CCNP Routing and Switching Prep Session

BRKCRT-2084
What Is CCNP-R&S: Coverage

- CCNP is:
  - Routing: EIGRP, OSPF, RIP, BGP
  - Switching
  - Routing and switching troubleshooting:

- CCNP is NOT:
  - Voice
  - Wireless
  - Security
  - Specific WAN protocols (MPLS, advanced BGP)
Certification for Network Engineers

- **CCENT**: install and verify basic IP network with supervision

- **CCNA**: also... configure and maintain a multisite enterprise network, as directed

- **CCNP**: also... plan and troubleshoot enterprise networks with advanced solutions, collaborating with network specialists

- **CCIE**: also... independently troubleshoot and optimize network performance in complex and integrated enterprise networks
Cisco Career Certifications

- Expand your professional options and advance your career

### Path to CCNP® - Routing and Switching

**Required: 642-902 ROUTE Exam**

Recommended Learning:
1. “Implementing Cisco IP Routing Course”
2. 5-day instructor-led training course
   - ROUTE E-Learning Bundle
   - 9 hours of self-paced demos

**Required: 642-813 SWITCH Exam**

Recommended Learning:
1. “Implementing Cisco Switched Networks”
   - 5-day instructor-led training course

**Required: 642-832 TSHOOT Exam**

Recommended Learning:
1. “Troubleshooting and Maintaining Cisco IP Networks”
   - 5-day instructor-led training course
2. TSHOOT E-Learning Bundle
   - 9 hours of self-paced demos and exercises
# CCNP Certification Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>#642-901 BSCI</td>
<td>Building Scalable Cisco Internetworks</td>
</tr>
<tr>
<td>#642-812 BCMSN</td>
<td>Building Cisco Multilayer Switched Networks</td>
</tr>
<tr>
<td>New</td>
<td>#642-925 ISCW</td>
</tr>
<tr>
<td>#642-845 ONT</td>
<td>Optimizing Converged Cisco Networks</td>
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<tr>
<td>#642-902 ROUTE</td>
<td>Implementing Cisco IP Routing</td>
</tr>
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<td>#642-813 SWITCH</td>
<td>Implementing Cisco Switched Networks</td>
</tr>
<tr>
<td>#642-832 TSHOOT</td>
<td>Troubleshooting and Maintaining Cisco IP Networks</td>
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# Certification Mix-and-Match

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<tr>
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<th>BSCI</th>
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<tr>
<td># 642-812</td>
<td>BCMSN</td>
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<tr>
<td># 642-892</td>
<td>COMP (BSCI and BCMSN)</td>
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<td># 642-825</td>
<td>ISCW</td>
</tr>
<tr>
<td># 642-845</td>
<td>ONT</td>
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</table>

Good News! Passing scores for BSCI, BCMSN and COMP will be accepted as long as they are valid, in place of the new ROUTE and SWITCH exams.

Passing scores on ISCW and ONT will expire on July 31, 2010.
CCNP Course Features

- Cover plan, implement, verify, and troubleshoot processes and activities
- More time devoted to hands-on practice and debriefing:
  - In ROUTE, from 23% to 42%
  - In SWITCH, from 33% to 52%
  - In TSHOOT, 92%
- New TSHOOT focuses on applying maintenance and troubleshooting skills
- Offer a blended learning experience with e-learning
- ROUTE and SWITCH are recommended prerequisites for TSHOOT
Switch
Course Goal

“To create an efficient and expandable enterprise network by installing, configuring, and verifying network infrastructure equipment according to the Enterprise Campus Architecture.”

Switching (SWITCH) v1.0
What Is Switch: Coverage

- **Switch is:**
  - Campus layer 2 management (VLANs, STP – all flavors)
  - Campus layer 3 management (Inter-VLAN Routing, first hop redundancy)
  - Campus network management (network design, security, voice, WLANs)

- **Switch is NOT:**
  - “Only layer 2”
  - Deep wireless, security or voice
Enterprise Campus Architecture
VLAN Deployment

- **End-to-end VLANs**
  
  Users are grouped into VLANs independent of physical location.

  If users are moved within the campus, their VLAN membership remains the same.

