



Multicast

รศ.ดร. อนันต์ พลเพิ่ม

Asso. Prof. Anan Phonphoem, Ph.D.

anan.p@ku.ac.th

<http://www.cpe.ku.ac.th/~anan>

Computer Engineering Department

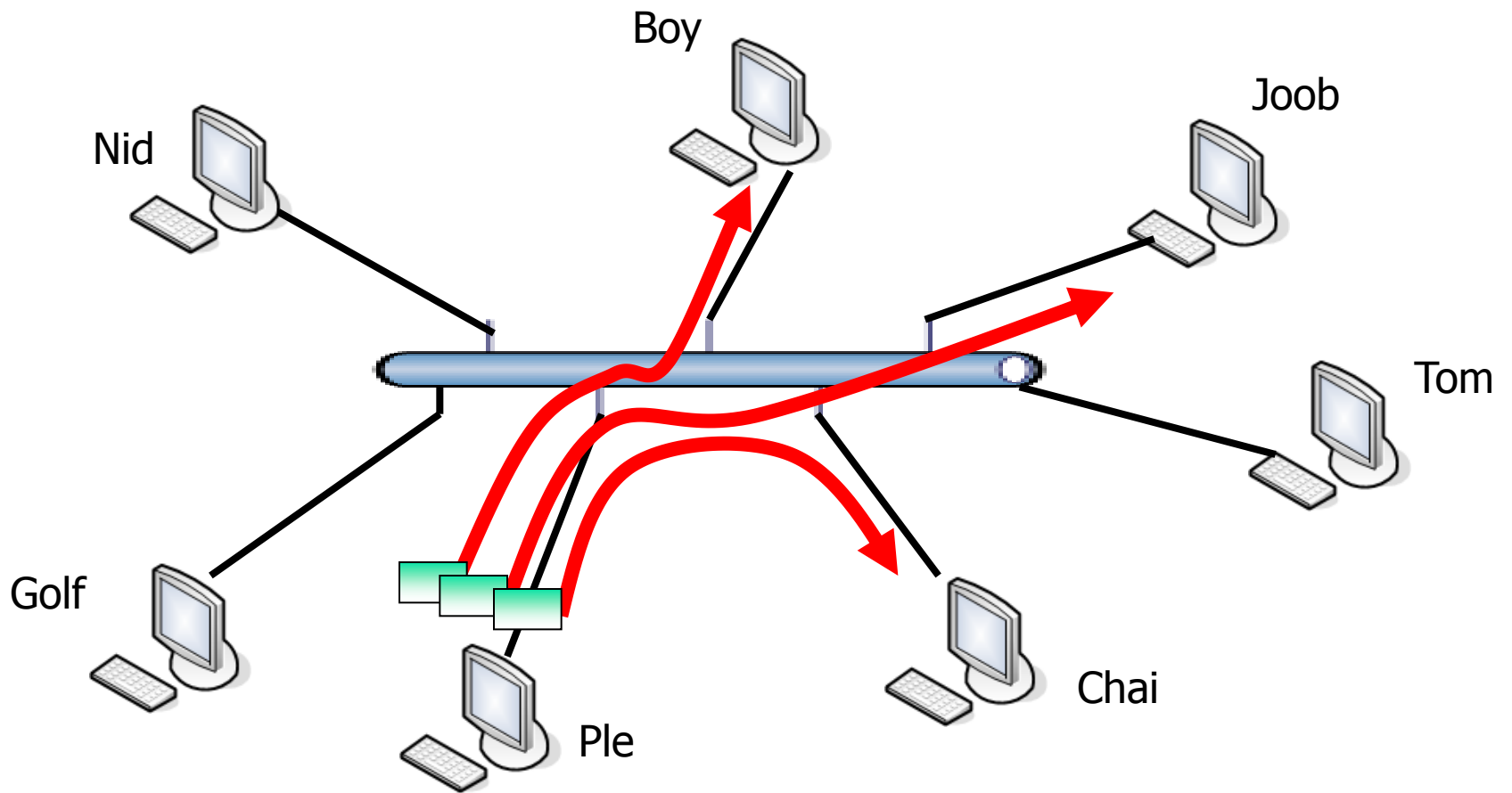
Kasetsart University, Bangkok, Thailand



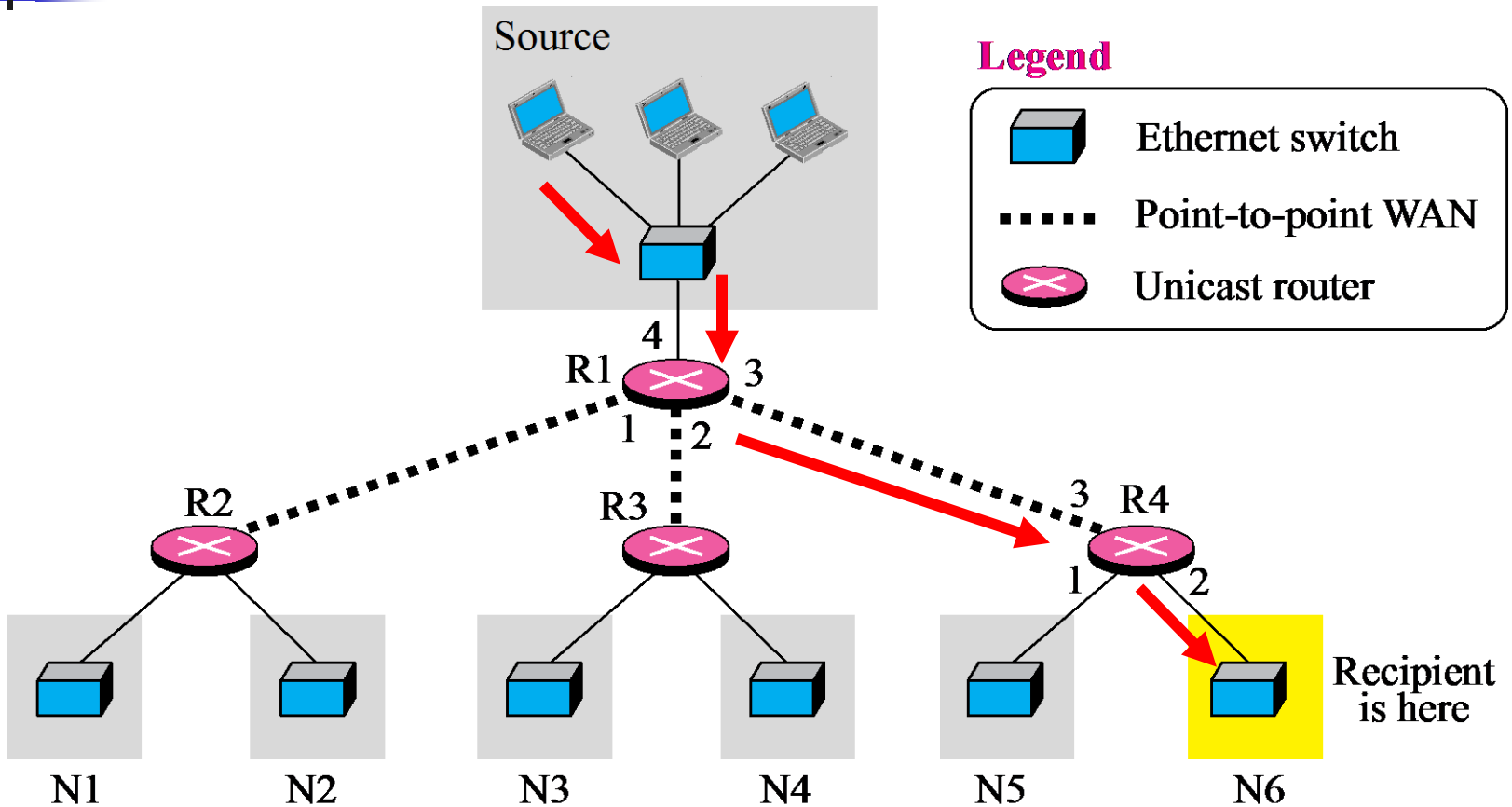
IP Datagram delivery

- Unicast
- Broadcast
- Multicast

