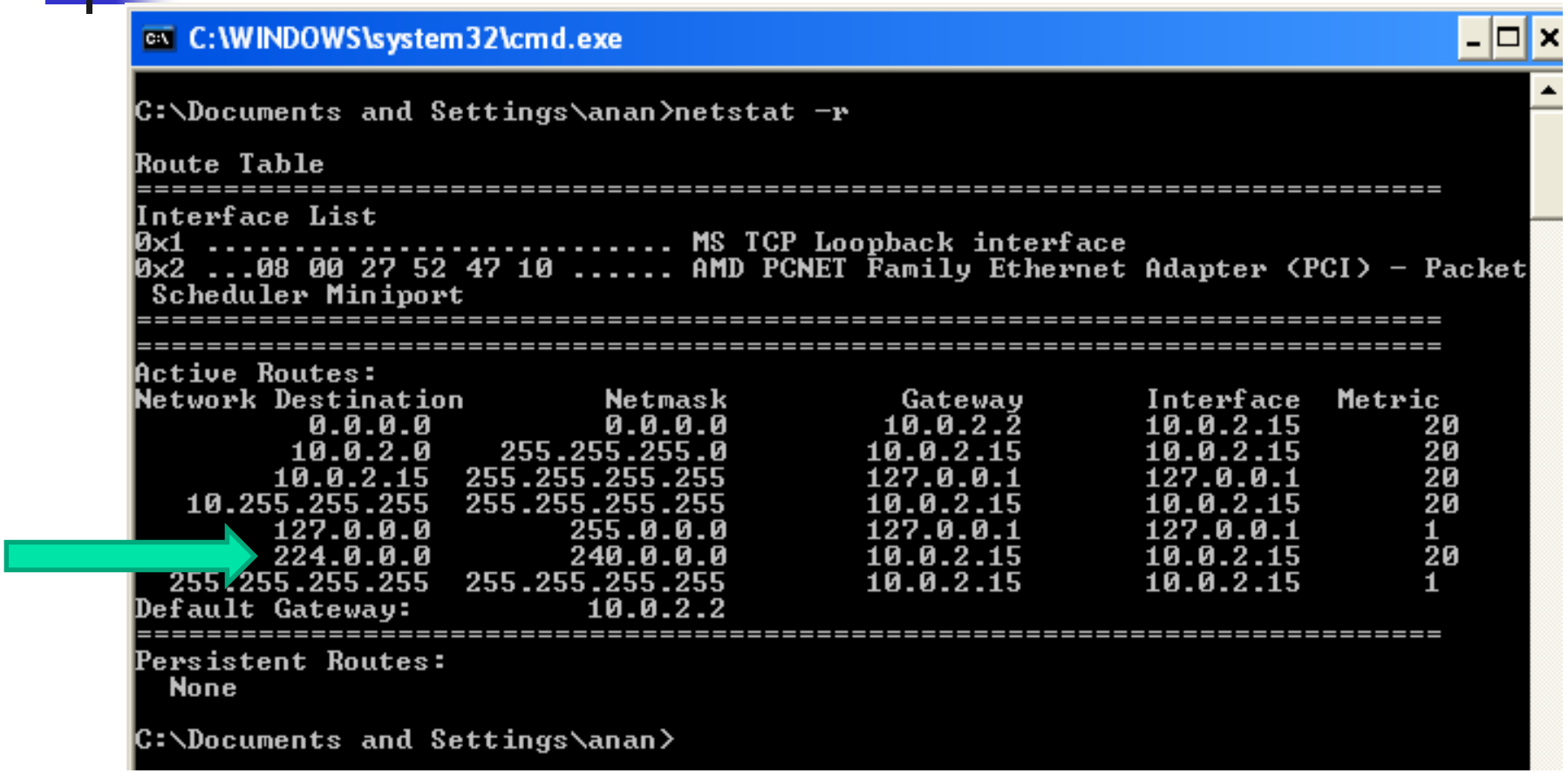
Available Formats

XML HTML Plain text

Registries included below

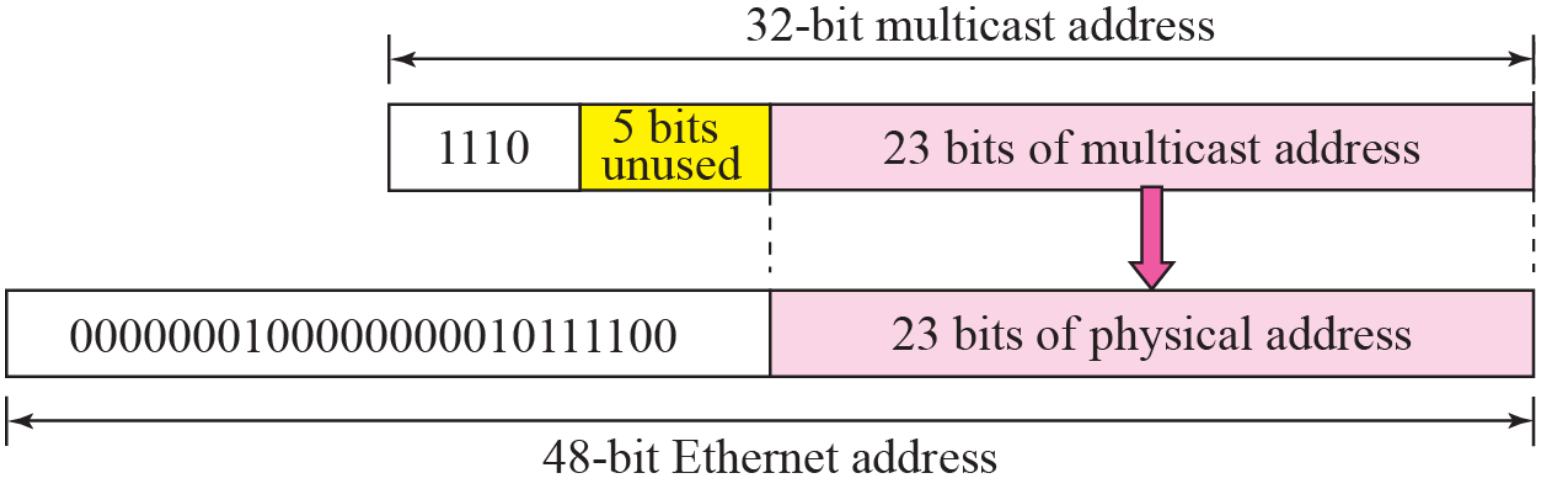
- Local Network Control Block (224.0.0.0 - 224.0.0.255 (224.0.0/24))
- Internetwork Control Block (224.0.1.0 - 224.0.1.255 (224.0.1/24))
- AD-HOC Block I (224.0.2.0 - 224.0.255.255)
- RESERVED (224.1.0.0-224.1.255.255 (224.1/16))
- SDP/SAP Block (224.2.0.0-224.2.255.255 (224.2/16))
- AD-HOC Block II (224.3.0.0-224.4.255.255 (224.3/16, 224.4/16))
- RESERVED (224.5.0.0-224.251.255.255 (251 /16s))
- DIS Transient Groups 224.252.0.0-224.255.255.255 (224.252/14))
- RESERVED (225.0.0.0-231.255.255.255 (7 /8s))
- Source-Specific Multicast Block (232.0.0.0-232.255.255.255 (232/8))
- GLOP Block
- AD-HOC Block III (233.252.0.0-233.255.255.255 (233.252/14))
- Unicast-Prefix-based IPv4 Multicast Addresses