- **Local VLANs**

  Recommended solution in the enterprise campus architecture.

  Users are grouped into VLANs depending on physical location.

  If users are moved within the campus, their VLAN membership changes.
## Comparison

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Resources Needed</th>
<th>Convergence</th>
</tr>
</thead>
<tbody>
<tr>
<td>CST</td>
<td>802.1D</td>
<td>Low</td>
<td>slow</td>
</tr>
<tr>
<td>PVST+</td>
<td>Cisco</td>
<td>High</td>
<td>slow</td>
</tr>
<tr>
<td>RSTP</td>
<td>802.1w</td>
<td>Medium</td>
<td>fast</td>
</tr>
<tr>
<td>PVRST+</td>
<td>Cisco</td>
<td>Very High</td>
<td>fast</td>
</tr>
<tr>
<td>MSTP</td>
<td>802.1s</td>
<td>Medium / high</td>
<td>fast</td>
</tr>
</tbody>
</table>
VLAN Configuration

Configure VLANs on all switches
Configure access mode on port
Configure access VLAN on port

switch(config)# vlan 3
switch(config-vlan)# name Accounting
switch(config-vlan)# exit
switch(config)# interface fa0/1
switch(config-if)# switchport mode access
switch(config-if)# switchport acces vlan 3
switch(config-if)# end
Trunk Configuration

- Configure VLANs
- Disable trunk negotiation
- Configure trunk mode
- Set native VLAN to unused VLAN
- Allow only required VLANs on trunks

```bash
switch(config)# vlan 5,7-9
switch(config-vlan)# exit
switch(config)# interface fastethernet 0/1
switch(config-if)# shutdown
switch(config-if)# switchport trunk encapsulation dot1q
switch(config-if)# switchport nonegotiate
switch(config-if)# switchport mode trunk
switch(config-if)# switchport trunk native vlan 99
switch(config-if)# switchport trunk allowed vlan 3,5,8,99
switch(config-if)# no shutdown
```
Issues with 802.1Q Native VLAN

Native VLAN frames are carried over the trunk link untagged
Native VLAN must match at the ends of a trunk
A native VLAN mismatch will merge traffic between VLANs
Default native VLAN is VLAN 1
Configure an unused VLAN as native VLAN on trunks
Spanning Tree Recommendations

- **Use only** when you have to!
  - Required to protect against “user-side” loops
  - Required when a VLAN spans access layer switches
  - More common in the data center

- Use PVRST+ or MSTP for best convergence

- Take advantage of the Cisco STP toolkit

- Keep STP domain as simple as possible

- Do not disable STP—it protects against unplanned loops

- Use routed links if possible
When switching was fast and routing was slow, campus networks were switched.

Today routing is almost as fast as switching; routing solves layer 2 loops issues and helps isolating VLANs.

Switches need to have IP addresses.
Cisco Layer 3 Switching Methods

- **Process switching**
  Slowest method—every packet examined by CPU, all forwarding decisions made in software

- **Fast switching (route caching)**
  Faster method—first packet in each flow examined by CPU, forwarding decision cached in hardware for subsequent packets in flow

- **Cisco Express Forwarding (topology-based switching)**
  Fastest method—hardware forwarding table created regardless of traffic flows, all packets switched using hardware
  Fast but does have limitations
  Switching mode for multi-layer switches

**Switching Methods**

<table>
<thead>
<tr>
<th>Routing Table, ACLs</th>
<th>Process Switching</th>
<th>Fast Switching</th>
<th>CES Switching</th>
<th>dCEF Switching</th>
<th>ARP Cache</th>
<th>Adjancency Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIB</td>
<td>Least</td>
<td>Efficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
External Router Configuration

switch(config)# vlan 10,20
switch(config)# interface fastethernet 0/1
switch(config-if)# switchport mode trunk
switch(config-if)# switchport trunk native vlan 99
switch(config-if)# switchport trunk allowed vlan 10,20

router(config)# interface fastethernet 0/0.10
router(config-if)# encapsulation dot1q 10
router(config-if)# ip address 10.1.10.1 255.255.255.0
router(config)# interface fastethernet 0/0.20
router(config-if)# encapsulation dot1q 20
router(config-if)# ip address 10.1.20.1 255.255.255.0
Switch Virtual Interface Configuration