Unicast



Unicast

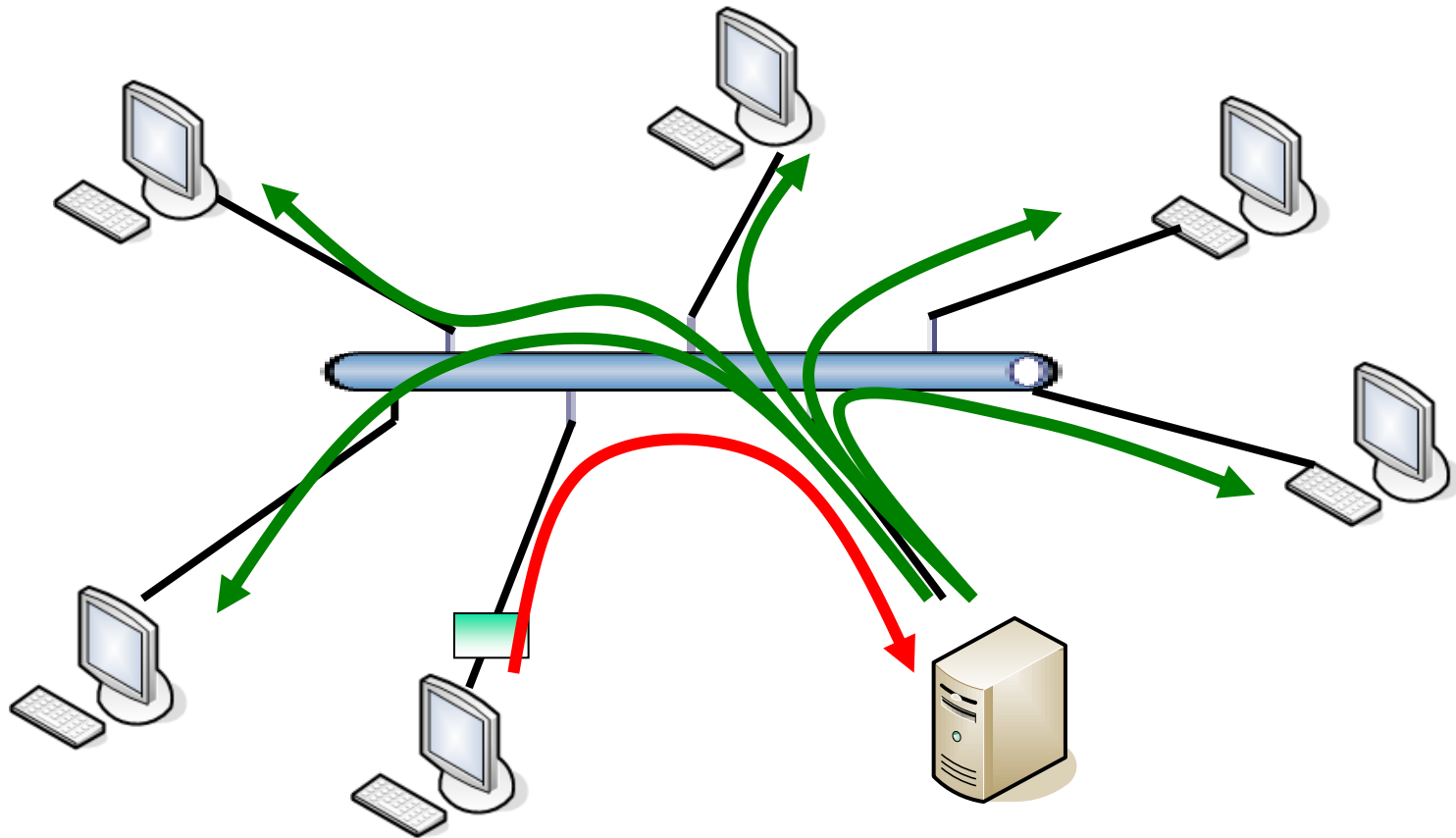




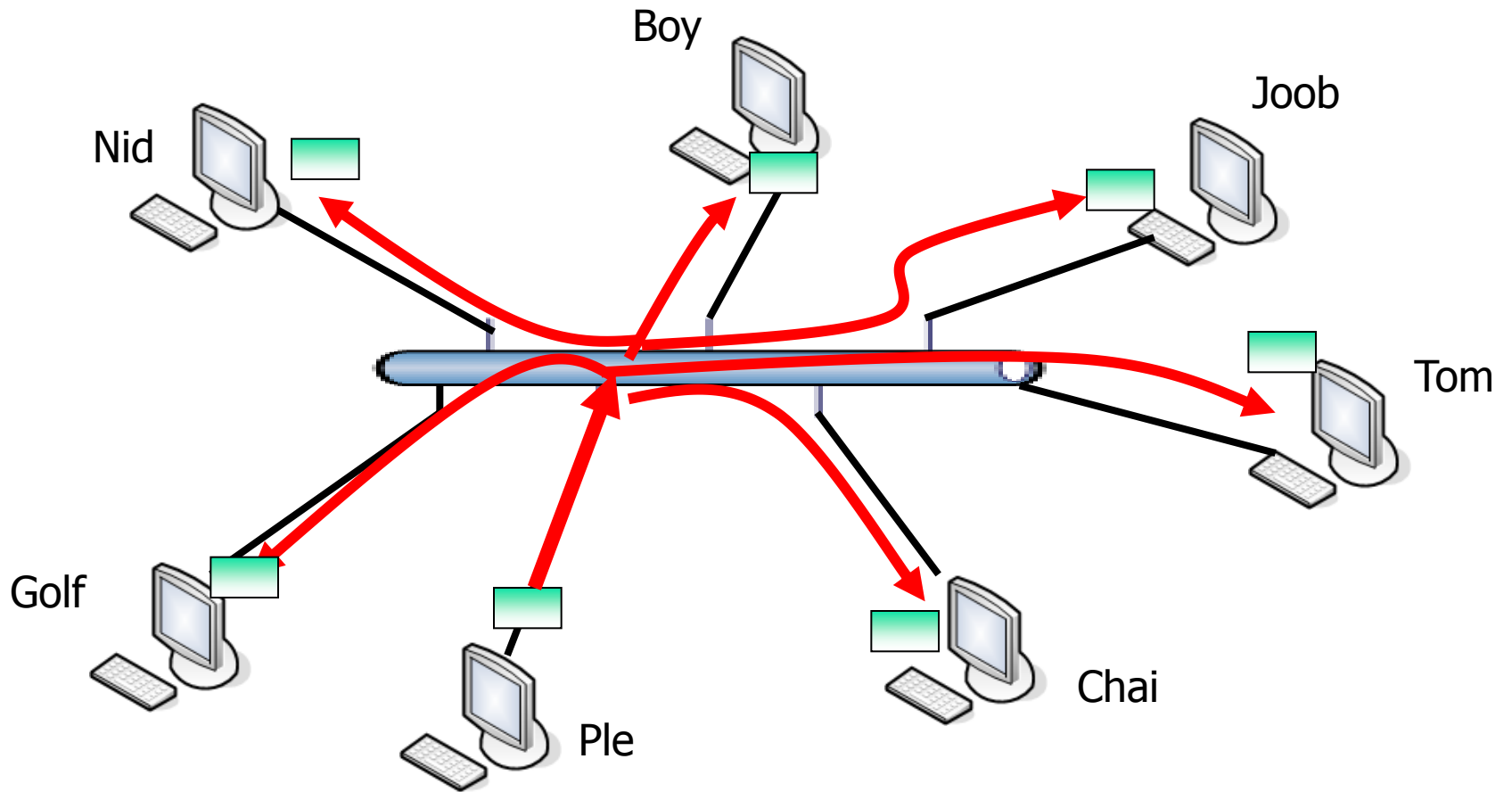
Unicast

- 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

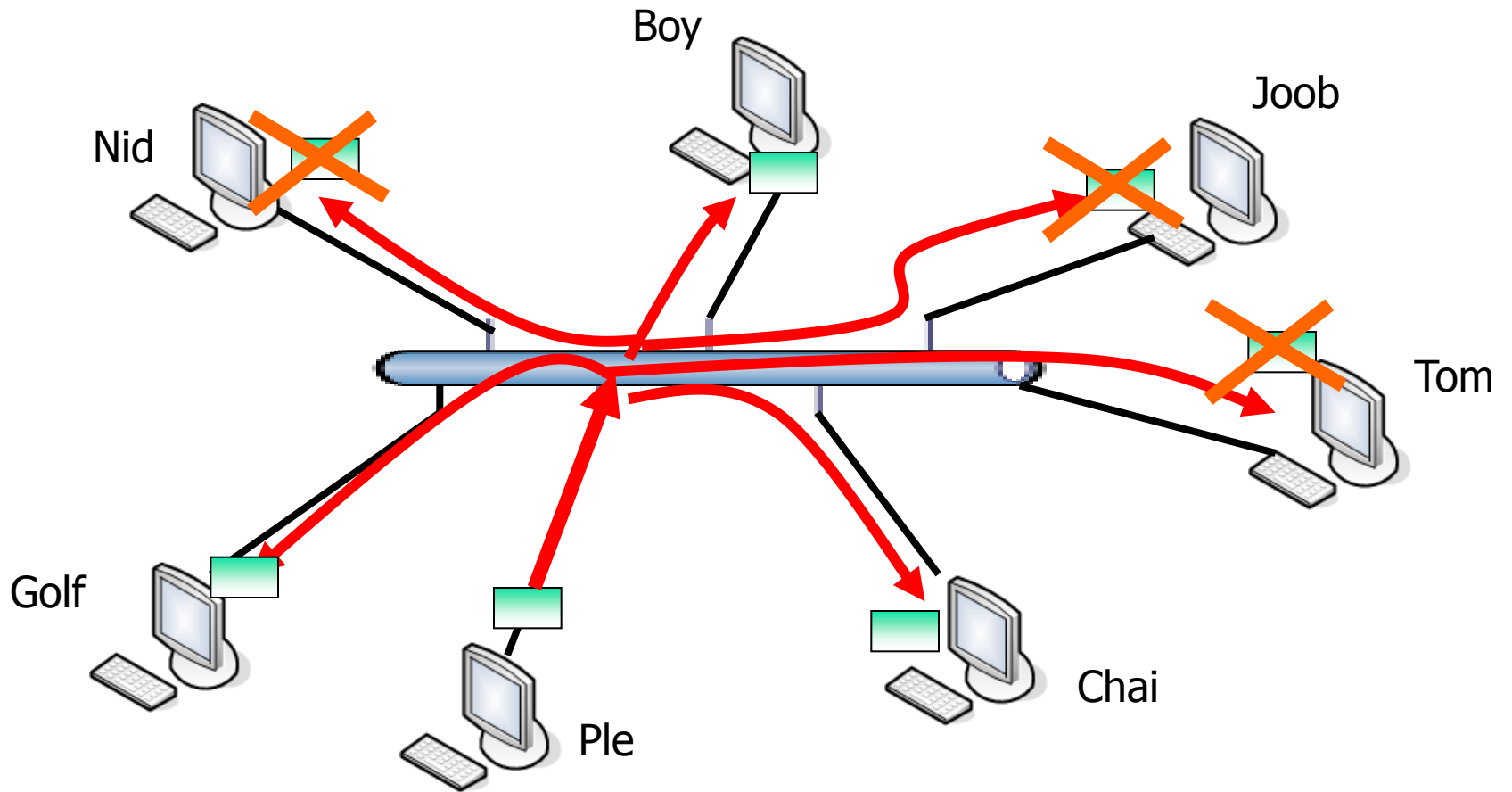
- One-to-all
- Data-Link implementation
 - Broadcast Add. FF-FF-FF-FF-FF-FF
- Each Frame to all nodes
 - Less Data Traffic



