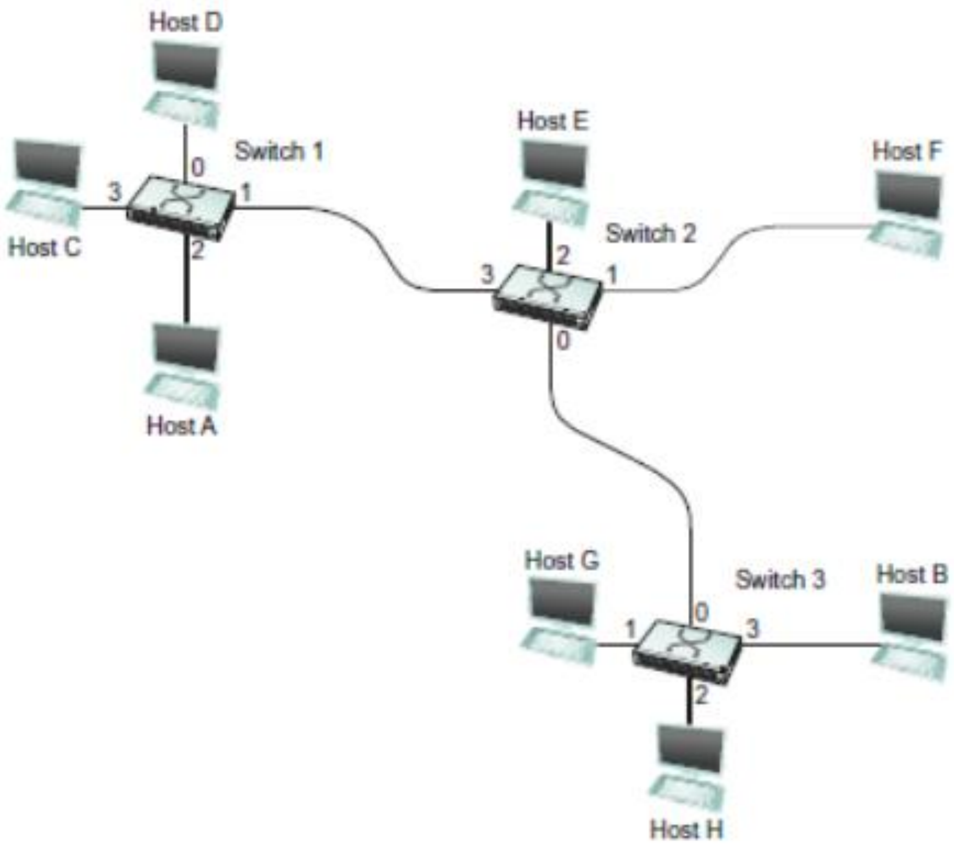
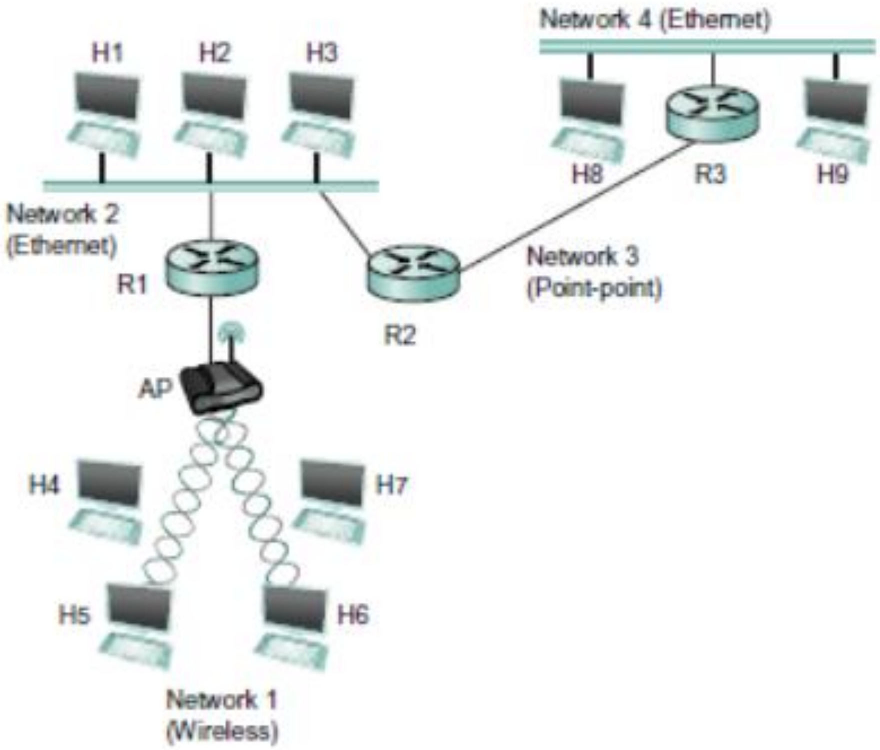
Homework 3 Discussion

Address Resolution Protocol (ARP)

Data Link Layer



Network Layer



	Data Link Layer	Network Layer
Protocol Data Unit(PDU)	Frames	Packets
Typical Device	Switch/Bridge	Router
Range	Local Area Network(LAN)	Internet
Identification	Hardware Address (MAC)	IP Address

Address Resolution Protocol (ARP)

- In the end, frame is the protocol data unit that get transmitted on the wire. Physical interfaces cannot understand IP addresses.