Enable IP routing
Configure an SVI for each VLAN
Configure an IP address
Enable the SVI
Configure the routing protocol

switch(config)# ip routing
switch(config)# interface vlan10
switch(config-if)# ip address 10.1.10.1 255.255.255.0
switch(config-if)# no shutdown
switch(config)# interface vlan20
switch(config-if)# ip address 10.1.20.1 255.255.255.0
switch(config-if)# no shutdown
Configure Routed Interface

Enable IP routing
Disable layer 2 processing on interface
Configure IP address

```
switch(config)# ip routing
switch(config)# interface fastethernet 0/24
switch(config-if)# no switchport
switch(config-if)# ip address 10.1.10.1 255.255.255.0
```
Voice and Video in the Campus Network
## Meeting the Requirements

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning</td>
<td>Voice VLAN</td>
</tr>
<tr>
<td>Management</td>
<td>DHCP</td>
</tr>
<tr>
<td>Security</td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>QoS</td>
</tr>
<tr>
<td>Delay / Jitter</td>
<td></td>
</tr>
<tr>
<td>Packet loss</td>
<td>Power over Ethernet</td>
</tr>
<tr>
<td>Power</td>
<td>UPS</td>
</tr>
<tr>
<td>Availability</td>
<td>High Availability</td>
</tr>
<tr>
<td></td>
<td>Redundancy</td>
</tr>
</tbody>
</table>
Voice VLAN Configuration

```
switch(config)# interface fastethernet 0/1
switch(config-if)# switchport mode access

switch(config-if)# switchport access vlan 10

switch(config-if)# switchport voice vlan 110
switch(config-if)# spanning-tree portfast

switch(config-if)# spanning-tree bpduguard enable

switch(config-if)# cdp enable
switch#show vlan

<table>
<thead>
<tr>
<th>VLAN</th>
<th>Name</th>
<th>Status</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>default</td>
<td>active</td>
<td>Fa0/6,Fa0/7,Fa0/8, Fa0/9,Fa0/10</td>
</tr>
<tr>
<td>10</td>
<td>VLAN0010</td>
<td>active</td>
<td>Fa0/1</td>
</tr>
<tr>
<td>110</td>
<td>VLAN0110</td>
<td>active</td>
<td>Fa0/1</td>
</tr>
</tbody>
</table>
```
PoE Switch

switch(config-if)# power inline {auto | never}

- PoE configuration

switch# show power inline [interface]

- Display PoE statistics

```
switch# show power inline
Available:124.0(w) Used:91.2(w) Remaining:32.8(w)

Interface       Admin Oper Power    Device              Class Max
--------------- ----- ------- ------- ----------------------- ------
Fa0/1           auto on    15.0   AIR-LAP1242AG-E-K9 3     15.4
Fa0/2           auto on    15.0   AIR-LAP1242AG-E-K9 3     15.4
Fa0/3           auto on    15.0   AIR-AP1242AG-E-K9  3     15.4
Fa0/4           auto on    15.4   AIR-LAP1142N-E-K9  3     15.4
Fa0/5           auto on    15.4   AIR-AP1252AG-E-K9  3     15.4
Fa0/6           never off  0.0     n/a                 n/a 15.4
Fa0/7           auto off   0.0     n/a                 n/a 15.4
Fa0/8           auto on    15.4   WS-C2960PD-8TT-L  3     15.4
```
Controller-Based WLAN Solution
Controller-Based AP

Access port
Native access point VLAN
No data VLANs

switch(config)# interface fastethernet 0/2
switch(config-if)# switchport access vlan 10
switch(config-if)# switchport mode access
switch(config-if)# spanning-tree portfast
switch(config-if)# mls qos trust dscp
WLAN Controller

