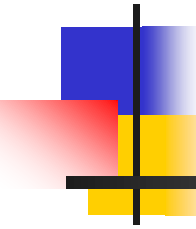

Multicast

รศ.ดร. อนันต์ ผลเพิ่ม

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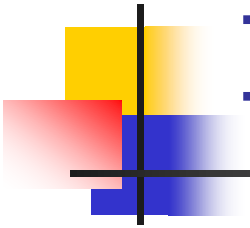
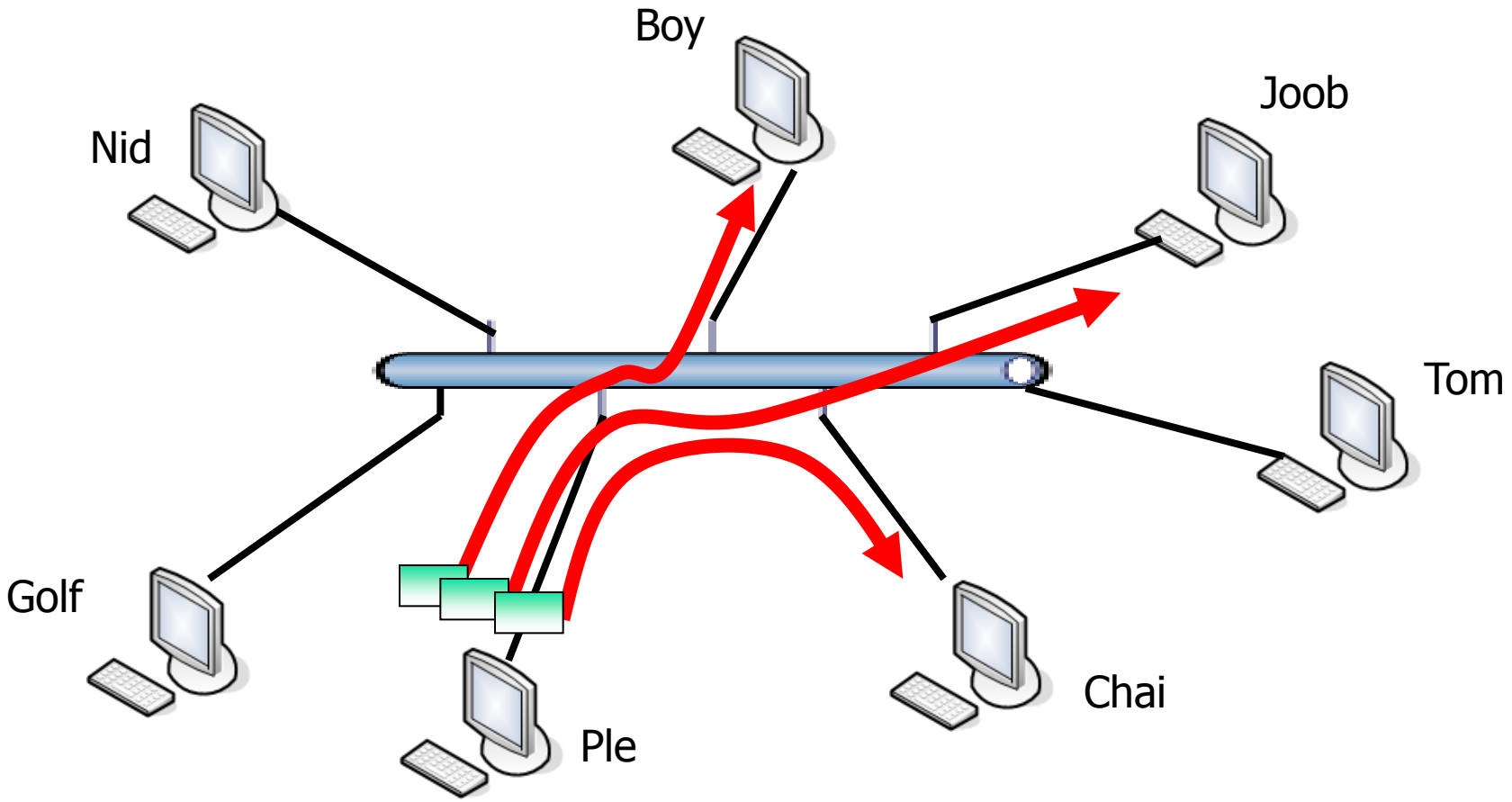