- Each host and router needs a link layer address (MAC address) to identify itself in Local Area Network (subnet), and also a network layer address (IP address to) identify its position in the internet.

- ARP provides a mechanism to translate IP addresses into hardware (MAC) addresses

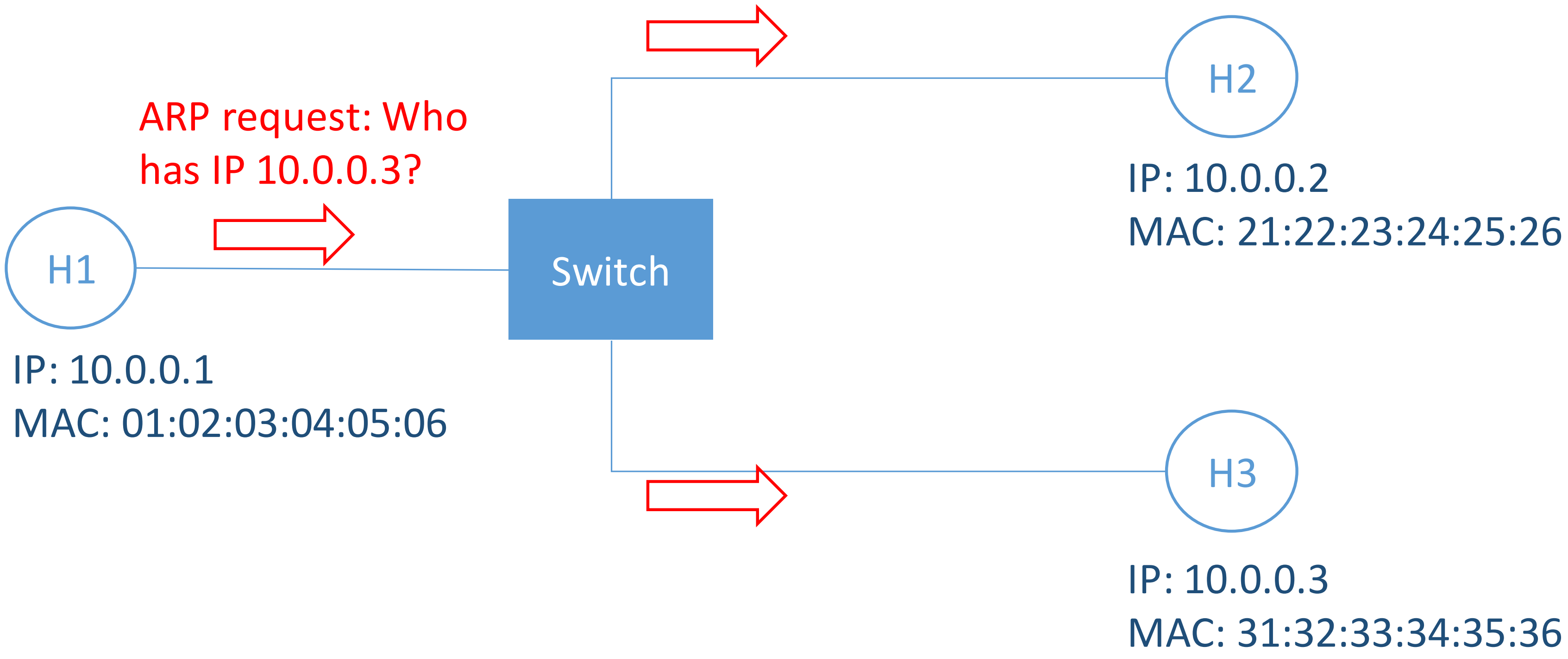
A host sends an IP packet within its Local Area Network

