



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

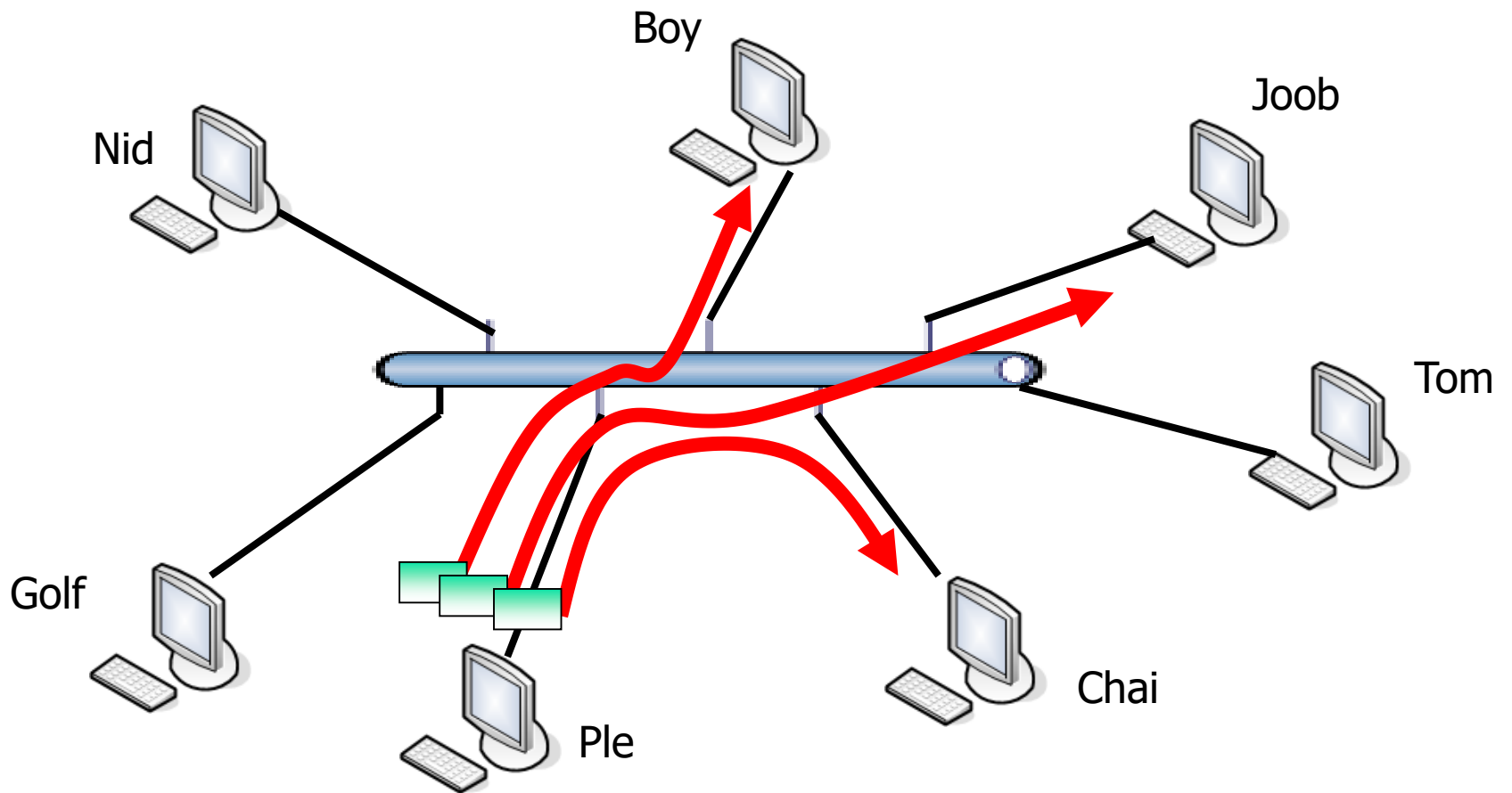
Kasetsart University, Bangkok, Thailand



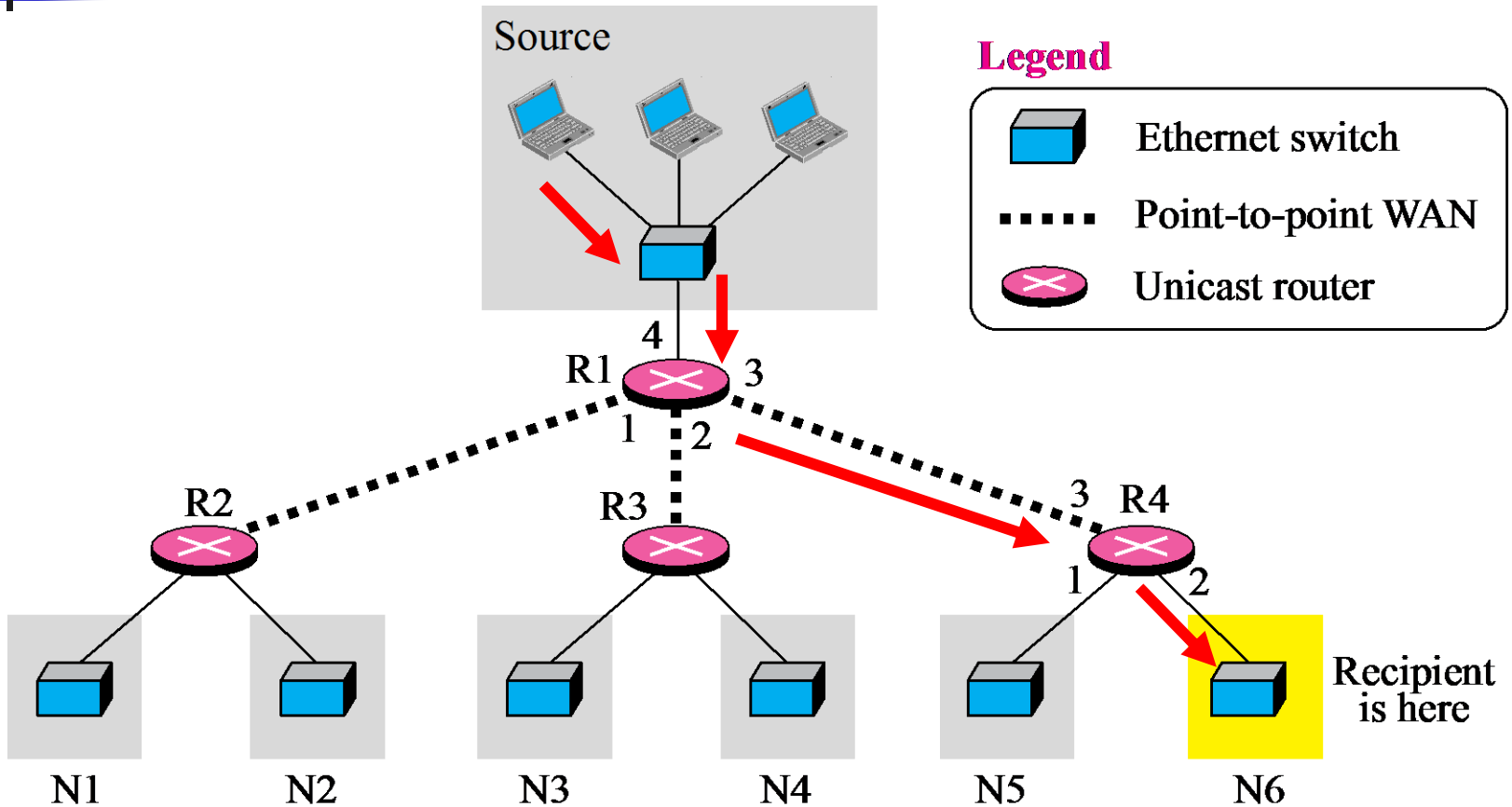
IP Datagram delivery

- Unicast
- Broadcast
- Multicast

Unicast



Unicast

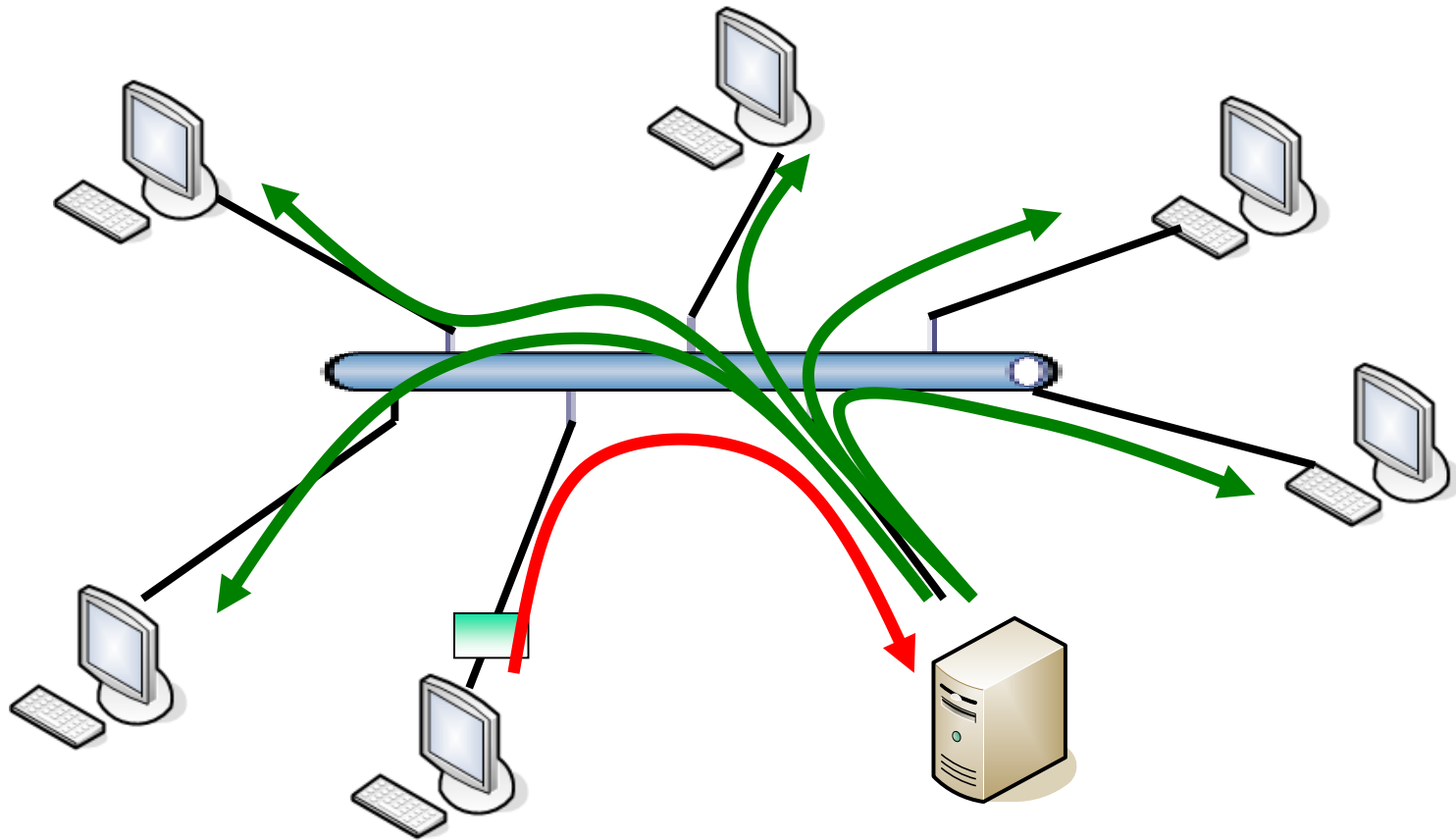




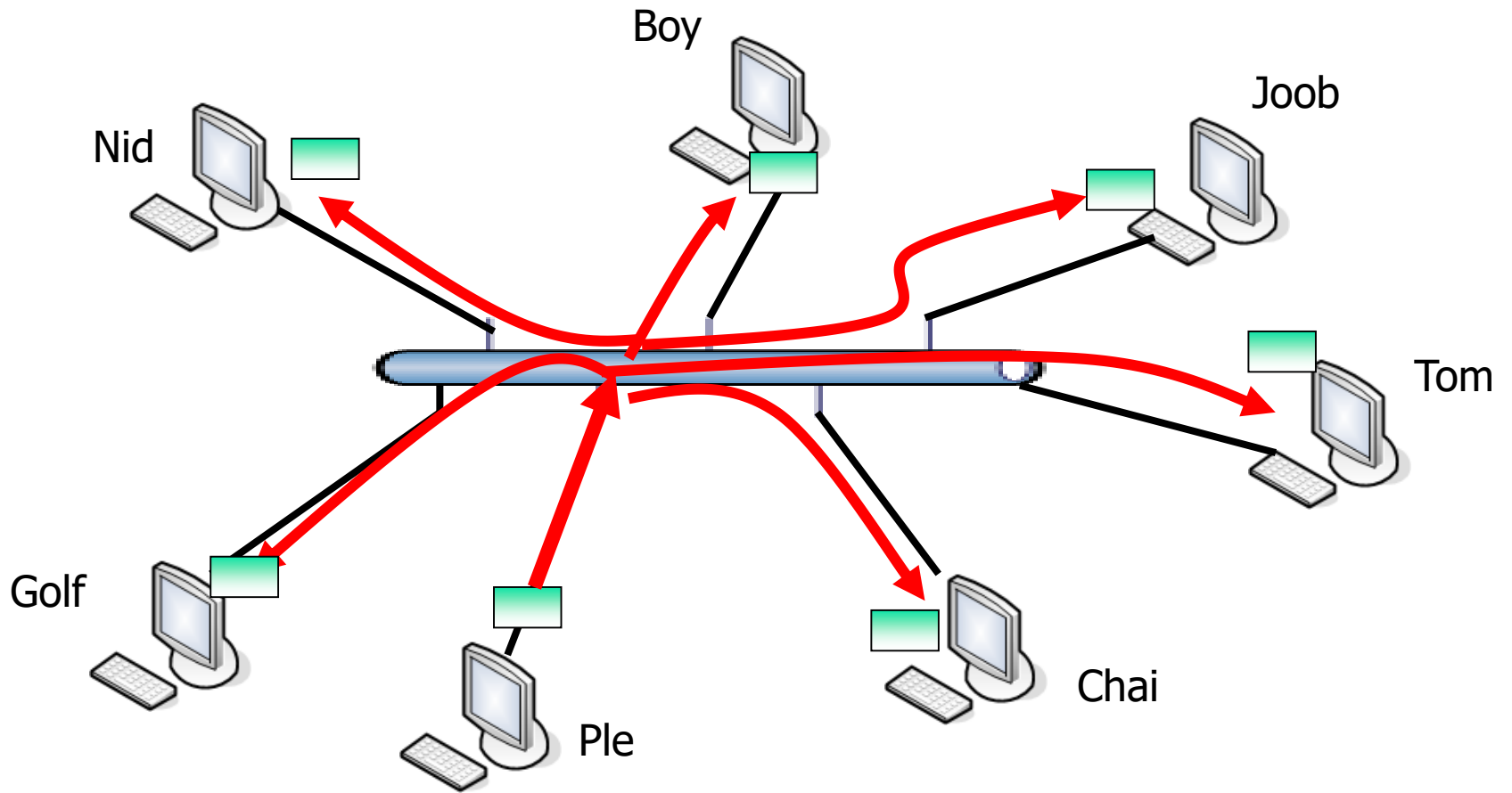
