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STATIC ROUTES CH.6 P1

Routers learn routes 2 ways: 1. Manually 2. Dynamically

Manually: Remote networks entered into r-table using static routes: Update every time topology changes

Dynamically: Auto learned w/dynamic routing protocol

- Neither mutually exclusive: Most networks use a combo of dynamic/static routes
- AD of static route is 1: Takes lead over dynamic learned routes | Administrative Distance: Trustworthiness of route

Advantages: Better security/less BW/no CPU cycles to calc routes/path known

- Smaller networks w/1 path to outside: Security for certain traffic: Links to networks for more control

Disadvantages: Time-consuming/error-prone/intervention for route changes/bad scalability/complete knowledge of network

Type	Dynamic Routing	Static Routing
Config	Irrelevant network size	Increases w/network
Topology	Auto adapts	Admin required
Scaling	Simple/complex topologies	Simple topologies
Security	Less	More
Resources	CPU/BW/Link BW	No extra resources
Predictability	Depends on topology	Always same

Static Routing: Primary uses:

1. Ease of r-table maintenance: Smaller networks [don't scale]
2. Routing to/from stub networks | Stub network: One accessed by single route: Router has 1 neighbor
3. Less resource waste

Used to:

- Connect to specific network: Provide Gateway of Last Resort to stub network: Connect stub router
- Summarize r-table entries: Create backup route
- Reduce # of routes advertised: Summarizes 7 contiguous networks as 1 static
- Backup route if primary route link fails

Standard Static Route	<ul style="list-style-type: none">○ IPv4/6 support config: Good for connecting to specific remote network
Default Static Route	<ul style="list-style-type: none">▪ A route that matches all packets▪ Default ID's gateway IP to which router sends all IP packets that don't have learned static▪ Config default creates Gateway of Last Resort▪ All routes ID specific destination w/larger mask take precedence over default<ul style="list-style-type: none">□ When no routes in r-table match packet destination IP <p>Stub router: A router that only has 1 other router connected to it</p>
Summary Static Route	<ul style="list-style-type: none">○ Reduce r-table entries: Multiple static routes can be grouped into single static if:<ul style="list-style-type: none">▪ Destination networks are contiguous: Summarized into single network address○ Multiple static routes: All use same exit int/next-hop IP
Floating Static Route	<ul style="list-style-type: none">○ Static routes used to provide backup path to primary static/dynamic routes: If link failure happens○ Only used when primary isn't available

Config: ip route

router(config)# ip route net-address mask { IP[int-type int-# [IP addr]] [distance] [name name] [permanent]][tag tag]

Params required for static route config:

Network-address	Destination of remote network to be added to r-table: AKA Prefix
Subnet-mask	Remote network to be added to r-table: Mask can be modified to summarize group of networks

1/both of the following must also be used:

IP	<ul style="list-style-type: none"> ○ IP of connecting router to use to forward packet to remote destination network ○ AKA next-hop: Connecting to broadcast media (Ethernet): Creates recursive loop
exit-intf	<ul style="list-style-type: none"> ○ Outgoing int to forward packet to next-hop: AKA directly attached static route ○ Used when connecting to P2P (point-to-point) config
Distance:	Used to create floating static by setting AD higher than dynamically learned route

Next-Hop Options: Can be ID'd by IP/exit int/or both

Destination specified route types:

1. Next-hop route: Only next-hop IP specified
2. Directly connected static route: Only router exit int specified

Config Next-Hop Static Route: Only next-hop IP specified: Output int derived from next-hop

Route resolvability: R-table must determine the exit int to use before any packets are fwded

- Depends on the type of fwding mechanism used by router: CEF (Cisco Express Fwding) default on IOS 12/later

How it works: When packet destined for specific network

1. It looks for match in r-table: Finds it has to fwd packets to next-hop IPv4
 - IPv4 doesn't reference the exit int: So it needs the next-hop IPv4 resolved using another route in r-table w/an exit int
2. There has to be a way to reach destination: Searches a 2nd time for match
 - If Pv4 matches route for directly connected network w/exit int: Lookup tells r-table to process packet
 - The packet is fwded out of that int

As stated: It takes 2 r-table lookup processes to fwd any packet

Recursive lookup: When a router performs multiple lookups in r-table before fwding packets

- Consumes router resources: Should be avoided

Recursive static valid (for r-table) only works when specified next hop resolves (directly/indirectly) to a valid exit int

CEF	<ul style="list-style-type: none"> ▪ Provides optimized lookup for efficient packet fwding <p>Uses 2 main data structures stored in data plane:</p> <ol style="list-style-type: none"> 1. FIB (Fwding Info Base): A copy of r-table 2. Adjacency table that includes L2 addressing info <ul style="list-style-type: none"> ○ Info in both tables work together: No recursive lookup needed for next-hop lookups ○ Static route using next-hop IP requires a single lookup with CEF enabled
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Config Directly Connected Static:

- Another option: Uses exit int to specify next-hop
- It was used in older IOS versions (prior to CEF) to avoid recursive lookups
- It allows an r-table to resolve the exit int in a single search: Instead of the 2
- R-Table of a static route will list AD as 1: Directly connected int has an AD of 0

Point-to-point ints: Can use static routes that point to exit ints/next-hop addresses

- Multipoint/broadcast ints: Better to use static routes that point to next-hop
- Static routes use only an exit int on point-to-point: Use of CEF fwding makes it unnecessary though

Fully Specified Static Route

- Both output int/next-hop IP are specified: Also used on older versions of IOS prior to CEF
- Used when output int is a multi-access int: Necessary to ID next hop: Must be directly connected.