netstat -r


C:\WINDOWS\system32\cmd.exe
C:\Documents and Settings\anan>netstat -r
Route Table
Interface List
0x1 ..... MS TCP Loopback interface
0x2 ...08 00 27 52 47 10 ..... AMD PCNET Family Ethernet Adapter (PCI) - Packet Scheduler Miniport
Active Routes:
Network Destination Netmask Gateway Interface Metric
0.0.0.0 0.0.0.0 10.0.2.2 10.0.2.15 20
10.0.2.0 255.255.255.0 10.0.2.15 10.0.2.15 20
10.0.2.15 255.255.255.255 127.0.0.1 127.0.0.1 20
10.255.255.255 255.255.255.255 10.0.2.15 10.0.2.15 20
127.0.0.0 255.0.0.0 127.0.0.1 127.0.0.1 1
224.0.0.0 240.0.0.0 10.0.2.15 10.0.2.15 20
255.255.255.255 255.255.255.255 10.0.2.15 10.0.2.15 1
Default Gateway: 10.0.2.2
Persistent Routes:
None
C:\Documents and Settings\anan>

Mapping
Multicast IP Add ←→ Physical Ethernet Add

use **ARP** ???
→ infeasible



01:00:5E:00:00:00 - 01:00:5E:7F:FF:FF

Mapping
Multicast IP Add → Physical Ethernet Add

Multicast IP Add: 232.196.28.3

E8.C4.1C.3

0

C4 → 1100 0100

Physical Ethernet Add: 01:00:5E:C4:1C:3

01:00:5E:44:1C:3

Mapping
Physical Ethernet Add → Multicast IP Add

01 : 00 : 5E : **44 : 1C : 3**

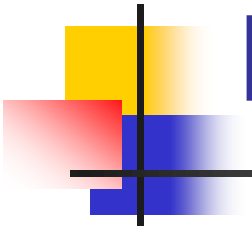
0000 0001 : 0000 0000 : 0101 1110 : 0**100 0100 : 0001 1100 : 0000 0011**

1110 XXXX : X100 0100 : 0001 1100 : 0000 0011

1110 0000 : 0100 0100 : 0001 1100 : 0000 0011 = 224.68.28.3
1110 0000 : 1100 0100 : 0001 1100 : 0000 0011 = 224.196.28.3
1110 0001 : 0100 0100 : 0001 1100 : 0000 0011 = 225.68.28.3
1110 0001 : 1100 0100 : 0001 1100 : 0000 0011 = 225.196.28.3
...
1110 1000 : 1100 0100 : 0001 1100 : 0000 0011 = 232.196.28.3
...
1110 1111 : 0100 0100 : 0001 1100 : 0000 0011 = 239.68.28.3
1110 1111 : 1100 0100 : 0001 1100 : 0000 0011 = 239.196.28.3