H1 to H3

Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	?	10.0.0.1	10.0.0.3	……

1. Is the destination IP in my subnet? - Yes

2. Send an ARP request to get the MAC of H3



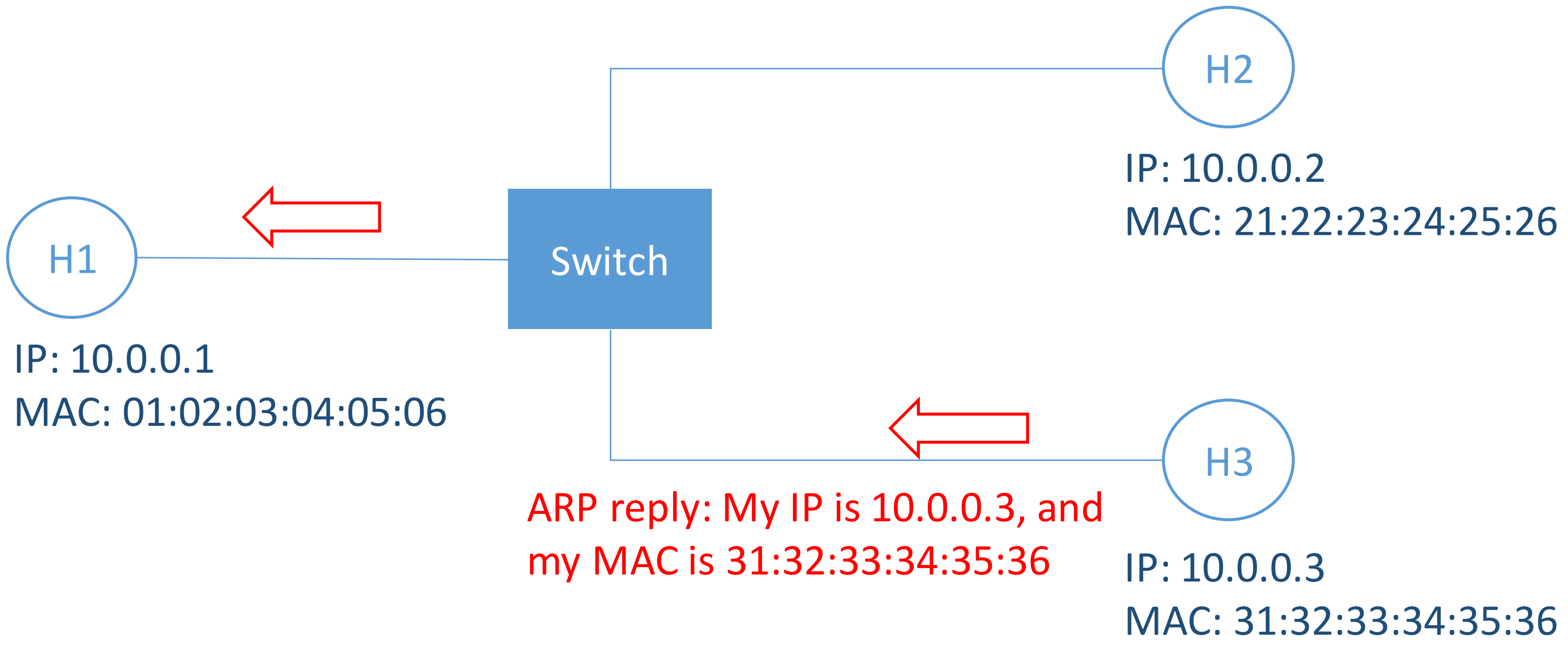
A host sends an IP packet to a host its Local Area Network

H1 to H3

Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	31:32:33:34:35:36	10.0.0.1	10.0.0.3	……