Differences: Ethernet multi-access/Point-to-point serial network:

- **Point-to-point:** Only 1 other device: Router at other end of link
- **Ethernet:** Many devices: Same multi-access: Hosts/multiple routers
- This is why next-hops can become insufficient/confused to determine in Ethernet
- CEF = Fully specified static: Unnecessary [static using next-hop address should be used]

Verifying static routes:

router# show ip route | begin Gateway

router# show ip route 192.168.1.1

router# show ip route static

router# show running-config | section ip route
ping/tracert

Default Static Route	<ul style="list-style-type: none">○ A route that matches all packets: Doesn't store all routes to networks in r-table○ Stores single default route: Represents any network not in r-table○ Can be learned from another router/dynamic r-protocol○ Used when no other routes in r-table match destination IP: Gateway of Last Resort
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Used when connecting: Edge router to service provider network/Stub router (only 1 upstream neighbor router)

- Commonly creates recursive lookup

Quad-zero route: IPv4 default static routes

S	Labels route as static
*	Indicates candidate for default route

NOTE: Subnet mask: In r-table determines how many bits match between destination IP of packet/route in r-table

Binary 1: Bits must match | Binary 0: Bits don't have to match | **/0 mask entry indicates no bits required to match**

Config Default Static

router# ip route 0.0.0.0 0.0.0.0 { ip-address | exit-intf }

IPv6: ipv6 route

ipv6 unicast-routing [*global config*] must be config'd to enable router to fwd IPv6 packets

- Static routes for IPv6 are config'd using ipv6 route [*global config*]
- Most params identical to IPv4 version

router(config)# ipv6 route ipv6-prefix/prefix-length { ipv6-address | exit-intf }

IPv6 static routes implemented	Standard IPv6 static Default IPv6 static Summary IPv6 static Floating IPv6 static <ul style="list-style-type: none">• Can be config'd as recursive/directly connected/fully specified
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Next-Hop Options: Next-hop can be ID'd by an IPv6 address/exit int/both.

Dest specified creates 1 of 3 route types:

1. **Next-hop static:** Only next-hop IPv6 address
2. **Directly connected static :** Only router exit int
3. **Fully specified static:** Next-hop IPv6 address/exit int

Config Next-Hop Static In next-hop static: Only next-hop address: Output int derived from next hop

- Before packet fwded: r-table must resolve route to determine exit int to use
- Process varies according to type of fwding mechanism used by router
- CEF (Cisco Express Forwarding): Default on most/IOS 12.0/later

Process:	<ol style="list-style-type: none">1. Looks for match in r-table: Finds it has to fwd packets to next-hop<ul style="list-style-type: none">□ Every route that references only next-hop and no exit int:□ Needs next-hop resolved using another route in r-table w/exit int2. Searches 2nd time for match: Lookup tells r-table packet is fwded out of int <p>Recursive lookup: When router performs multiple lookups in r-table before fwding</p> <ul style="list-style-type: none">○ Recursive static is valid (for r-table) only when specified next-hop resolves directly/indirectly to valid exit int
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Config Directly Connected Static

- Point-to-point: Alt to using next-hop is to specify exit int
- Older IOS/CEF disabled: Avoids recursive lookup problems |No other lookups required
- Config directly connected static route w/exit int: Allows r-table to resolve in single search
- CEF make static routes w/exit int pointless: Lookup uses combo of FIB/adjacency table stored in

data plane

Config Fully Specified Static: Both output int/next-hop address

- If CEF not enabled on router/exit int on multi-access network
- CEF: Static route using only next-hop preferred method even when exit int is multi-access

If IPv6 static uses IPv6 link-local as next-hop: Fully specified static route including exit int must be used!

- IPv6 link-locals not contained in v6 r-table: They are only unique on given link/network
- Next-hop link-locals may be valid on multiple networks connected to router: Necessary exit int

Verify Static Routes

ping

tracert

show ipv6 route

show ipv6 route static

show ipv6 route network

Default Static: Matches all packets: Instead of storing routes stores single default: Represents any network not in table

- Uses dynamic routing protocol when no other routes match packet's destination IP in table
- If more specific match doesn't exist: Use default route as Gateway of Last Resort

Common use
◦ Edge router to service provider
◦ Stub router

ipv6 route ::/0 { ipv6-address | exit-intf }

::/0 Mask indicates no bits required to match: As long as specific match doesn't exist: Default static route matches all packets