All 32 IP adds→ map to the same MAC address **01:00:5e:44:1c:3**

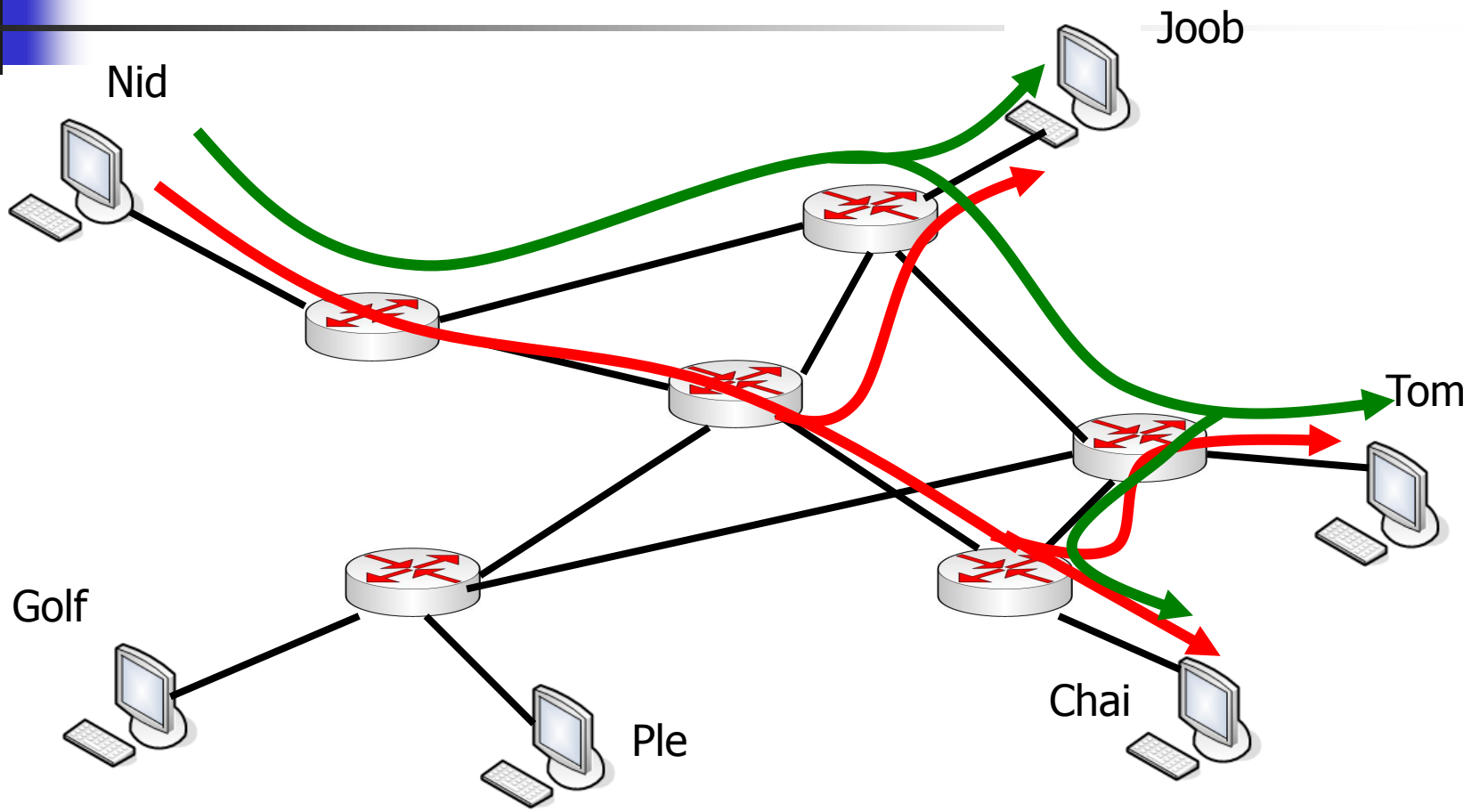
Multicast Forwarding



- Build a **logical tree** structure
- Packet flows from

  root → trunk → branch → leave (destination)
- Objective to reduce
  - **travel length**
  - **amount of data**
- Can be multiple data sources

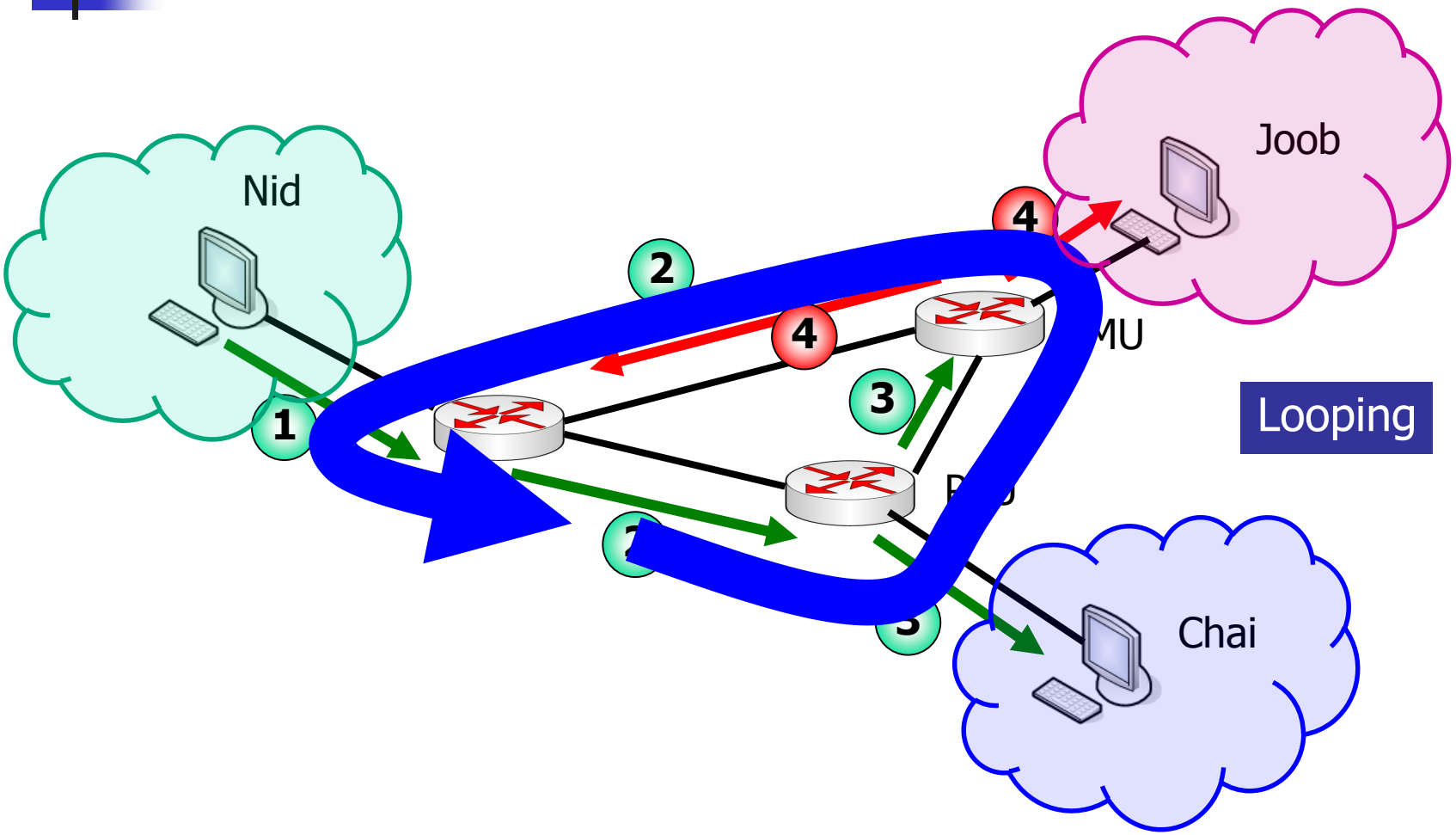
Multicast paths

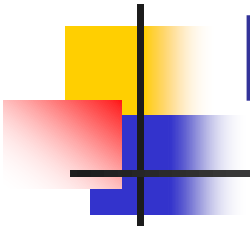


For red path: Joob(3 hops), Tom(4 hops), Chai(3 hops) : Total packet (7 hops)

For green path: Joob(2 hops), Tom(3 hops), Chai(4 hops) : Total packet (6 hops)