1. Is the destination IP in my subnet? - Yes

2. Send an ARP request to get the MAC of H3



A host sends an IP packet to a host in other network

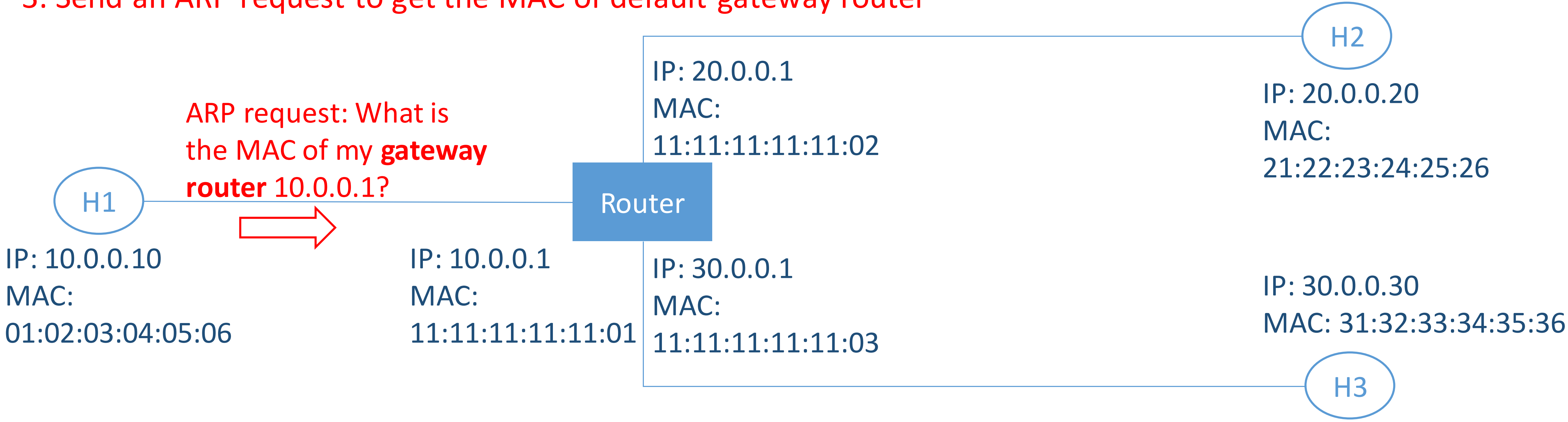
H1 to H3

Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	?	10.0.0.10	30.0.0.30	……

1. Is destination IP in my subnet? - No

2. Send this IP packet to my default gateway router

3. Send an ARP request to get the MAC of default gateway router



A host sends an IP packet to a host in other network

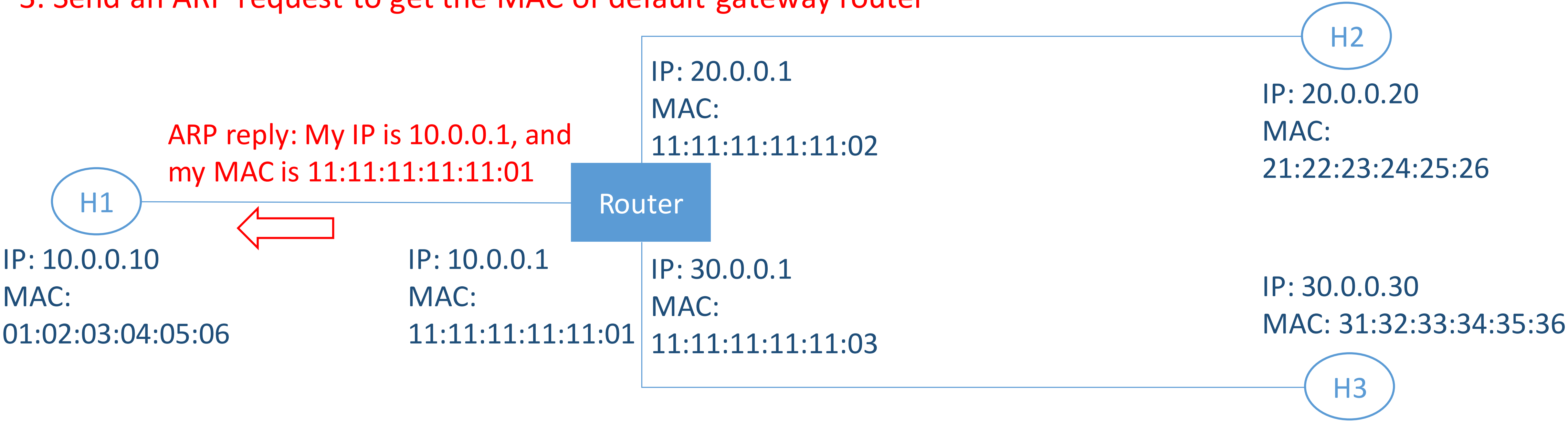
H1 to H3

Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	11:11:11:11:11:01	10.0.0.10	30.0.0.30	……

1. Is destination IP in my subnet? - No

2. Send this IP packet to my default gateway router

3. Send an ARP request to get the MAC of default gateway router



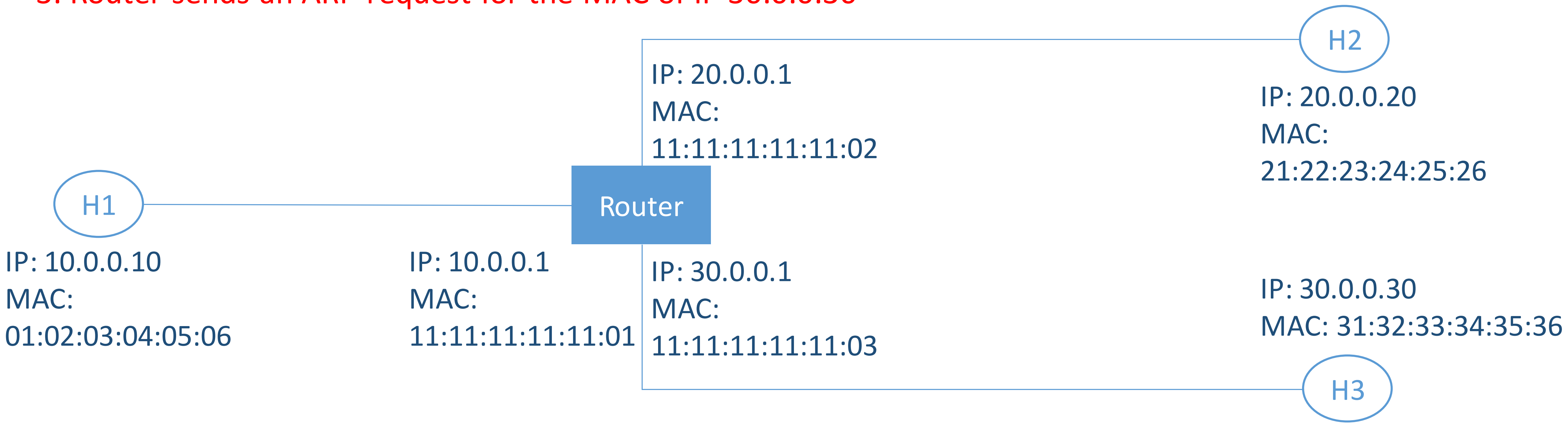
When router receives a Frame

Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	11:11:11:11:11:01	10.0.0.10	30.0.0.30	……

1. By searching the destination IP in its forwarding table, router knows that the next hop is in its southbound interface.