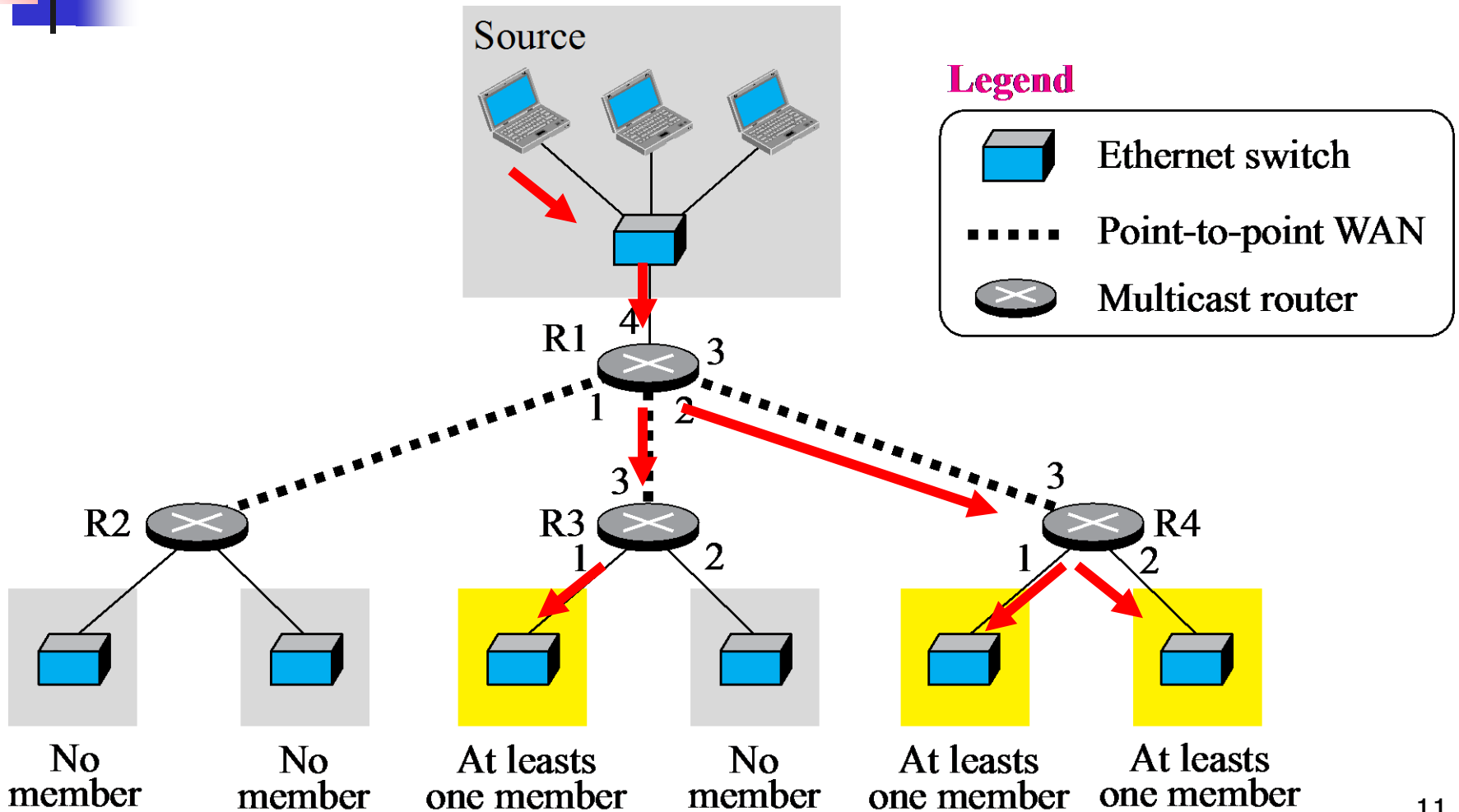
Broadcast Problem

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

Multicast



Multicast





Multicast

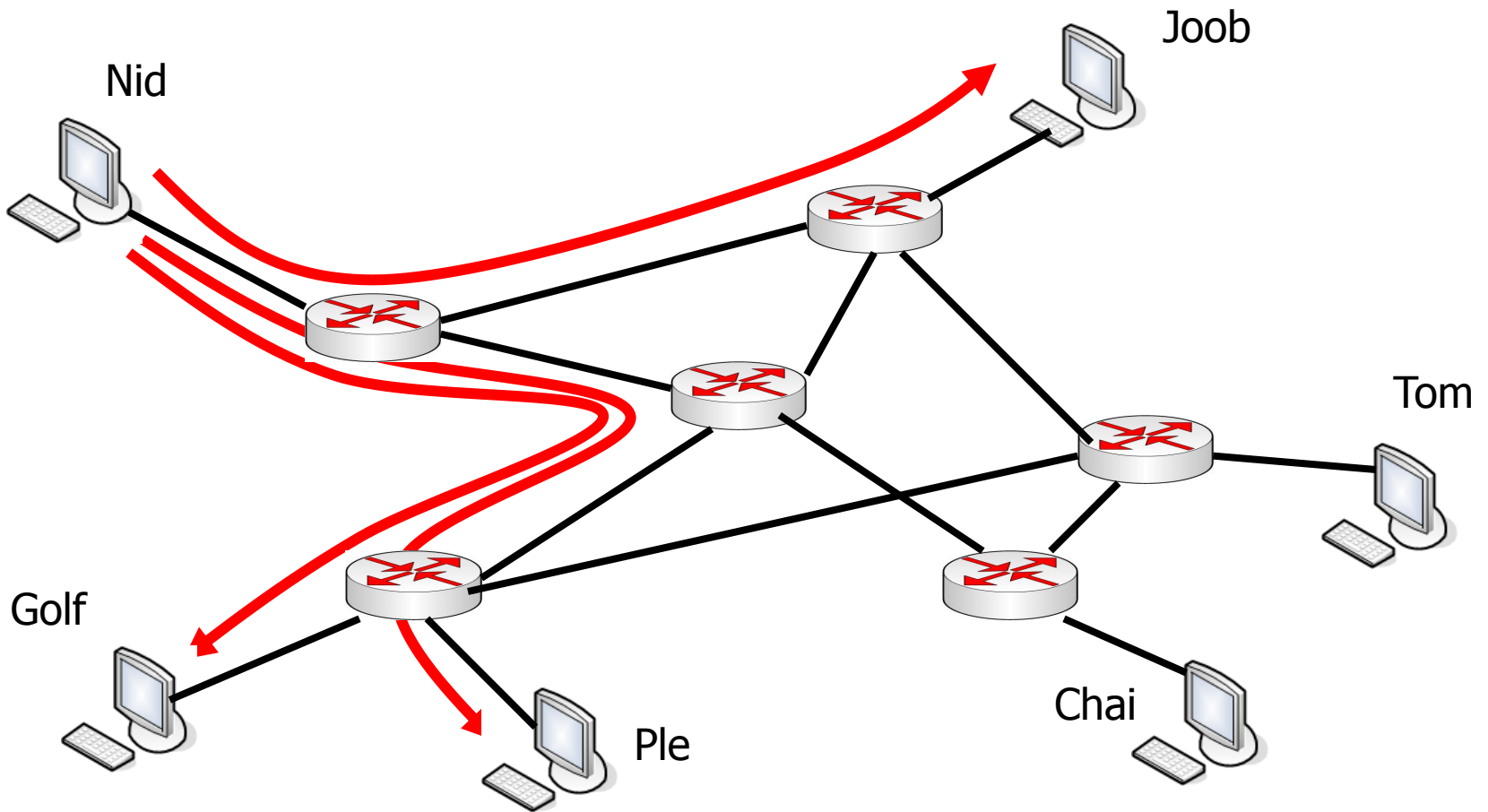
- One-to-many (Not to all)
- Need special address for the group
- Actually broadcast
 - Still have processing overhead
 - Non-participate stations only look and throw away
→ Less overhead