Multicast Scenario

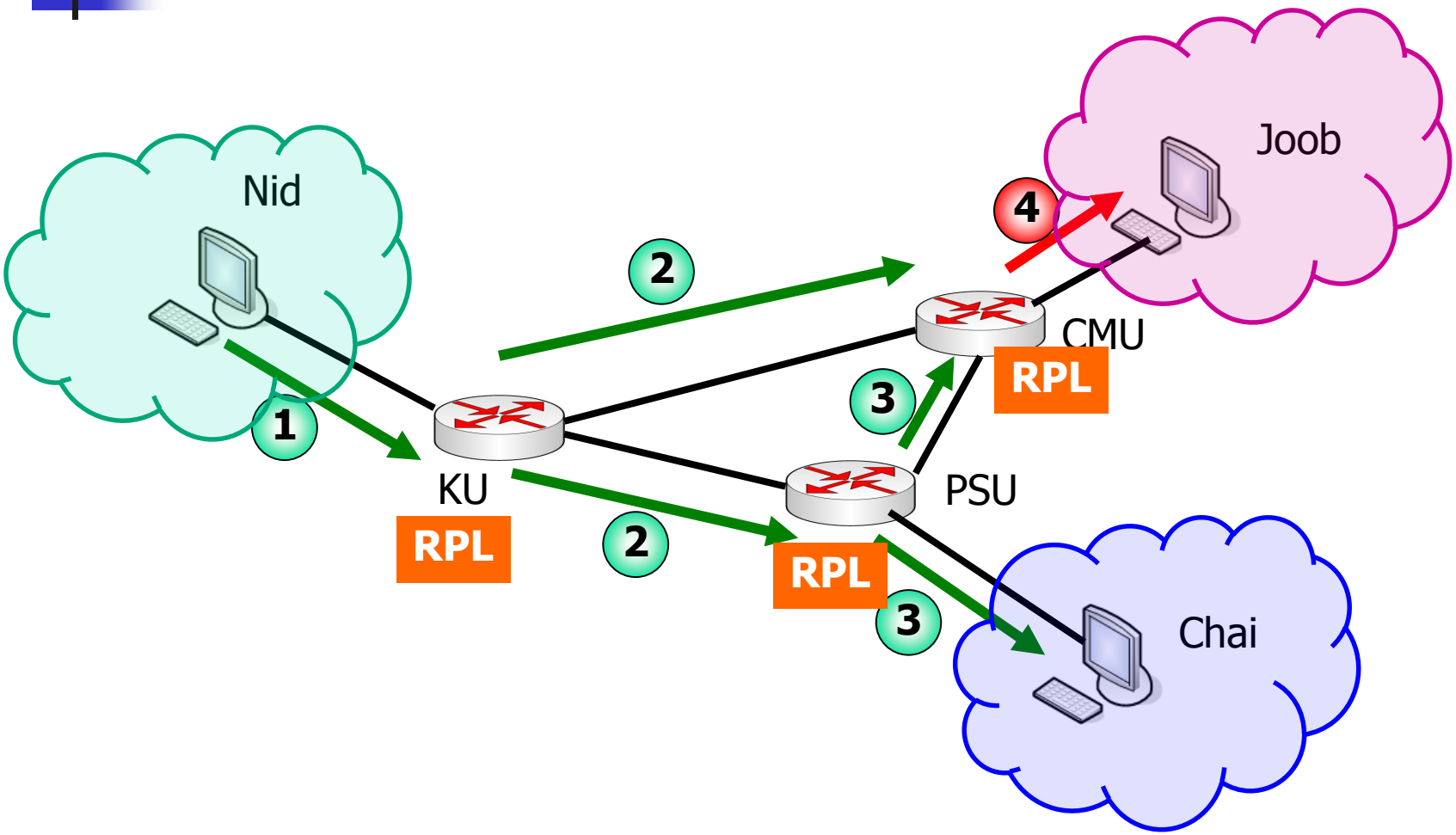


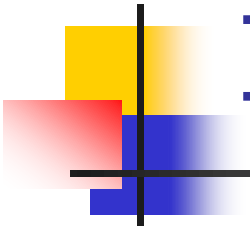


Reverse Path Lookup (RPL)

- Determine to forward / not forward
- Based on algorithm
  - e.g. shortest path

Reverse Path Lookup (RPL)

