Basic Knowledge of IP Routing

Foreword

The forwarding of frames and switching has introduced the data link layer operations, and in particular the role of IEEE 802 based standards as the supporting underlying communication mechanism, over which upper layer protocol suites generally operate. With the introduction of routing, the physics that define upper layer protocols and internetwork communication are established. An enterprise network domain generally consists of multiple networks for which routing decisions are needed to ensure optimal routes are used, in order to forward IP packets (or datagrams) to intended network destinations. This section introduces the foundations on which such IP routing is based.
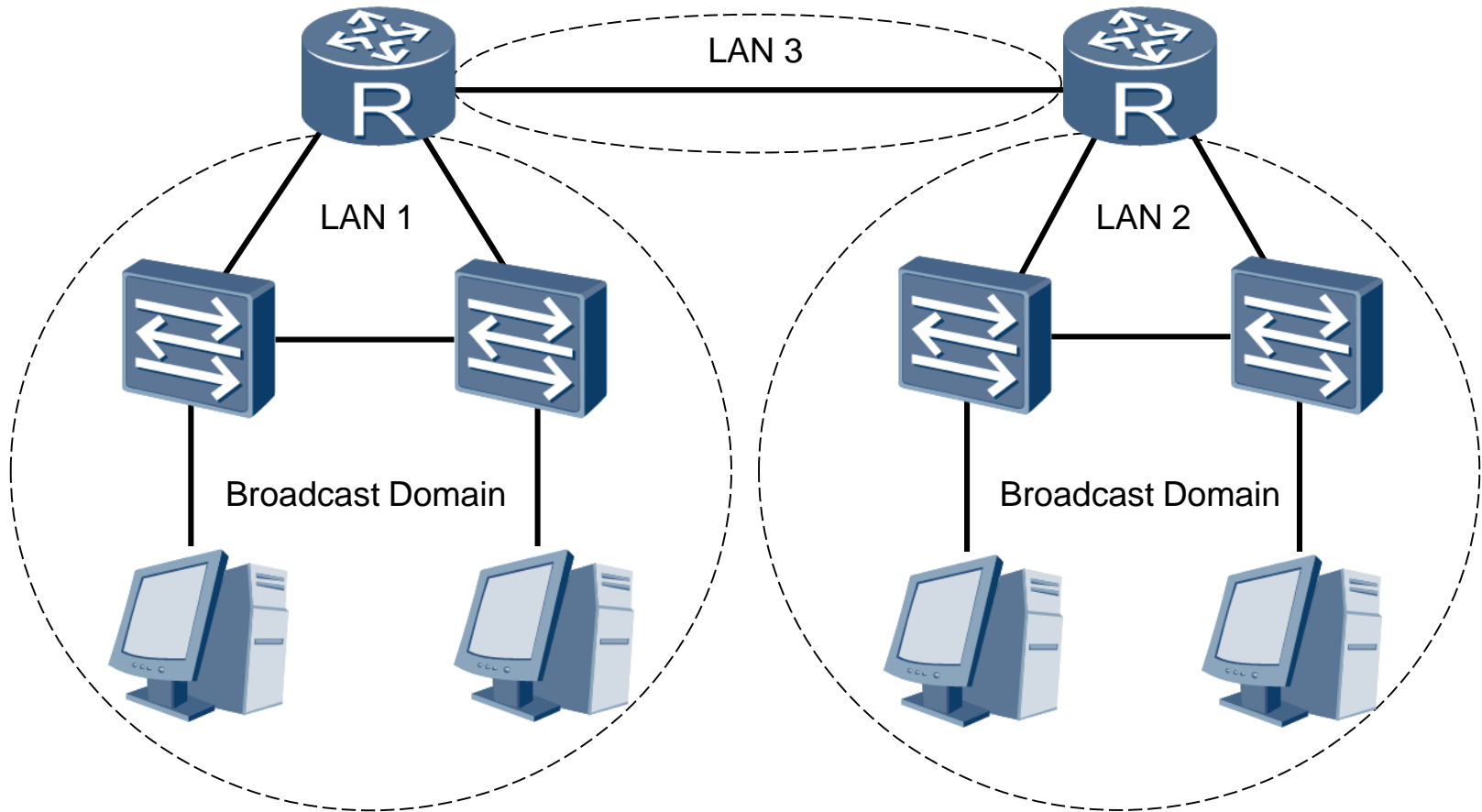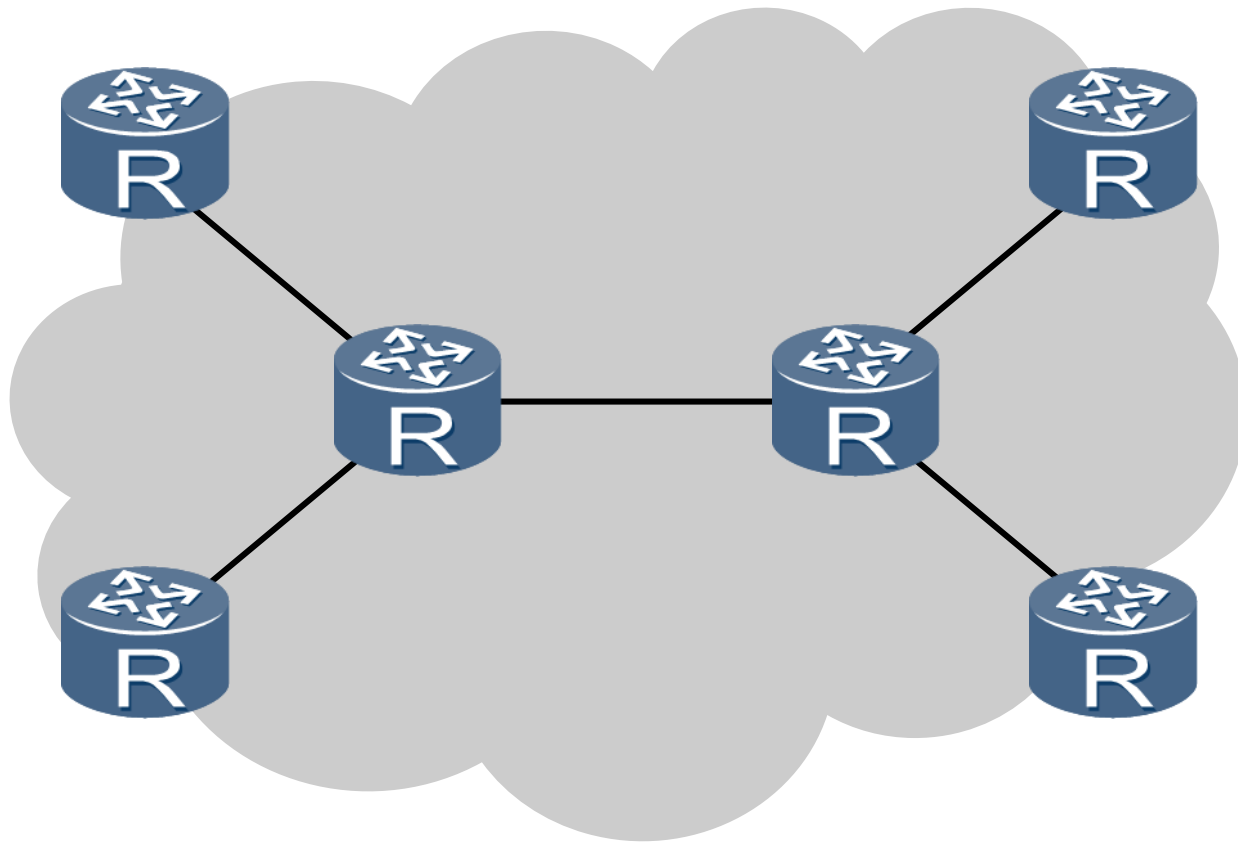
Objectives