- Can Reduces more ?
 - Possible to map IP multicast to MAC multicast



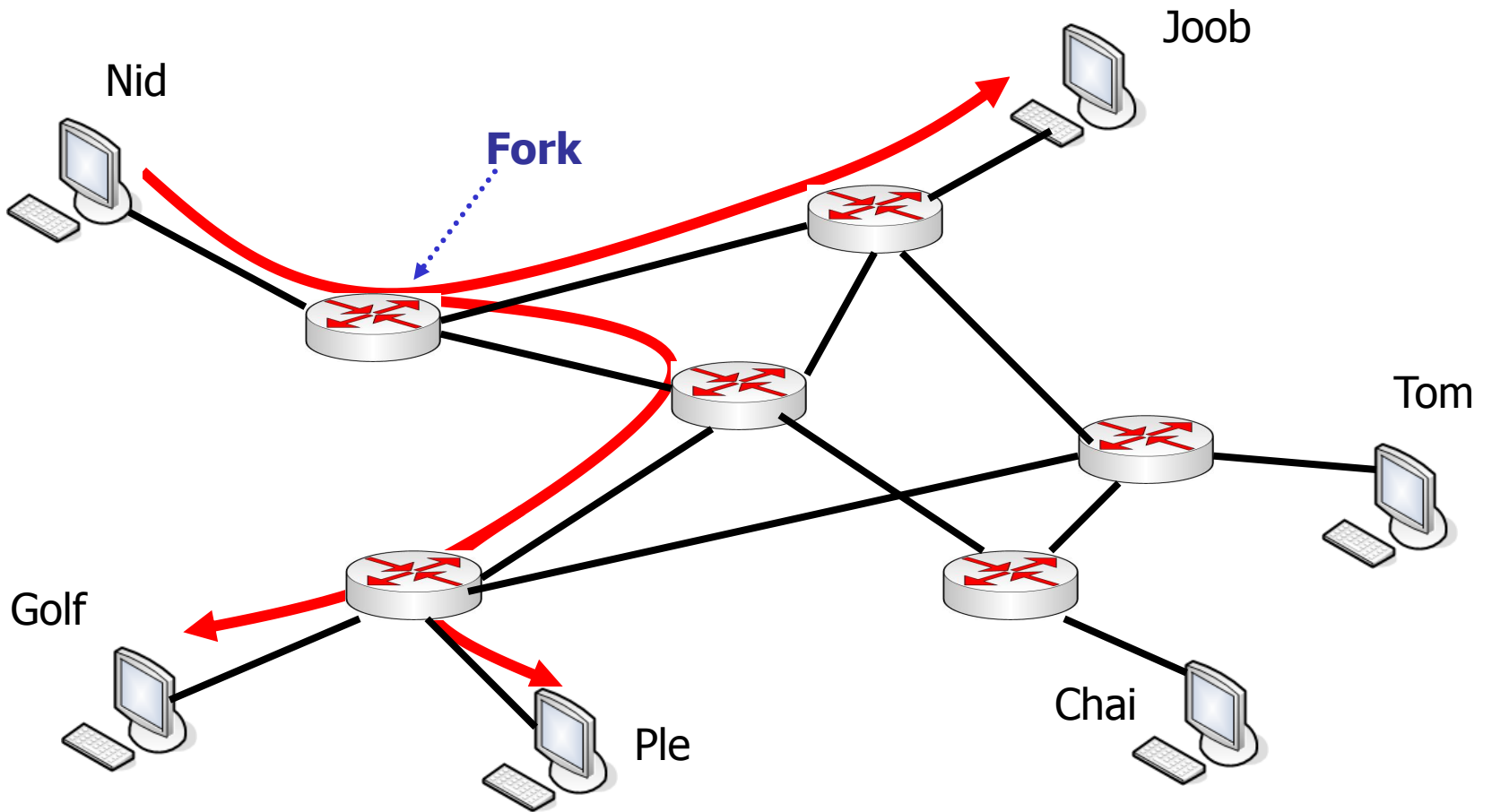
Multicast

- 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

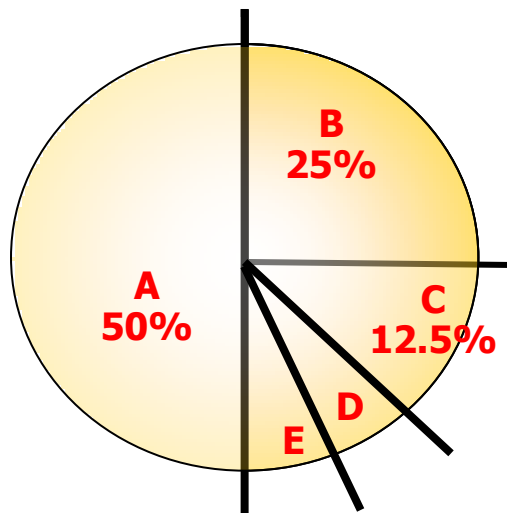


Multicast Applications

- 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



Class A	0	Netid
Class B	1 0	Netid
Class C	1 1 0	
Class D	1 1 1 0	
Class E	1 1 1 1	