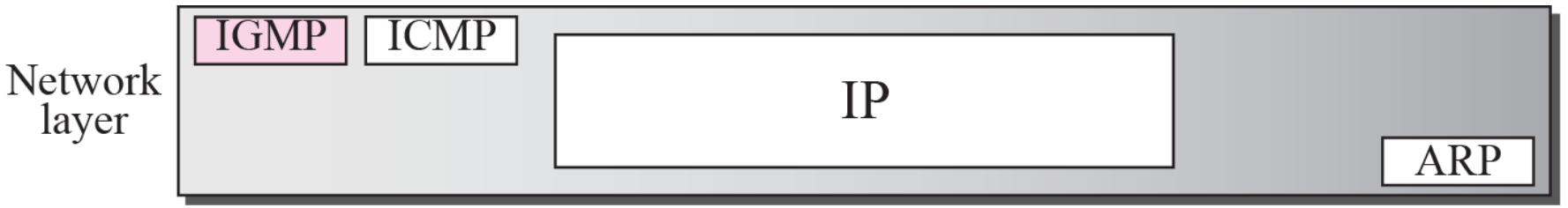


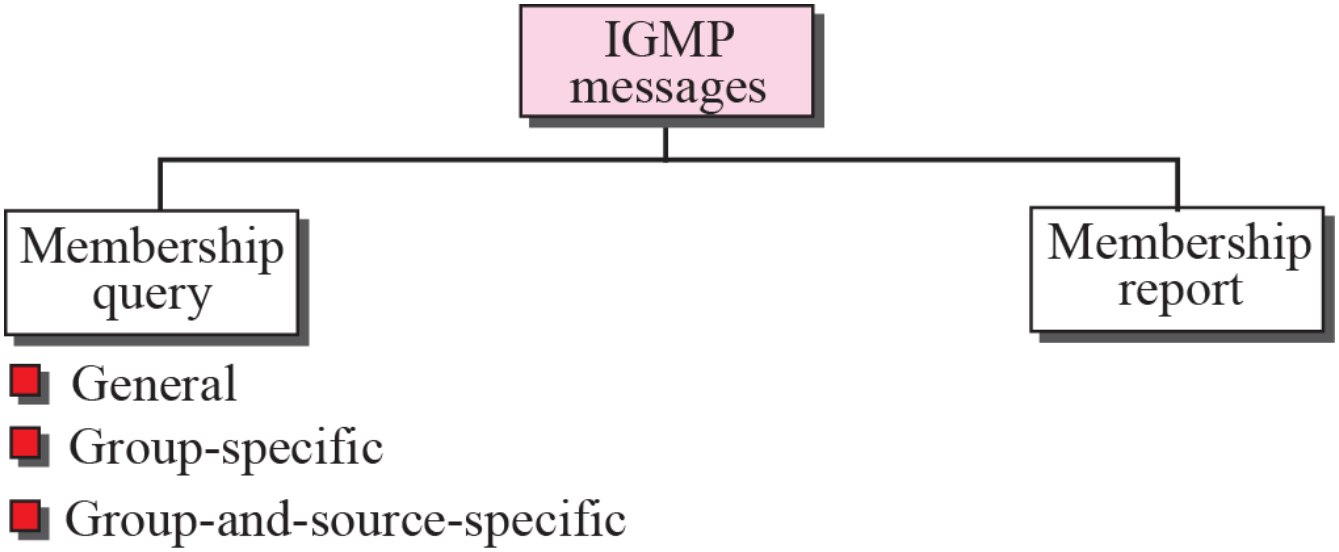


IGMP

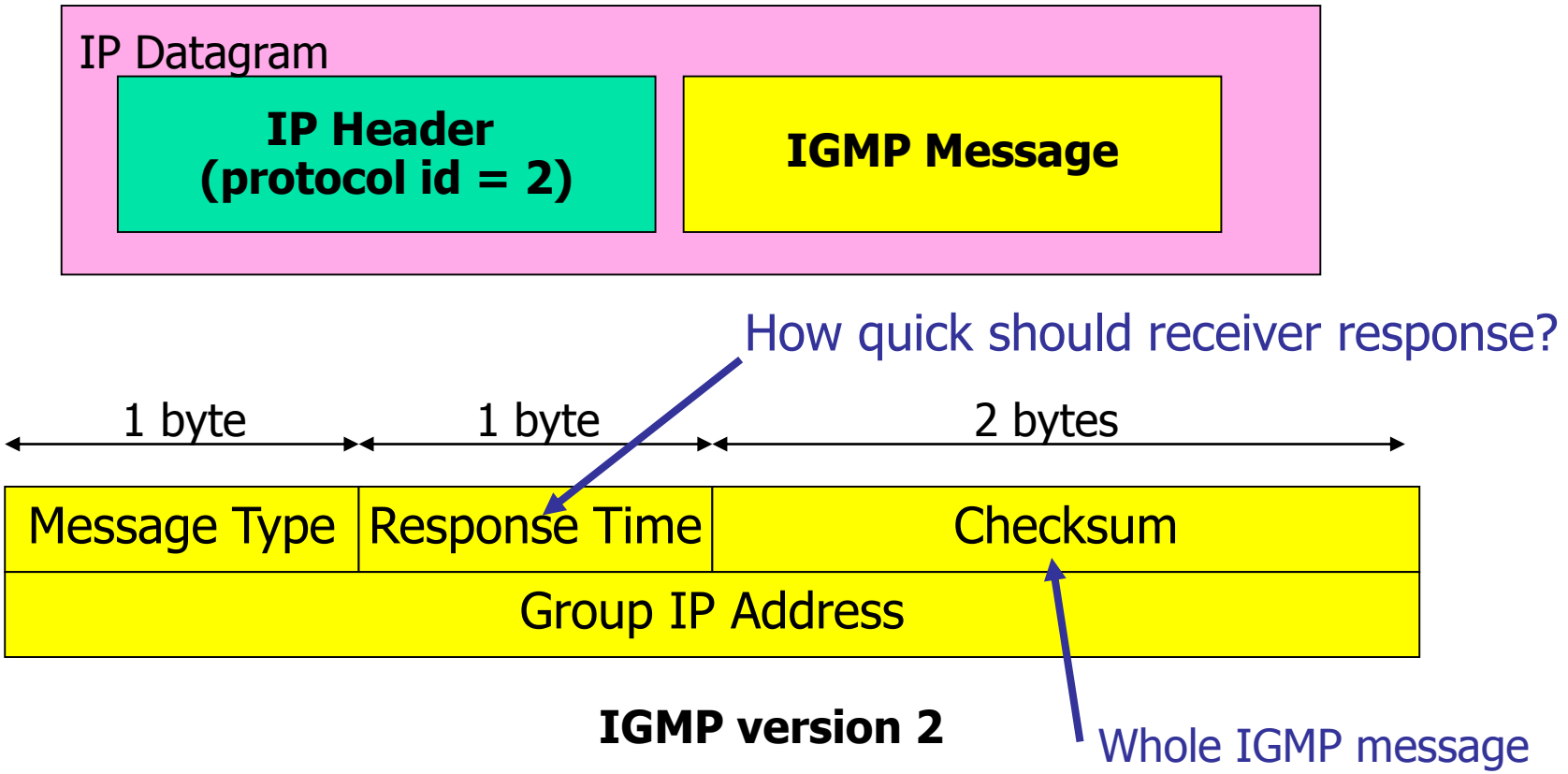
- Internet Group Management Protocol
- Multicast Group
  - Collection of hosts/routers wish to receive same packets
- Determine
  - station to register / withdraw
  - other hosts in group

IGMP


Network layer
IGMP
ICMP
IP
ARP

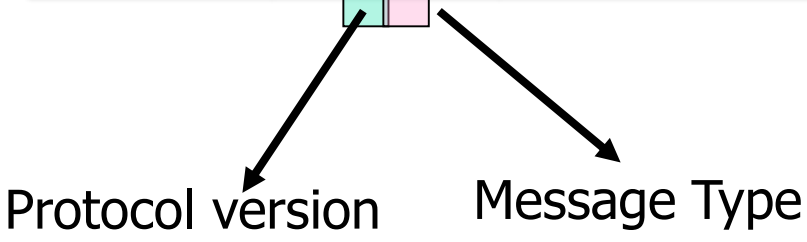

IGMP messages
Membership query
Membership report
General
Group-specific
Group-and-source-specific