Upon completion of this section, trainees will be able to:

- Explain the principles that govern IP routing decisions.

- Explain the basic requirements for packet forwarding.
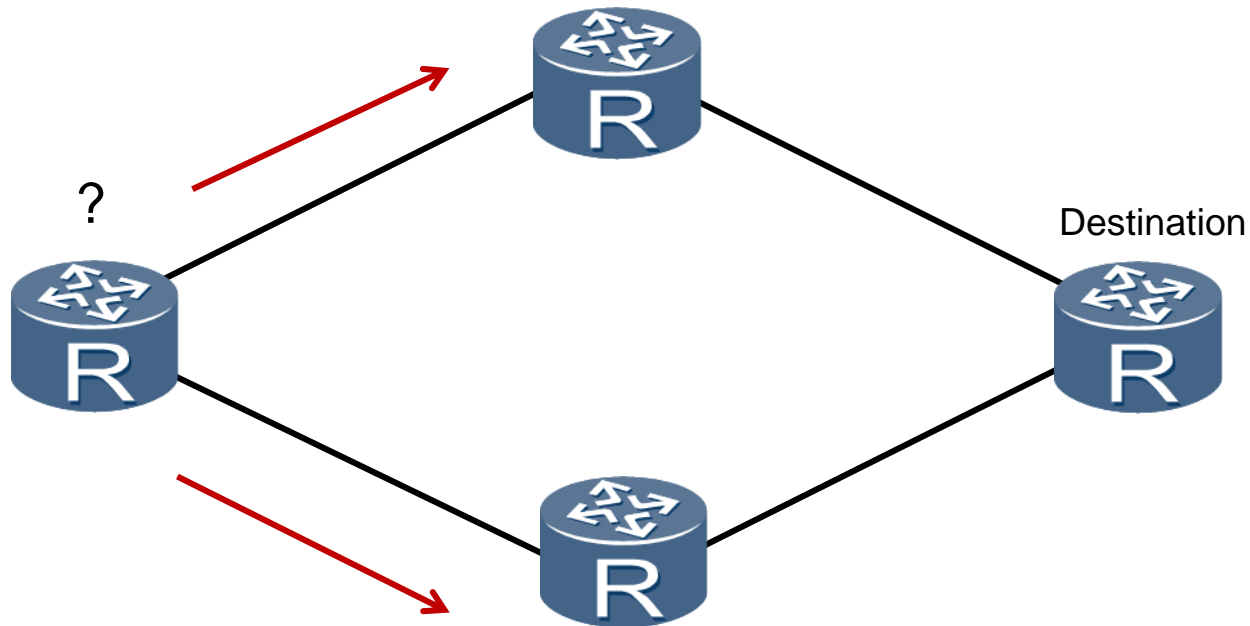
Local Area Network and Broadcast Domains
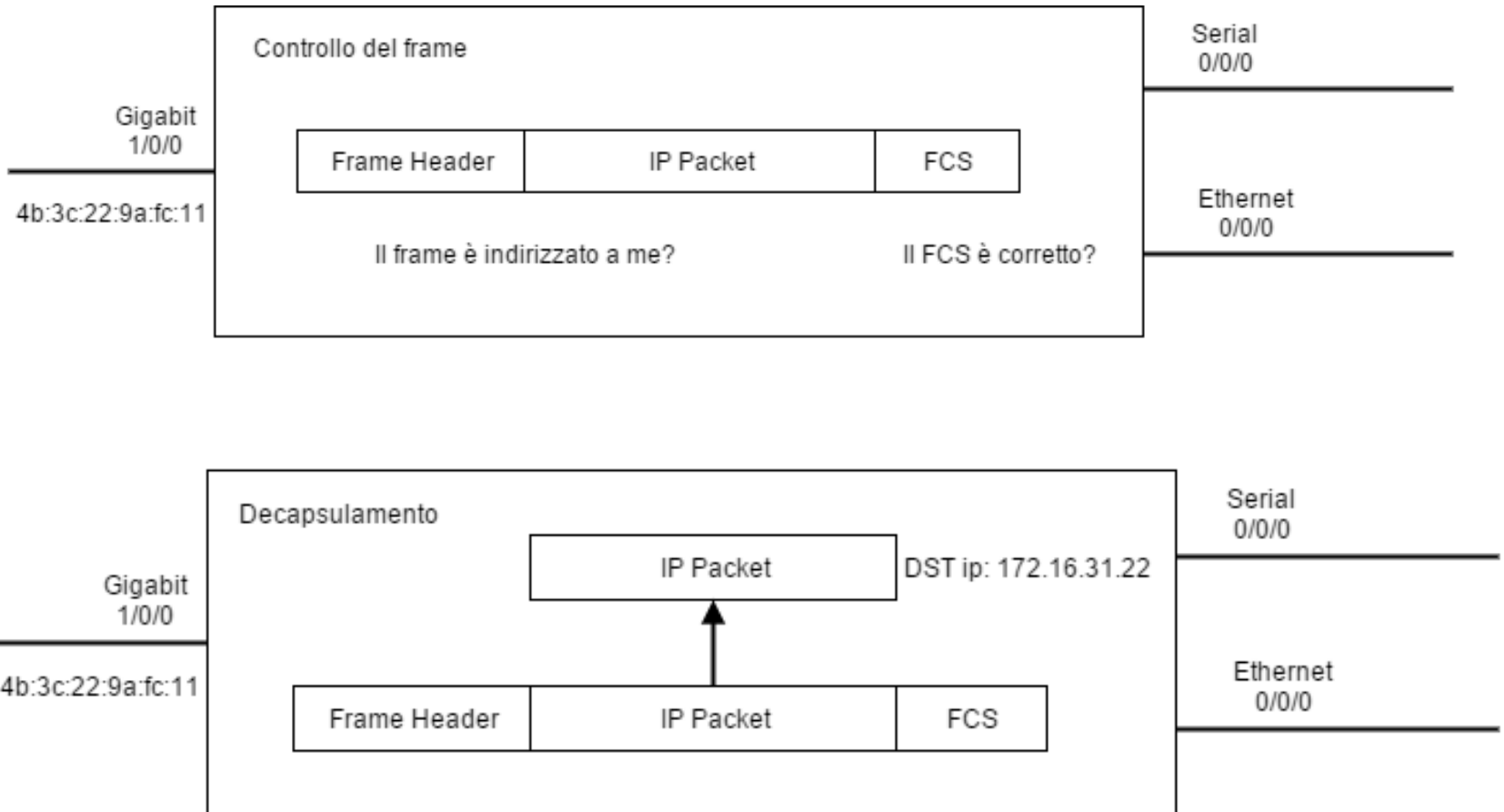
Autonomous Systems

