

Chapter 6

Delivery and Routing of IP Packets

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- **STATIC AND DYNAMIC ROUTING**
- **ROUTING TABLE AND MODULE**
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6.1

CONNECTION-ORIENTED VERSUS CONNECTIONLESS SERVICES

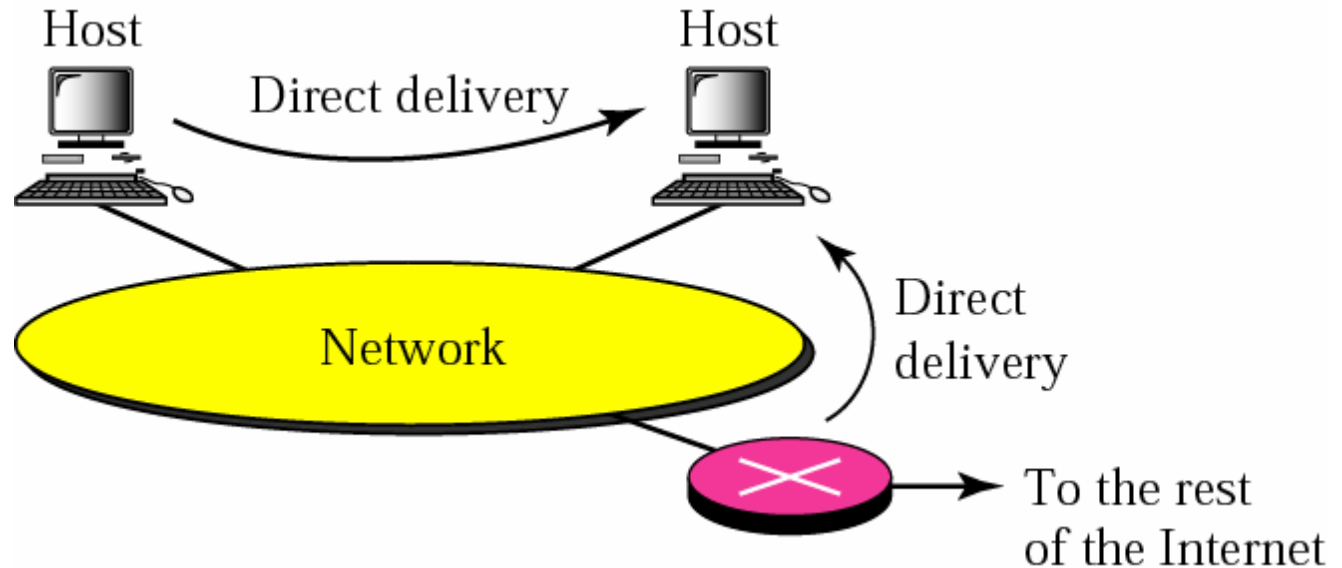
In a connection-oriented situation,
the network layer protocol
first makes a connection.

In a connectionless situation,
the network layer protocol treats each
packet independently,
with each packet having
no relationship to any other packet.

