

# Routing Concepts


# Functions of a Router and Longest Match

1. **Determine the best path** to forward packets based on the information in its **routing table**.
2. **Forward packets** towards their destination.

**Best Path = Longest Match** = Routing table entry that has the **greatest number of far-left matching bits with the destination IP address** of the packet.

Destination IPv4 Address: 172.16.0.10

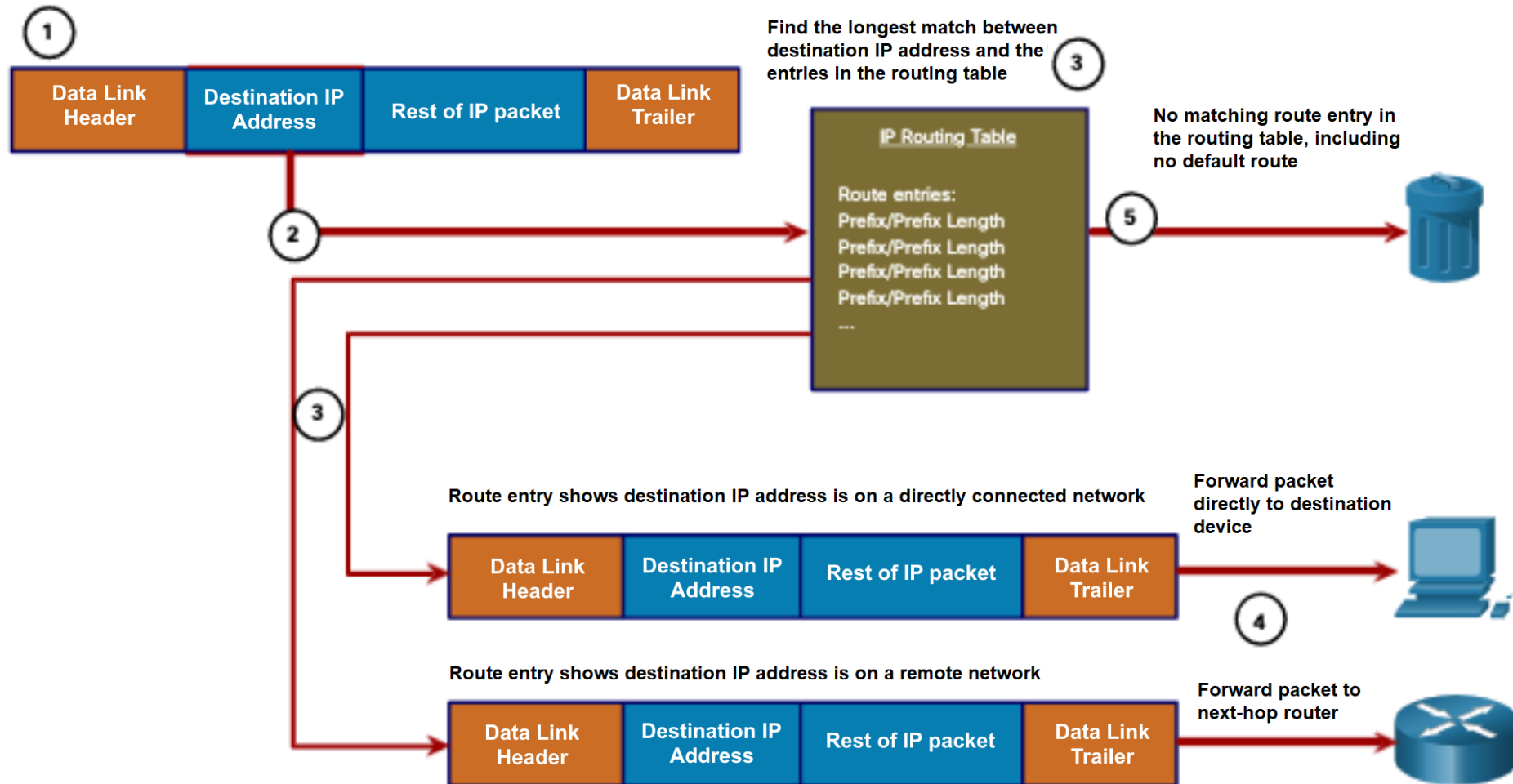
Route entries:

1. 172.16.0.0/12
2. 172.16.0.0/18
3. 172.16.0.0/26  **Longest Match**

# Routing Table

- **Directly Connected:** Local interface configured with an IP address and subnet mask and is active (up/up)
- **Remote networks** Networks not directly connected to the router.
  - **Static routes:** route manually configured
  - **Dynamic routing protocols:** routing protocols dynamically learn routes
- **Default route:** next-hop router when routing table does not contain a matching
  - /0 prefix length
  - Also known as **gateway of last resort**

# Packet Forwarding Decision Process



# Packet Forwarding Mechanisms

## 1. Process switching

- Packet arrives on interface → forwarded to control plane → CPU matches destination address in routing table → forwards to exit interface

## 2. Fast switching

- Uses fast-switching cache to store next-hop information → cache re-used without CPU intervention

## 3. Cisco Express Forwarding (CEF)

- Default Cisco IOS forwarding mechanism
- CEF builds a Forwarding Information Base (FIB) and adjacency table.
- Table entries are change-triggered.

# Route Sources

- **c** : directly connected network
- **L** : address assigned to a router interface (IPv4 /32, IPv6 /128)
- **s** : static route
  - small networks not expected to grow significantly
  - path to any network that does not have a more specific match with another route in the routing table
  - routes to and from stub networks.
- **o** : dynamically learnt network using OSPF
- **\*** : candidate for default route. 0.0.0.0/0 or ::/0

# Route Table Entries

0	10.0.4.0/24	[110/50]	via 10.0.3.2,	00:13:29	Serial0/1/0
(1)	(2)	(3)(4)	(5)	(6)	(7)

1. Route source
2. Destination network
3. Administrative distance
4. Metric
5. Next-hop
6. Route timestamp
7. Exit interface

When a router has 2 or more paths to a destination with equal cost metrics, then the router forwards the packets using both paths equally. This is called **equal cost load balancing**.

# Structure of an IPv4 Routing Table

Parent route (Classful network address of this subnet)

Child route (Indented, Route source and all the forwarding info)

Example:

```
Router# show ip route
(Output omitted)
    192.168.1.0/24 is variably..
C    192.168.1.0/24 is direct..
L    192.168.1.1/32 is direct..
O    192.168.2.0/24 [110/65]..
O    192.168.3.0/24 [110/65]..
    192.168.13.0/24 is variably..
C    192.168.13.0/30 is direct..
L    192.168.13.1/32 is direct..
    192.168.23.0/30 is subnette..
O    192.168.23.0/30 [110/128]..
```



# Administrative distance

Route Source	Administrative Distance
-----	-----
Directly connected	0
Static route	1
EIGRP summary route	5
External BGP	20
Internal EIGRP	90
OSPF	110
IS-IS	115
RIP	120
External EIGRP	170
Internal BGP	200

# Static and dynamic routes

## Static routes:

- As a **default route** forwarding packets to a **service provider**
- For **routes outside the routing domain** and not learned dynamically
- When you want to **explicitly define the path** for a specific network
- For routing between **stub networks**

## Dynamic routes:

- In networks consisting of **more than just a few routers**
- When a **change** in the network topology requires the network to **automatically determine another path**
- For **scalability**. As the network grows, the dynamic routing protocol automatically learns about any new networks.

# Dynamic Routing Protocols

Interior Gateway Protocols				Exterior Gateway Protocols	
Distance Vector		Link-State		Path Vector	
-----		-----		-----	
IPv4	RIPv2	EIGRP	OSPFv2	IS-IS	BGP-4
IPv6	RIPng	EIGRP	OSPFv3	IS-IS	BGP-MP

- **RIP:** Metric is "**hop count**" (each **router** adds a hop). Maximum of **15 hops** allowed.
- **OSPF:** Metric is "**cost**" (based on the **cumulative bandwidth** from source to destination). Faster links are assigned lower costs compared to slower (higher cost) links.
- **EIGRP:** Metric based on the **slowest bandwidth and delay values**. It could also include **load and reliability** into the metric calculation. Supports unequal cost load balancing.