● An IP network, or networks, controlled by one or more operators with a clear policy that governs how routing decisions are made.

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Routing Decisions

?

Destination

- Routers are responsible for the decision making process that determines the path via which packets are forwarded.

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Routing Decisions

Routing Decisions

Decapsulamento

IP Packet

Subnet	Mask	Interface	Next Router
10.0.1.23	/24	Serial 0/0/0	192.168.1.2
172.16.30.0	/22	Serial 0/0/1	172.16.33.2
172.16.31.0	/24	Ethernet 0/0/0	172.16.39.1

Gigabit 1/0/0

4b:3c:22:9a:fc:11

Serial 0/0/0

Ethernet 0/0/0
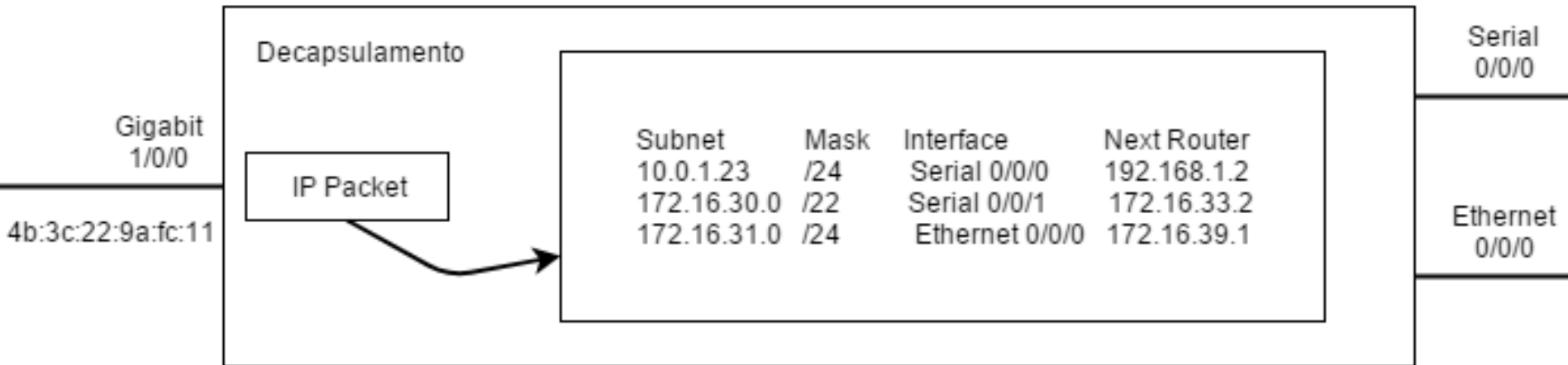
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IP Routing Table

```
[Huawei]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------
Routing Tables: Public
         Destinations : 2         Routes : 2
Destination/Mask   Proto   Pre   Cost Flags NextHop     Interface
 127.0.0.0/8       Direct  0     0     D    127.0.0.1   InLoopBack0
 127.0.0.1/32      Direct  0     0     D    127.0.0.1   InLoopBack0
```
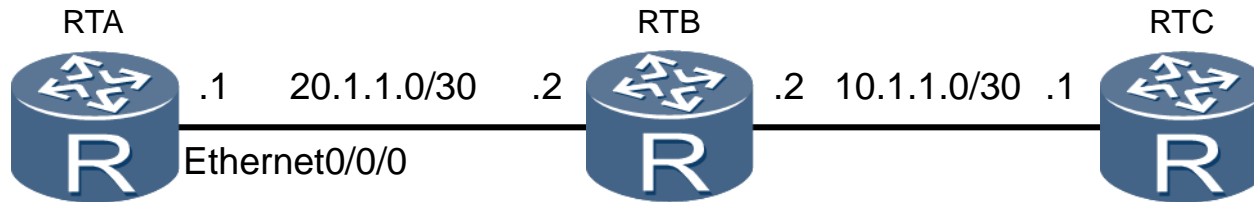
● The IP routing table lists the networks that are reachable via the router. Packets that have no route are subsequently discarded.

Routing Decisions – Longest Match


```
[RTA]display ip routing-table

Destination/Mask   Proto    Pre   Cost  Flags  NextHop     Interface
10.1.1.0/24        Static   60    0     RD     20.1.1.2    Ethernet0/0/0
10.1.1.0/30        Static   60    0     RD     20.1.1.2    Ethernet0/0/0
```

● Routes to the same network destination will be initially compared and chosen based on a longest match.

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Routing Decisions – Longest Match

- Pacchetto con destinazione: 192.168.31.3

Destinazione	Netmask	Gateway	Interfaccia
193.205.130.0	255.255.255.0	0.0.0.0	Eth0
192.168.16.0	255.255.240.0	192.168.16.1	Eth1
192.168.31.0	255.255.255.0	192.168.31.254	eth2

Destinazione	1100 0000	1010 1000	0001 1111	0000 0011
1 entry	1100 0001	1100 1101	1000 0010	0000 0000
2 entry	1100 0000	1010 1000	0001 0000	0000 0000
3 entry	1100 0000	1010 1000	0001 1111	0000 0000