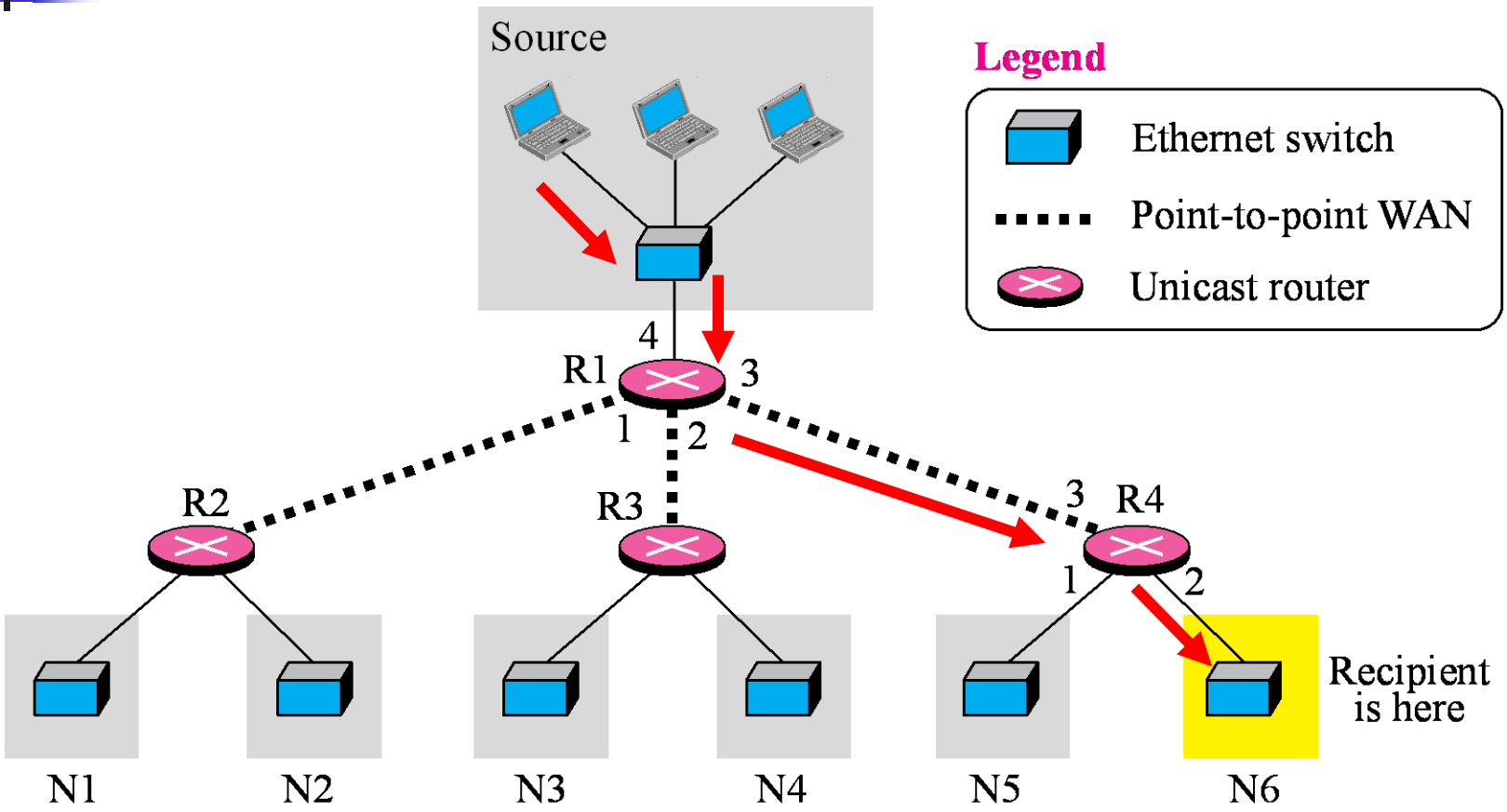
IP Datagram delivery

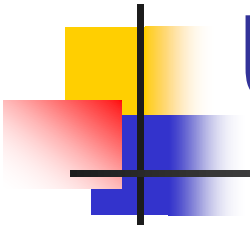
- Unicast
- Broadcast
- Multicast

Unicast



Unicast

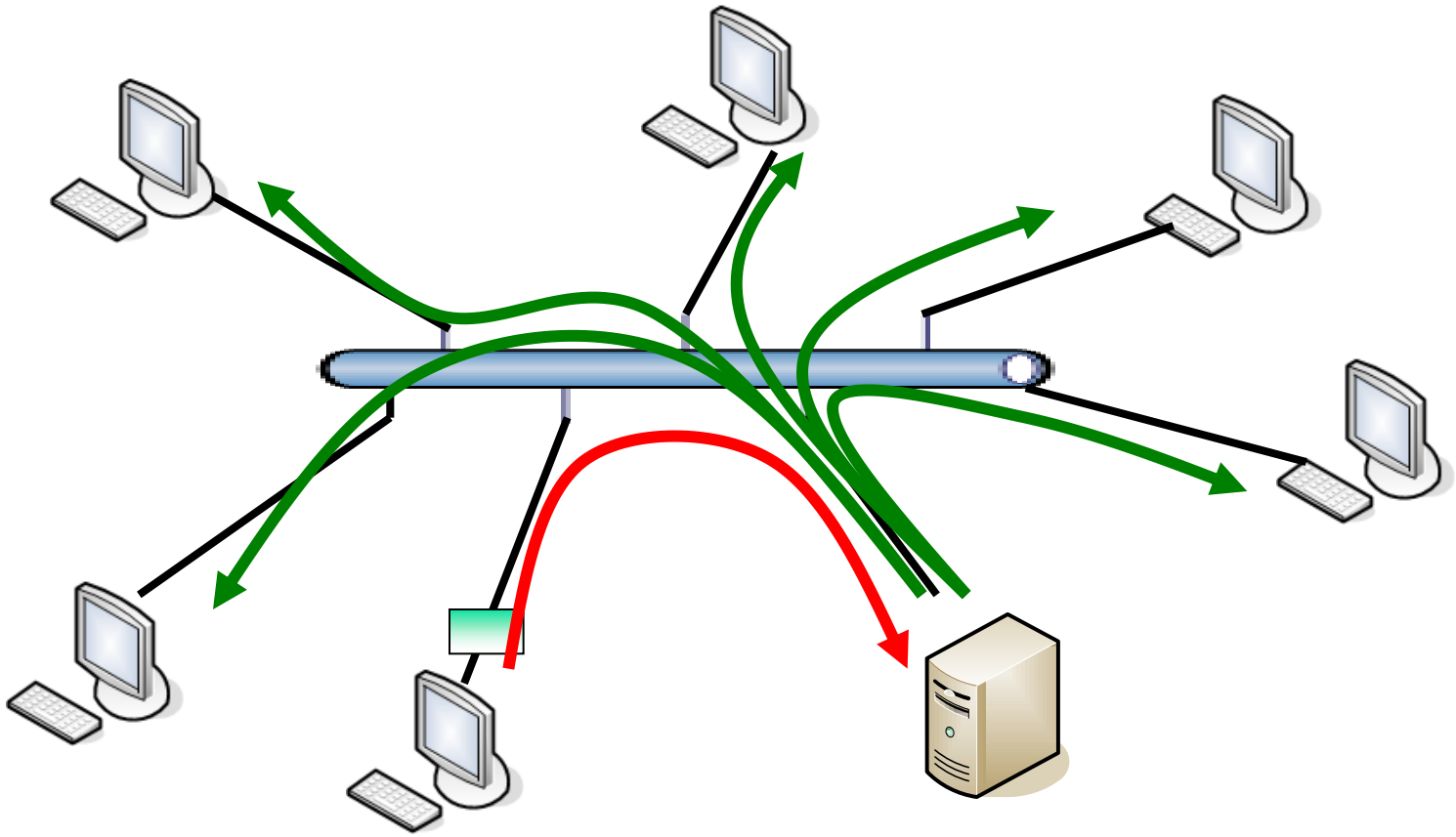

Source
Legend
Ethernet switch
Point-to-point WAN
Unicast router
R1
R2
R3
R4
4
3
1
2
3
1
2
N1
N2
N3
N4
N5
N6
Recipient
is here



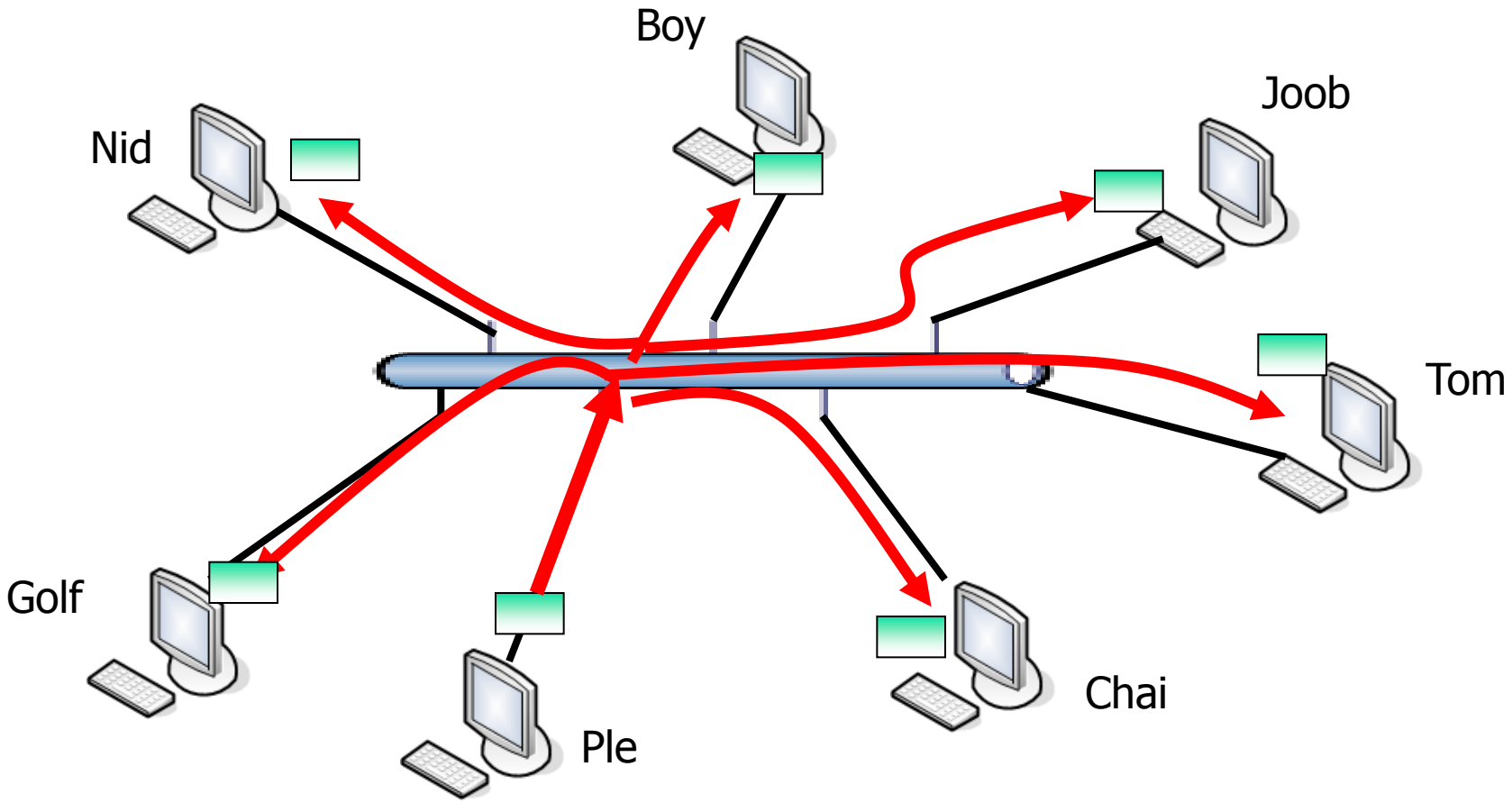
Unicast

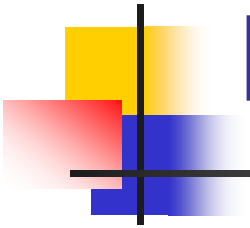
- One-to-one delivery
- Each datagram to single destination
- Need additional buffer
- Large amount of data traffic
- Secure (Only to specified destination)

Conference Server



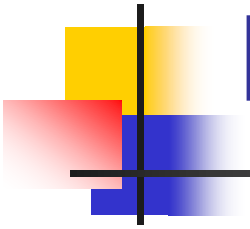
Broadcast





Broadcast

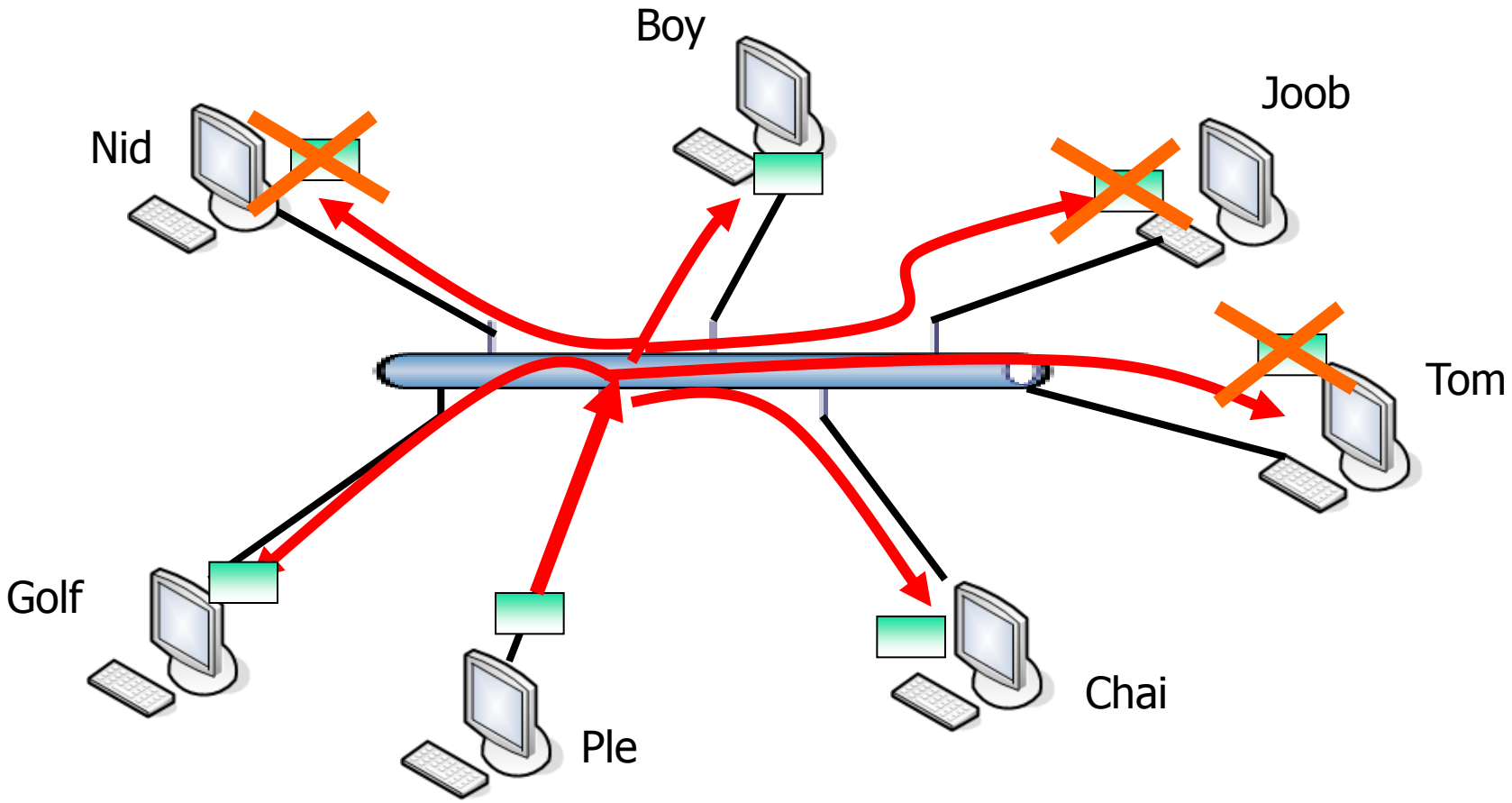
- One-to-all
- Data-Link implementation
  - Broadcast Add. FF-FF-FF-FF-FF-FF
- Each Frame to all nodes
  - Less Data Traffic