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

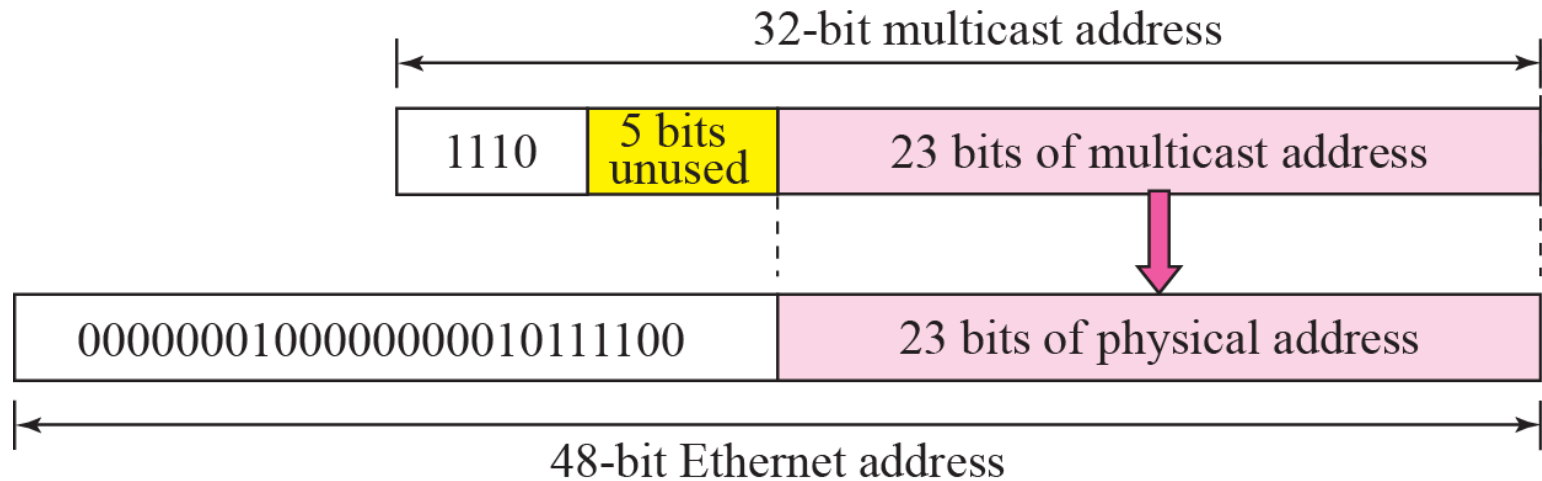
C:\Documents and Settings\anan>
```



Mapping

Multiclass IP Add \leftrightarrow 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

Hex

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 : X**100 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

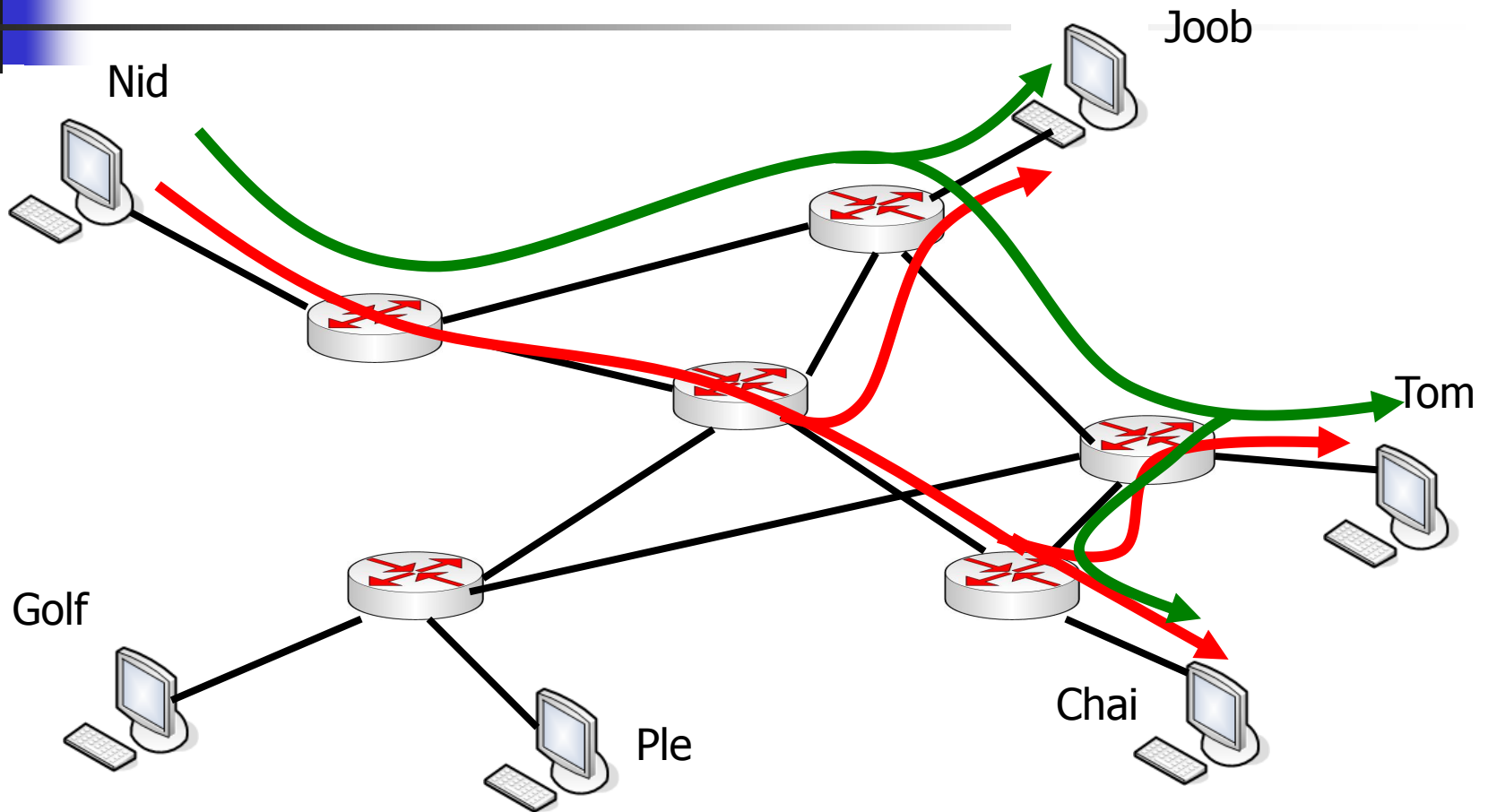
All 32 IP adds → map to the same MAC address **01:00:5e:44:1c:3**



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