802.1Q Trunk port
Management VLAN
Data VLANs
802.1p QoS

```
switch(config)# interface fastethernet 0/3
switch(config-if)# switchport encapsulation dot1q
switch(config-if)# switchport trunk native vlan 99
switch(config-if)# switchport trunk allowed vlan 10,20
switch(config-if)# switchport mode trunk
switch(config-if)# spanning-tree portfast trunk
switch(config-if)# mls qos trust cos
```
Switch Configuration for LAG

Gigabit Etherchannel 802.1Q Trunk port
- Management VLAN
- Access point VLAN
- Data VLANs
- 802.1p QoS

- Ports can be connected to different switches in a stacked switch or to different line cards in a modular switch

```
switch(config)# interface gigabitethernet 0/1
switch(config-if)# channel-group 1 mode on
switch(config)# interface gigabitethernet 0/2
switch(config-if)# channel-group 1 mode on
switch(config)# interface port-channel 1
switch(config-if)# switchport encapsulation dot1q
switch(config-if)# switchport trunk native vlan 99
switch(config-if)# switchport trunk allowed vlan 10,20
switch(config-if)# switchport mode trunk
switch(config-if)# spanning-tree portfast trunk
switch(config-if)# mls qos trust cos
```
Route
Course Goal

“To train network professionals on the techniques to plan, implement, and monitor a scalable IP routing network.”

Implementing Cisco IP Routing (ROUTE) v1.0
What Is Route: Coverage

- Route is:
  - IGP Routing: EIGRP, OSPF, RIP
  - Path control: route maps, filters, redistribution, policy-based routing
  - ISP connection management: standard BGP
  - IPv6
  - Branch offices and remote workers connectivity: VPN, GRE

- Route is NOT:
  - Voice
  - Wireless
  - Security
  - Specific WAN protocols (MPLS, IS-IS, advanced BGP)
  - Multicast
Routing Protocols

Campus Backbone: OSPF, EIGRP, BGP

Selected Campus Backbone Protocol

Building Distribution: Selected Building Access Protocol

Building Access: RIPv2, OSPF, EIGRP, or Static

To PSTN

To Internet

Internet and Remote Access

To WAN

WAN
Example: Enterprise network

- EIGRP is used as IGP
- BGP is used as EGP
- Static routes for remote access and VPN
# Routing Protocol Comparison

<table>
<thead>
<tr>
<th>Parameters</th>
<th>EIGRP</th>
<th>OSPF</th>
<th>BGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Network (Small-Medium-Large-Very Large)</td>
<td>Large</td>
<td>Large</td>
<td>Very Large</td>
</tr>
<tr>
<td>Speed of Convergence (Very High-High-Medium-Low)</td>
<td>Very High</td>
<td>High</td>
<td>Slow</td>
</tr>
<tr>
<td>Use of VLSM (Yes-No)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mixed-Vendor Devices (Yes-No)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Network Support Staff Knowledge (Good-Poor)</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
</tr>
</tbody>
</table>
OSPF
Link-State Protocols

Link-State Database (LSDB)

DIJKSTRA

Routing Table

Best paths

SPF Tree
Area Terminology and Router Types

- Link-state routing requires a hierarchical network structure:
  - Transit area (backbone or area 0)
  - Normal areas (non-backbone areas)

- **ABR**: Area Border Router
- **ASBR**: Autonomous System Boundary Router
- **R5, R6**: Internal routers
- **R1**: Backbone router
OSPF Packet Types

OSPF Uses Five Types of Routing Protocol Packets

1. Hello
2. Database Description
3. Link-State Request
4. Link-State Update
5. Link-State Acknowledgment
Example of Different LSAs

- External (type 7): ASBR → IR (only in NSSA)
- Network link (type 2): DR → IR
- External (type 5): ASBR ↔ IR
- ABR Summary (type 3): IR ↔ ABR → IR
- ABR Summary (type 4): ABR → IR (about ASBR)
- Router link (type 1): IR ↔ IR

Note: only one example of each LSA type exchange is demonstrated in this graphic.
Types of Areas

- **NSSA Area**: Does not accept external LSAs. Allows ASBR.
- **Totally NSSA Area**: Does not accept external or summary LSAs, allows ASBR.
- **Stub Area**: Does not accept external LSAs.
- **Totally Stubby Area**: Does not accept external or summary LSAs.
- **Backbone Area 0**: Accepts link updates, summaries, and external routes.
- **Normal Area**: Allows ASBR.
Example of Different Areas
Design Limitations of OSPF