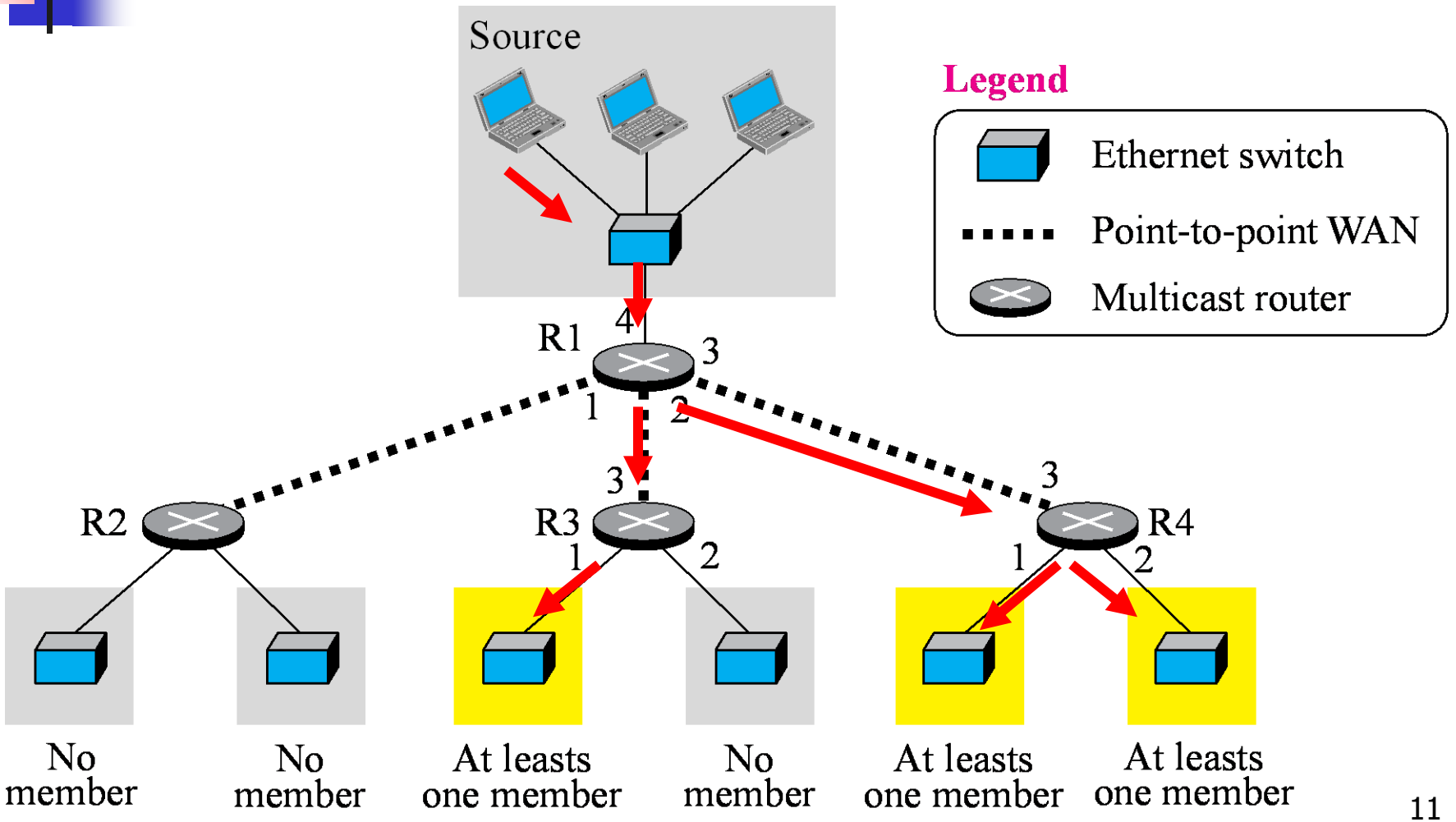
Broadcast Problem

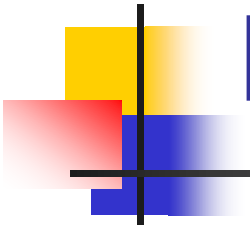
- If not all nodes want the data
  - Higher Layer needs to be involved
  - Unacceptable processing overhead
  - Security vulnerability

Multicast



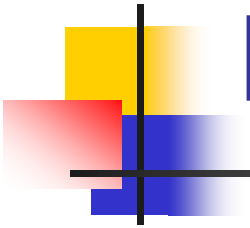
Multicast


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

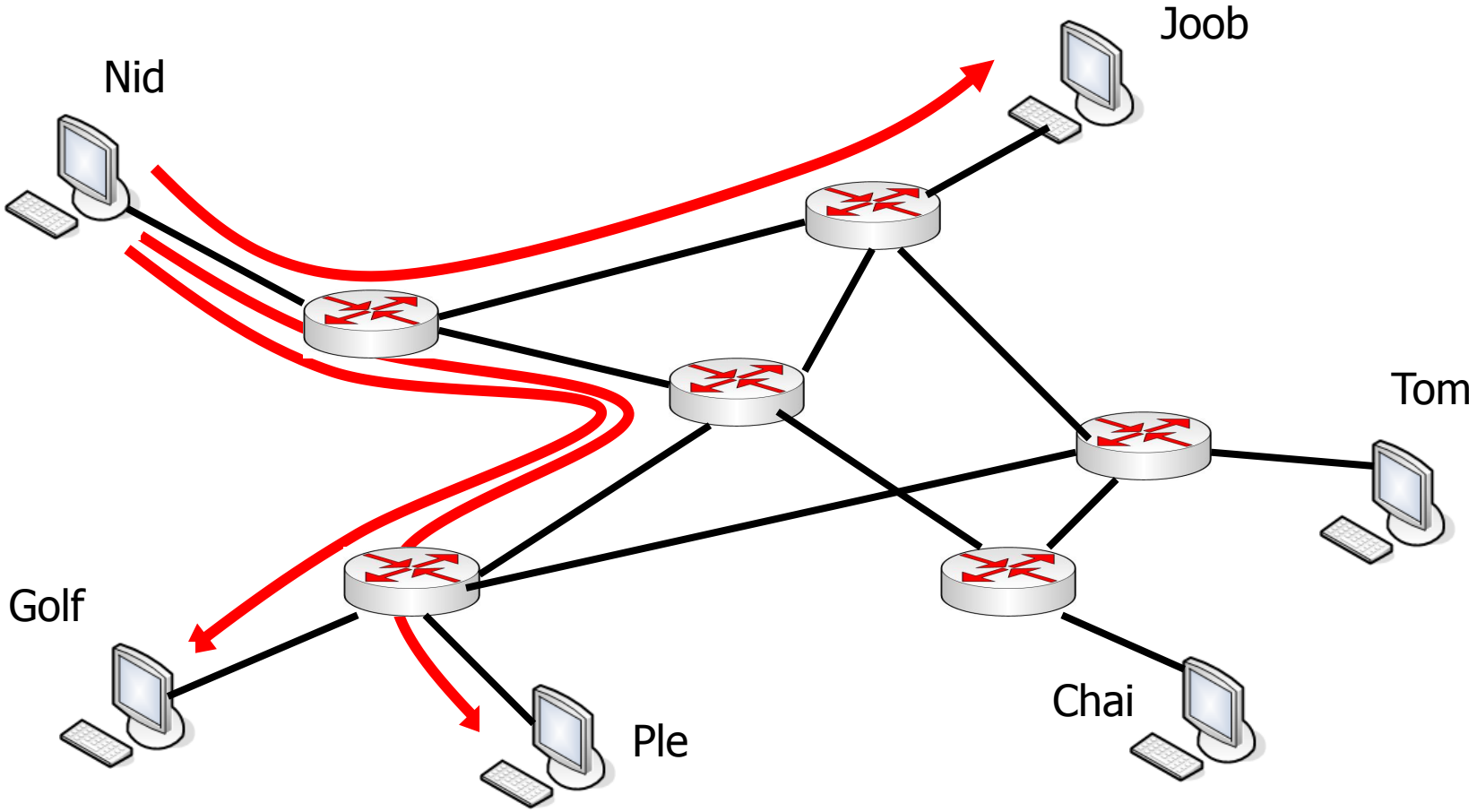
- One-to-many (Not to all)
- Need special address for the group
- Actually broadcast
  - Still have processing overhead
  - Non-participate stations only look and throw away → Less overhead
- Can Reduces more ?
  - Possible to map IP multicast to MAC multicast