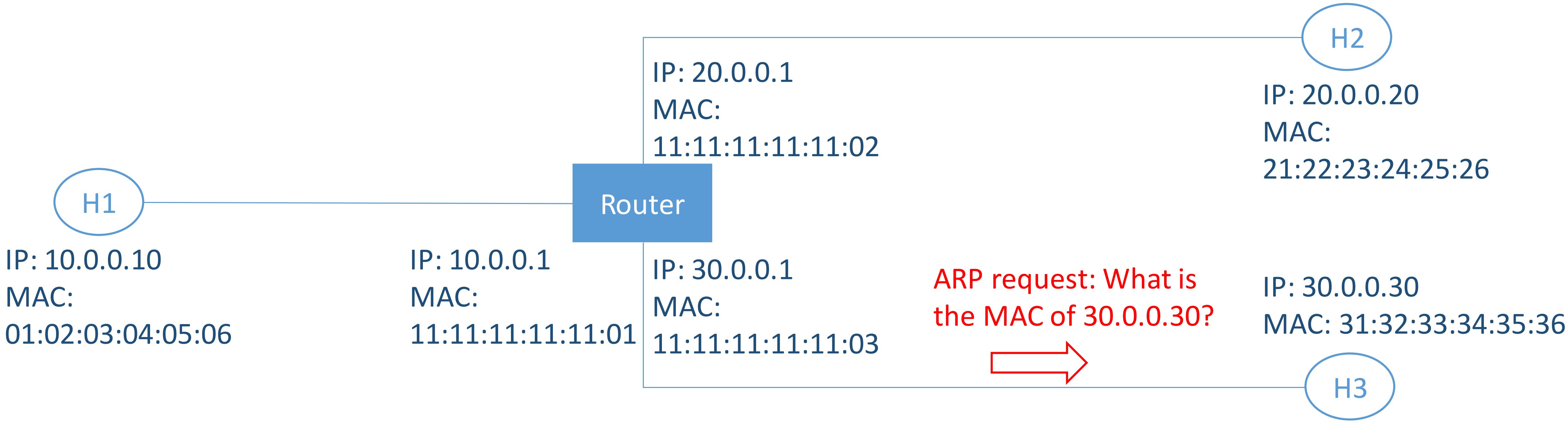
2. Router has to rewrite the Ethernet header to get the frame transmitted in a new subnet.

3. Router sends an ARP request for the MAC of IP 30.0.0.30



When router receives a Frame

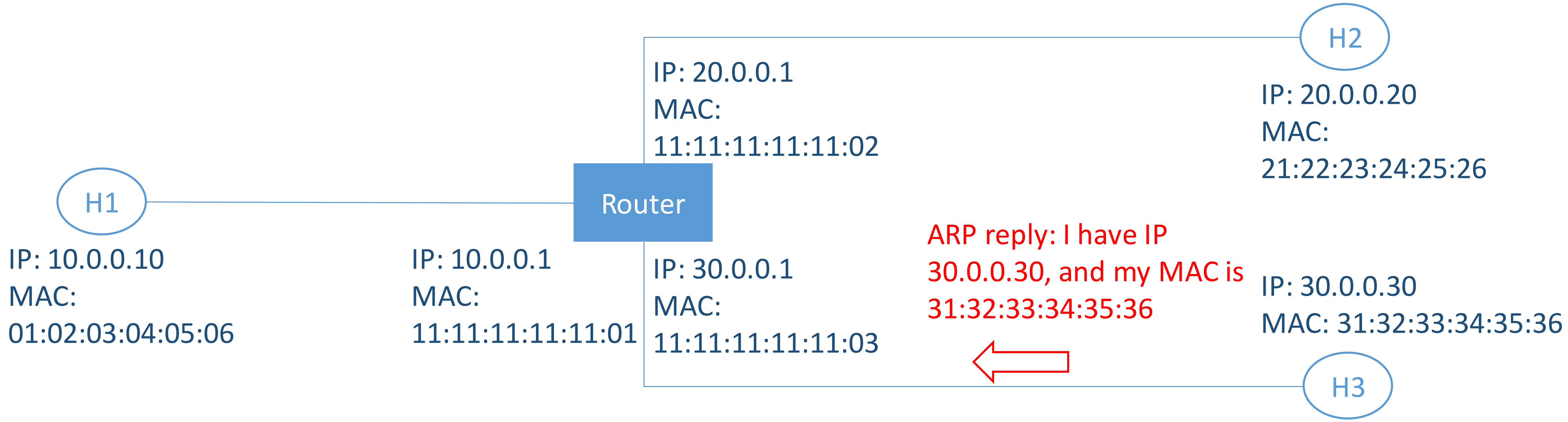
Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	11:11:11:11:11:01	10.0.0.10	30.0.0.30	……



When router receives a Frame

Source MAC	Destination MAC	Source IP	Destination IP	
01:02:03:04:05	11:11:11:11:11:01	10.0.0.10	30.0.0.30	……

Source MAC	Destination MAC	Source IP	Destination IP	
11:11:11:11:11:03	31:32:33:34:35:36	10.0.0.10	30.0.0.30	……



ARP Cache

(1)A table that maps IP addresses into physical (MAC) addresses

(2) Dynamically updated when a host/router receives an ARP request or reply.

```
C:\>ipconfig  | grep Default
   Default Gateway . . . . . . . . . : 192.168.1.254

C:\>arp -a

Interface: 192.168.1.68 --- 0xf
  Internet Address      Physical Address      Type
  192.168.1.254         64-55-b1-82-cc-a0     dynamic
  192.168.1.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static
```