6.2

DIRECT VERSUS INDIRECT DELIVERY

Direct
delivery



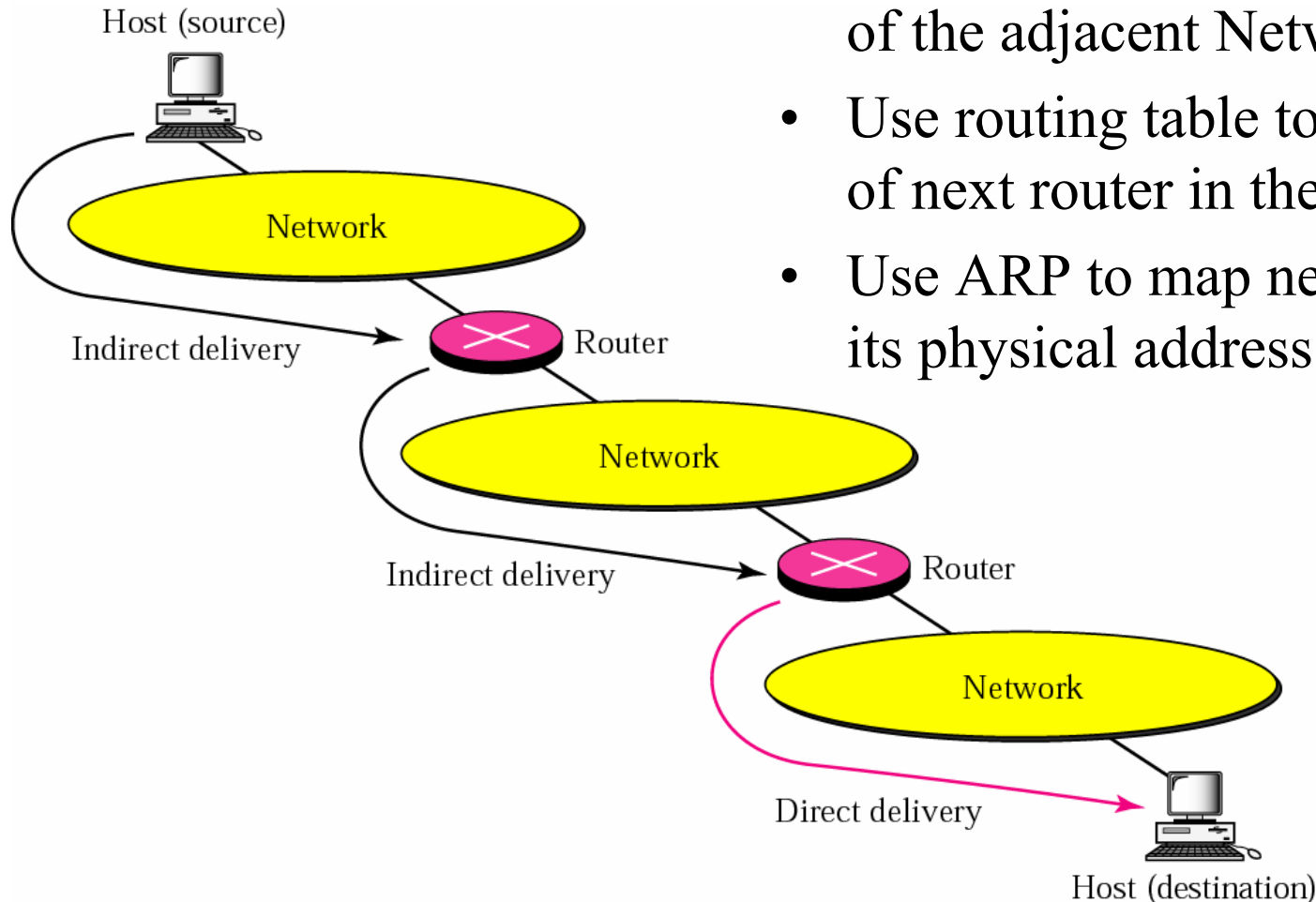
At the Router

- Destination IP AND Mask = some adjacent Network Address
- Use ARP to map destination IP to destination physical address.

Indirect delivery

At the Router

- Destination IP AND Mask = none of the adjacent Network Addresses
- Use routing table to map IP_{dest} to IP of next router in the delivery route.
- Use ARP to map next router IP to its physical address.