- If more than one area is configured, one of these areas has to be area 0—backbone area
- All areas must be connected to area 0
- Area 0 must be contiguous
No Direct Physical Connection to Area 0

- Area 20 added with no physical access to area 0
- A virtual link provides logical path to the backbone
- The OSPF database treats the link between routers ABR1 and ABR2 as a direct link
Discontiguous Area 0

- Two companies merge without a direct link between them
- Virtual links are used to connect a discontiguous area 0
- A logical link is built between routers ABR1 and ABR2
- Virtual links are recommended for backup or temporary connections too
OSPF Virtual Link Configuration

- Configure a virtual link
- Router ID of the remote router is used in the command

```
ABR1#
router ospf 100
network 172.16.0.0 0.0.255.255 area 1
network 10.0.0.0 0.255.255.255 area 0
area 1 virtual-link 10.2.2.2

ABR2#
router ospf 100
network 172.16.0.0 0.0.255.255 area 1
network 10.0.0.0 0.255.255.255 area 0
area 1 virtual-link 10.1.1.1
```
Path Control
Running Different Routing Protocols

- Running different protocols in different areas within the same autonomous system
  
The number of routing protocol processes receiving the updates at the same time
Redistribution Techniques

17.16.0.0

Redistribute

Redistributed and Filter

Redistributed and Change Administrative Distance

10.0.0.0
Two-Way Multipoint Redistribution Issue

Routing protocol B

Routing protocol A

Metric is lost on redistribution from routing protocol B to A

Result: Suboptimal routing
Controlling Routing Update Traffic Using Distribute-lists

How can we prevent routing update traffic from crossing some of these links?
Controlling Redistribution with Distribute Lists

```
R2#
router ospf 1
    network 10.0.0.8 0.0.0.3 area 0
    redistribute rip subnets
distribute-list 2 out rip

router rip
    network 10.0.0.0
    version2
    passive-interface s3
    redistribute ospf 1 metric 5
distribute-list 3 out ospf 1

access-list 2 permit 10.0.0.0 0.255.255.255
access-list 3 permit 10.8.0.0 0.255.255.255
```
Tshoot
Course Goal

“To train network engineers on monitoring and troubleshooting routed and switched networks through extensive use of hands-on lab exercises.”

Troubleshooting and Maintaining Cisco IP Networks (TSHOOT) v1.0
What Is Tshoot: Coverage

- Tshoot is:
  - Routing: EIGRP, OSPF, RIP, BGP
  - Switching
  - Heavily focused on hands-on experience:

- Tshoot is NOT:
  - CIT (Cisco Internetwork Troubleshooting) v2.0
  - Wireless
  - Voice
  - Security
  - Specific WAN protocols (MPLS, advanced BGP)
What Is Troubleshooting?

Problem → Diagnosis → Solution

- Car with an empty fuel gauge
- Fuel gauge
- Gas station
Diagnostic Principles

- Diagnosis is the process of identifying the nature and cause of a problem

- Fundamental elements of this process are:
  - Information gathering
  - Analysis
  - Elimination
  - Proposing hypotheses
  - Testing
Troubleshooting Methods

- A troubleshooting method is a guiding principle that determines how you move through the phases of the troubleshooting process.
Troubleshooting and Communication

- Communication is an essential element of the troubleshooting process

- Recording communication is key to efficient troubleshooting
The “Shoot from the Hip” Method

- Quickly formulating a first hypothesis based on common problem causes and corresponding solutions can be very effective in the short run.
Top-Down Troubleshooting

- This method follows the layers of the OSI model starting from the application layer and moving down to the physical layer.

![Diagram of the OSI model with a top-down troubleshooting approach](image)
Bottom-Up Troubleshooting

- This method follows the layers of the OSI model starting from the physical layer and moving up to the application layer.
Divide and Conquer

- This method starts in the middle of the OSI model and moves up or down depending on results
Follow the Path

- Tracing the path of packets through the network eliminates irrelevant links and devices from the troubleshooting process
Spot the Differences

- Comparing functioning to malfunctioning devices or processes and spotting the differences may enable one to implement a solution or workaround to a problem without even understanding the root cause.

