



Routing Concepts

Static Routing

In This Section

- + IP Routing Process Overview
 - + Routing
 - + Switching
 - + Encapsulation
- + Longest Match Routing
- + Metric vs. Distance
- + Routing to a Next-Hop
- + Routing to an Interface
- + Default Routing

IP Routing Process Overview

- + Packet routing involves three main steps
- + Routing
 - + Find the outgoing interface for the packet
- + Switching
 - + Move the packet between interfaces
- + Encapsulation
 - + Rebuild the packet's layer 2 header

First Step - The Routing Process

- + What does the router do when a packet enters?
- + Find the longest match to the destination
 - + show ip route 1.2.3.4
 - + 1.0.0.0/8
 - + 1.2.0.0/16
 - + 1.2.3.0/24
- + Recurse to the outgoing interface
 - + 1.2.3.4 via 5.6.7.8
 - + 5.6.7.8 via 9.0.1.2
 - + 9.0.1.2 via 3.4.5.6
 - + 3.4.5.6 directly connected, GigabitEthernet1
- + Note: a route cannot be installed in the routing table unless the recursive lookup is successful

Metric vs. Distance

- + What if there are multiple longest matches?
- + Same protocol
 - + Choose lowest metric
 - + Rules vary per protocol
 - + E.g. OSPF internal over external
- + Different protocols
 - + Choose lowest Administrative Distance

Second Step - The Switching Process

- + Move the packet between interfaces
 - + Called the “switching path”
 - + Process, Fast, CEF, etc.
- + This is where load balancing occurs
 - + Ideally per flow, not per packet
- + Verification
 - + show ip interface
 - + show ip cef [address] [detail]
 - + show ip cef exact-route [source] [destination]

Final Step - The Encapsulation Process

- + Build the layer 2 header
 - + Header type depends on egress interface
 - + E.g. Ethernet vs. PPP
- + For multipoint interfaces, layer 3 to layer 2 resolution is required
 - + Ethernet
 - + Frame Relay Multipoint
 - + ATM Multipoint
 - + mGRE (DMVPN)

Encapsulation on Ethernet

- + Resolve the next-hop IP to next-hop MAC
 - + Address Resolution Protocol (ARP)
- + Check the ARP cache first
 - + show ip arp
- + If no match, broadcast the request
 - + debug arp

Encapsulation on mGRE (DMVPN)

- + Resolve the tunnel IP to the NBMA IP
 - + Next-Hop Resolution Protocol (NHRP)
- + Check the NHRP cache first
 - + show ip nhrp
- + If no match, ask the next-hop server (NHS)
 - + debug nhrp
 - + debug dmvpn

Routing to a Next-Hop

- + Recurse to the interface
- + If multipoint, resolve next-hop
- + Example
 - + `ip route 10.0.0.0 255.0.0.0 1.2.3.4`
 - + Find interface for 1.2.3.4
 - + If multipoint, find layer 2 address of 1.2.3.4

Routing to a Multipoint Interface

- + Recursion not required
- + Resolve layer 2 address for final destination
 - + Ethernet Proxy-ARP
 - + NHRP mappings
- + Example
 - + `ip route 10.0.0.0 255.0.0.0 FastEthernet0/0`
 - + Find layer 2 address of 10.0.0.1

Routing to a Point-to-Point Interface

- + Recursion not required
- + Layer 2 resolution not required
- + Example
 - + `ip route 10.0.0.0 255.0.0.0 Serial0/0.1`

Default Routing

- + To a next-hop
 - + Use the layer 2 address of the next hop for all layer 3 destinations
- + To a multipoint interface
 - + All destinations require layer 3 to layer 2 resolution
 - + Layer 2 mapping table size problems
- + To a point-to-point interface
 - + No layer 3 to layer 2 resolution required

Other Default Routing

- + ip default-gateway
 - + Only when IP routing is off
- + ip default-network
 - + Network flagged as default in routing advertisements
 - + Must be a classful network that is not directly connected





Routing Concepts

Reliable Static Routing

What is Reliable Static Routing?

- + Only criteria for installing a static route is the route recursion process
 - + Can I find the outgoing interface?
- + Static routes don't know the network conditions on the other end of the link
 - + Next hop may be reachable or may be down
- + Reliable static routes combine static routing with enhanced objects
 - + Enhanced object calls IP SLA feature to track remote reachability
 - + If tracked object is down, static route is removed from the routing table
- + Allows for more intelligence with floating static routes
 - + Primary static route tracks remote next hop
 - + If remote next hop is unreachable, remove the static route
 - + Floating static replaces it and connectivity can be maintained

Configuring Reliable Static Routing

- + Define IP SLA agreement
 - + E.g. ping the remote end of the link
- + Define tracked object
 - + Tracked object calls IP SLA agreement
- + Tie tracked object to static route



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Routing Concepts

Policy Based Routing (PBR)

In This Section

- + What is Policy Based Routing?
- + How Policy Based Routing Works
- + PBR Configuration

What Is Policy Based Routing (PBR)?

- + Normal IP routing is destination based
 - + Find the longest match to the destination
 - + Route the packet towards the next-hop
- + PBR allows forwarding decision to be based on...
 - + Source
 - + Destination
 - + Protocol type (FTP, HTTP, etc.)
 - + Incoming interface

How Policy Based Routing Works

- + Traffic criteria defined by a route-map match
 - + Permit means to policy route
 - + Deny means to use normal forwarding
 - + match [interface | ip address | ...]
- + Action defined by route-map set
 - + set ip [default] next-hop
 - + set [default] interface
- + Policy can be verified with...
 - + debug ip policy

Policy Routing Variations

- + PBR can apply to two types of traffic
- + Incoming traffic
 - + PBR applied at the link level
 - + ip policy route-map [route-map]
- + Locally originated traffic
 - + PBR applied globally
 - + ip local policy route-map [route-map]
 - + Be careful, some versions don't have control plane checks

Policy Routing Caveats

- + Most platforms can't hardware accelerate PBR
- + Platforms that do have strict criteria limits
- + Outside of this PBR should be used sparingly
 - + High CPU due to interrupts means process switching problem



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