Unicast

- 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

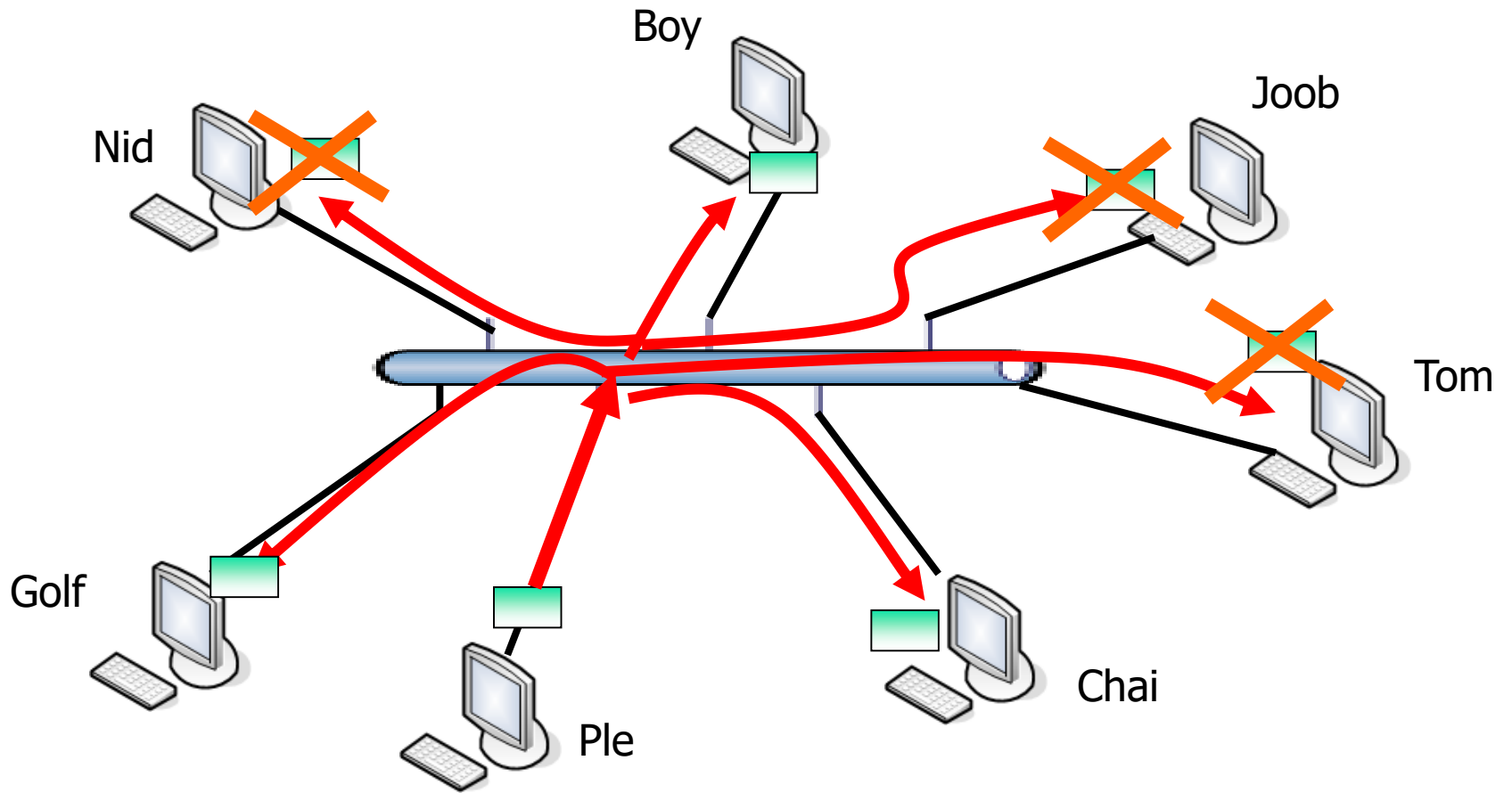
- One-to-all
- Data-Link implementation
 - Broadcast Add. FF-FF-FF-FF-FF-FF
- Each Frame to all nodes
 - Less Data Traffic



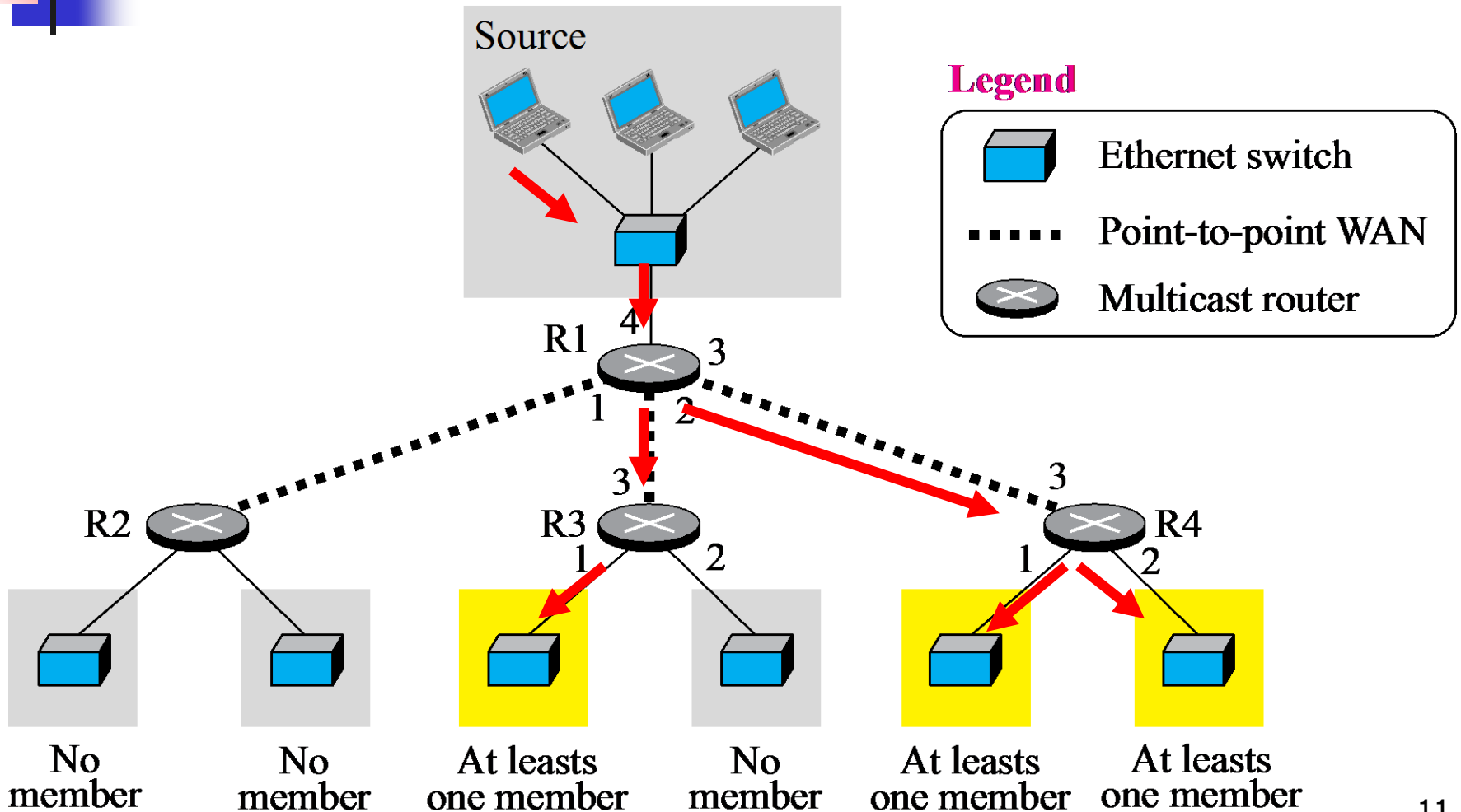
Broadcast Problem

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

