



# 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





# 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

