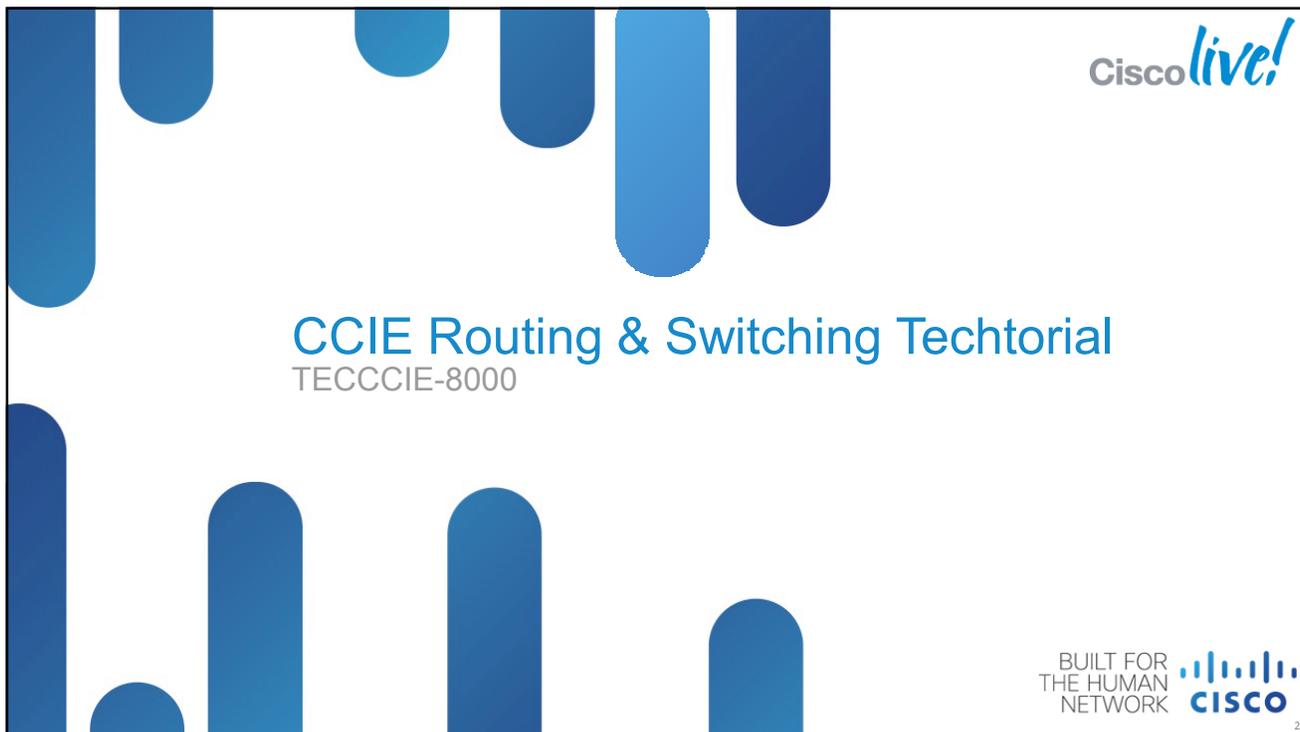


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# What You Make Possible



BUILT FOR THE HUMAN NETWORK 



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## CCIE Routing & Switching Techtorial

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## Agenda

Section 1	CCIE Program Overview
Section 2	CCIE Routing and Switching Version 4
Section 3	Study plan: Content topics review and Sample questions
Section 4	Study plan: Preparation materials
Section 5	Lab Exam: Tips and tricks
Section 6	Troubleshooting Case Studies
Section 7	Conclusion

## Disclaimer

- Not all the topics discussed today appear on every exam
- For time reasons, we're unable to discuss every feature and topic possible on the exam