6.3

ROUTING METHODS

Next-hop routing

Routing table for host A

Destination	Route
Host B	R1, R2, Host B

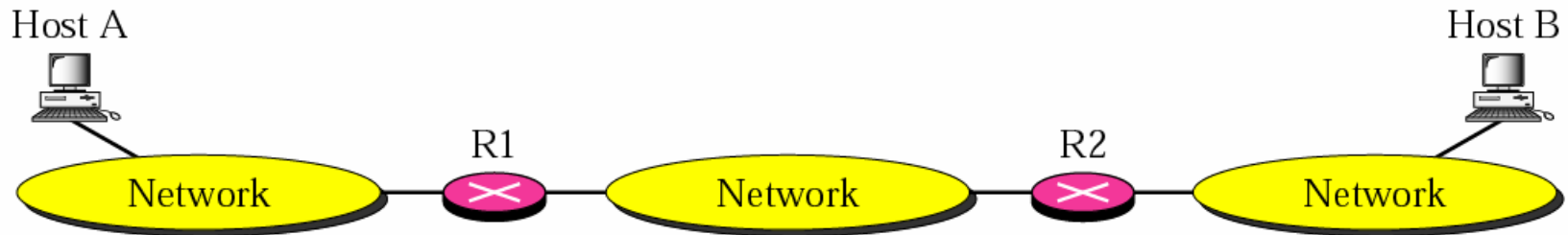
Routing table for R1

Destination	Route
Host B	R2, Host B

Routing table for R2

Destination	Route
Host B	Host B

a. Routing tables based on route



Routing table for host A

Destination	Next Hop
Host B	R1

Routing table for R1

Destination	Next Hop
Host B	R2

Routing table for R2

Destination	Next Hop
Host B	—

b. Routing tables based on next hop

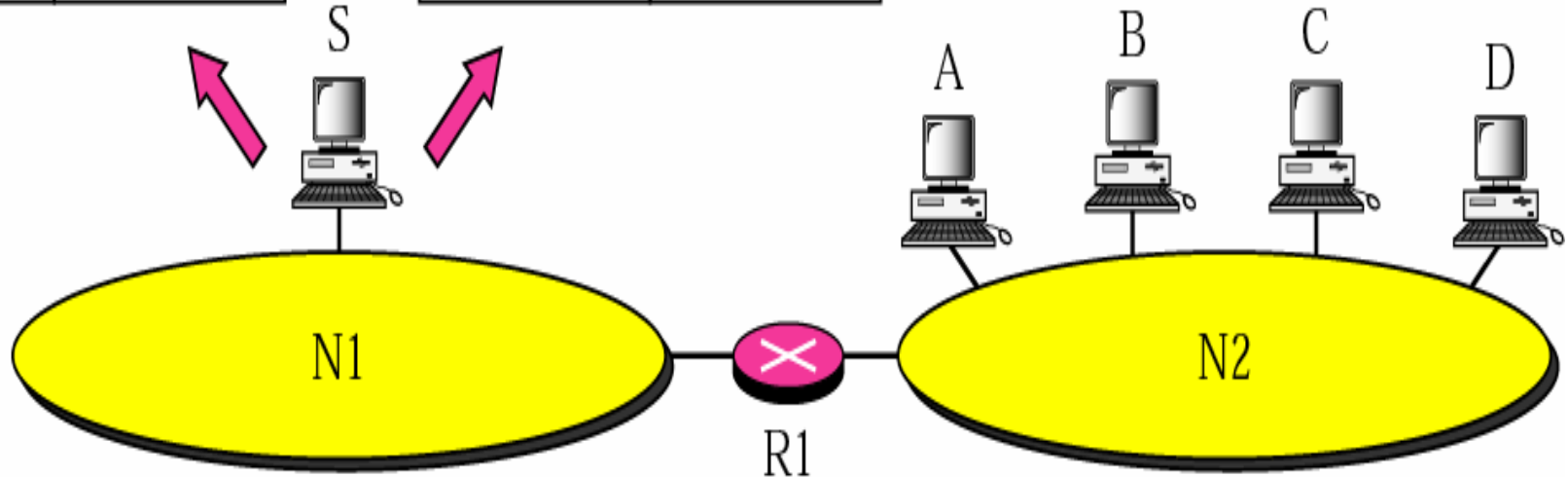
Network-specific routing

Routing table for host S based
on host-specific routing

Destination	Next Hop
A	R1
B	R1
C	R1
D	R1

Routing table for host S based
on network-specific routing

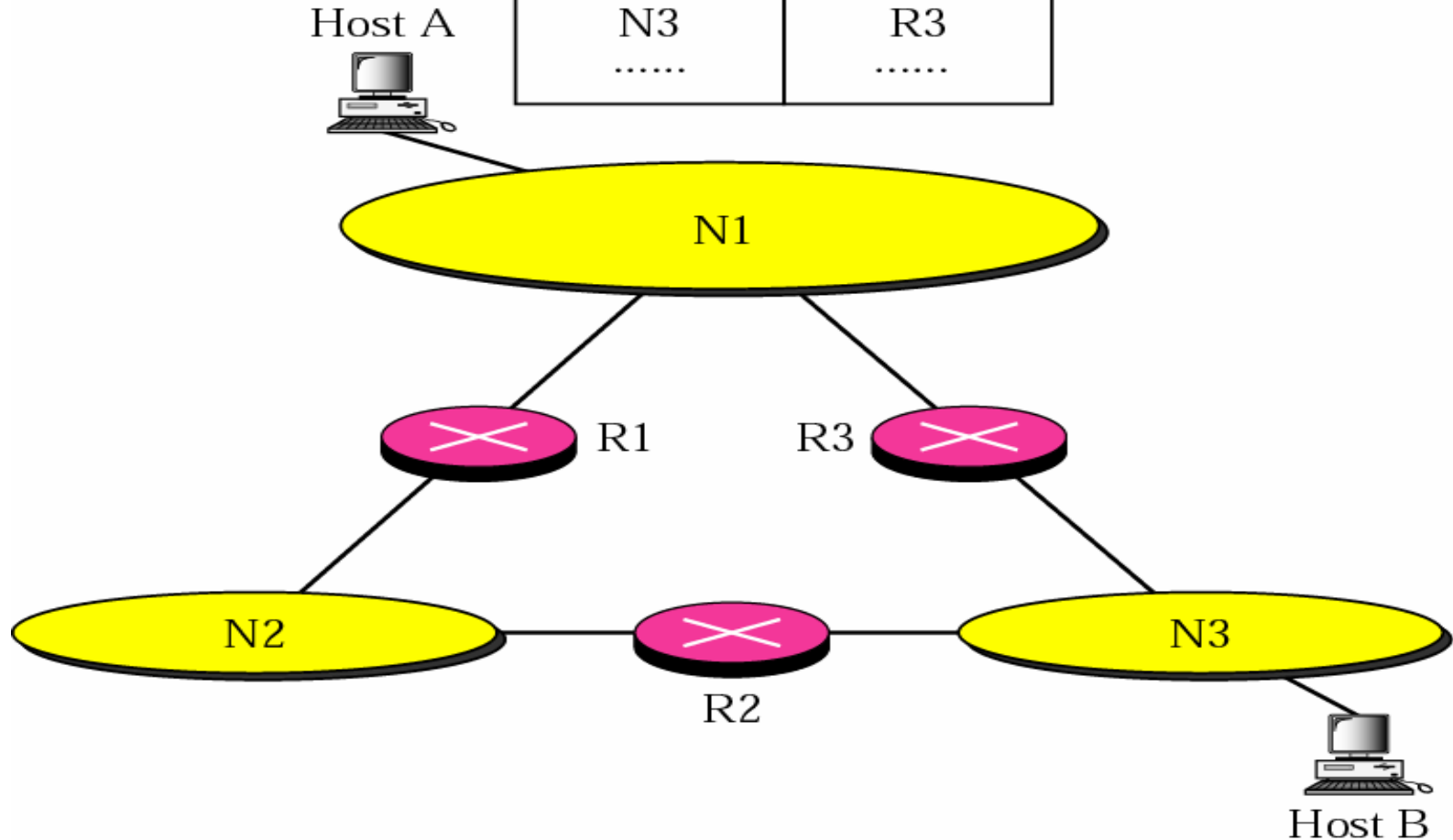
Destination	Next Hop
N2	R1



Host-specific routing

Routing table for host A

Destination	Next Hop
Host B	R3
N2	R1
N3	R3
.....