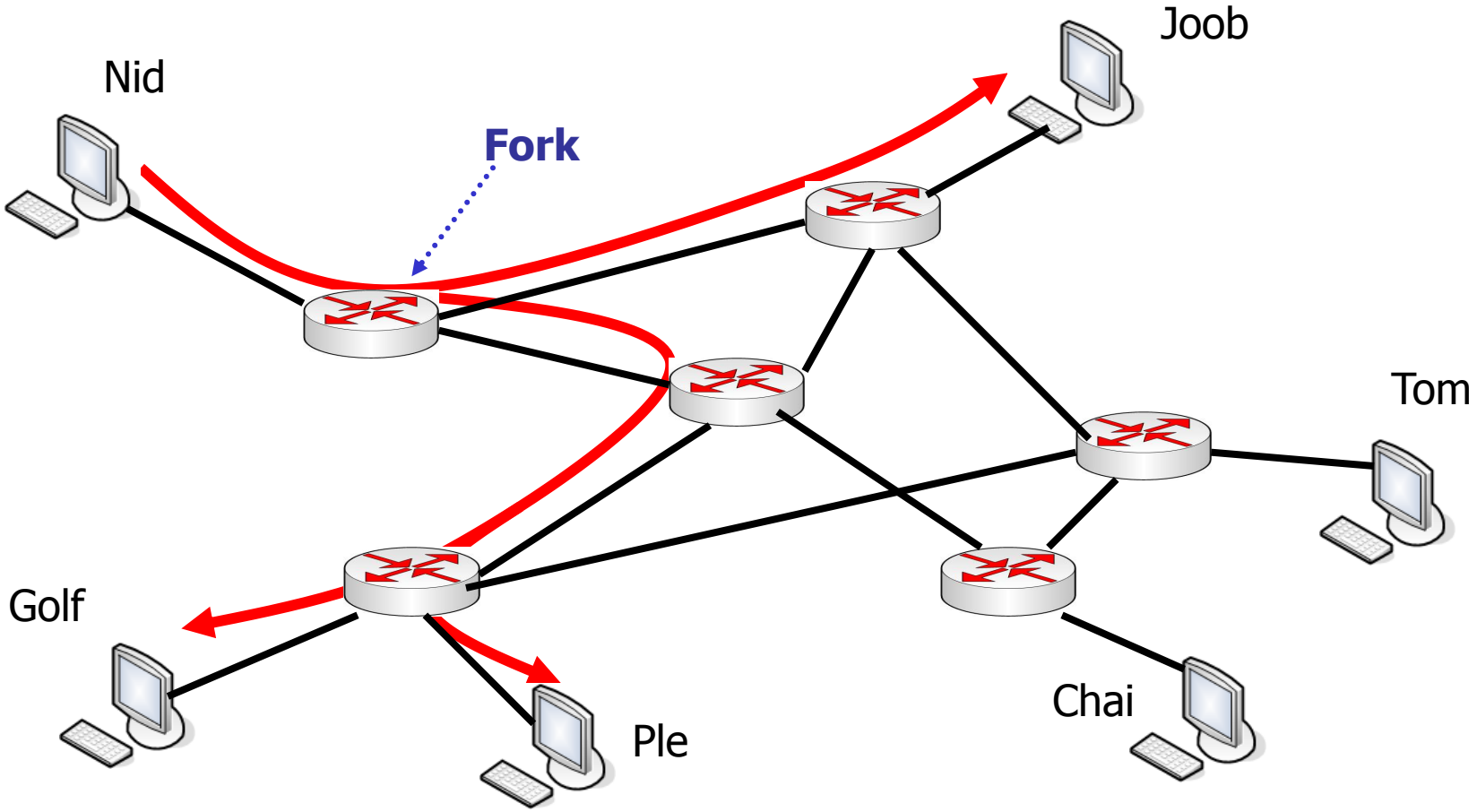
Multicast

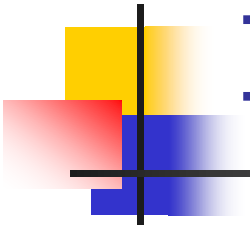
- Data-Link Layer broadcast frames are not forwarded across routers
- IP Broadcast packets are also not forwarded across routers
- Multiple copies