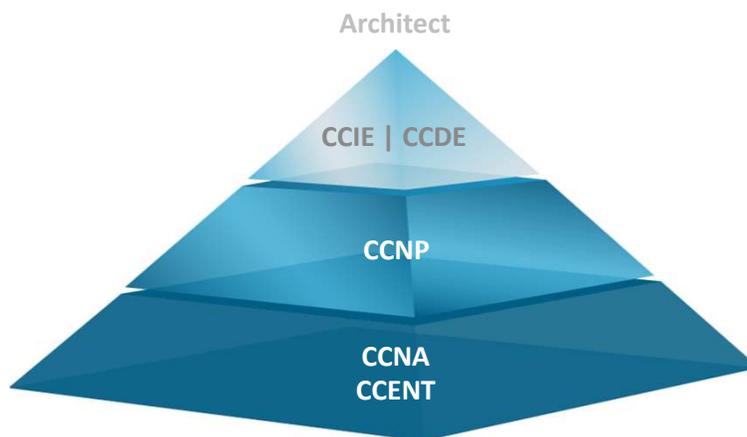
Know what you don't know



## Agenda

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Section 7	<b>Conclusion</b>

## Cisco Certifications



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## CCIEs Worldwide

- Most highly respected IT certification
  - for more than 15 years (almost 20!)
- Industry standard
  - validating expert skills and experience
- Roughly 30,000 individuals ever certified (worldwide)
  - less than 3% of all professionals certified by Cisco
- Demonstrate strong commitment and investment to networking career, life-long learning, and dedication to remaining an active CCIE



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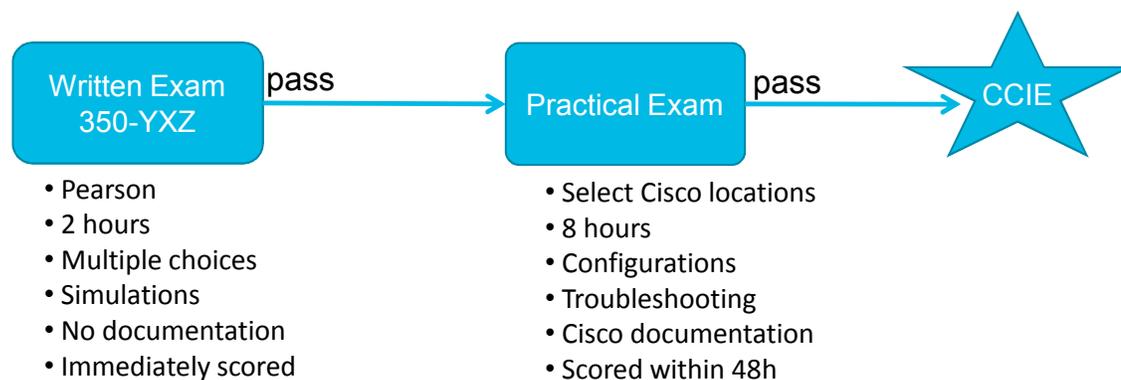
8

## Cisco CCIE Certifications

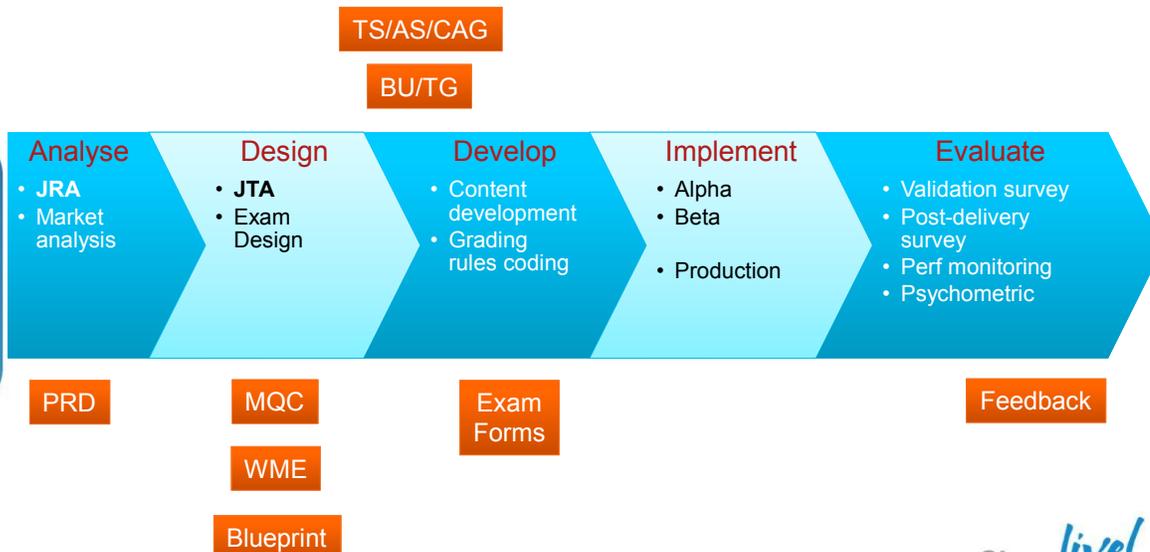
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CCIE Track	Major skills
<b>R&amp;S</b>	Configure and troubleshoot complex converged networks
<b>Security</b>	Configure complex, end-to-end secure networks, troubleshoot environments, and anticipate and respond to network attacks
<b>Service Provider</b>	Configure and troubleshoot advanced technologies to support service provider networks
<b>Storage</b>	Configure and troubleshoot storage area networks over a variety of interfaces
<b>Voice</b>	Configure complex, end-to-end telephony, as well as network, troubleshoot, and resolve VoIP-related problems
<b>Wireless</b>	Plan, design, implement, operate, and troubleshoot wireless network and mobility infrastructure
<b>SP Operation</b>	Troubleshoot network performance problems, identify implementation plans problems, manage network fault management system and operation processes