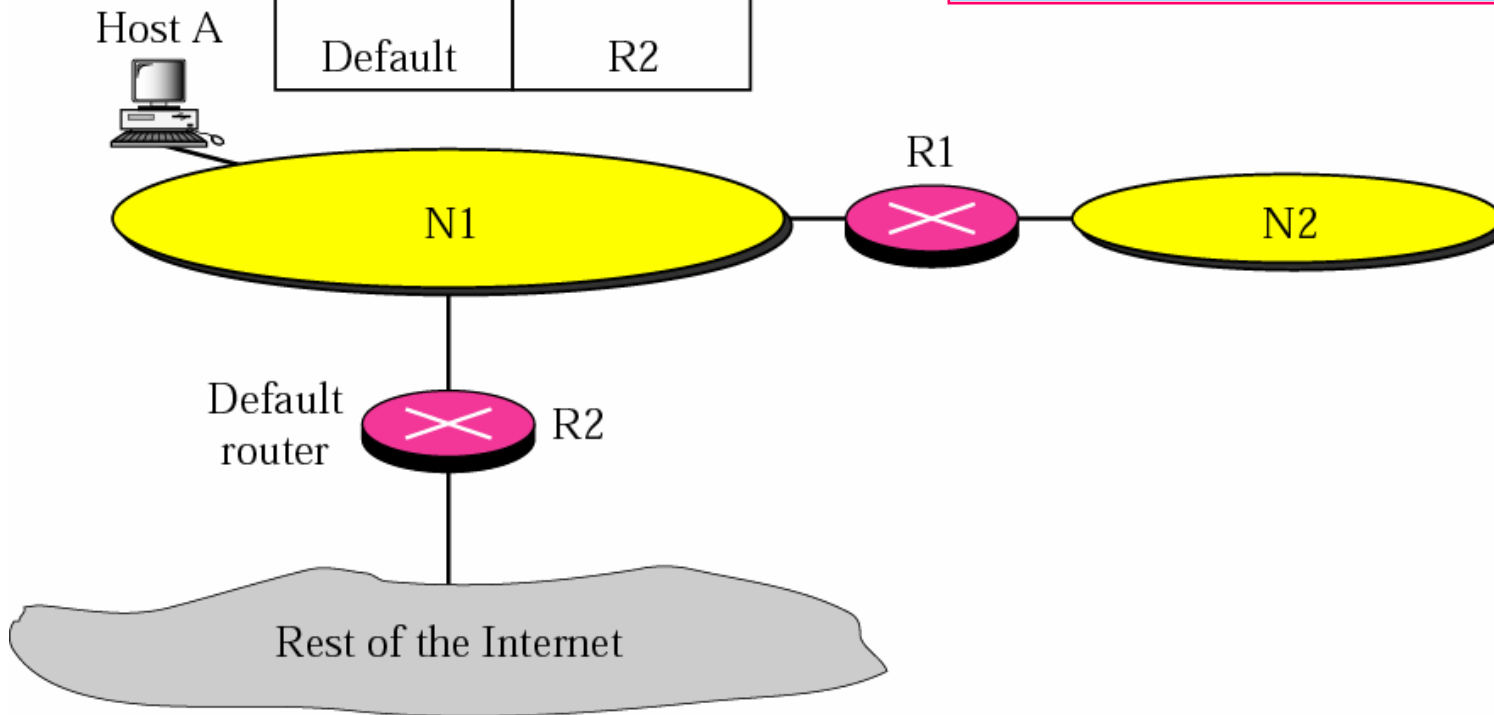


Default routing

Routing table for host A

Destination	Next Hop
N2	R1
.....
Default	R2

Use 0.0.0.0 for the Default destination



6.4

STATIC VERSUS DYNAMIC ROUTING

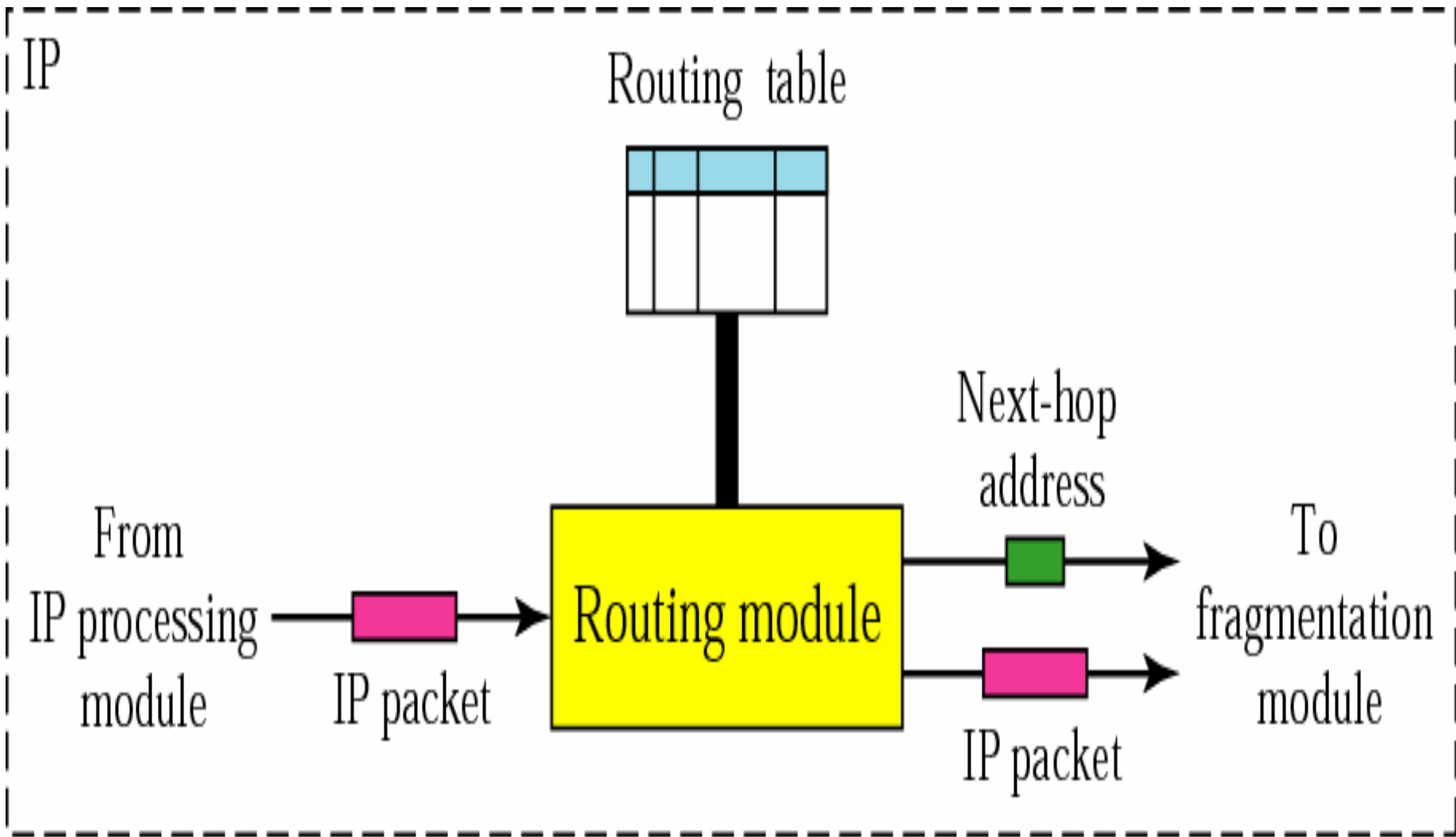
- A **static routing table** contains information entered manually.
 - Does not adapt to network changes
 - Used for small internetworks or for experimentation.
- A **dynamic routing table** is updated periodically using one of the dynamic routing protocols such as RIP, OSPF, or BGP