Multicast



Multicast





Multicast

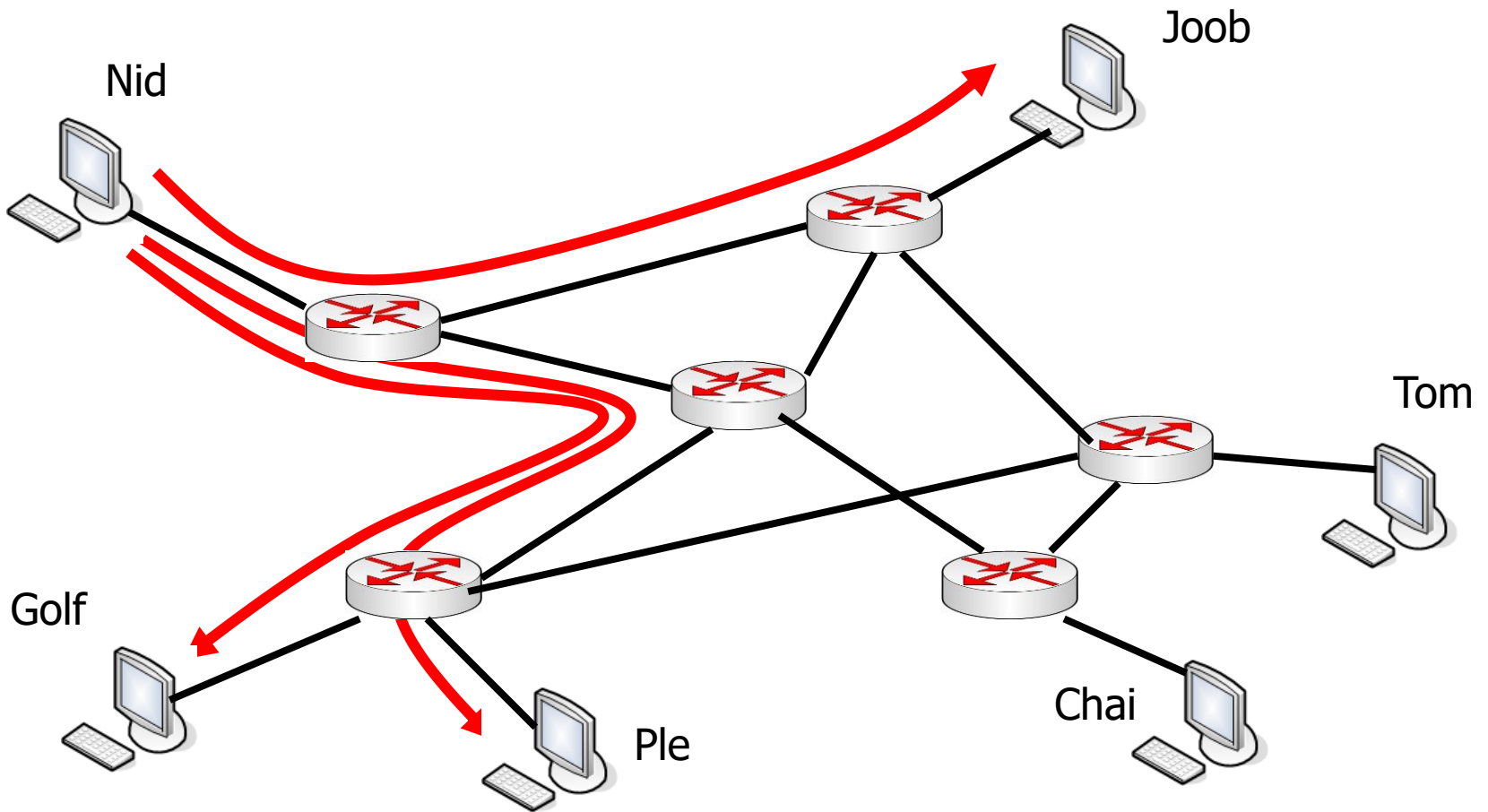
- One-to-many (Not to all)
- Need special address for the group
- Actually broadcast
 - Still have processing overhead
 - Non-participate stations only look and throw away
→ Less overhead
- Can Reduces more ?
 - Possible to map IP multicast to MAC multicast