Data Across the Internet



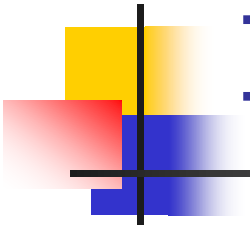
IP Multicast





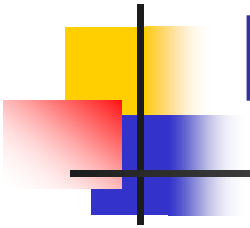
IP Multicast Challenge

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



IP Multicast

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

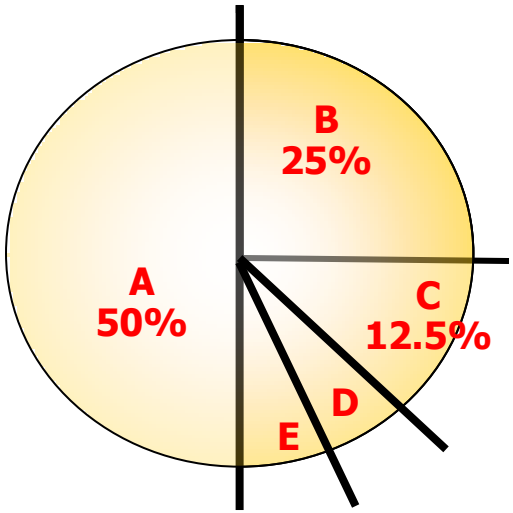


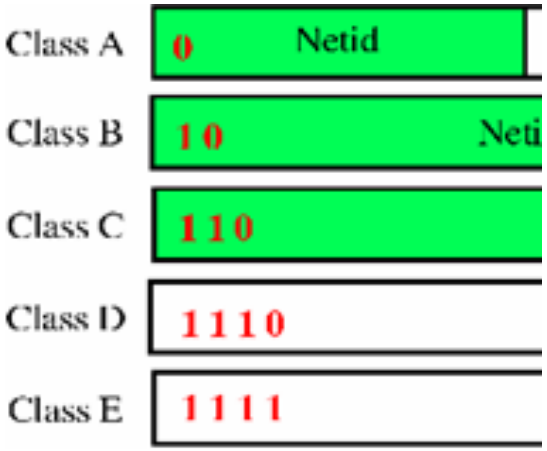
Multicast Applications

- 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

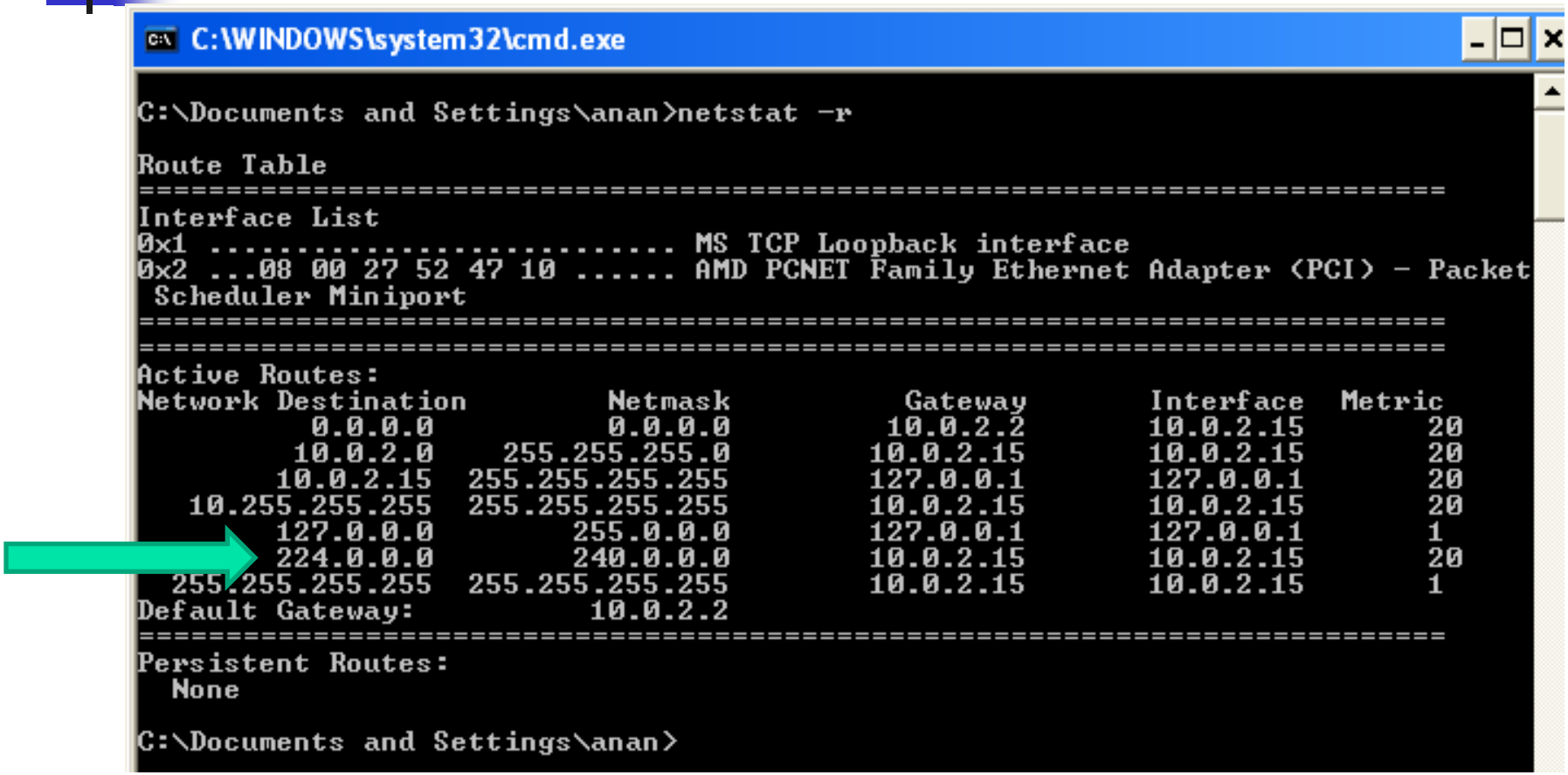




IP Multicast Ranges

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

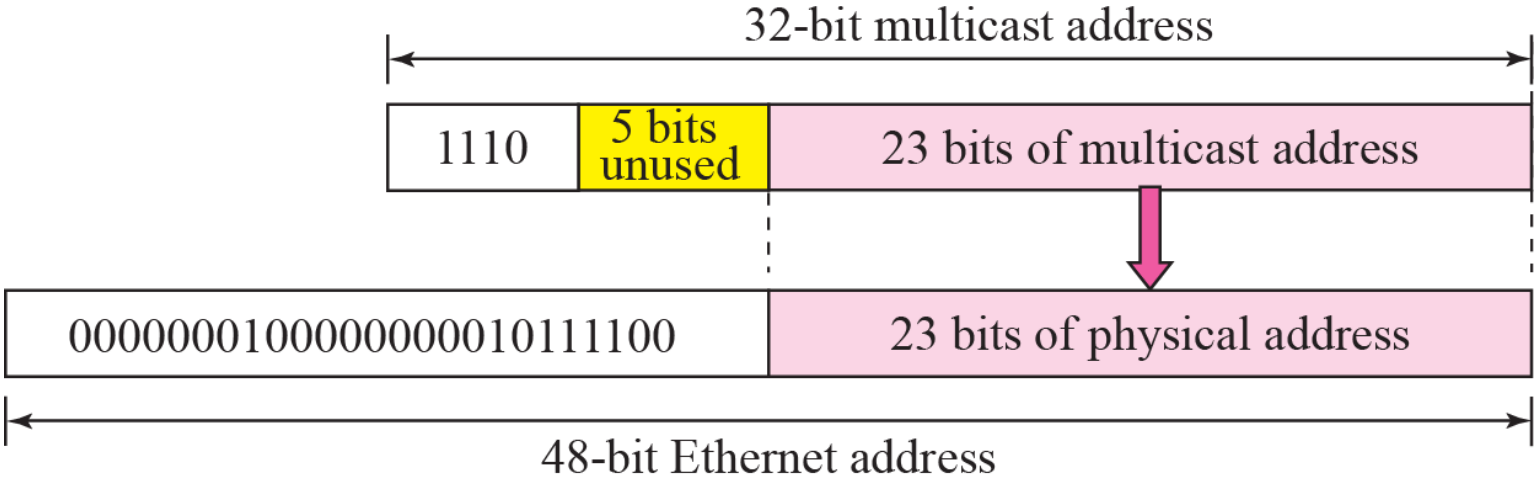
netstat -r


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

Multiclass IP Add ←→ Physical Ethernet Add

use **ARP** ???
→ infeasible



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

Mapping
Multiclass IP Add → Physical Ethernet Add

Multicast IP Add: 232.196.28.3

E8.C4.1C.3

0

C4 → ~~1~~100 0100

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

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

Mapping

Physical Ethernet Add → Multiclass IP Add

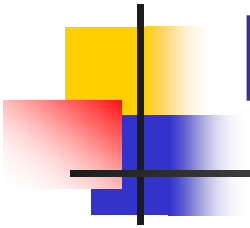
01 : 00 : 5E : **44 : 1C : 3**

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**

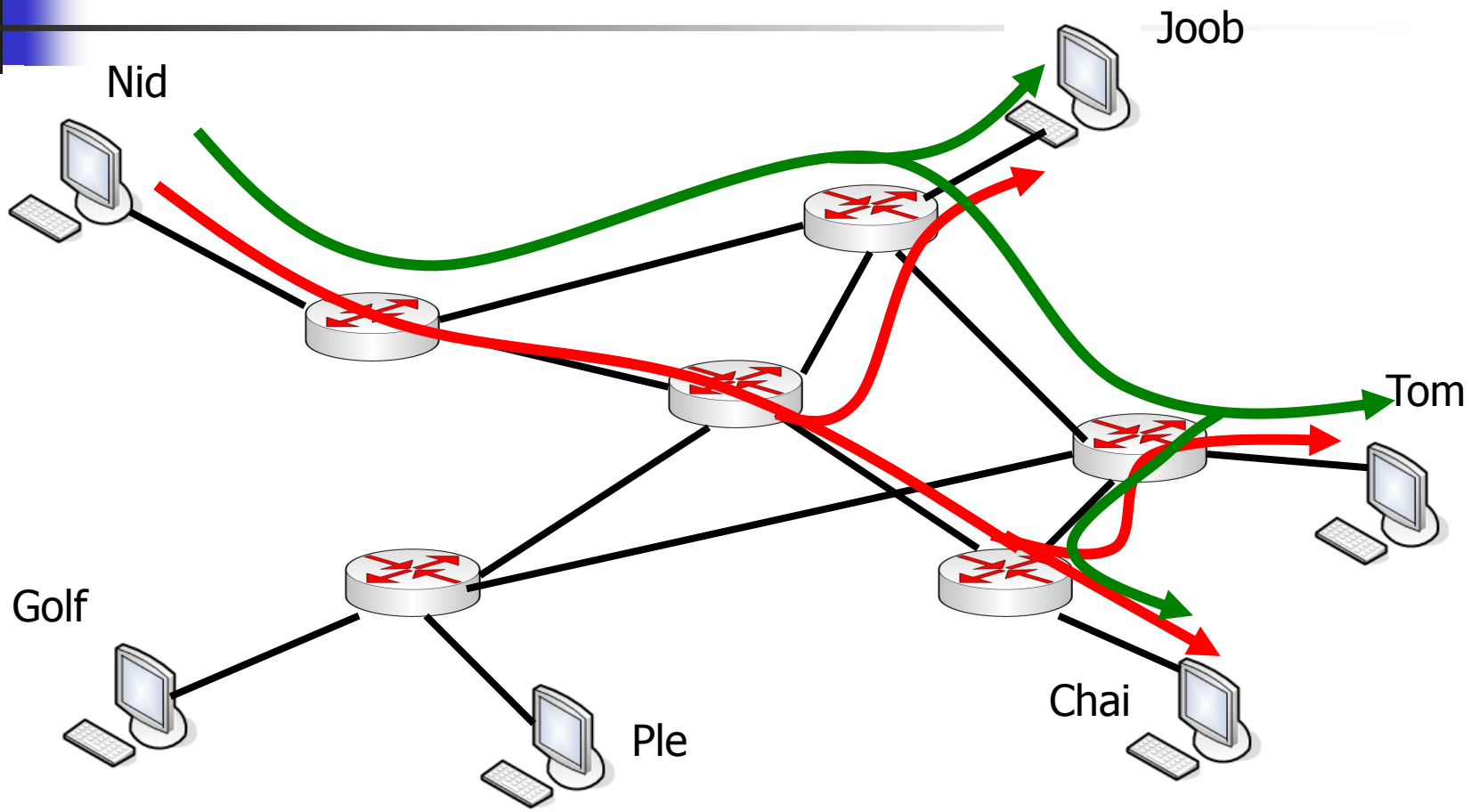


Multicast Forwarding

- 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

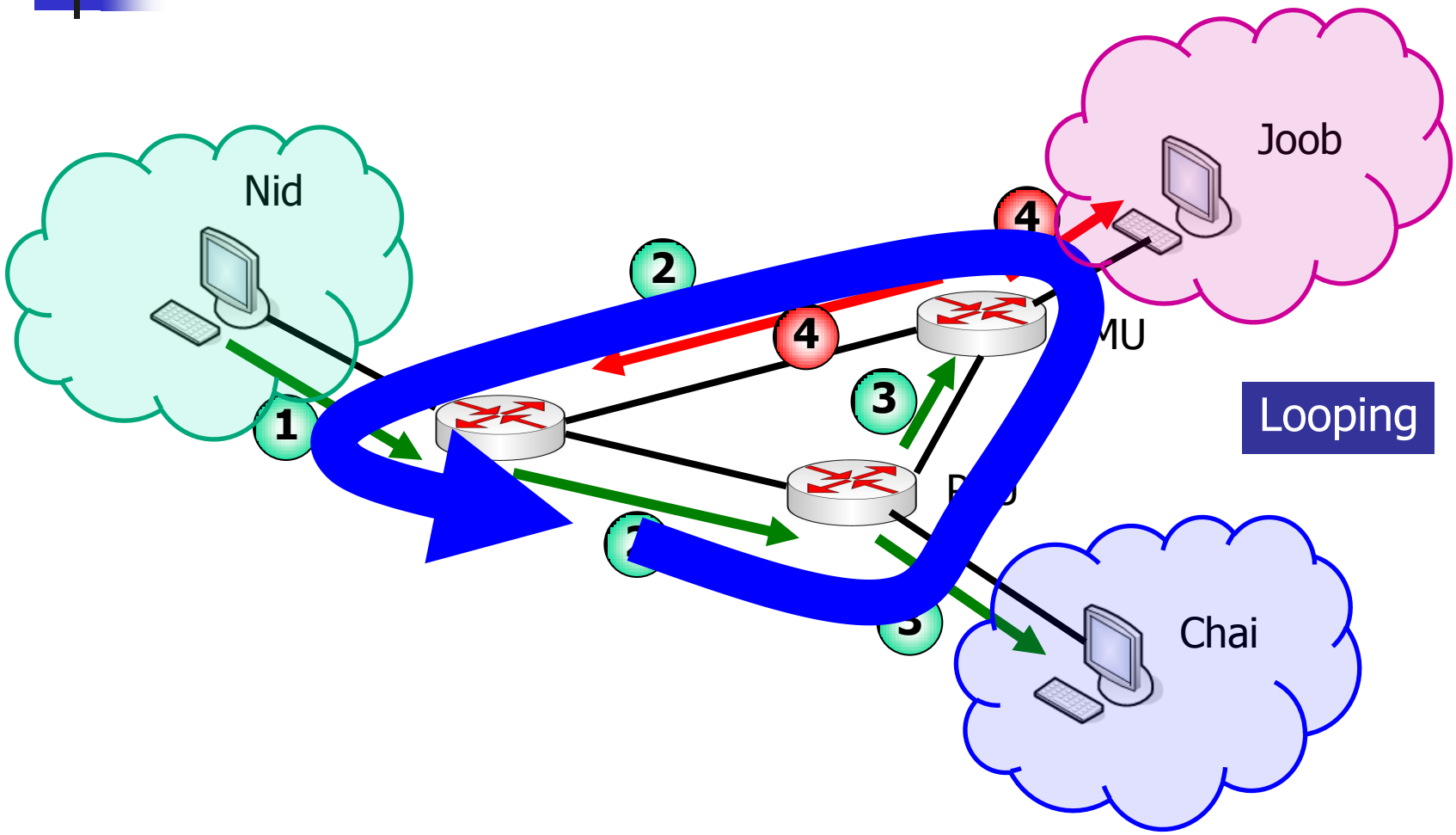
Multicast paths

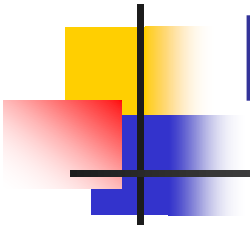


For red path: Joob(3 hops), Tom(4 hops), Chai(3 hops) : Total packet (7 hops)