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Routing Decisions – Preference
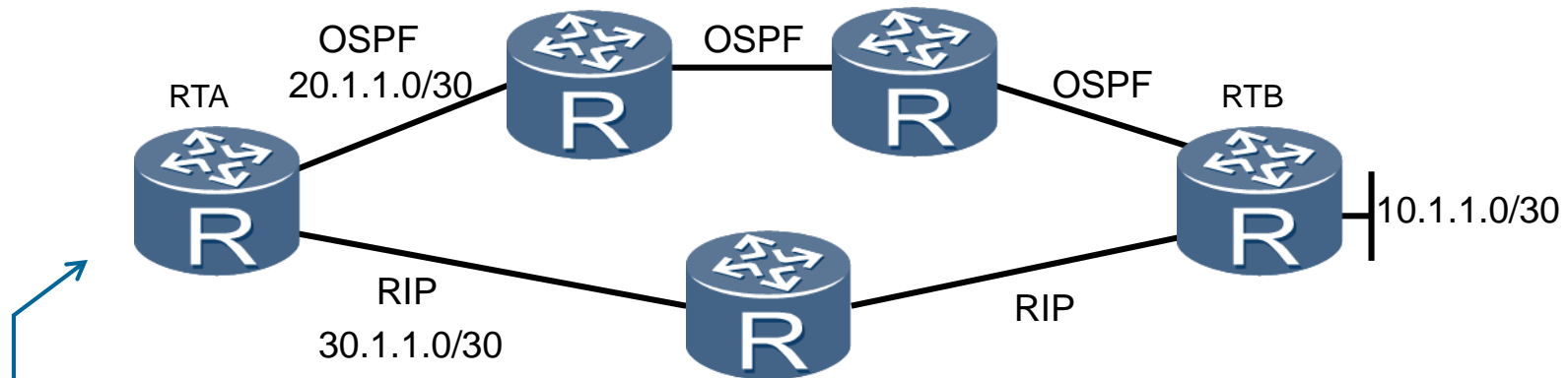

```
[RTA]display ip routing-table
Destination/Mask    Proto    Pre    Cost  Flags  NextHop      Interface
10.1.1.0/30         OSPF      10     60    RD     20.1.1.2  Ethernet0/0/0
……
```