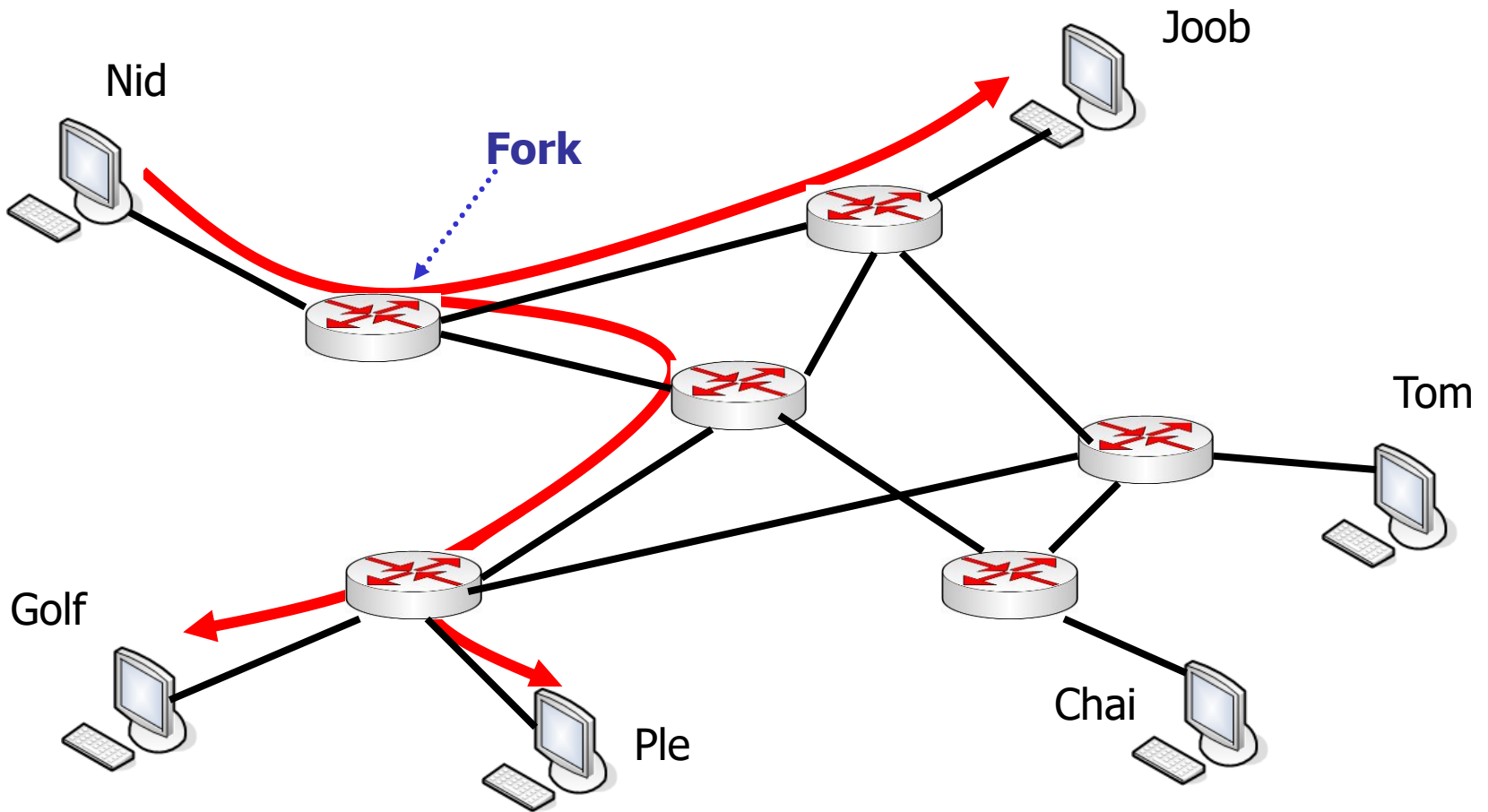
Multicast

- 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

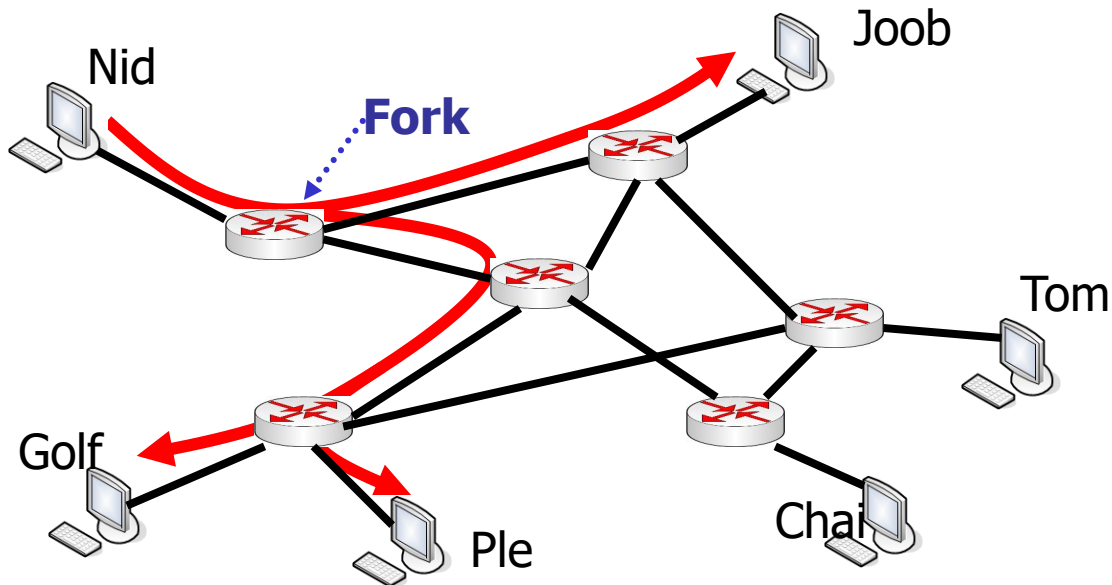


IP Multicast



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

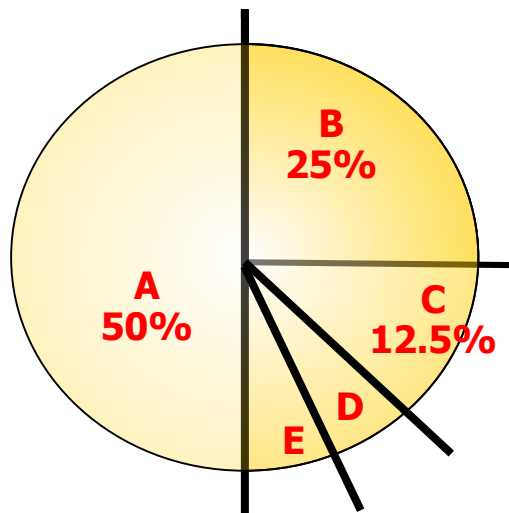


Multicast Applications

- 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

<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

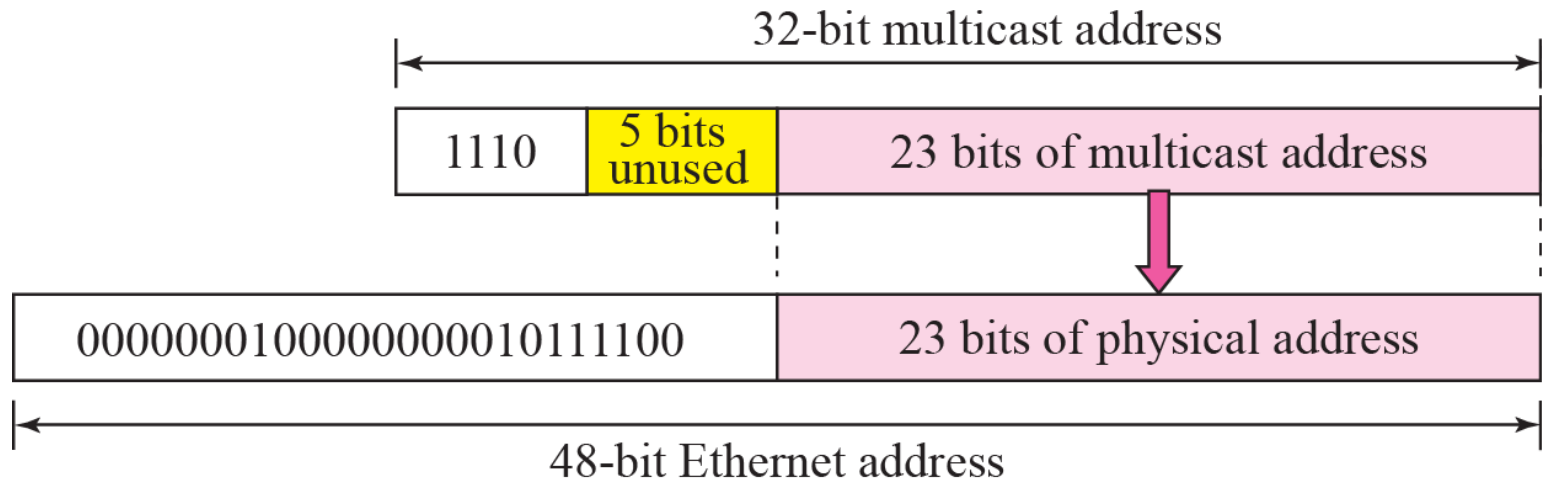