Branch1# show ip route
<...output omitted...>
  10.0.0.0/24 is subnetted, 1 subnets
  C  10.132.125.0 is directly connected, FastEthernet4
  C  192.168.36.0/24 is directly connected, BVI1
  S* 0.0.0.0/0 [254/0] via 10.132.125.1

Branch2# show ip route
<...output omitted...>
  10.0.0.0/24 is subnetted, 1 subnets
  C  10.132.126.0 is directly connected, FastEthernet4
  C  192.168.37.0/24 is directly connected, BVI1

- Branch 1 is working Branch 2 is not. Can you solve the problem?
Move the Problem

- An elementary troubleshooting technique is to swap components and observe if the problem stays, moves or disappears.

- You install a couple of PCs, laptops and a switch. Laptop B cannot establish a link. You suspect a hardware failure.
- How do you find out if the problem is the switch, the cable or the laptop?
Example: Filtering ‘show ip route’

- Alternatively, you can limit the output of the command to the subset of prefixes that fall within a particular block

```
CRO1#show ip route 10.1.193.0 255.255.255.0 longer-prefixes
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 46 subnets, 6 masks
C 10.1.193.2/32 is directly connected, Serial0/0/1
C 10.1.193.0/30 is directly connected, Serial0/0/1
D 10.1.193.6/32 [90/20517120] via 10.1.192.9, 2d01h, FastEthernet0/1
  [90/20517120] via 10.1.192.1, 2d01h, FastEthernet0/0
D 10.1.193.4/30 [90/20517120] via 10.1.192.9, 2d01h, FastEthernet0/1
  [90/20517120] via 10.1.192.1, 2d01h, FastEthernet0/0
D 10.1.193.5/32 [90/41024000] via 10.1.194.6, 2d01h, Serial0/0/0.122
```
Filtering show command output

- Regular expressions can be used to filter the output of show commands

R01#show processes cpu | include IP Input

71 3149172 7922812 397 0.24% 0.15% 0.05% 0 IP Input

Selecting lines that include a certain expression

SW1#show ip interface brief | exclude unassigned

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP-Address</th>
<th>OK? Method Status</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vlan128</td>
<td>10.1.156.1</td>
<td>YES NVRAM up</td>
<td>up</td>
</tr>
</tbody>
</table>

Selecting lines that exclude a certain expression

SW1#show running-config | begin line vty

line vty 0 4
  transport input telnet ssh
line vty 5 15
  transport input telnet ssh
!
end

Or selecting a starting point for the output
Filtering show command output (Cont.)

A section that starts at a particular point can be selected

```
RO1#show running-config | section router eigrp
router eigrp 1
    network 10.1.192.2 0.0.0.0
    network 10.1.192.10 0.0.0.0
    network 10.1.193.1 0.0.0.0
    no auto-summary
```

The full regular expression syntax allows for creating complex match criteria and combining multiple criteria

In this last example, the “|” signifies a logical “or” and combines the lines that include “IP Input” with lines that start with “CPU”, as denoted by the “^CPU” expression
Redirecting show command output

- The output of a **show command** can be redirected, copied or appended to files.

```
RO1# show tech-support | redirect tftp://192.168.37.2/show-tech.txt
```

The output can be redirected to a file using **redirect**

```
RO1# show ip interface brief | tee flash:show-int-brief.txt
```

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP-Address</th>
<th>OK? Method Status</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>FastEthernet0/0</td>
<td>10.1.192.2</td>
<td>YES manual up</td>
<td>up</td>
</tr>
<tr>
<td>FastEthernet0/1</td>
<td>10.1.192.10</td>
<td>YES manual up</td>
<td>up</td>
</tr>
<tr>
<td>Loopback0</td>
<td>10.1.220.1</td>
<td>YES manual up</td>
<td>up</td>
</tr>
</tbody>
</table>

