Routing Concepts

📕 CCNA2v7 Module 14 Routing Concepts

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Functions of a Router and Longest Match

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

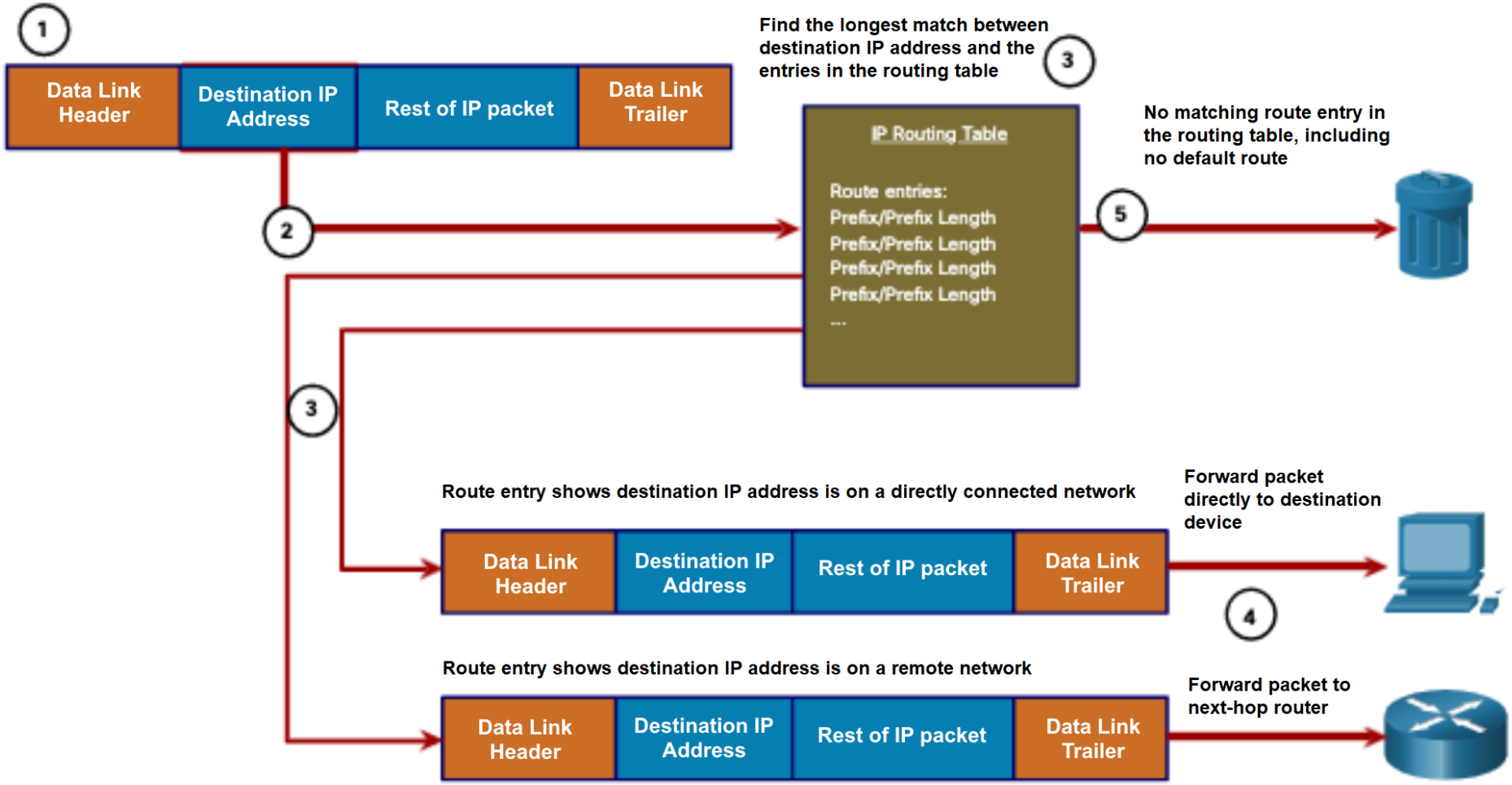
Best Path = **Longest Match** = Routing table entry that has the **greatest number of far-left matching bits with the destination IP address** of the packet.

> 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

1️⃣ Process switching

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

2️⃣ Fast switching

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

3️⃣ 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

```
 O  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)
   172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C     172.16.1.0/24 is directly connected, GigabitEthernet0/0
L     172.16.1.1/32 is directly connected, GigabitEthernet0/0
C     172.16.3.0/30 is directly connected, Serial0/0
L     172.16.3.1/32 is directly connected, Serial0/0
   192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
L     192.168.10.4/30 is directly connected, Serial0/0/1
      192.168.10.5/32 is directly connected, Serial0/0/1
   192.168.23.0/30 is subnetted, 1 subnets
O     192.168.23.0 [110/128] via 192.168.10.6, 00:02:39, Serial0/0/1
                   [110/128] via 172.16.3.2, 00:18:52, Serial0/0/0
```

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.