Route	Direct	OSPF	Static	RIP
Preference	0	10	60	100

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Routing Decisions – Metric

Metric = 100

20.1.1.0/30
OSPF

RTA

OSPF

RTB

10.1.1.0/30

Ethernet0/0/1

OSPF
30.1.1.0/30

OSPF

Metric = 50
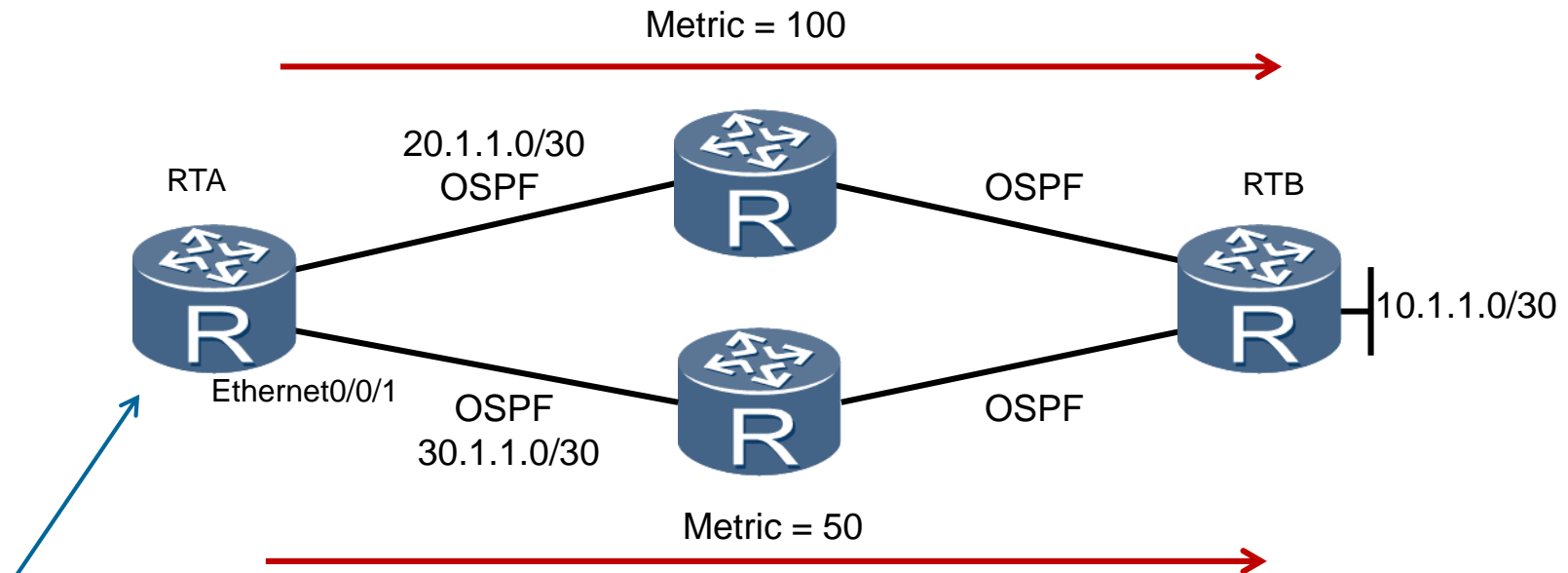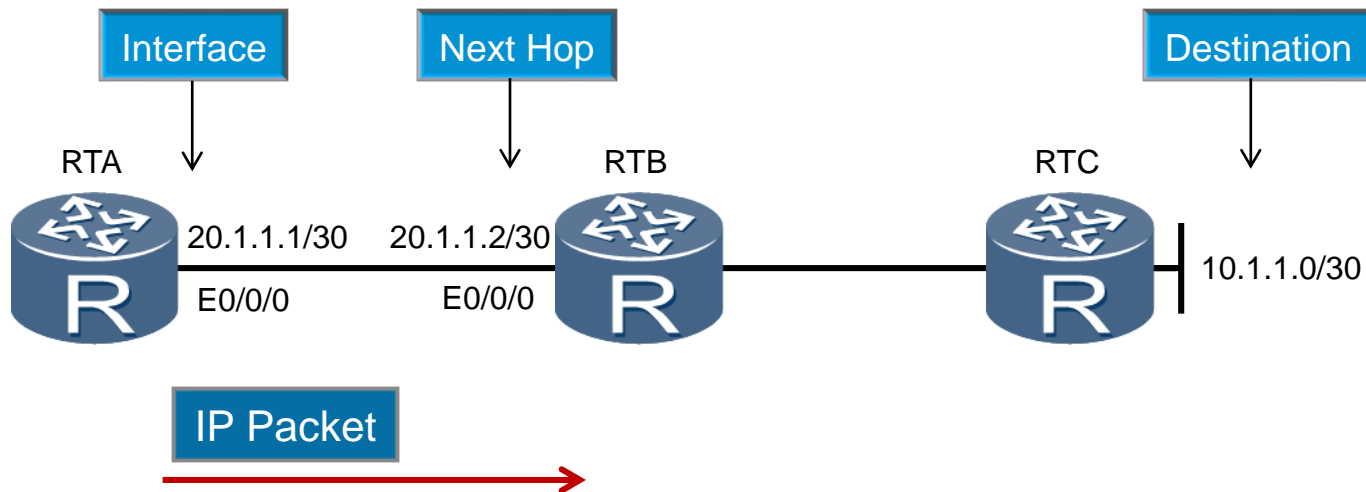
```
[RTA]display ip routing-table
Destination/Mask    Proto    Pre    Cost  Flags   NextHop      Interface
10.1.1.0/30         OSPF      10     50    RD      30.1.1.2  Ethernet0/0/1
```

Routing Table Forwarding Requirements

- The forwarding of packets requires that the destination be known as well as the forwarding interface and next-hop.