IGMP Format

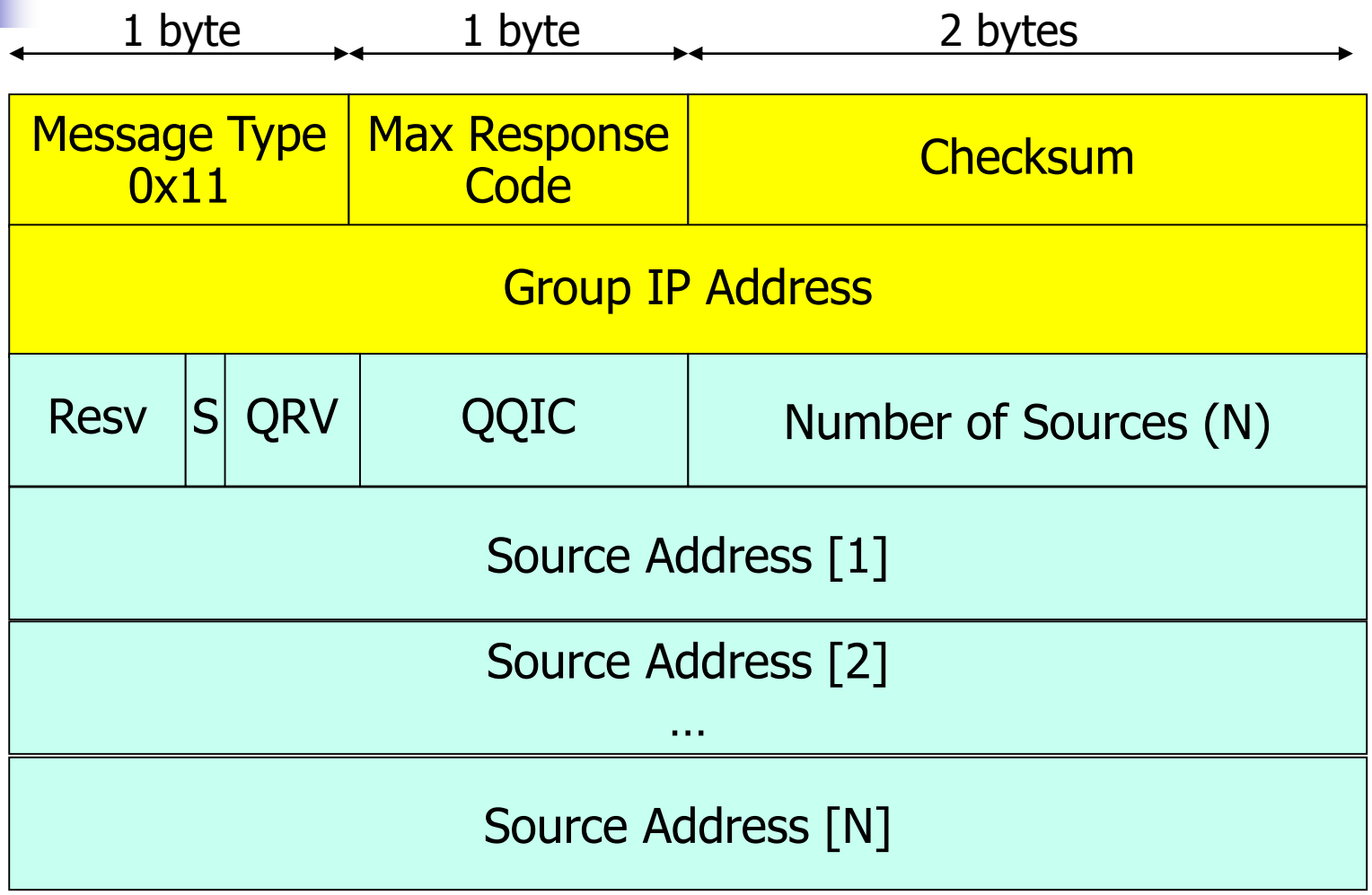

IP Datagram
IP Header
(protocol id = 2)
IGMP Message
How quick should receiver response?
1 byte
1 byte
2 bytes
Message Type
Response Time
Checksum
Group IP Address
IGMP version 2
Whole IGMP message

IGMP Message Types

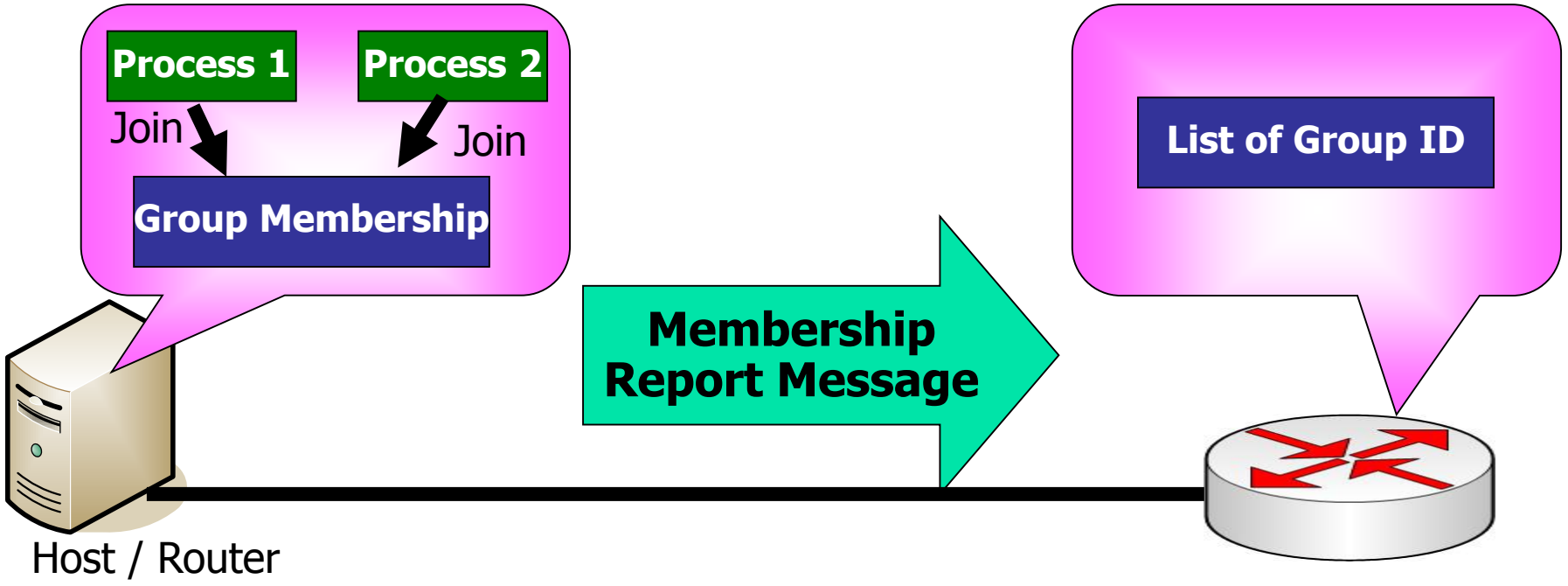
Message Type		Meaning
Ver.1	Ver.2	
1	17	Group membership query
2	18	Response to Group query
6	22	Response to Group query
7	23	Announcement leaving a group