Common AS relationships and Policies

Provider-Customer:

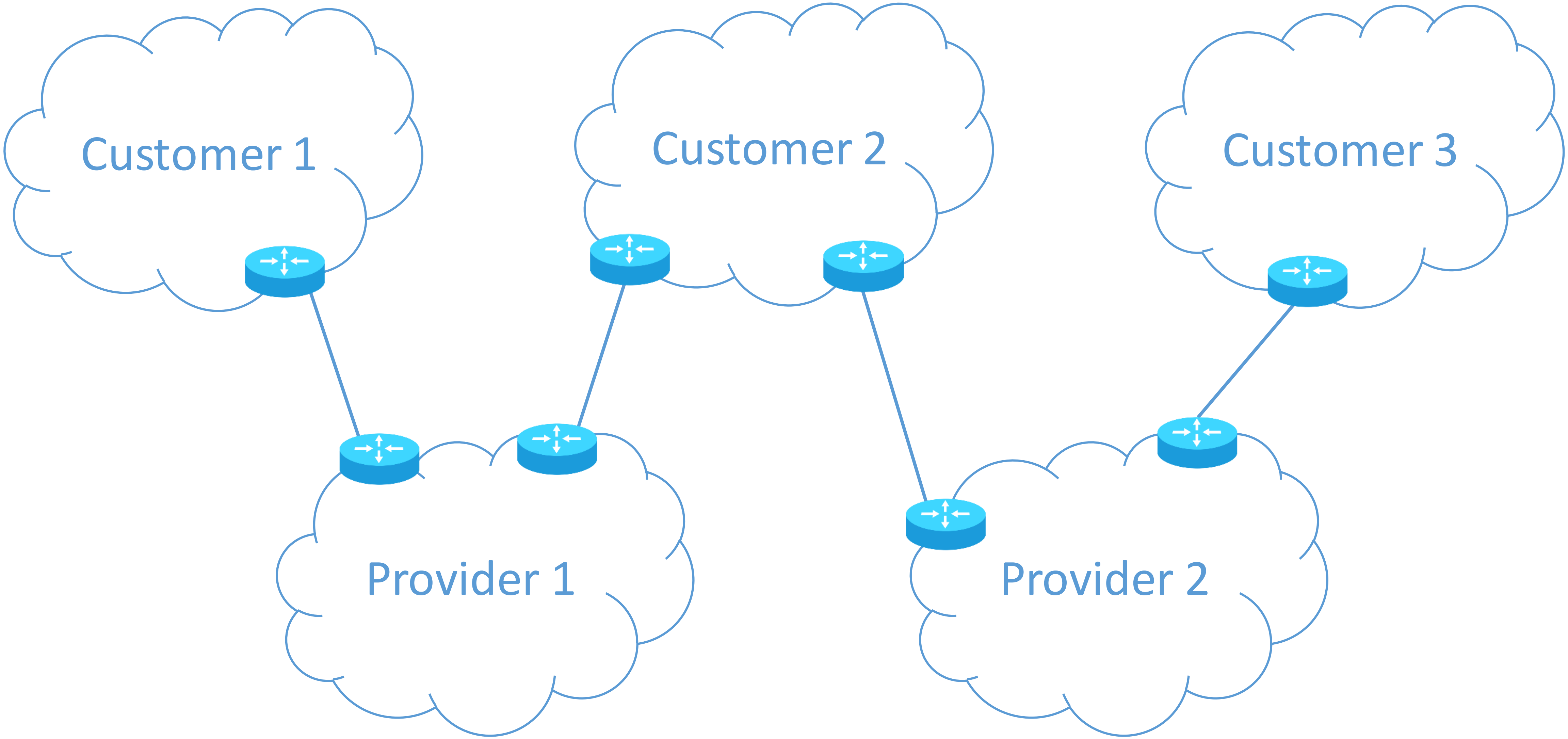
1. Provider advertises all the routes he knows to the customer
2. Provider advertises all the routes learned from the customer to everyone else

Customer-Provider:

1. Customer advertises his own prefixes to the provider
2. Customer advertises all the routes learned from his customer to the provider
3. Customer advertises all the routes learned from the provider to his customer
4. Customer should not advertise any route learned from one provider to another provider