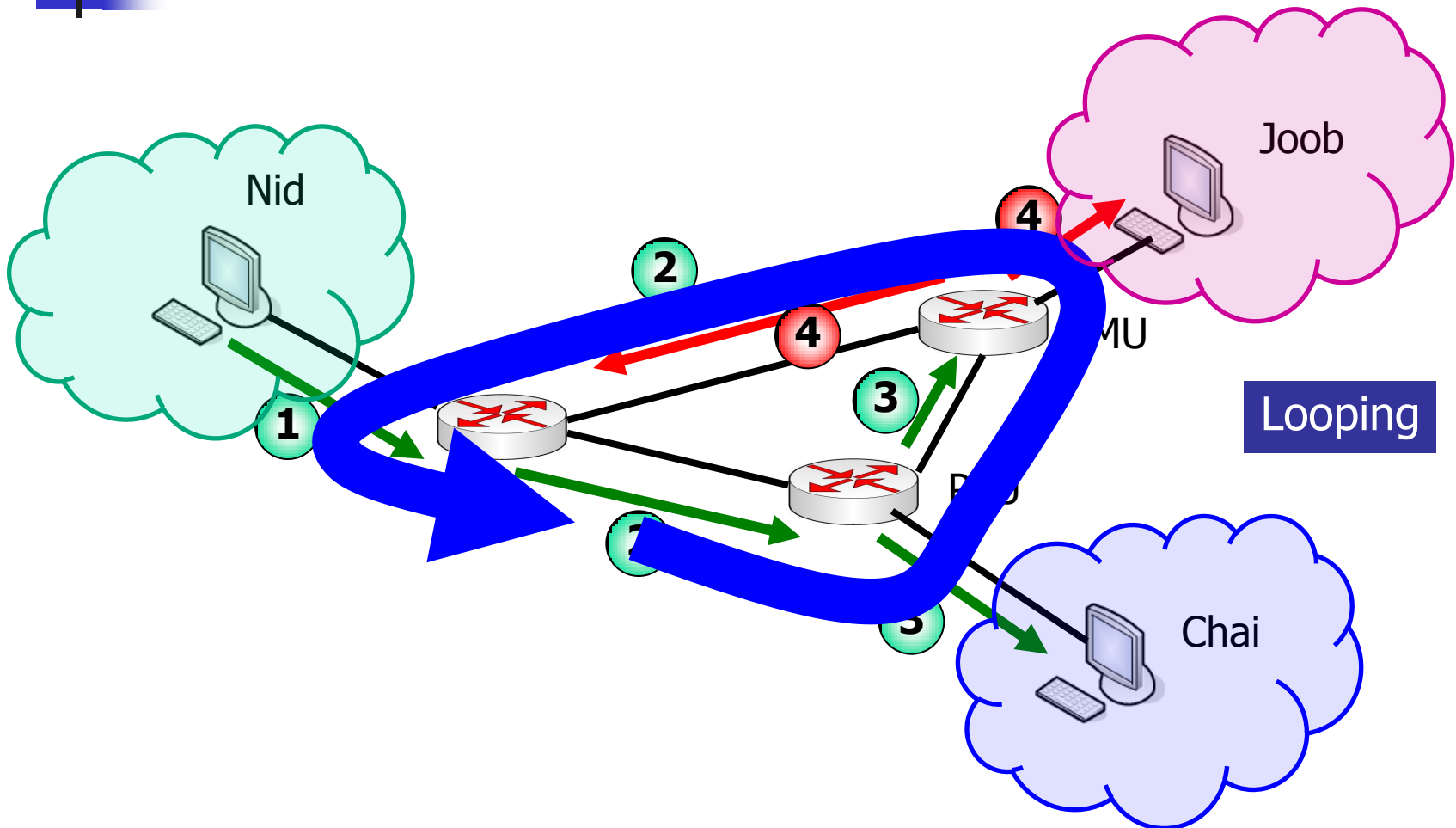
Multicast paths



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

For green path: Job(2 hops), Tom(3 hops), Chai(4 hops) : Total packet (6 hops)₂₆

Multicast Scenario

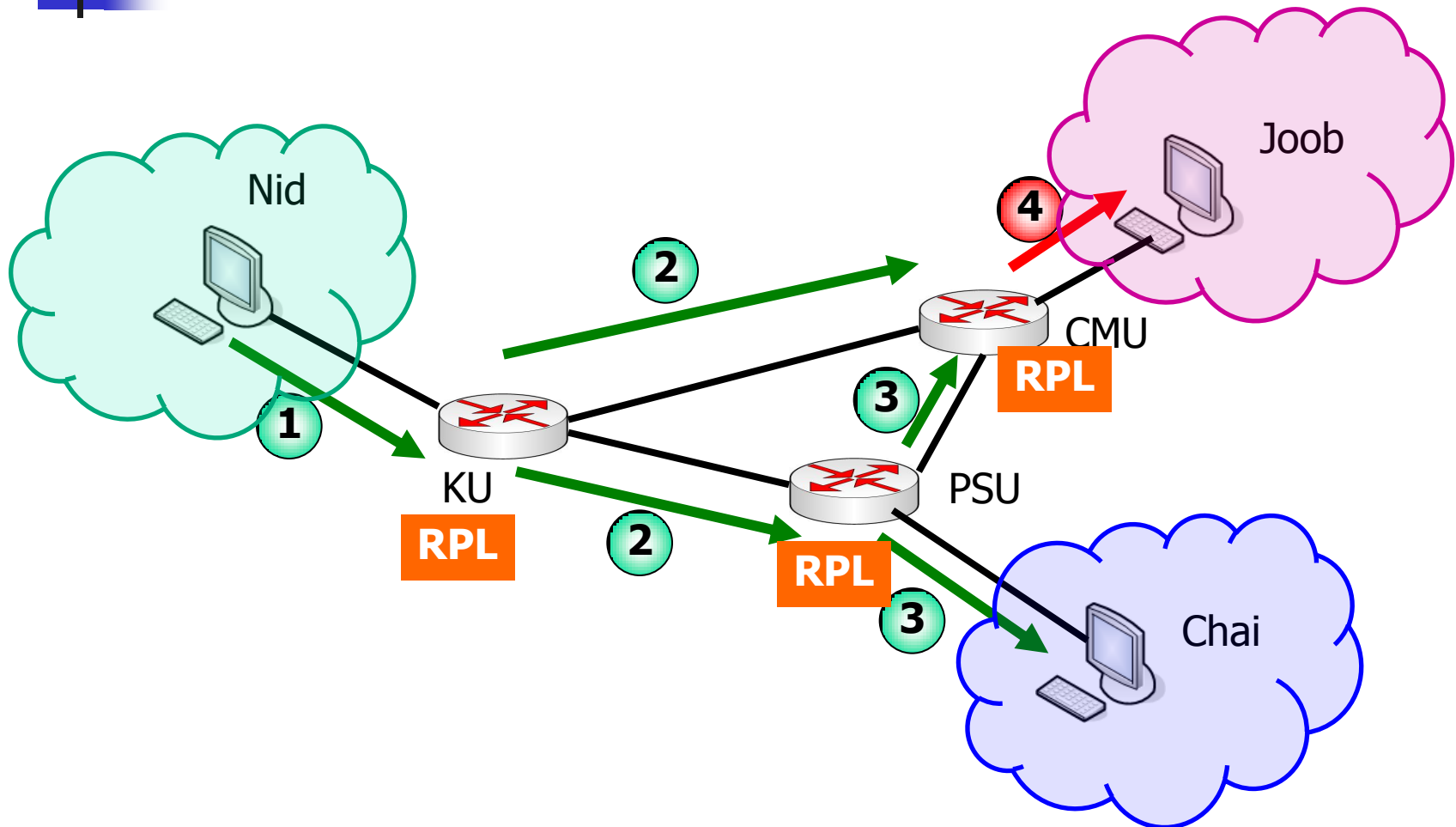




Reverse Path Lookup (RPL)

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

Reverse Path Lookup (RPL)



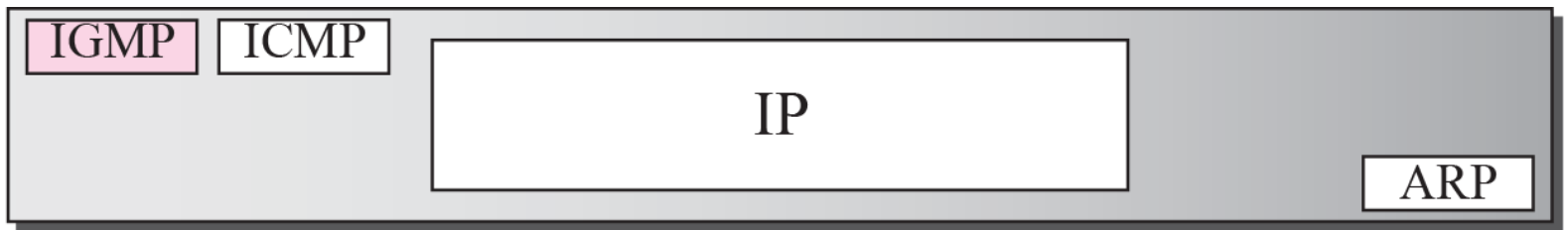


IGMP

- 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



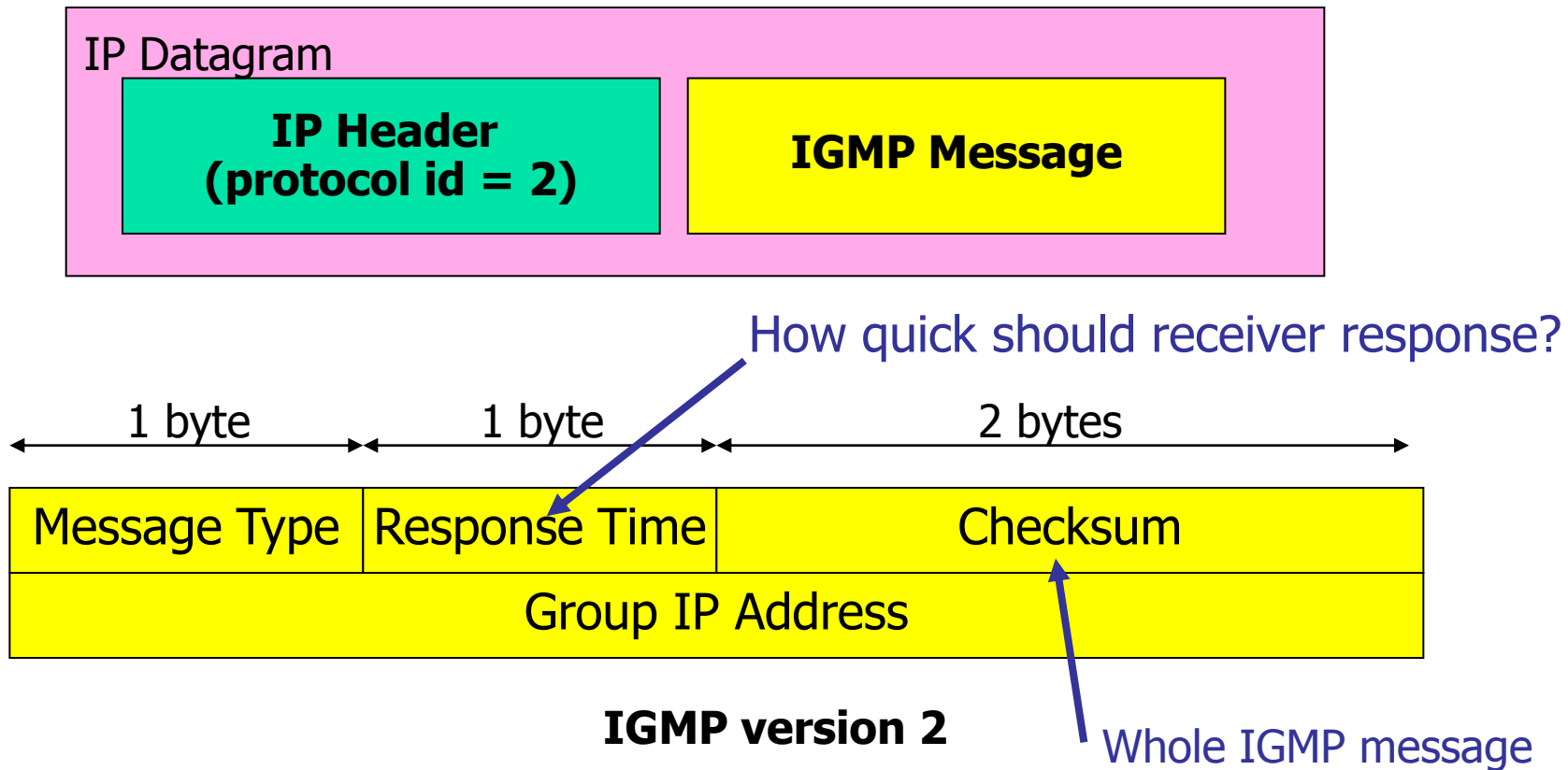
IGMP messages

Membership query