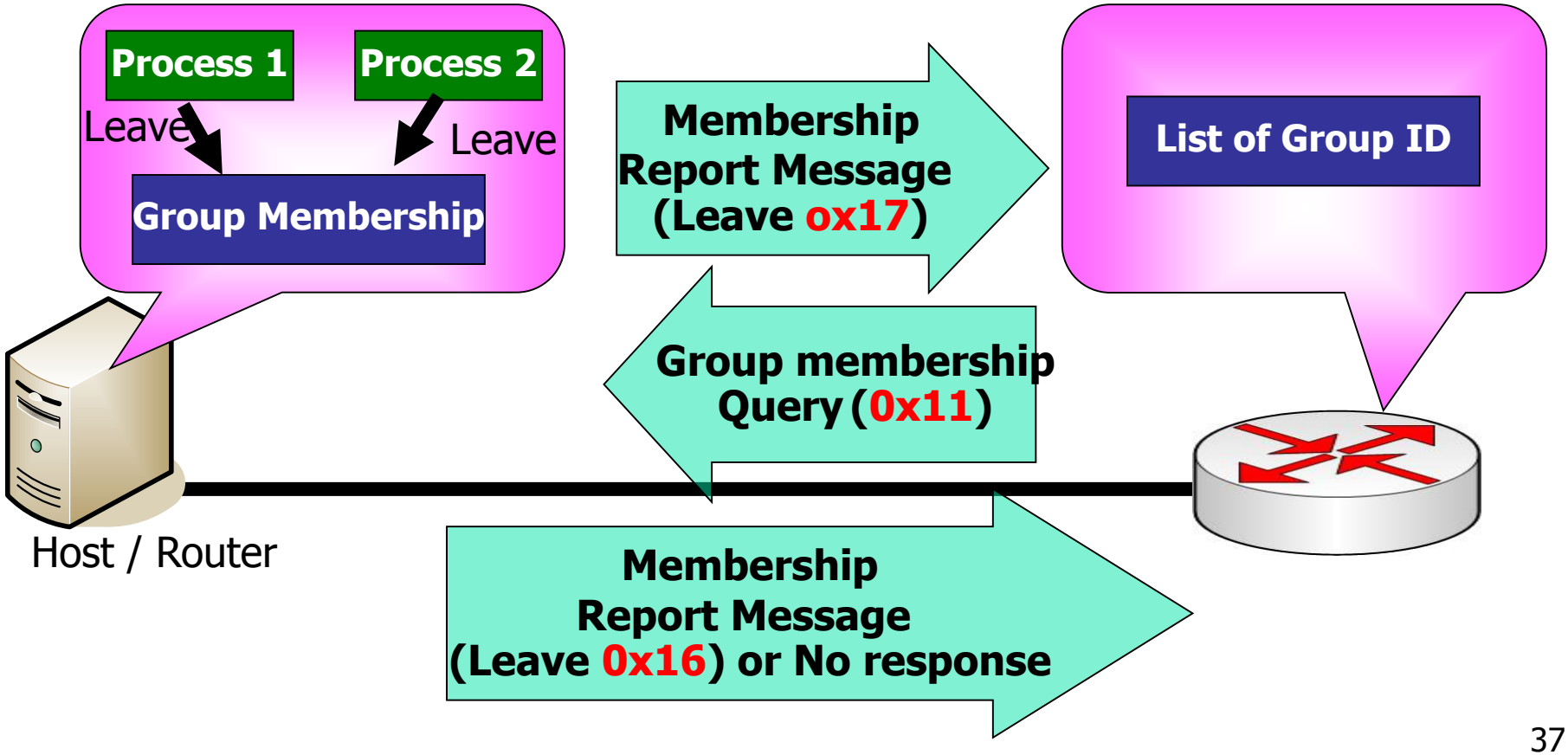
IGMP v3


1 byte
1 byte
2 bytes
Message Type 0x11
Max Response Code
Checksum
Group IP Address
Resv
S
QRV
QQIC
Number of Sources (N)
Source Address [1]
Source Address [2]
...
Source Address [N]