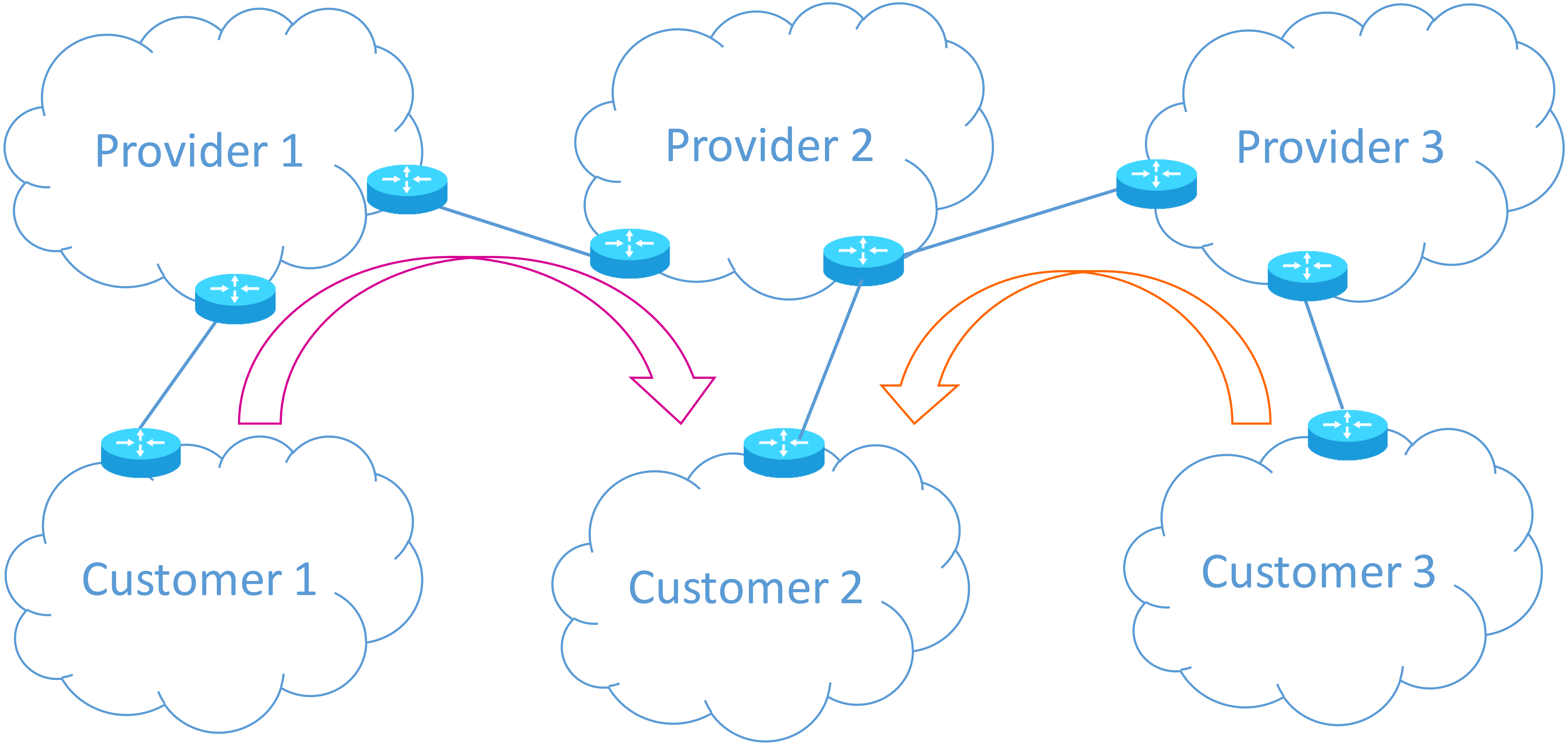
Peer (Provider-Provider):

1. Provider advertises all the routes learned from his customer to the peer
2. Provider advertises all the routes learned from the peer to his customer
3. Provider should not advertise any route learned from the peer to other provider.



Customer 1 and 3 don’t know each other

Customer should not advertise any route learned from one provider to another provider



Customer 1 and 3 don't know each other

Provider should not advertise any route learned from the peer to other provider

Distance-vector Routing

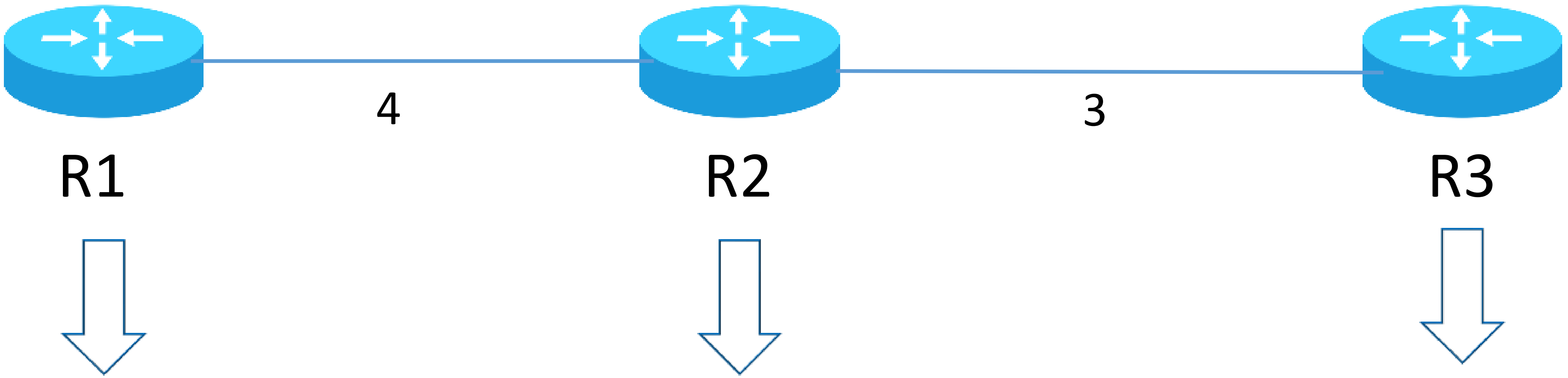
Assumption: Each router knows the cost to reach each of its directly connected neighbors.