C:\Documents and Settings\anan>
```



Mapping

Multicast IP Add \leftrightarrow Physical Ethernet Add

use **ARP ???**
 \rightarrow 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 → Multicast 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

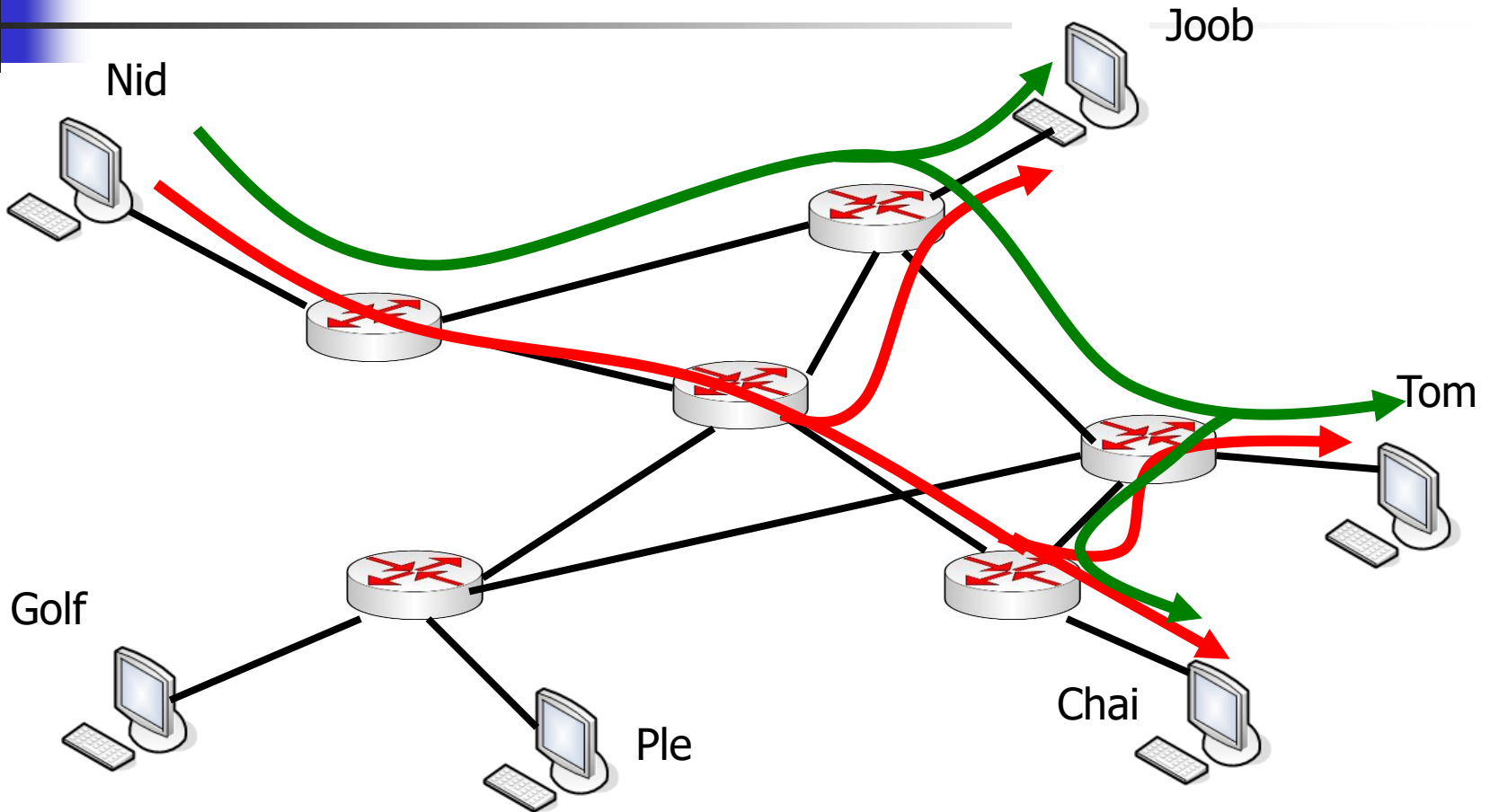
All 32 IP adds → map to the same MAC address **01:00:5e:44:1c:3**



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