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

Multicast Scenario

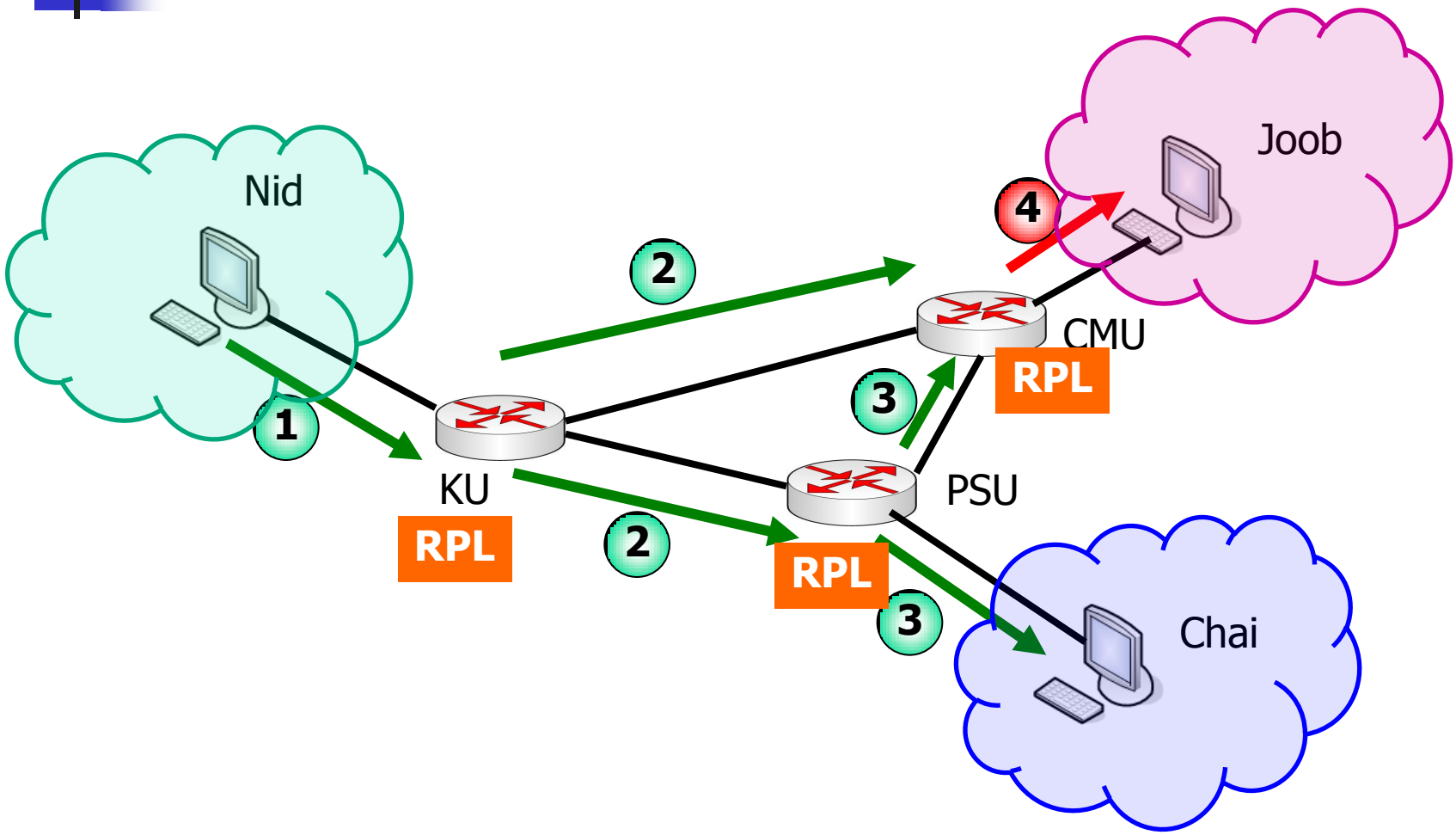


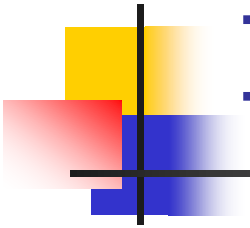


Reverse Path Lookup (RPL)

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

Reverse Path Lookup (RPL)

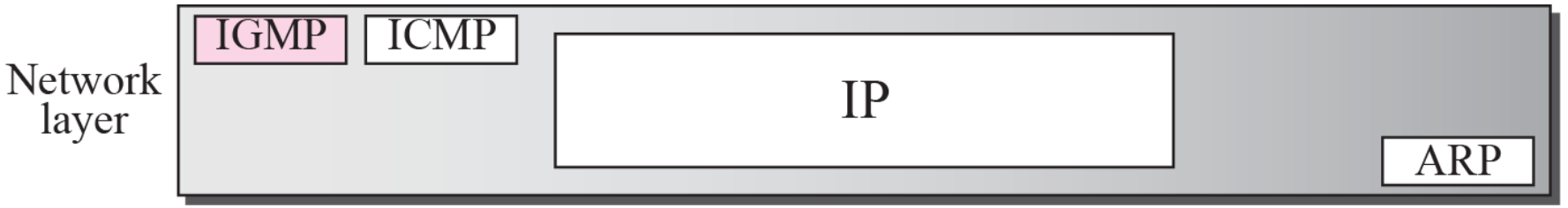


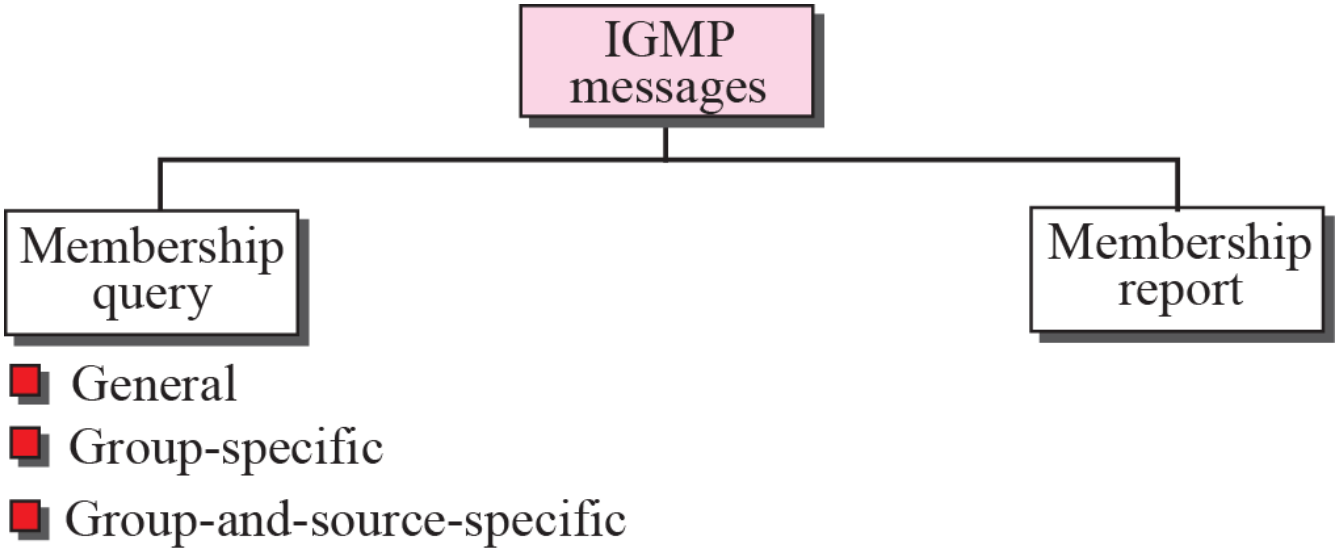


IGMP

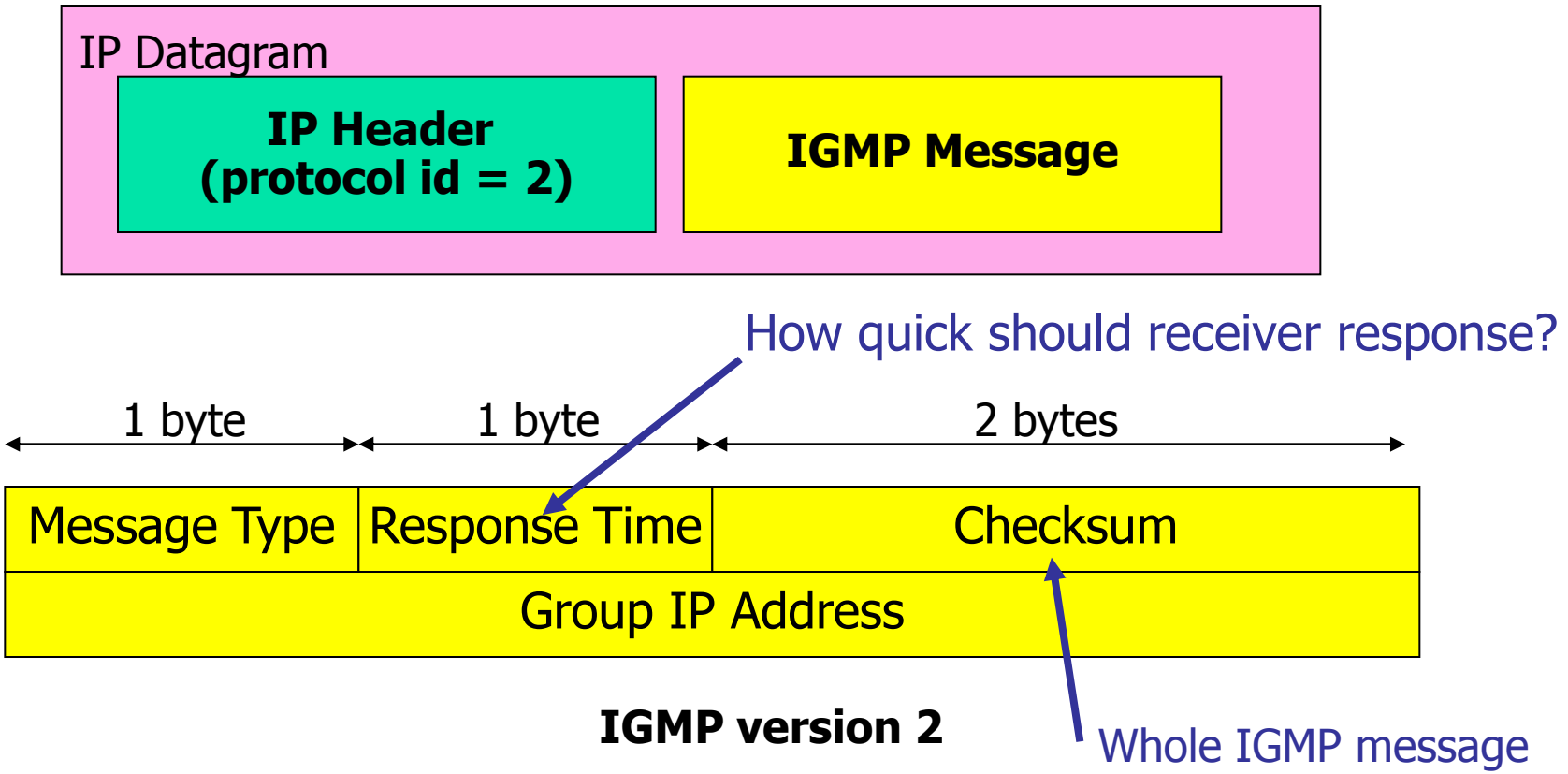
- Internet Group Management Protocol
- Multicast Group
  - Collection of hosts/routers wish to receive same packets
- Determine
  - station to register / withdraw
  - other hosts in group