6.5

ROUTING TABLE AND ROUTING MODULE

- Order of Routing
 1. Direct Delivery
 2. Host-Specific Routing
 3. Network-Specific Routing
 4. Default Routing
- Implemented inside :
 - the routing table (simplifies the routing module, *we will use this approach in our discussion*), or
 - the routing module itself.

Routing module as part of the IP Layer



Routing Table

Finds Network or Subnetwork address
255.255.255.255 for Host- Specific
0.0.0.0 for Default Routing

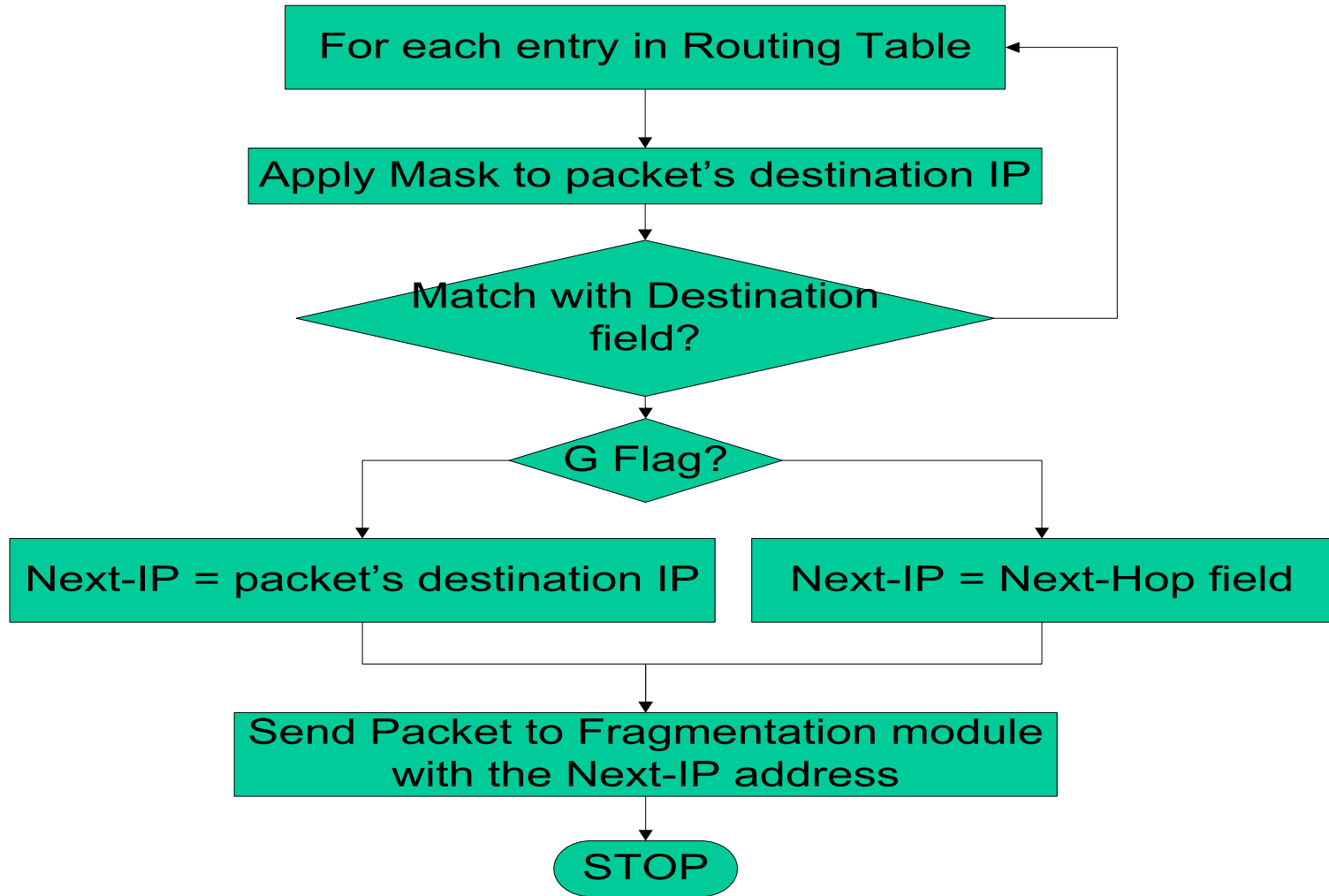
Mask	Destination address	Next-hop address	Flags	Reference count	Use	Interface
255.0.0.0	124.0.0.0	145.6.7.23	UG	4	20	m2

