Post 8

Thursday, January 24, 2019 11:12 PM

ROUTING: PATH DETERMINATION, IOS CONFIGS

Checking Int Settings (recap): Several show cmds

IPv4

show ip int br	Summary all ints including IPv4's on int: Status
show ip route	• Contents of IPv4 routing table stored in RAM • IOS15: Active ints should appear/2 related entries **C:** Connected || **L:** Local • Local host route: Admin distance 0: Routes on router of IP **IPv4** /32 mask || **IPv6** /128 mask • Allows router to process packets to destination
show running-config int	Display cmds config'd on specific int
show int	Int info: Packet flow count for all ints on device
show ip int	IPv4 info: All ints on router

IPv6

show ipv6 int br	• Summary for each int • [up/up] same line as int name: L1/L2 int state • Display 2 config'd IPv6's per int • Manual entry: 1 global unicast address • Auto added on global unicast assignment: **FE80:** 1 link-local
show ipv6 int gigabitethernet 0/0	• Display int status of all IPv6 belonging to int (link-local/global uni) • Includes multicasts assigned to int: **FF02**
show ipv6 route	• Verify IPv6 network/ints installed in r-table • Only IPv6 networks • Config'd w/global unicast: [up/up] • IPv6 prefix/length added to r-table as connected route • **Local route:** /128 prefix
ping	• Verify L3 connectivity
show int	
show ipv6 routers	

Filter Show

terminal length [*number*] Specify # of lines displayed (0 prevents router from pausing bet screens)

| enables filtering after show/params/expressions

section	Entire section: Starts w/filter expression
include	Match filter expression
exclude	Match filtering expression
begin	Outtput from certain point

```
show running-config | section line vty
show ip int br | include up
show ip int br | exclude unassigned
show ip route | begin Gateway
```

History

- **Ctrl+P/Up Arrow:** cmds in history buffer
- **Ctrl+N/Down Arrow:** down history buffer
- History enabled: Default
- show history :priv EXEC: Display contents of buffer
- terminal history size [*size*] :usr EXEC: Increase/decrease buffer size

Router Switching functions

Switching: Moving packets from source to destination (not L2 switch functions)

- Routers fwd packets to destination and use a switching function.

Switching function: Process used by router to accept packet on 1 int/fwd it out another int

- Key role: Encapsulating packets in right data link frame for outward link
- After exit int known using path determination function:
- Router encapsulates packet into data link frame of outgoing int

When a packet is received from 1 network/destined for another:

1. De-encapsulates L2 frame header/trailer to expose L3 packet
2. Examines destination IP to find best path via routing table
3. If finds path: Encapsulates L3 packet into new L2 frame: Fwds frame out exit int
    - May require different L2 frame encapsulation (eth0 int > process > serial int)
    - Serial links are point-to-point connections: Use different L2 frames: Doesn't require MAC address

Sending Packets

Send packet	• Source determines packet w/**AND** operation on IPv4 address/mask • Same **AND** operation uses packet destination IPv4 address/mask • If destination same as source: Doesn't use gateway • Refers to ARP cache for MAC to complete packet/send destination • If destination address on different network: Packet fwded to gateway • To determine MAC gateway: Source checks ARP table for address of gateway/associated MAC • No ARP entry exists in table? > ARP request sent > Router sends back ARP reply • Packet fwded to MAC gateway **IPv6** • Similar for ipv6 packets Instead of ARP: • IPv6 address resolution uses: ICMPv6 neighbor solicitation/neighbor advertisement msgs IPv6-to-MAC mapping kept in table like ARP [AKA] **neighbor cache**

Fwd to Next Hop

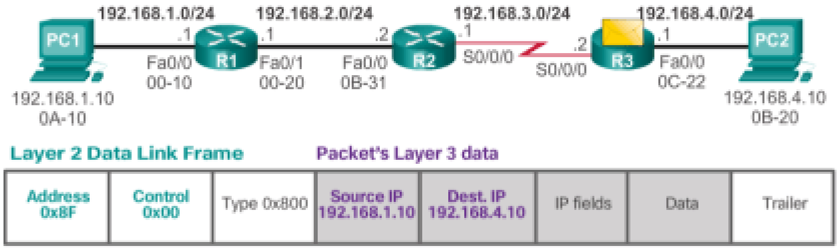
Router receives an Ethernet frame from PC:

1. Examines destination MAC: Matches MAC of receiving int: Copies frame into buffer
2. Router ID's eth0 type field as 0x800: IPv4 packet is in data portion of frame
3. De-encapsulates frame
4. Destination IPv6 address of packet doesn't match any directly connected networks of router:
    a. Consults routing table to route packet
    b. Searches table for network address: Includes IPv4 destination of packet w/in network
5. Packet encapsulated w/new eth0 frame: Destination MAC of IPv4: Next hop

If exit int on eth0 network: Router resolves next-hop IPv4 w/destination MAC using ARP

1. Router looks up next-hop IPv4 address in ARP cache
    a. If entry not there: Sends ARP request out of int > Another router send back ARP reply
    b. 1st router updates ARP cache w/an entry for associated MAC address
2. IPv4 packet encapsulated into new eth0 frame/fwded out original int

