

Day 11: Routing Fundamentals

CCNA 200-301 Study Guide: IP Routing Fundamentals & Static Routing

1.0 Introduction: The Core of IP Connectivity

IP routing is the Layer 3 function that enables communication across different network segments. It is a major component of the IP Connectivity domain, representing 25% of the CCNA exam.

Layer 2 Switching vs. Layer 3 Routing

Function	Layer 2 Switching	Layer 3 Routing
Primary Role	Forwards traffic within a single LAN/broadcast domain.	Forwards traffic between different IP networks/subnets.
PDU Handled	Frame. Decisions based on Destination MAC.	Packet. Decisions based on Destination IP.
Unknown Destination	Floods the frame to all ports (except source).	Drops the packet if no matching route is found.

2.0 Deconstructing the IP Routing Table

The routing table is a RAM-based map of the network. The command to view it is `show ip route`.

Routing Table Components

Component	Description	Significance
Source Code	A letter code (e.g., S, C, L, O, R).	Identifies how the route was learned and its trustworthiness.
Destination Network	The remote network prefix and mask.	The "destination" target for incoming packets.
Admin Distance (AD)	A value from 0-255.	Tie-breaker for trustworthiness (Lower is better).
Metric	Path "cost" calculated by the protocol.	Tie-breaker if multiple routes have the same AD.
Next Hop	The IP of the next router in the path.	The immediate next device to receive the packet.
Exit Interface	The local physical/virtual outbound port.	The "door" the packet leaves through.

Automatically Populated Routes

- Connected (C): The network segment directly attached to an active interface.
- Local (L): A host route (255.255.255.255) for the specific IP assigned to the router's interface.

3.0 The Path Selection Process: A Router's Logic

Routers follow a non-negotiable, three-step hierarchical logic to determine the "Best Path."

1. Longest Prefix Match (LPM): The router prefers the most specific route (the one with the longest subnet mask).

- Example: For destination 10.1.1.5, a /32 route beats a /24 route.
2. Administrative Distance (AD): If prefix lengths are identical, the router selects the source with the lowest AD.
 - Connected: 0
 - Static: 1
 - OSPF: 110
 3. Metric: If both prefix length and AD are identical, the path with the lowest cost (metric) is chosen.

4.0 Static Routing: Manual Network Navigation

Static routes are manually configured using the ip route command. They are ideal for "Stub" networks with a single exit path.

Advantages	Disadvantages
Low CPU/RAM overhead (no protocol calculations).	Not scalable for large, complex networks.
Highly predictable and explicit traffic flow.	Requires manual intervention for every topology change.
Secure (does not advertise network info).	High administrative effort.

Configuration Methods

- Next-Hop IP: Recommended for multi-access (Ethernet) segments.
 - ip route 10.2.2.0 255.255.255.0 192.168.1.2
- Exit Interface: Primarily for point-to-point links.
 - ip route 10.2.2.0 255.255.255.0 g0/1
- Fully Specified: Provides both interface and next-hop; avoids recursive lookups.
 - ip route 10.2.2.0 255.255.255.0 g0/1 192.168.1.2

5.0 The Default Route: Gateway of Last Resort

The default route acts as a safety net for packets that do not match any other specific entry in the routing table.

- Syntax: 0.0.0.0 0.0.0.0 (CIDR notation: /0).
- Logic: Because it has a prefix length of zero, it is the least specific route possible and is only used if all other entries fail to match.
- Verification: Identified in the routing table by the code S*. The asterisk (*) signifies the active candidate for the gateway of last resort.

6.0 Packet Forwarding Mechanics: L2 and L3 Journey

As a packet travels across routers, its encapsulation changes.

- IP Addresses (Layer 3): Remain unchanged from source to destination (unless NAT is applied).
- MAC Addresses (Layer 2): Are rewritten at every hop. Each router replaces the source MAC with its own exit interface and the destination MAC with the next hop's address.

The Forwarding Procedure

1. De-encapsulate: Strip the L2 frame to see the L3 packet.
2. Lookup: Find the best path in the routing table.
3. Re-encapsulate: Wrap the packet in a new L2 frame for the next hop.

7.0 Core Troubleshooting for Static Routes

1. Verify Interface Status: Use `show ip interface brief`. Interfaces must be up/up. A static route is removed if its exit interface is down.
2. Confirm Route Presence: Use `show ip route`. Ensure no typos were made during configuration.
3. Recursive Lookup Check: The router must have a valid route to the Next-Hop IP for the static route to be installed in the table.
4. Ensure Route Symmetry: Check that the return path exists on the remote router. Routing is a one-way decision.

8.0 Summary of Key Concepts

- LPM is the first rule of routing; specificity always wins.
- Static Routes have a default AD of 1.
- Connected Routes have the lowest possible AD of 0.
- Default Routes handle all otherwise unmatchable traffic and use the /0 mask.

Revision #1

Created 2026-03-14 19:20:31 UTC by Tony Utter

Updated 2026-03-14 19:20:48 UTC by Tony Utter