Flags

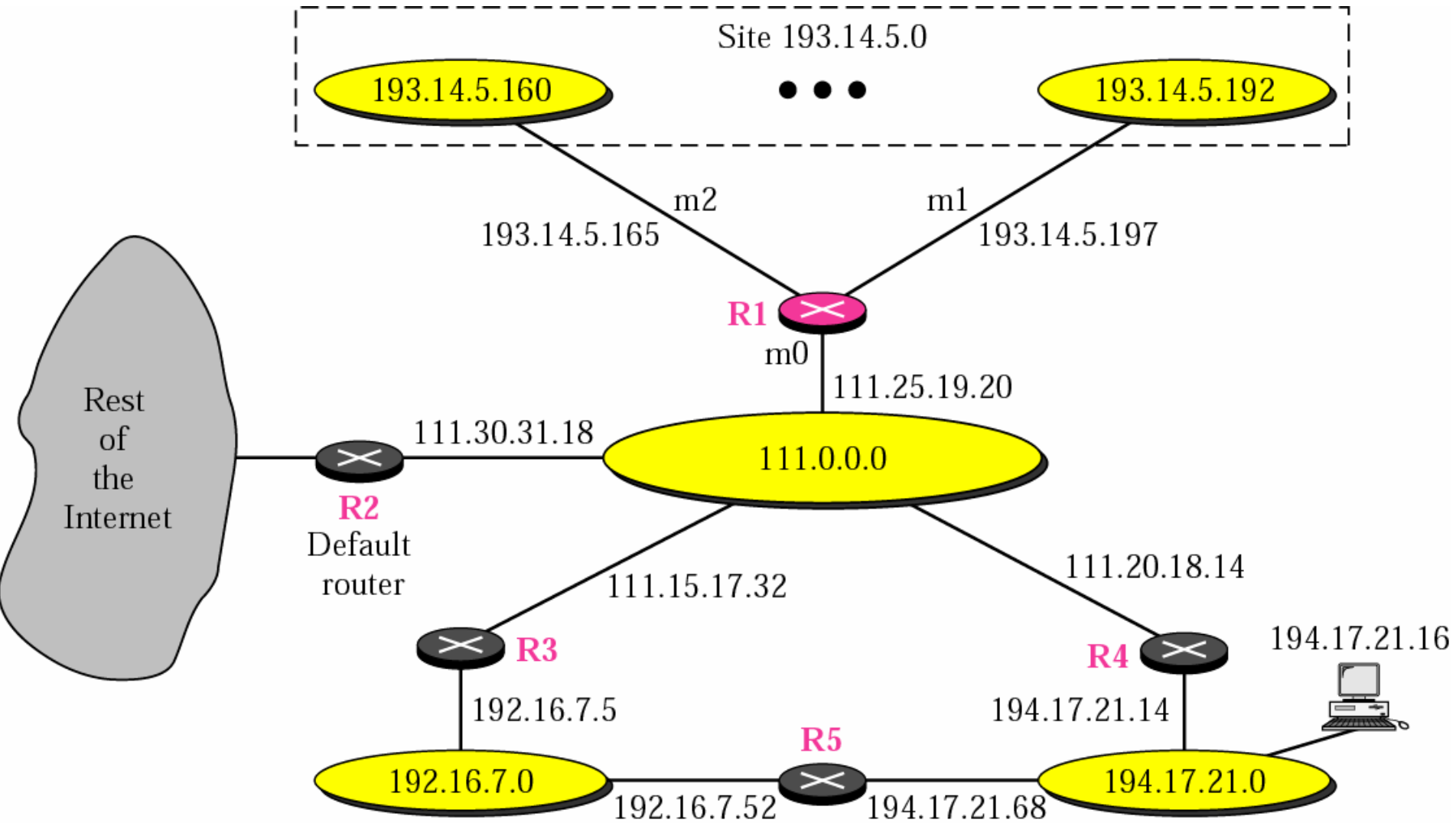
U The router is up and running.
G The destination is in another network.

H Host-specific address.
D Added by redirection.
M Modified by redirection.

Routing Module



Configuration for routing example



<u>Mask</u>	Dest.	Next Hop	I.
255.0.0.0	111.0.0.0	--	m0
255.255.255.224	193.14.5.160	-	m2
255.255.255.224	193.14.5.192	-	m1

255.255.255.255	194.17.21.16	111.20.18.14	m0

255.255.255.0	192.16.7.0	111.15.17.32	m0
255.255.255.0	194.17.21.0	111.20.18.14	m0

0.0.0.0	0.0.0.0	111.30.31.18	m0

Example 1

Router R1 receives 500 packets for destination 192.16.7.14; the algorithm applies the masks row by row to the destination address until a match (with the value in the second column) is found:

Solution

Direct delivery

192.16.7.14 & 255.0.0.0 → 192.0.0.0 no match

192.16.7.14 & 255.255.255.224 → 192.16.7.0 no match

192.16.7.14 & 255.255.255.224 → 192.16.7. no match

Host-specific

192.16.7.14 & 255.255.255.255 → 192.16.7.14 no match

Network-specific

192.16.7.14 & 255.255.255.0 → 192.16.7.0 **match**

Example 2

Router R1 receives 100 packets for destination 193.14.5.176; the algorithm applies the masks row by row to the destination address until a match is found:

Solution

Direct delivery

193.14.5.176 & 255.0.0.0 → 193.0.0.0 no match

193.14.5.176 & 255.255.255.224 → 193.14.5.160 **match**

Example 3

Router R1 receives 20 packets for destination 200.34.12.34; the algorithm applies the masks row by row to the destination address until a match is found:

Solution

Direct delivery

200.34.12.34 & 255.0.0.0 → 200.0.0.0 no match

200.34.12.34 & 255.255.255.224 → 200.34.12.32 no match

200.34.12.34 & 255.255.255.224 → 200.34.12.32 no match

Host-specific

200.34.12.34 & 255.255.255.255 → 200.34.12.34 no match

Solution

Network-specific

200.34.12.34 & 255.255.255.0 ➔ 200.34.12.0 no match

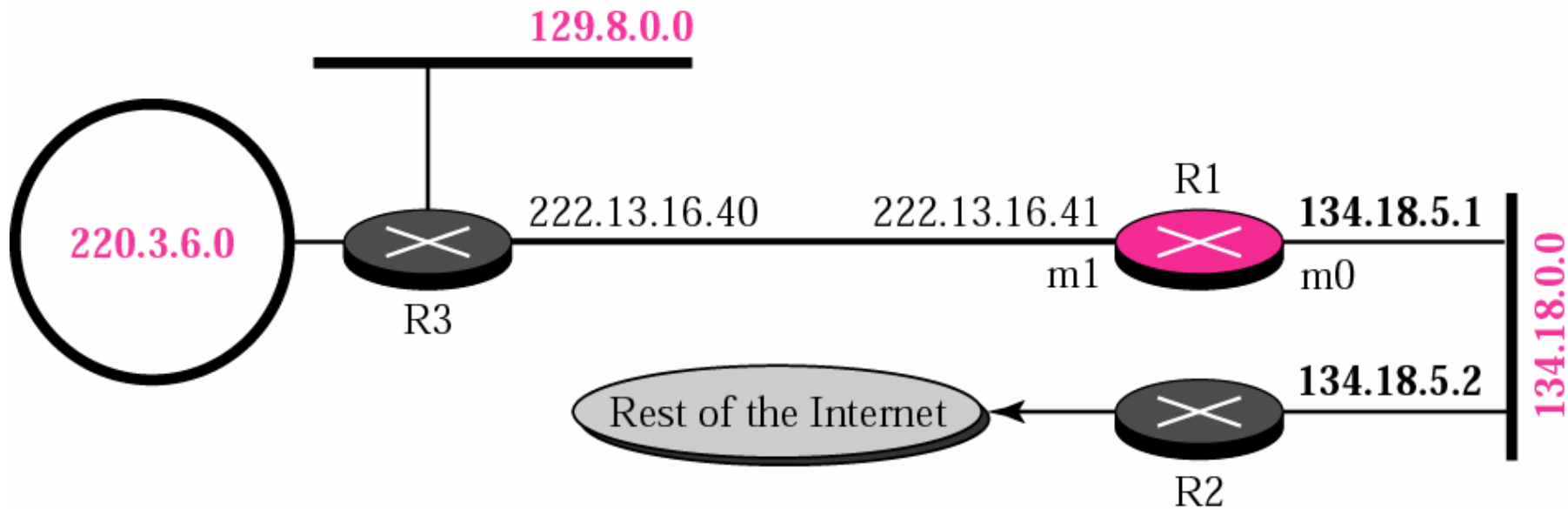
200.34.12.34 & 255.255.255.0 ➔ 200.34.12.0 no match