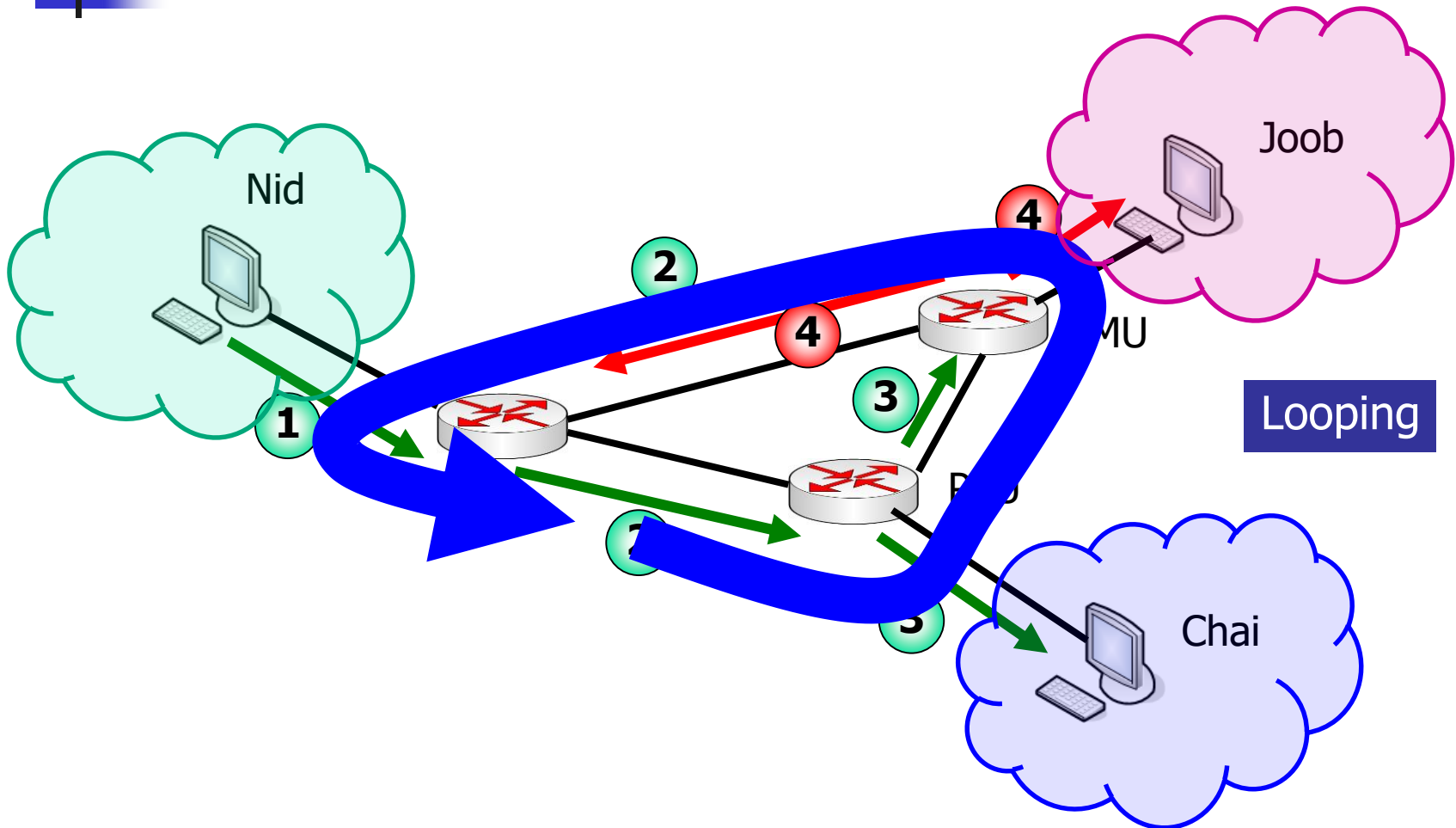
Multicast paths



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)**₂₇

Multicast Scenario

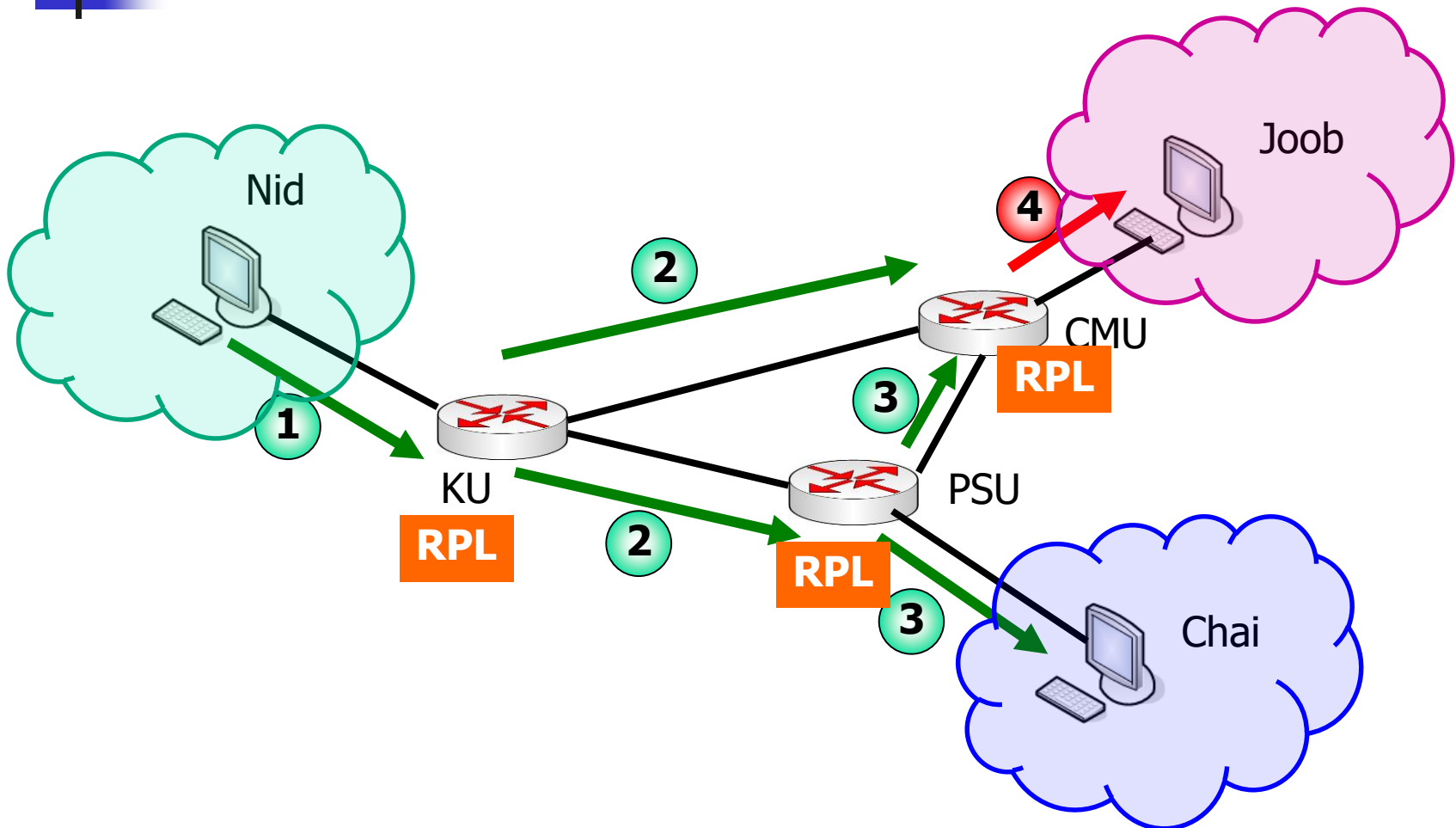




Reverse Path Lookup (RPL)

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

Reverse Path Lookup (RPL)



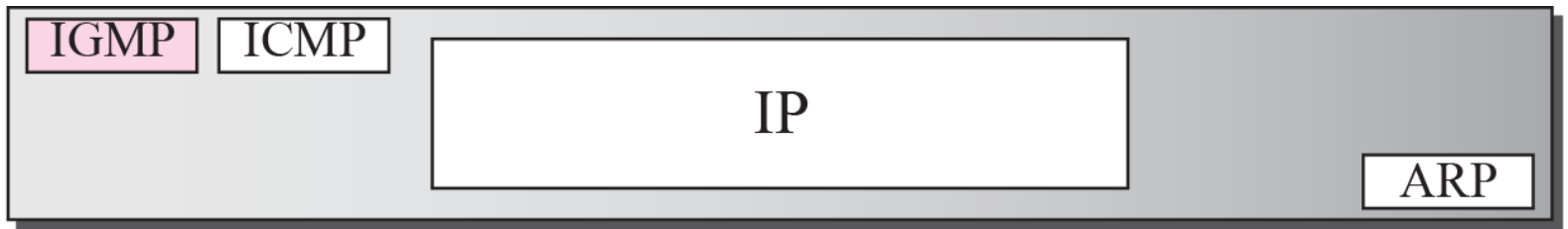


IGMP

- 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



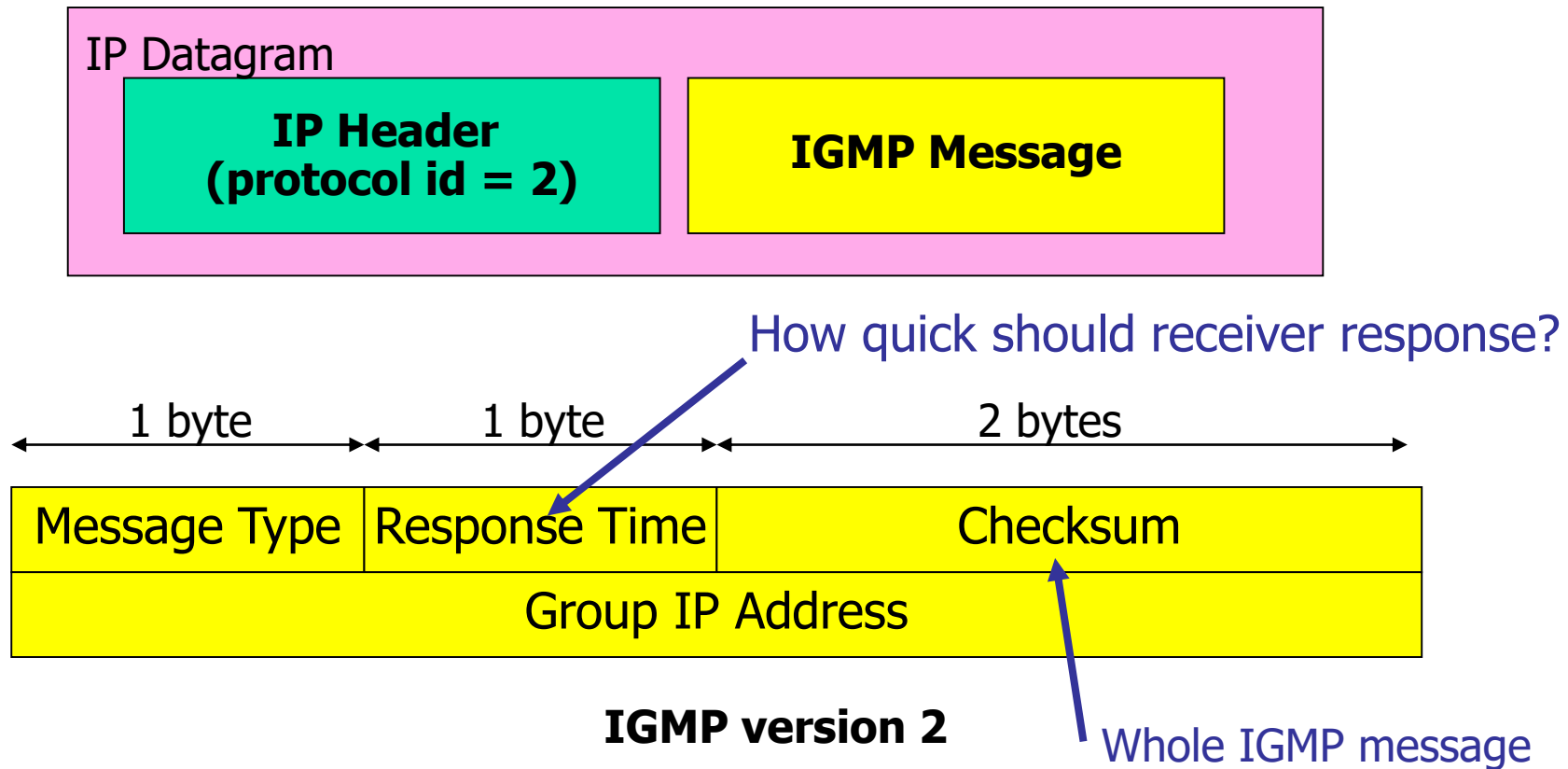