IGMP


Network layer
IGMP
ICMP
IP
ARP

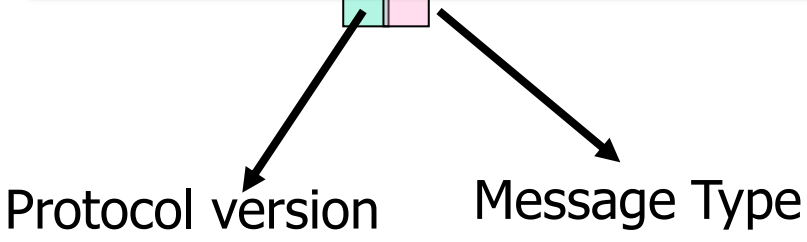

IGMP messages
Membership query
Membership report
General
Group-specific
Group-and-source-specific

IGMP Format

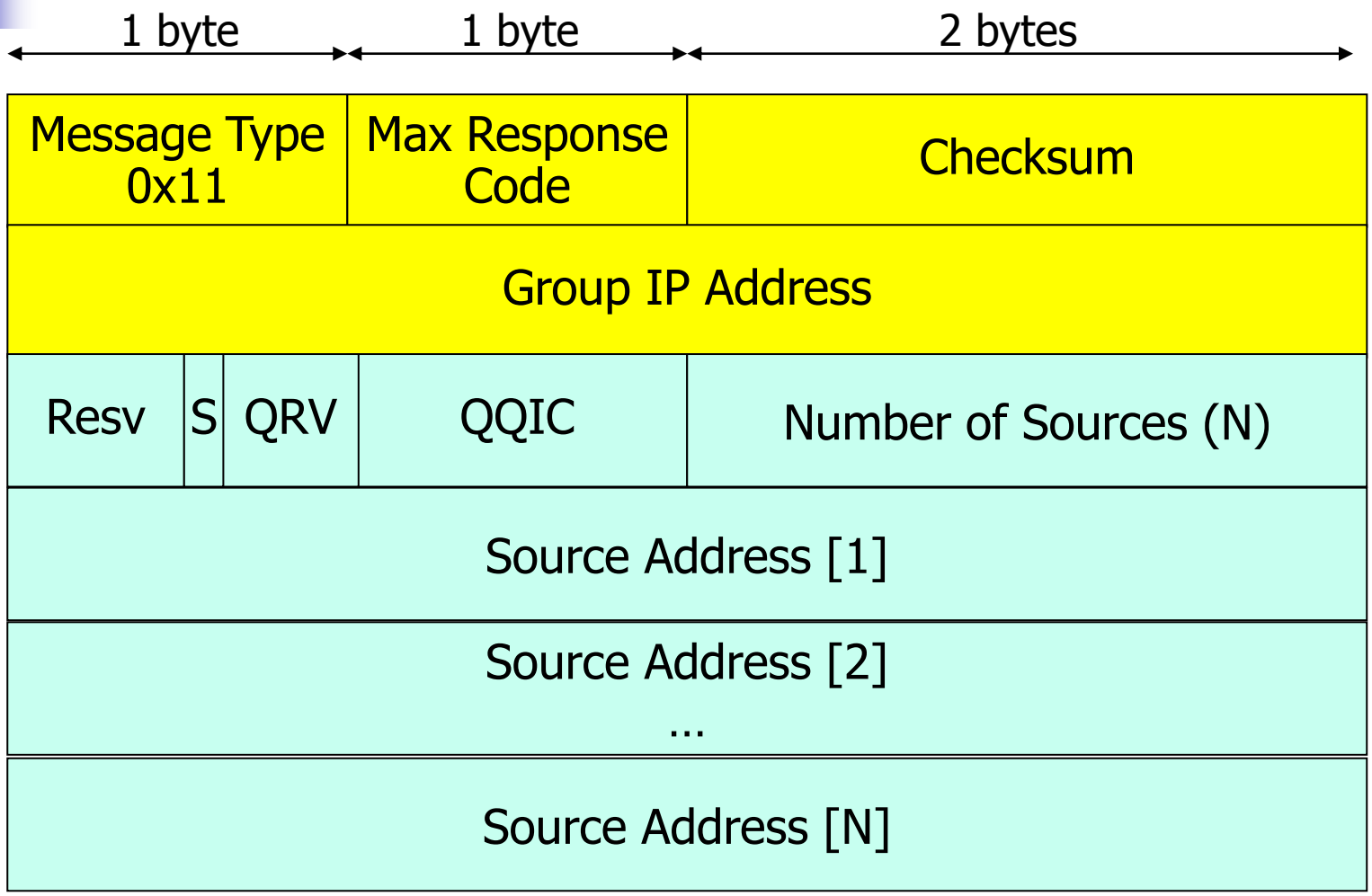

IP Datagram
IP Header
(protocol id = 2)
IGMP Message
How quick should receiver response?
1 byte
1 byte
2 bytes
Message Type
Response Time
Checksum
Group IP Address
IGMP version 2
Whole IGMP message

IGMP Message Types

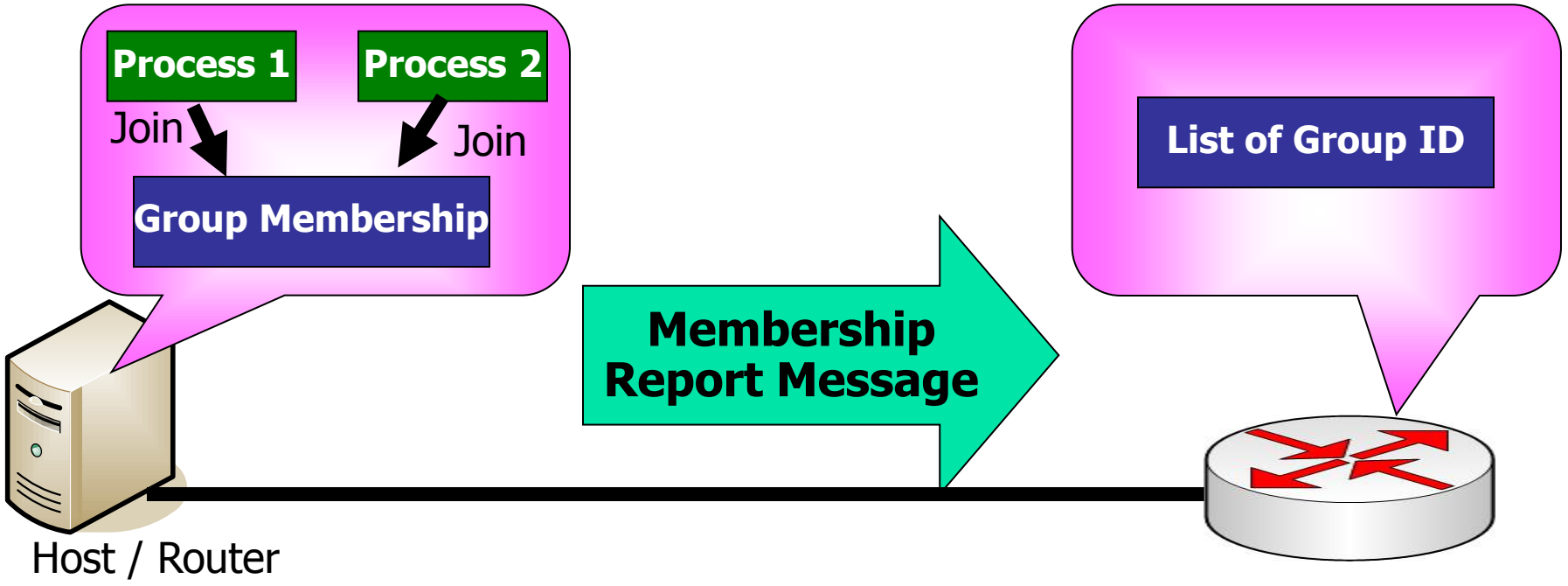
Message Type		Meaning
Ver.1	Ver.2	
1	17	Group membership query
2	18	Response to Group query
6	22	Response to Group query
7	23	Announcement leaving a group