Basic idea: Each router tells its neighbors what it knows about everyone

Each router only knows the costs to every other router, but does not know the entire network topology

Please look through lecture 14 for more details

Counting to Infinity Problem

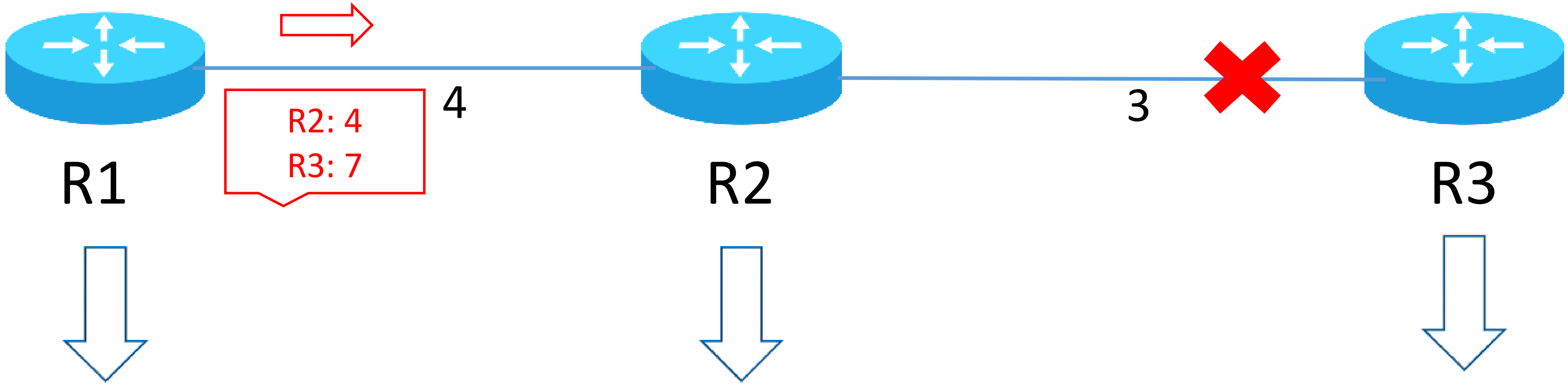


Node	Distance
R1	0
R2	4
R3	7

Node	Distance
R1	4
R2	0
R3	3

Node	Distance
R1	7
R2	3
R3	0

Counting to Infinity Problem

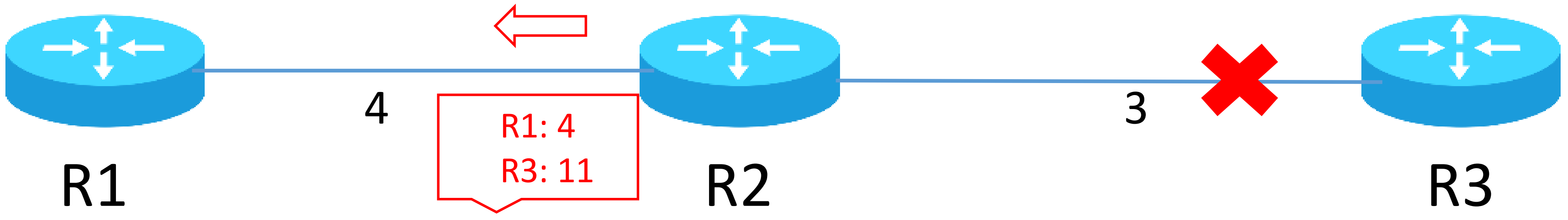


Node	Distance
R1	0
R2	4
R3	7

Node	Distance
R1	4
R2	0
R3	~~3~~ **11**

Node	Distance
R1	~~7~~ **Inf**
R2	~~3~~ **Inf**
R3	0

Counting to Infinity Problem



Node	Distance
R1	0
R2	4
R3	~~7~~ **15**

Node	Distance
R1	4
R2	0
R3	~~3~~ **11**

Node	Distance
R1	~~7~~ **Inf**
R2	~~3~~ **Inf**
R3	0

Until distance becomes infinity

Link-state Routing

Assumption: Each router knows the cost to reach each of its directly connected neighbors.

Basic idea: Each router tells everyone what it knows about its neighbor

Each router knows the costs to every other router, and the entire network topology

Please look through lecture 13 for more details

Link-state Routing

How does router know the entire network topology?

1. A router sends out its own routing message that is guaranteed to be received by all routers.

2. A router can construct the network graph by learning received the routing messages from all routers.

3. Apply Dijkstra's algorithm to find the shortest path to each router

When router R1 receives the following message

Sender ID:	R2
Links:	[R1: 2] [R3: 3] [R4: 4]

Sender ID:	R3
Links:	[R2: 3] [R4: 5]

Sender ID:	R4
Links:	[R1: 1] [R2: 4] [R3: 5]

Use Dijkstra's algorithm to find the shortest path