Membership report

- General
- Group-specific
- Group-and-source-specific

IGMP Format



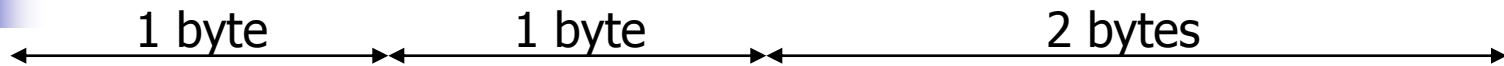
IGMP Message Types

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

Protocol version

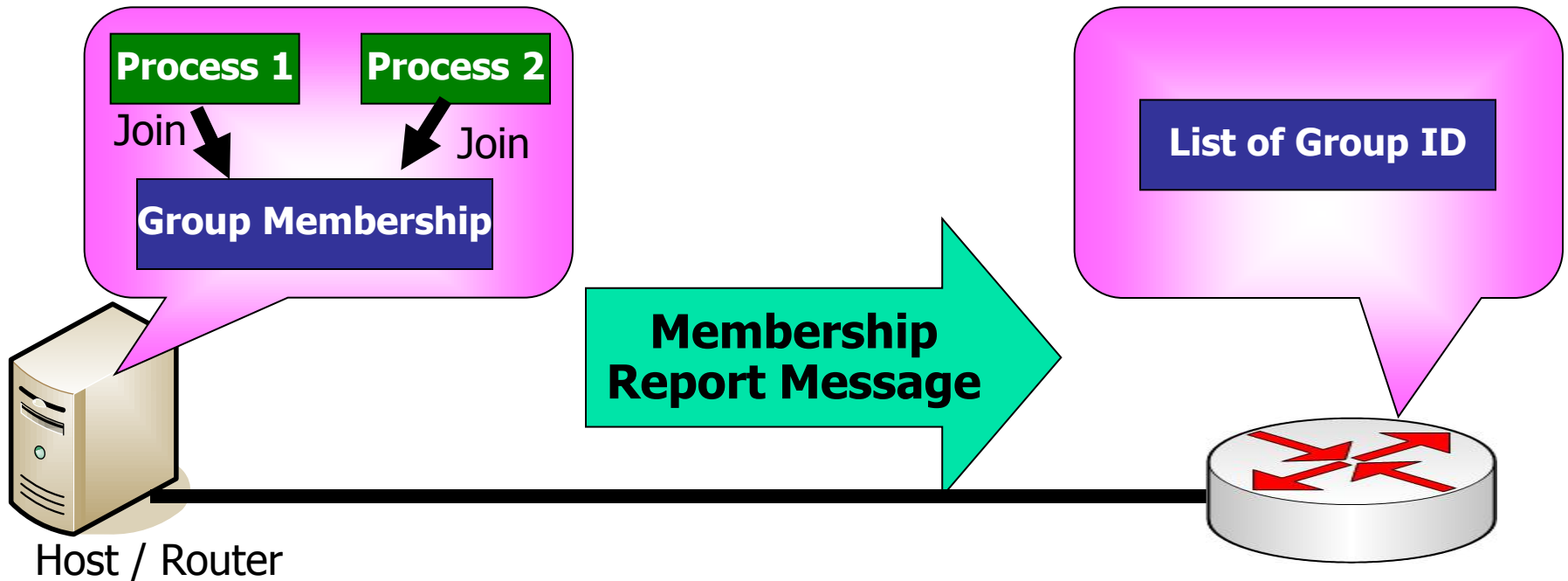
Message Type

IGMP v3

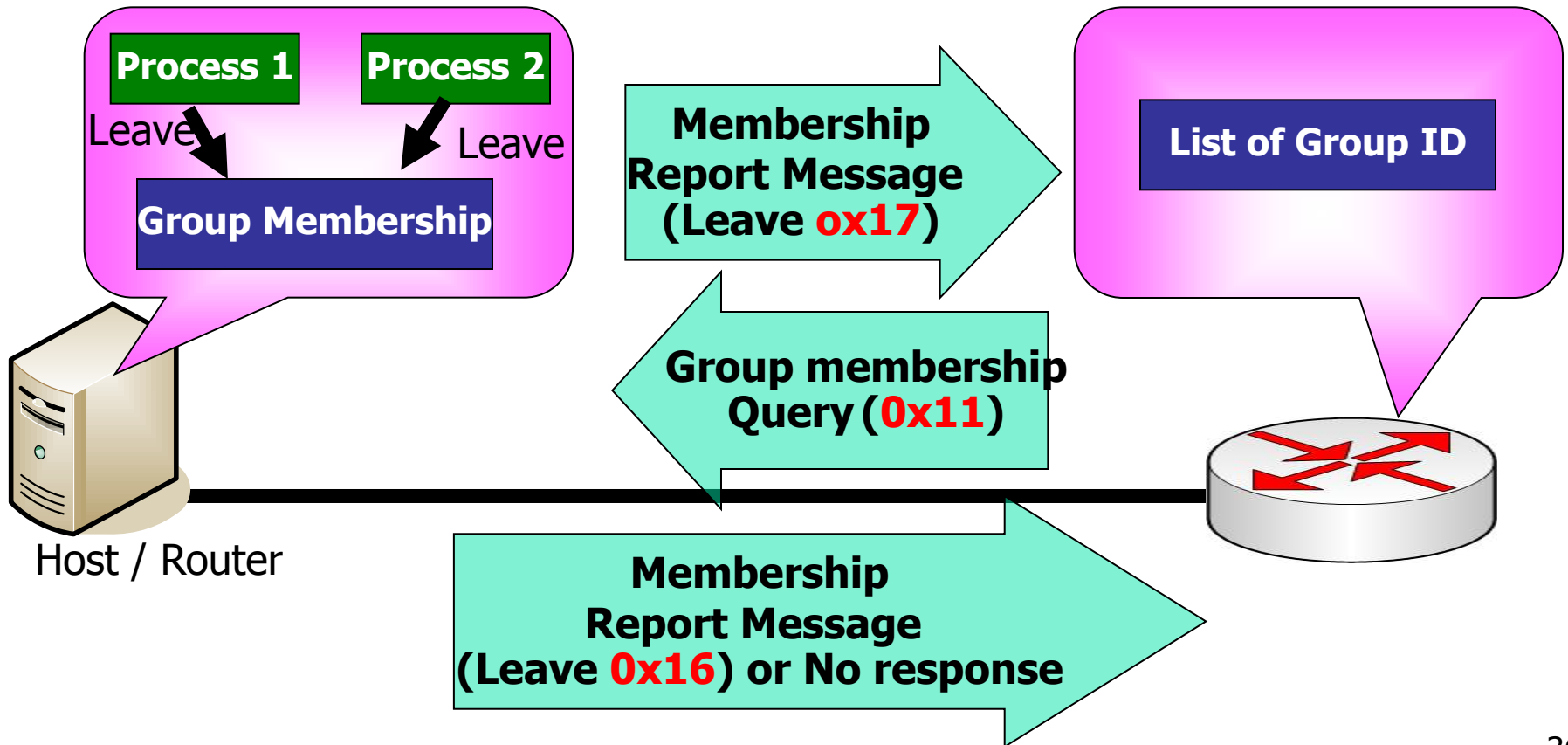


Message Type 0x11		Max Response Code		Checksum	
Group IP Address					
Resv	S	QRV	QQIC	Number of Sources (N)	
Source Address [1]					
Source Address [2]					
...					
Source Address [N]					

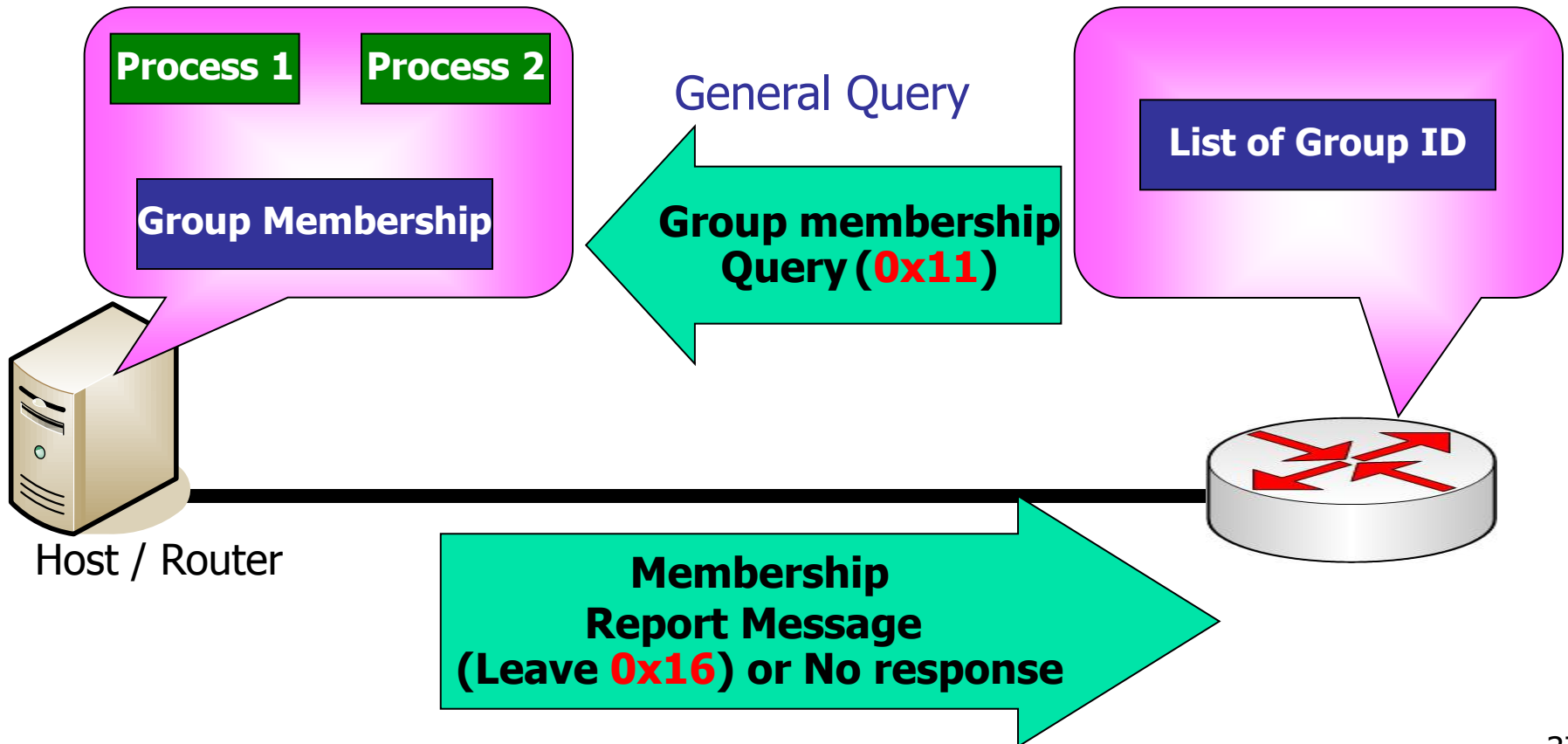