IGMP messages

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

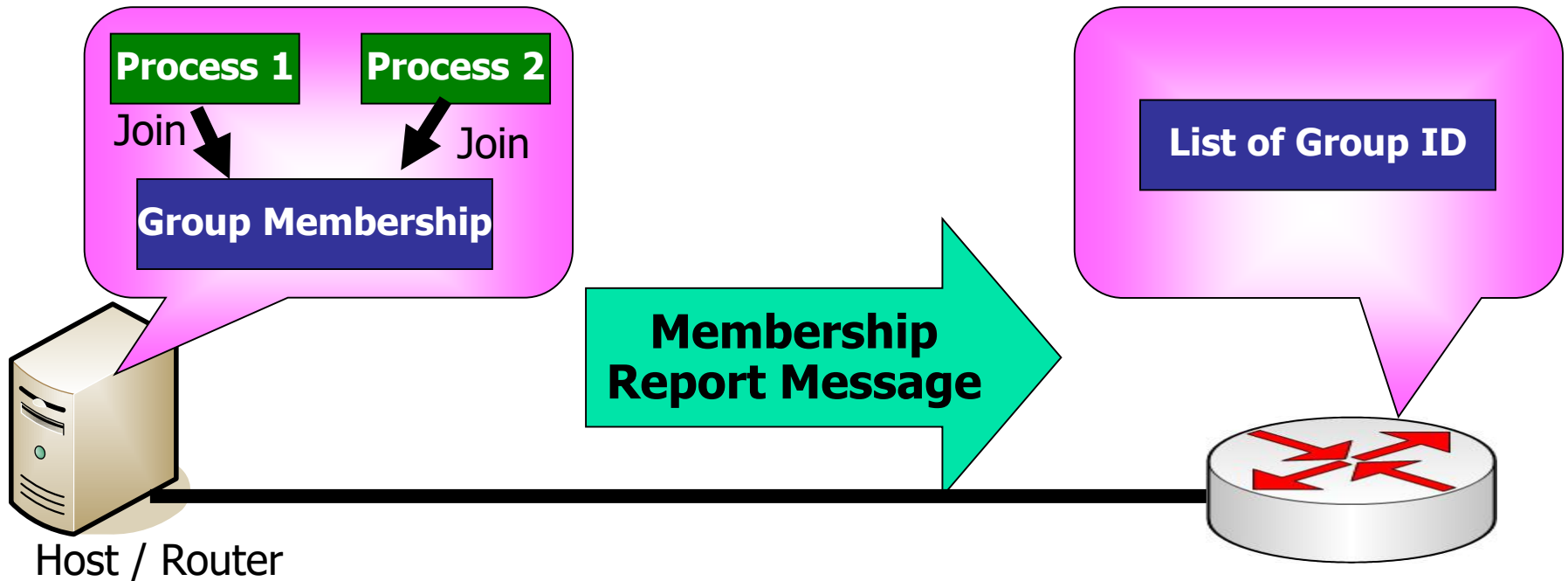
Message Type

IGMP v3

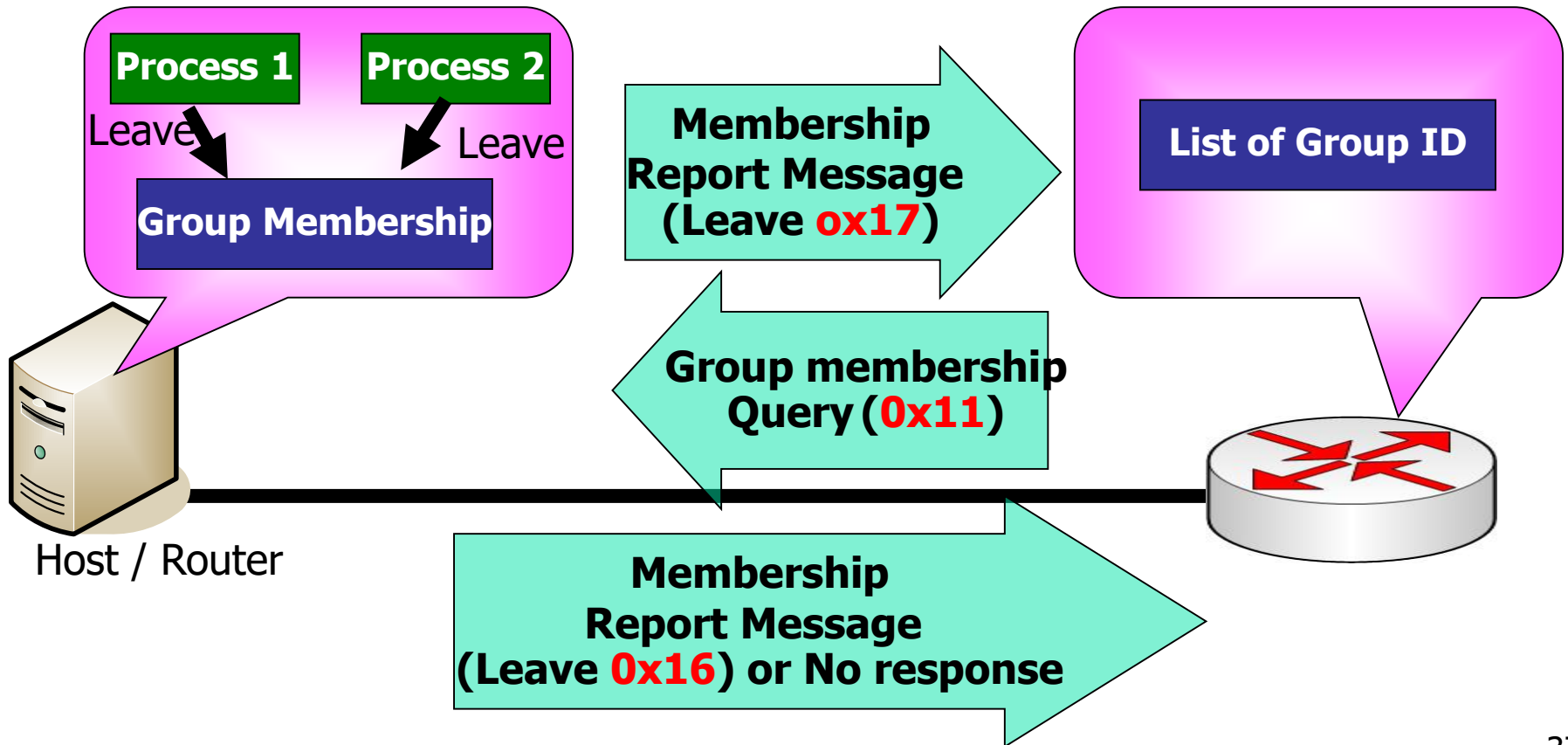


Message Type 0x11		Max Response Code		Checksum	
Group IP Address					
Resv	S	QRV	QQIC	Number of Sources (N)	
Source Address [1]					
Source Address [2]					
...					
Source Address [N]					

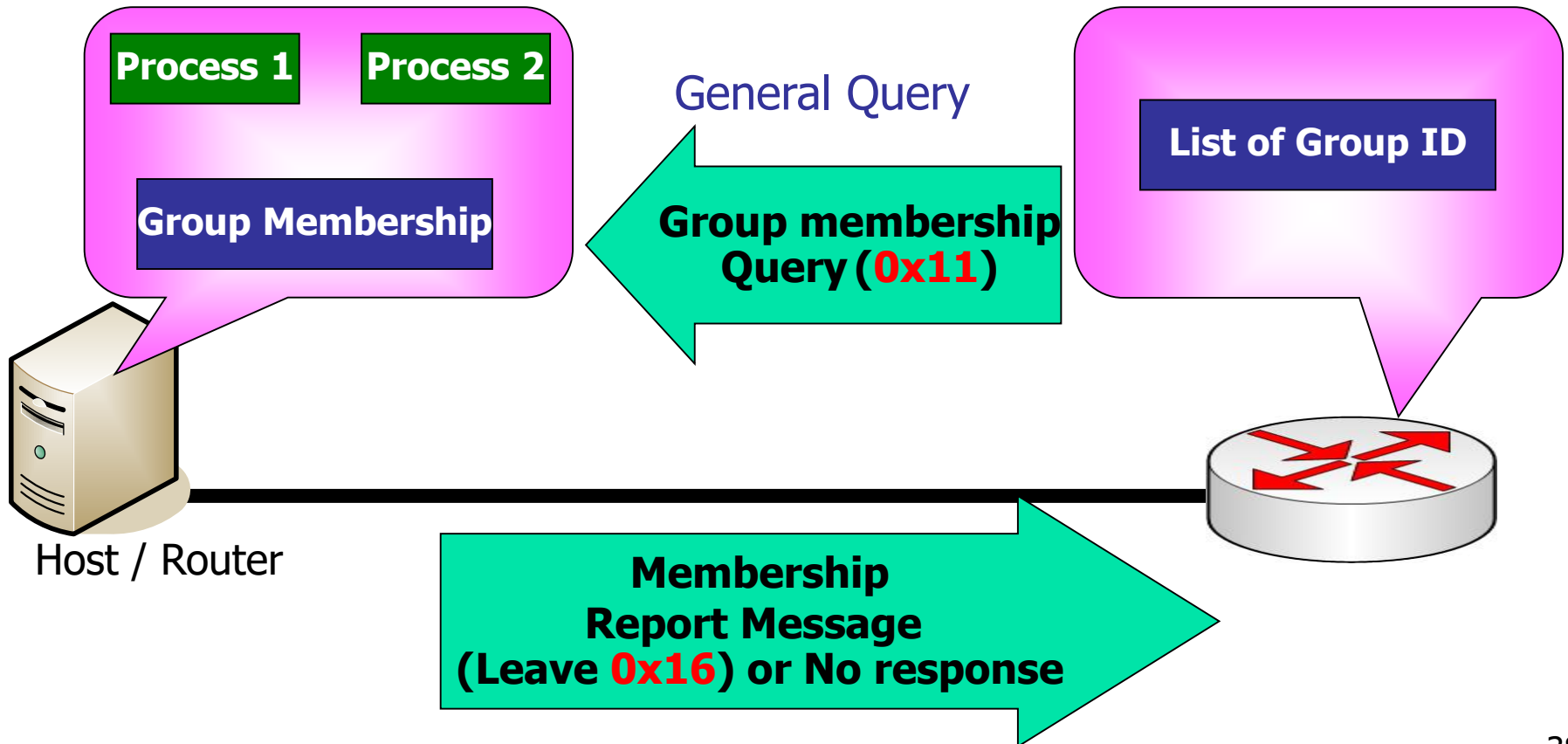
Joining a group



Leaving a group