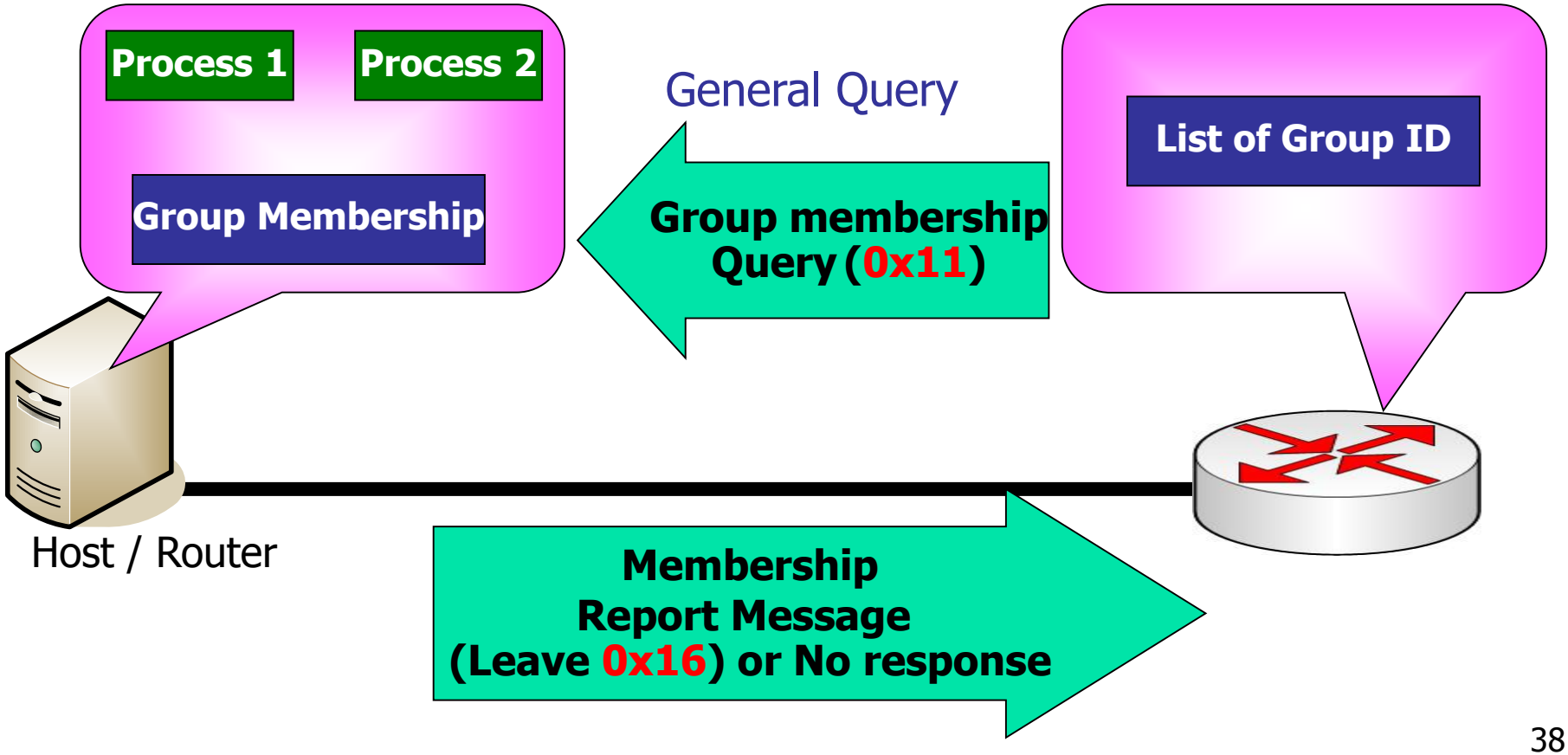
Joining a group

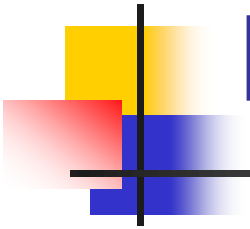


Leaving a group



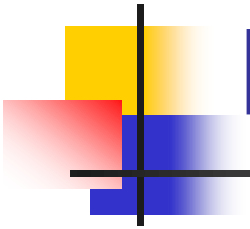
Membership Monitoring





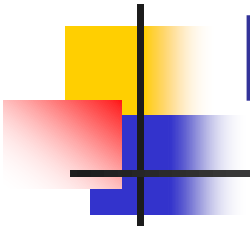
Multicast Routing

- Protocol Independent Multicast
  - Dense Mode (PIM-DM)
  - Sparse Mode (PIM-SM)



Multicast Routing

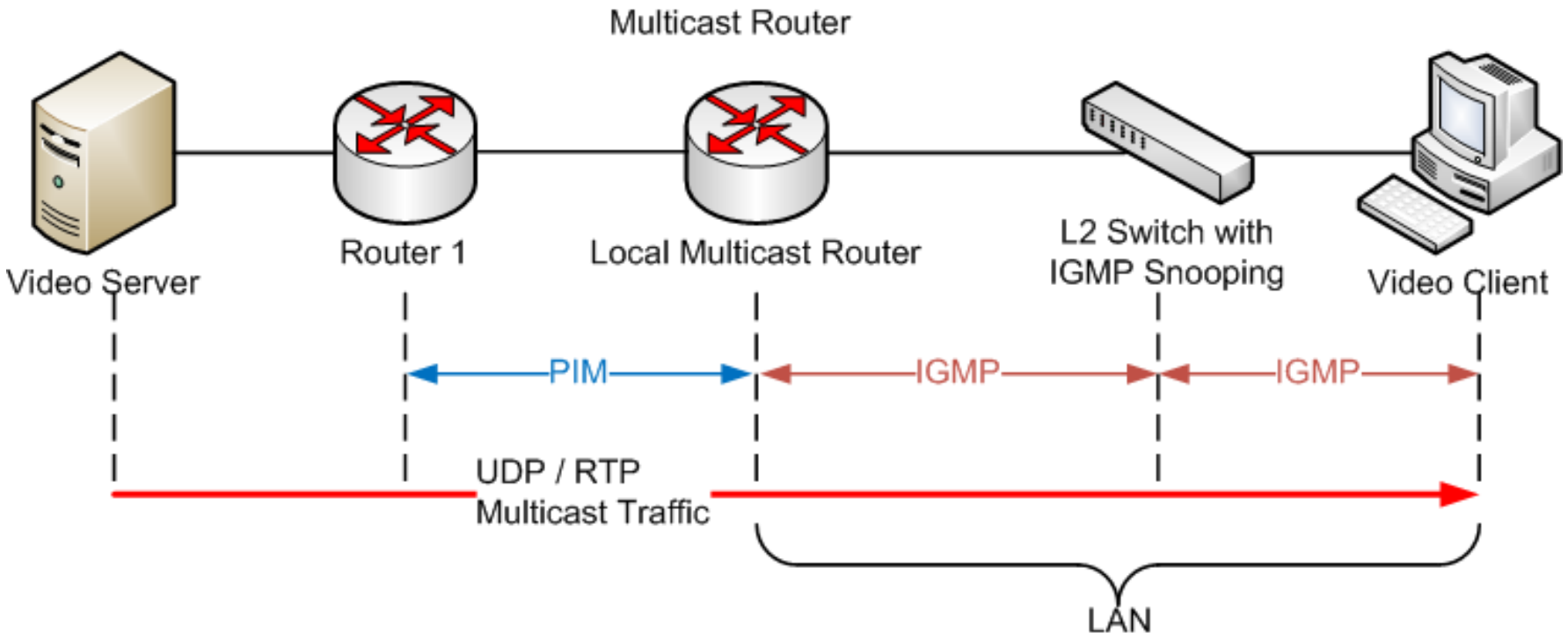
- Dense mode protocols
  - assumes dense group membership
  - Source distribution tree and NACK type
  - DVMRP (Distance Vector Multicast Routing Protocol)
  - PIM-DM (Protocol Independent Multicast, Dense Mode)



Multicast Routing

- Sparse mode protocol
  - assumes sparse group membership
  - Shared distribution tree and ACK type
  - PIM-SM (Protocol Independent Multicast, Sparse Mode)

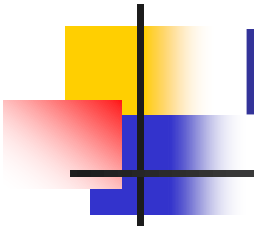
Multicast Basic Architecture



http://en.wikipedia.org/wiki/Internet_Group_Management_Protocol

Why deploy Multicast Service?

- Emerging IP-based applications best served by multicast
  - Electronic software/data distribution
  - Distance learning
  - Corporate announcements, communications across multiple locations
  - Audio/video conferencing
  - Webcasting



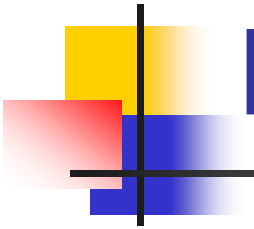
Management Concerns

- New service needs to be reliable
  - predeployment analysis, experiments, pilots
  - rapid fault diagnosis & repair
  - capacity planning

Management Concerns

- Fear effects of multicast on existing network
  - router misconfiguration, defects, CPU load
  - increased traffic
- Control and security

Ongoing monitoring helps alleviate all these concerns



Multicast Challenges

- Few people understand multicast technology
- Public domain tools require protocol knowledge
- No commercial monitoring facilities available
- Traffic control
- Accounting
- Performance, QoS assessment