## Certification Process



## Certification Process

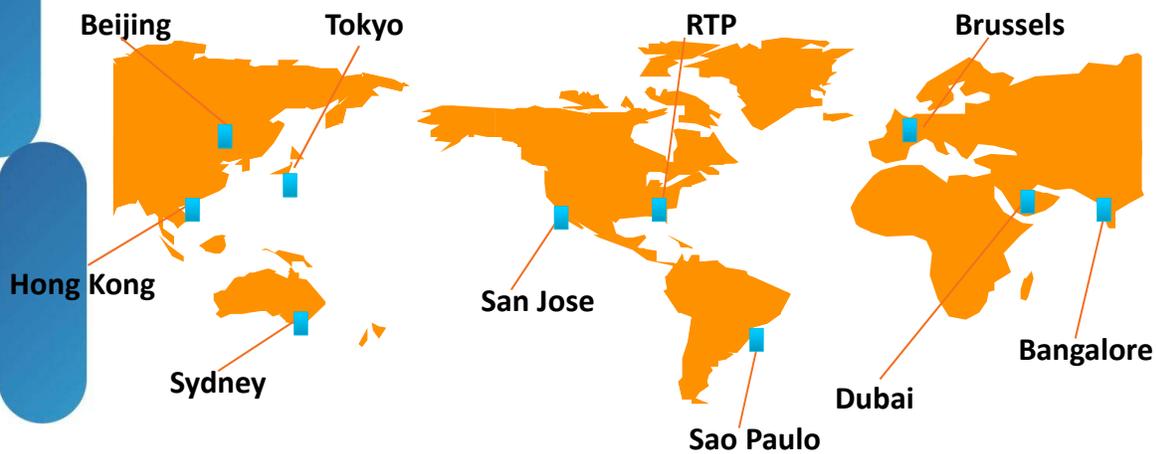


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## CCIE Permanent Lab Locations: R&S



Permanent CCIE R&S Lab Locations

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## CCIE R&S Mobile Labs: 2012



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## CCIE R&S Mobile Labs: 2012