Joining a group



Leaving a group



Membership Monitoring





Multicast Routing

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



Multicast Routing

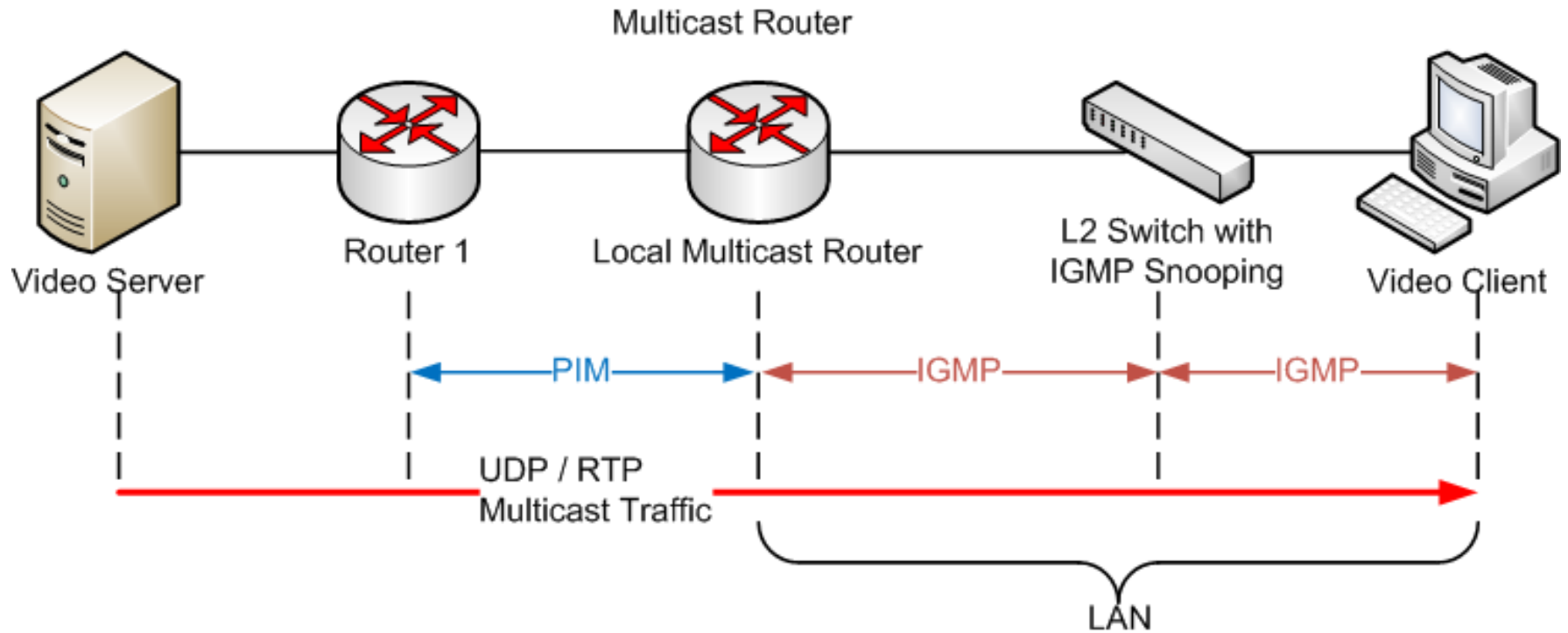
- Dense mode protocols
 - assumes dense group membership
 - Source distribution tree and NACK type
 - DVMRP (Distance Vector Multicast Routing Protocol)
 - PIM-DM (Protocol Independent Multicast, Dense Mode)



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





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