Default

200.34.12.34 & 0.0.0.0 ➔ 0.0.0.0 **match**

Example 4

Make the routing table for router R1

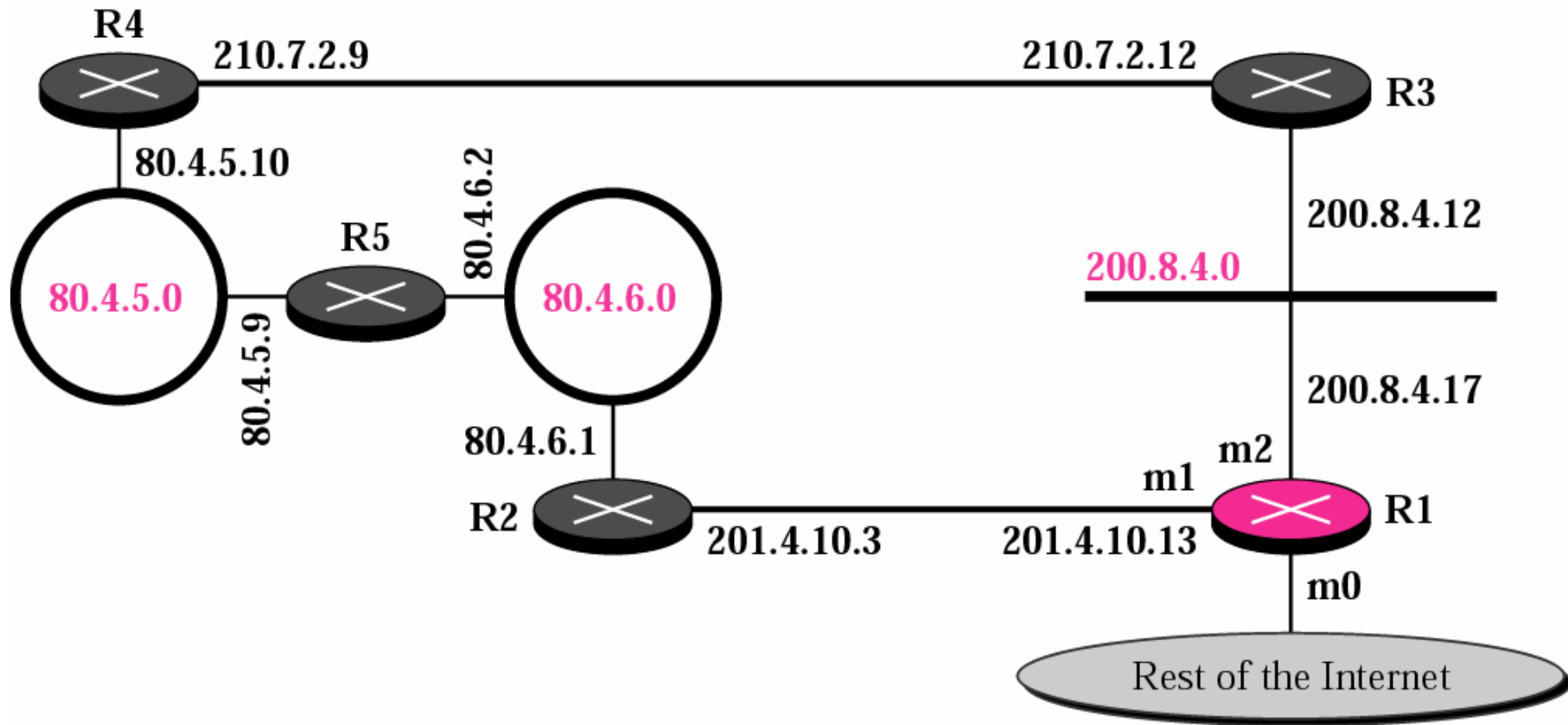


Solution

Mask	Destination	Next Hop	I.
255.255.0.0	134.18.0.0	--	m0
255.255.0.0	129.8.0.0	222.13.16.40	m1
255.255.255.0	220.3.6.0	222.13.16.40	m1
0.0.0.0	0.0.0.0	134.18.5.2	m0

Example 5

Make the routing table for router R1



Solution

Mask	Destination	Next Hop	I.
255.255.255.0	200.8.4.0	----	m2

255.255.255.0	80.4.5.0	201.4.10.3	m1
		or 200.8.4.12	or m2

255.255.255.0	80.4.6.0	201.4.10.3	m1
		or 200.4.8.12	or m2

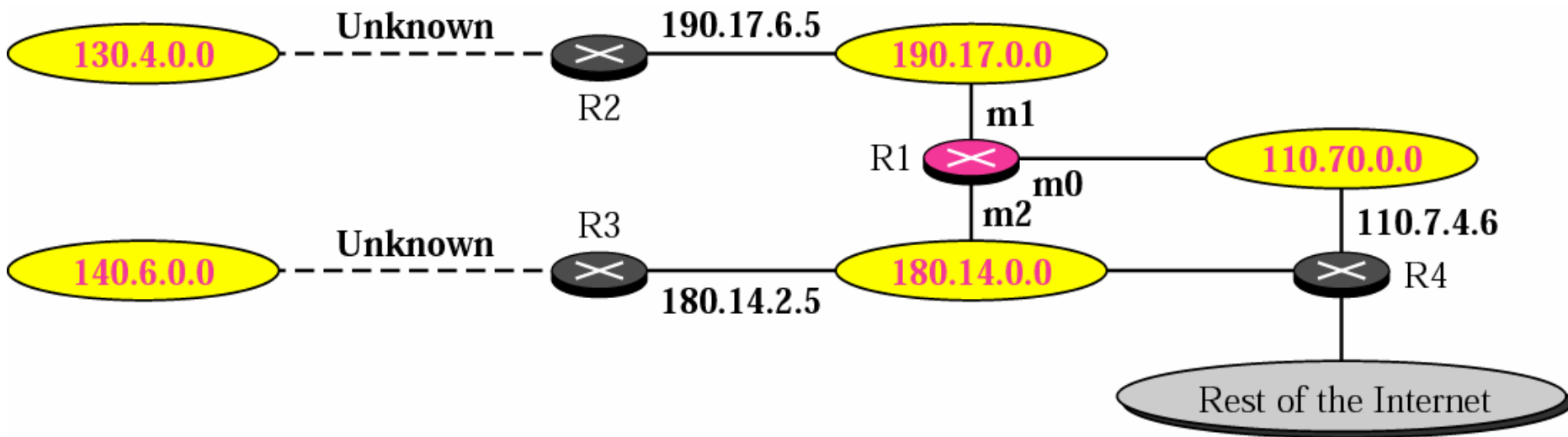
0.0.0.0	0.0.0.0	??????????????	m0

Example 6

The routing table for router R1 is given below.
Draw its topology

Mask	Destination	Next Hop	I.
255.255.0.0	110.70.0.0	-	m0
255.255.0.0	180.14.0.0	-	m2
255.255.0.0	190.17.0.0	-	m1
255.255.0.0	130.4.0.0	190.17.6.5	m1
255.255.0.0	140.6.0.0	180.14.2.5	m2
0.0.0.0	0.0.0.0	110.70.4.6	m0

Example 6 (Solution)

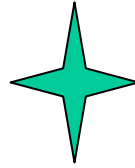


6.6

CLASSLESS ADDRESSING: CIDR

ISSUES

Routing Table Size



Hierarchical Routing



Geographical Routing



Routing Table Search Algorithms