Packet Routing



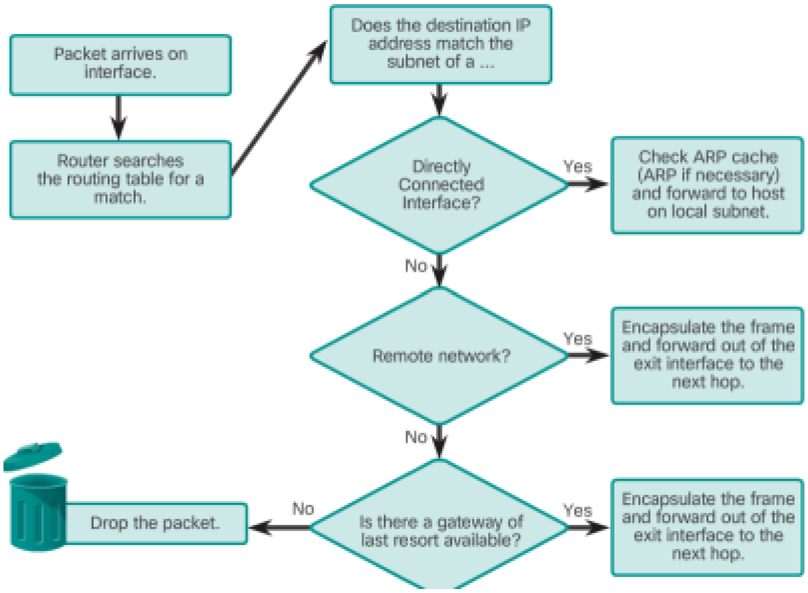
1. Router examines destination MAC: Matches MAC on receiving int: Copies frame into buffer
2. Router ID's eth0's type field: 0x800: eth0 contains IPv4 packet in data!
3. De-encapsulates frame

If destination IPv4 packet doesn't match int of router: Router consults table to route packet: Searches for other table

1. If finds route: Next-hop IPv4/exit int of serial used B/C exit **NOT** eth0: Doesn't resolve next-hop w/destination MAC
2. IPv4 packet encapsulated into new data link frame: Sent out serial exit int

- **Int is P2P serial?** Router encapsulates IPv4 packet into data link frame by exit int (HDLC/PPP/etc…)
- **No MAC addresses on serial ints:** Data link destination is equivalent to broadcast

Decisions: Table searches result in 1 of 3 path determinations


Packet arrives on interface.
Router searches the routing table for a match.
Does the destination IP address match the subnet of a ...
Directly Connected Interface?
Yes
Check ARP cache (ARP if necessary) and forward to host on local subnet.
No
Remote network?
Yes
Encapsulate the frame and forward out of the exit interface to the next hop.
No
Is there a gateway of last resort available?
Yes
Encapsulate the frame and forward out of the exit interface to the next hop.
No
Drop the packet.

Path determinations

Directly connected network	**If destination IP of packet:** • Belongs to device on network directly connected to int of router • Packet fwded directly to destination device
Remote Network	**If destination IP of packet:** • Belongs to remote network • Packet is fwded to another router • Remote networks can only be reached by fwding packets to another router
No route determined	**If destination IP of packet:** • Doesn't belong to connected/remote • Router determines if Gateway of Last Resort available **Gateway of Last Resort:** Router usually config'd w/own gateway • If default route: Packet fwded to Gateway of Last Resort • If no default route: Packet dropped

Best Path

- Shortest/optimum path ideal
- When multiple paths to same network exist: Each uses different exit int on router to reach it
- Selected by r-protocol based on value/metric used to determine distance reached

Metric: Quantitative value used to measure distance

- Best path: Lowest metric
- Dynamic routing protocols: Use own rules/metrics to build/update tables
- Algorithm generates value/metric for each path: Can be based on single/multiple chars of path
- Some protocols base selection on multiple metrics combined as 1

Dynamic protocols/metrics used

RIP	• **Routing Information Protocol** • Hop count
OSPF	• **Open Shortest Path First** • Cisco: Based on cumulative BW from source-to-destination
EIGRP	• **Enhanced Interior Gateway Routing Protocol** • BW: Delay: Load: Reliability

Load Balancing

If routing table has 2/more paths w/identical metrics to same destination:

- **Load balancing**: Router fwds packets using both paths equally
- Table contains single destination network, but multiple exit ints: 1 for each equal cost path
- Fwds packets using multiple exit ints listed in table
- Can increase effectiveness/performance
- Can be config'd to use both dynamic protocols/static routes

EIGRP: Supports unequal cost load balancing

Administrative Distance

- Config router w/multiple routing protocols/static routes
- R-table: May have more than 1 route source for same destination
- Each r-protocol may decide on different path to reach destination, based on metrics

Example: RIP/EIGRP are config'd on router: Both may learn of same destination: Use different paths based on metrics

Administrative distance: AD: Cisco IOS: Used to determine route to install into IP table

- Represents "trustworthiness" of route: Lower AD: More trustworthy source
- Example: Static route = AD 1 || EIGRP-discovered route = AD 90
- Given 2 separate routes, router chooses 1 w/lowest AD

Default AD's

Connected	0	**Static**	1
EIGRP summary route	5	**External BGP**	20
Internal EIGRP	90	**IGRP**	100
OSPF	110	**IS-IS**	115
RIP	120	**External EIGRP**	170
Internal BGP	200		