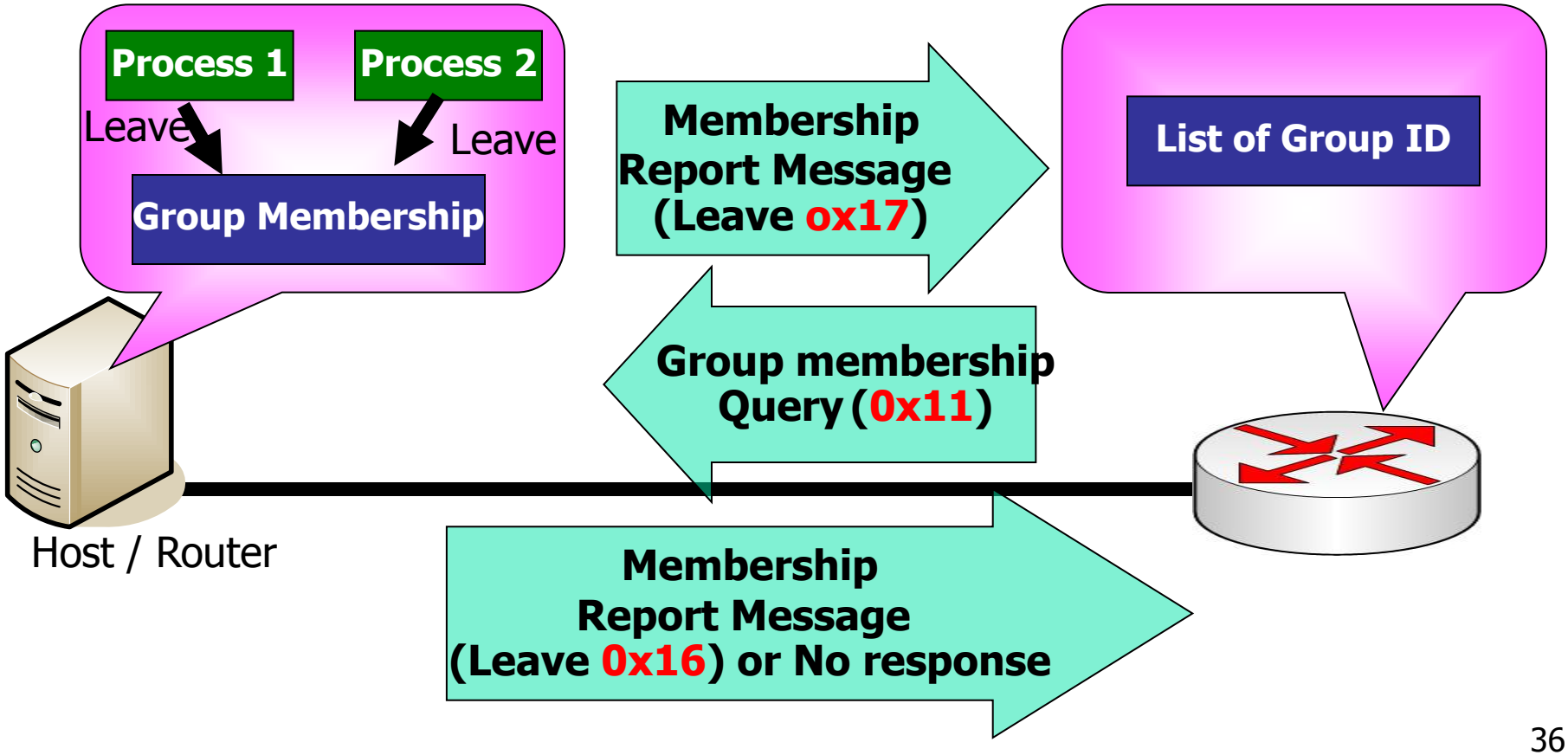
IGMP v3


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]

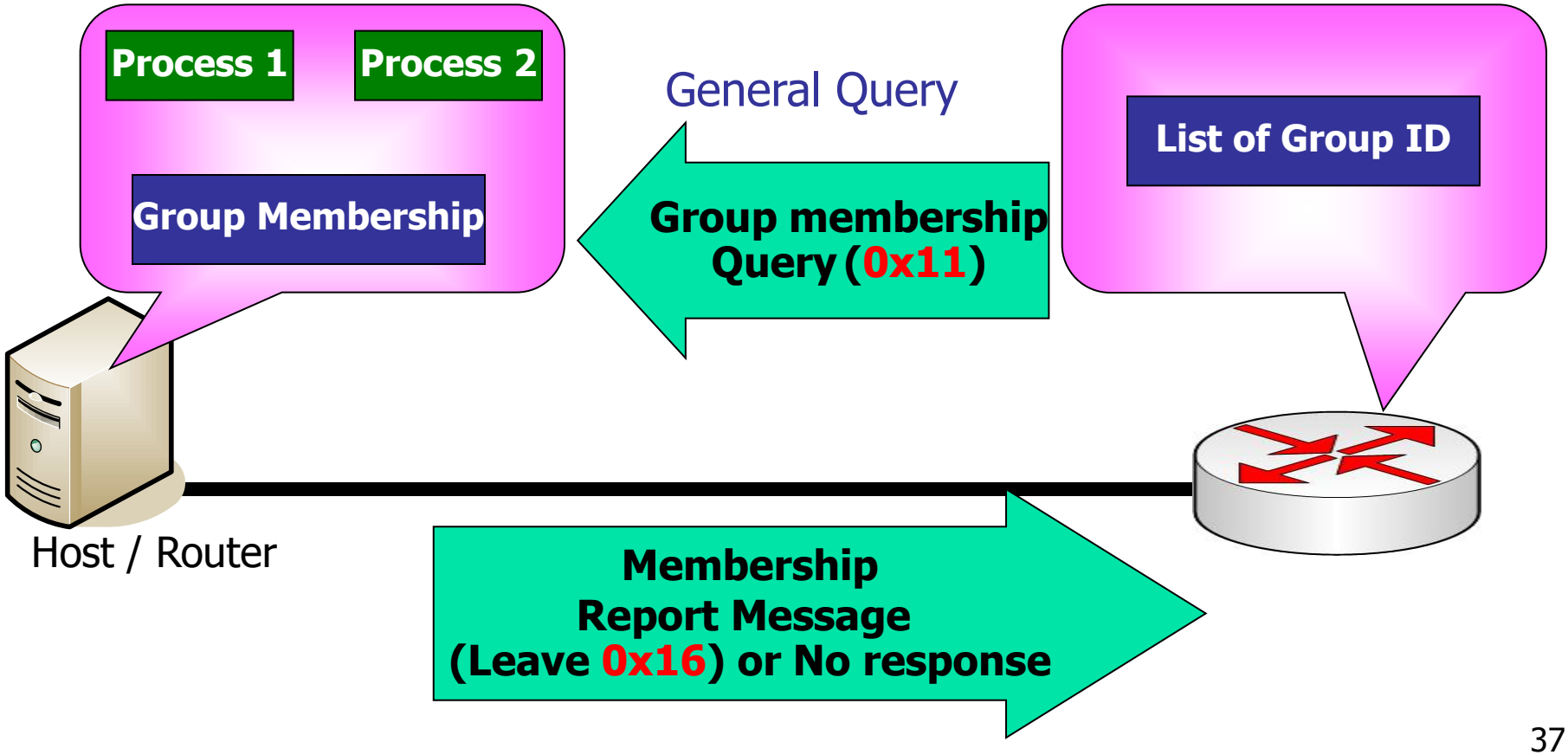
Joining a group

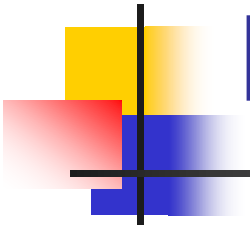


Leaving a group



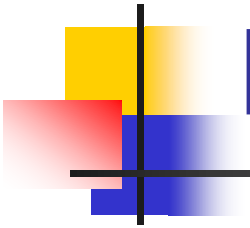
Membership Monitoring





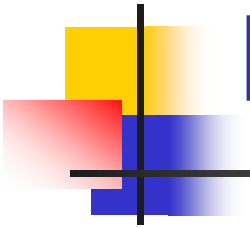
Multicast Routing

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



Multicast Routing

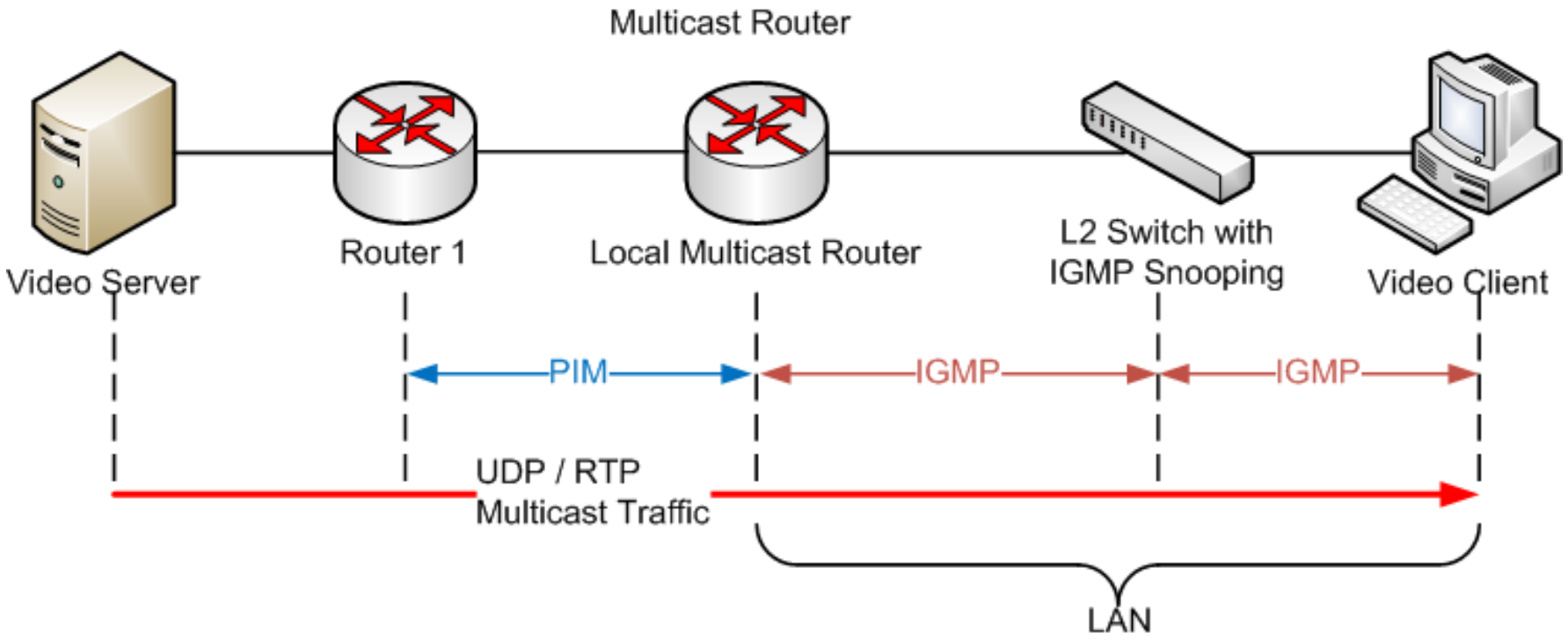
- Dense mode protocols
  - assumes dense group membership
  - Source distribution tree and NACK type
  - DVMRP (Distance Vector Multicast Routing Protocol)
  - PIM-DM (Protocol Independent Multicast, Dense Mode)



Multicast Routing

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

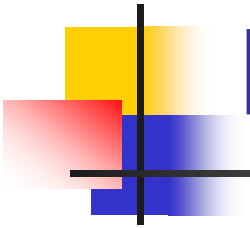
Multicast Basic Architecture



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

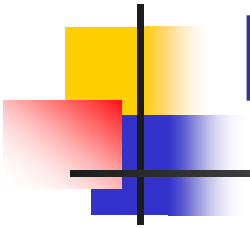
Why deploy Multicast Service?

- 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

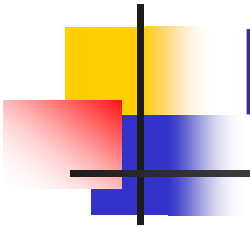
- New service needs to be reliable
  - predeployment analysis, experiments, pilots
  - rapid fault diagnosis & repair
  - capacity planning



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