Overlapping Routes

● Si possono avere a seguito di configurazioni complesse o di errori.

```
[R1]dis ip routing-table
Route Flags: R - relay, D - download to fib
-----------------------------------------------------------------
Routing Tables: Public
         Destinations : 15        Routes : 15

Destination/Mask      Proto   Pre  Cost     Flags NextHop        Interface

10.0.0.0/24           Direct  0    0        D     10.0.0.1       GigabitEthernet 0/0/1
10.0.0.1/32           Direct  0    0        D     127.0.0.1      GigabitEthernet 0/0/1
10.0.0.255/32         Direct  0    0        D     127.0.0.1      GigabitEthernet 0/0/1
11.3.2.0/24           RIP     100  1        D     172.16.31.2    GigabitEthernet 0/0/0
127.0.0.0/8           Direct  0    0        D     127.0.0.1      InLoopBack0
127.0.0.1/32          Direct  0    0        D     127.0.0.1      InLoopBack0
127.255.255.255/32    Direct  0    0        D     127.0.0.1      InLoopBack0
172.16.31.0/24        Direct  0    0        D     172.16.31.1    GigabitEthernet 0/0/0
172.16.31.1/32        Direct  0    0        D     127.0.0.1      GigabitEthernet 0/0/0
172.16.31.255/32      Direct  0    0        D     127.0.0.1      GigabitEthernet 0/0/0
192.168.0.0/20        RIP     100  2        D     172.16.31.2    GigabitEthernet 0/0/0
192.168.1.0/24        Static  60   0        RD    10.0.0.3       GigabitEthernet 0/0/1
192.168.20.0/24       RIP     100  1        D     172.16.31.2    GigabitEthernet 0/0/0
192.168.21.0/24       RIP     100  1        D     172.16.31.2    GigabitEthernet 0/0/0
255.255.255.255/32    Direct  0    0        D     127.0.0.1      InLoopBack0
```

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Overlapping Routes

● Il router come sceglie il percorso migliore?

Uso del commando:

display ip routing-table <address> <mask>

```
[R1]dis ip routing-table 192.168.1.0 24
Route Flags: R - relay, D - download to fib
-------------------------------------------------------------------
Routing Table : Public
Summary Count : 1
Destination/Mask     Proto    Pre   Cost       Flags NextHop           Interface

192.168.1.0/24       Static   60    0          RD    10.0.0.3          GigabitEthernet 0/0/1
```

Display ip routing-table

```
<Huawei> display ip routing-table
Route Flags: R - relay, D - download to fib
--------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 8          Routes : 9

   Destination/Mask  Proto  Pre  Cost  Flags   NextHop     Interface

        10.1.1.1/32   Static  60    0     D    0.0.0.0      NULL0
                      Static  60    0     D    192.168.0.2  GigabitEthernet1/0/0
     192.168.0.0/24   Direct   0    0     D    192.168.0.1  GigabitEthernet1/0/0
     192.168.0.1/32   Direct   0    0     D    127.0.0.1    GigabitEthernet1/0/0
   192.168.0.255/32   Direct   0    0     D    127.0.0.1    GigabitEthernet1/0/0
        127.0.0.0/8   Direct   0    0     D    127.0.0.1    InLoopBack0
        127.0.0.1/32  Direct   0    0     D    127.0.0.1    InLoopBack0
  127.255.255.255/32  Direct   0    0     D    127.0.0.1    InLoopBack0
  255.255.255.255/32  Direct   0    0     D    127.0.0.1    InLoopBack0
```

Table 1 Description of the display ip routing-table command output

Item	Description
Route Flags	Flag of a route: • R: indicates that the route is an iterated route. • D: indicates that the route is delivered to the FIB table.
Routing Table: Public	The routing table is a public routing table. If the routing table is a private Routing Tables: ABC.
Destinations	Total number of destination networks or hosts.
Routes	Total number of routes.
Destination/Mask	Address and mask length of the destination network or host.
Proto	Routing protocol that learns a route.
Pre	Preference of a route.
Cost	Cost of a route.
Flags	Route flags in the heading of the routing table.
NextHop	Next-hop address of a route.
Interface	Outbound interface through which the next hop of a route is reachable.

Summary

- What is the order in which routing decisions are made?

- What does the preference represent?

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Thank you

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