CRO1# dir flash:
Directory of flash:/

```
1  -rw-  23361156  Mar 2 2009 16:25:54 -08:00 c1841-advipservicesk9-mz.124-23.bin
2  -rw-    680  Mar 7 2009 02:16:56 -08:00 show-int-brief.txt
```

Or the output can be copied to a file using **tee**
Example: Troubleshooting EIGRP
Exchanging and Processing Routing Information

- Routing protocols use the following high level elements and processes:

  1. Reception of routing information from neighbors
  2. Transmission of routing information to neighbors
  3. Routing Protocol Data Structures
  4. Route injection or redistribution
  5. Route selection and installation
  6. Routing Table
EIGRP Data Structures

- EIGRP tracks information using these data structures:
  - Interface table: active interfaces
  - Neighbor table: discovered neighbors
  - Topology table: all routes received from neighbors or injected locally
EIGRP Commands

- The following Cisco IOS commands can be used to gather information from the EIGRP data structures or to analyze the flow of routing information in real time:

  - `show ip eigrp interfaces`
  - `show ip eigrp neighbors`
  - `show ip eigrp topology`
  - `show ip route eigrp`
  - `debug eigrp packets`
  - `debug ip eigrp`
  - `debug ip routing`
Case Study: Troubleshooting EIGRP

Consider the following situation:

A traceroute command from router BRO1 to the loopback IP address of router CRO1 reveals that packets to that loopback are routed via router BRO2 instead of being routed directly to CRO1 via the WAN connection.

A ping command from router BRO1 to the 10.1.194.1 address is successful, proving that there is IP connectivity across the WAN.
Case Study: Troubleshooting EIGRP (Cont.)

- Displaying the topology table on router BRO1 for network 10.1.220.1/32 yields the following result:

```plaintext
BRO1#show ip eigrp topology 10.1.220.1 255.255.255.255
IP-EIGRP (AS 1): Topology entry for 10.1.220.1/32
    State is Passive, Query origin flag is 1, 1 Successor(s), FD is 40642560
    Routing Descriptor Blocks:
        10.1.163.130 (FastEthernet0/1.30), from 10.1.163.130, Send flag is 0x0
    Composite metric is (40642560/40640000), Route is Internal
    Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 25100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
```

- The topology table contains only a single entry for the prefix
- The route across the WAN is not listed

**Conclusion:** Routing information is not exchanged correctly between routers BRO1 and CRO1
Case Study: Troubleshooting EIGRP (Cont.)

- Displaying the neighbor table on router BRO1 yields the following result:

```
BRO1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
   (sec)         (ms)       Cnt Num
0   10.1.163.130            Fa0/1.30          12 00:09:56    4   200  0  585
```

There is only one entry in the neighbor table: router BRO2 CRO1 is not listed as a neighbor

**Conclusion:** A neighbor relationship between routers BRO1 and CRO1 has not been established
Case Study: Troubleshooting EIGRP (Cont.)

- Displaying the interface table on router BRO1 yields the following result:

```
BRO1#show ip eigrp interfaces
IP-EIGRP interfaces for process 1

+-----------------+-------------+---------------+------------+---------------+-------------+---------+----------+
| Interface       | Peers       | Un/Reliable  | SRTT       | Un/Reliable  | Flow Timer  | Routes  |
|-----------------+-------------+---------------+------------+---------------+-------------+---------+----------|
| Fa0/1.30        | 1           | 0/0           | 4          | 0/1           | 50          | 0       |
```

There is only one entry in the neighbor table: the Fast Ethernet interface that leads to router BRO2

The serial interface that leads to router CRO1 is not listed

**Conclusion:** either there is no network statement that matches the IP address of the serial interface, or the serial interface has been configured as a passive interface
Case Study: Troubleshooting EIGRP (Cont.)

- Displaying the EIGRP configuration on router BRO1 yields the following result:

```
BRO1#show running-config | section router eigrp
router eigrp 1
  network 10.1.163.129 0.0.0.0
  network 10.1.194.1 0.0.0.0
  no auto-summary
```

The network statements do not match the IP address of BRO1 (10.1.194.2)

The network statement is changed to match the correct IP address:

```
BRO1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
BRO1(config)#router eigrp 1
BRO1(config-router)#no network 10.1.194.1 0.0.0.0
BRO1(config-router)#network 10.1.194.1 0.0.0.0
```
Case Study: Troubleshooting EIGRP (Cont.)