Membership Monitoring





Multicast Routing

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



Multicast Routing

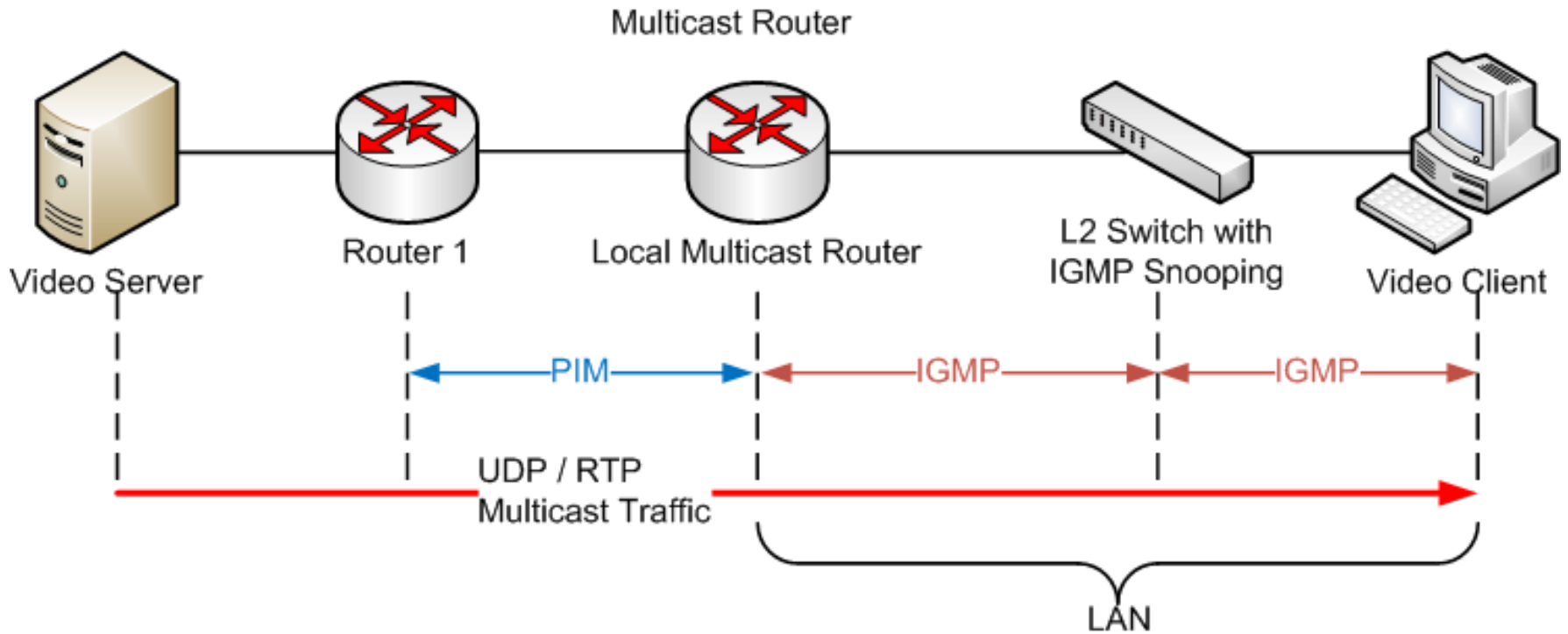
- Dense mode protocols
 - assumes dense group membership
 - Source distribution tree and NACK type
 - DVMRP (Distance Vector Multicast Routing Protocol)
 - PIM-DM (Protocol Independent Multicast, Dense Mode)



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