- The interface table and neighbor tables now show the WAN connection as expected

```
BRO1#show ip eigrp interfaces
IP-EIGRP interfaces for process 1

<table>
<thead>
<tr>
<th>Interface</th>
<th>Peers</th>
<th>Xmit Queue</th>
<th>Un/Reliable</th>
<th>Mean SRTT</th>
<th>Pacing Time</th>
<th>Un/Reliable</th>
<th>Multicast</th>
<th>Pending Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fa0/1.30</td>
<td>1</td>
<td>0/0</td>
<td></td>
<td>1</td>
<td>0/1</td>
<td></td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Se0/0/0.111</td>
<td>1</td>
<td>0/0</td>
<td></td>
<td>707</td>
<td>10/380</td>
<td></td>
<td>4592</td>
<td>0</td>
</tr>
</tbody>
</table>

BRO1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1

<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold Uptime</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.1.194.1</td>
<td>Se0/0/0.111</td>
<td>14 00:10:10</td>
<td>707</td>
<td>4242</td>
<td>0</td>
<td>783</td>
</tr>
<tr>
<td>0</td>
<td>10.1.163.130</td>
<td>Fa0/1.30</td>
<td>12 01:34:49</td>
<td>1</td>
<td>200</td>
<td>0</td>
<td>587</td>
</tr>
</tbody>
</table>
```
Case Study: Troubleshooting EIGRP (Cont.)

- The topology table now shows both routes and has selected the route via the serial as the best route

```plaintext
BR01#show ip eigrp topology 10.1.220.1 255.255.255.255
IP-EIGRP (AS 1): Topology entry for 10.1.220.1/32
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 40640000
  Routing Descriptor Blocks:
    10.1.194.1 (Serial0/0/0.111), from 10.1.194.1, Send flag is 0x0
      Composite metric is (40640000/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1

    10.1.163.130 (FastEthernet0/1.30), from 10.1.163.130, Send flag is 0x0
      Composite metric is (40642560/40640000), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 25100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
```
Case Study: Troubleshooting EIGRP (Cont.)

- The route via the serial interface has been successfully installed in the routing table and the traceroute shows that packets are not routed via BRO2 any longer.

```
BRO1#show ip route 10.1.220.1 255.255.255.255
Routing entry for 10.1.220.1/32
  Known via "eigrp 1", distance 90, metric 40640000, type internal
  Redistributing via eigrp 1
  Last update from 10.1.194.1 on Serial0/0/0.111, 00:20:55 ago
  Routing Descriptor Blocks:
    * 10.1.194.1, from 10.1.194.1, 00:20:55 ago, via Serial0/0/0.111
      Route metric is 40640000, traffic share count is 1
      Total delay is 25000 microseconds, minimum bandwidth is 64 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1

BRO1#traceroute 10.1.220.1

Type escape sequence to abort.
Tracing the route to cro1.mgmt.tshoot.local (10.1.220.1)

1 10.1.194.1 16 msec 12 msec *
```
Visual Objective for Lab 5-1: Layer 3 Connectivity and EIGRP
Route and Tshoot E-Learning
CCNP E-Learning

- Complement and enhance your classroom experience
- Reinforce concepts and their application
- Learn at your own pace
- Review advanced topics
- Experience real-life scenarios through directed demonstrations
E-Learning Module Structure

Addressing and Topology Specifics

Debrief: Alternative Configuration

route-map TAGS deny 10
match tag 1000
route-map TAGS permit 20
set tag 1000

router ospf 1
redistribute eigrp 1 metric 4 route-map TAGS

router eigrp 1
redistribute ospf 1 metric 1000000 0 255
1 800 route-map TAGS

Policy routing matches: 0 packets, 0 bytes
route-map SETTAG, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
R1#trace 192.168.254.1

Type escape sequence to abort.
Tracing the route to 192.168.254.1

1 192.168.2.2 12 msec * 12 msec
R1#
R1#
Q & A

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