Lab Locations	2012 Dates	Status	Lab
Mexico City, Mexico	Jan 9 - 13	R	Routing & Switching, Security and Voice
Johannesburg, South Africa	Jan 23 - 27	R	Routing & Switching, Security
Bangkok, Thailand	Jan 30 -Feb 3	R	Routing & Switching, Security
Riyadh, Saudi Arabia	Feb 4 - 8	R	Routing & Switching, Security
Sao Paulo, Brazil	Feb 13 - 17	R	Routing & Switching, Security
Cairo, Egypt	Feb 19 - 23	R	Routing & Switching, Security
Buenos Aires, Argentina	Mar 5 - 9	R	Routing & Switching, Security and Voice
Moscow, Russia	Mar 19 - 23	R	Routing & Switching, Security
Seoul, South Korea	Mar 19 - 23	R	Routing & Switching, Security and Voice
Mexico City, Mexico	Apr 2 - 6	R	Routing & Switching, Security and Voice
Istanbul, Turkey	Apr 16 - 20	R	Routing & Switching, Security
Lagos, Nigeria	Apr 30 - May 4	R	Routing & Switching, Security
Moscow, Russia	May 14 - 18	R	Routing & Switching, Security
Johannesburg, South Africa	May 28 - Jun 1	R	Routing & Switching, Security
Singapore, Singapore	Jun 4 - 8	R	Routing & Switching, Security and Voice
Rio de Janeiro, Brazil	Jun 11 - 15	R	Routing & Switching, Security
Toronto, Canada	Jun 18-22	R	Routing & Switching, Security and Voice
Warsaw, Poland	Jun 25 - 29	R	Routing & Switching, Security
Shanghai, PR China	Jul 23 - 27	R	Routing & Switching, Security

Dates for 2012 available at: <https://learningnetwork.cisco.com/docs/DOC-3224>



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## CCIE Routing and Switching Version 4

- Most popular track, over 80% of CCIE candidates attempt R&S first
- Expert-level knowledge of **LAN** and **WAN** interfaces, **Routing Protocols**, and variety of routers and switches
- Expert-level in **troubleshooting** to solve complex connectivity problems and apply solutions to increase bandwidth, improve response times, maximize performance, improve security, and support global applications



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## CCIE R&S Exam Philosophy

- The routing and switching exams test your ability to apply configuration knowledge, troubleshooting skills and skills to adapt to new situations;
- **It is not a design test, nor is it always a test of “best practices” for use in the field!**

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## CCIE R&Sv4: Minimally Qualified Candidate

“The minimally qualified Routing and Switching CCIE can **abstract** functional elements of a complex network environment, **understand** how infrastructure components **interoperate**, grasp **subtle issues**, **perceive** problem areas, and quickly **resolve** problems.

The expert’s fluency makes them ideally suited for **configuring** and **validating** implementations, **troubleshooting** critical network issues, and participating in network **design** teams. ”



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## CCIE R&S v4.0 Certification

- New certification standards released on May 5, 2009
- V4.0 exams released October 18, 2009
- Added coverage of **MPLS** (L3VPN only)
- Written exam added **simulations** (flash based items)
- Lab exam added hands-on **troubleshooting**
- Exam durations and pricing remained same

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## Recent Changes to CCIE R&S

- New areas include:
  - Troubleshoot networking issues
  - MPLS and VPN networking
  - Performance routing (PfR)
  - EIGRPv6
  - IPv6 multicast
  - PPPoE
  - ...

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## CCIE R&Sv4: Written Exam Topics

- Implement Layer 2 Technologies
  - Implement IPv4 – includes BGP
  - Implement IPv6
  - Implement MPLS Layer 3 VPNs
  - Implement IP Multicast
  - Implement Network Services
  - Implement Quality of Service
  - Implement Network Security
  - Troubleshoot a Network
  - Optimize the Network
- 
- Evaluate proposed changes to a Network

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pdf required

Same as for the Lab exam!

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## CCIE R&Sv4: Lab Exam Topics

- Implement Layer 2 Technologies
- Implement IPv4 – includes BGP
- Implement IPv6
- Implement MPLS Layer 3 VPNs
- Implement IP Multicast
- Implement Network Services
- Implement Quality of Service
- Implement Network Security
- Troubleshoot a Network
- Optimise the Network

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Same as for the Written exam!

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## CCIE R&Sv4: Lab Exam Checklist

- “Expanded blueprint” to be used as a rough guide
- Not an exhaustive list either
- Example:

2.0	Implementing IPv4 - Configuring and Troubleshooting IPv4	
2.1.	IPv4 Addressing	
2.1.1.	IPv4 Addressing	
2.1.2.	IPv4 Subnetting	
2.1.3.	IPv4 VLSM	
2.2.	OSPFv2	
2.2.01.	OSPF on a Broadcast Multicast Access Network (Ethernet)	
2.2.02.	OSPF over a Frame Relay Multipoint Network by Changing Network Types	
2.2.03.	OSPF over a Frame Relay Multipoint Network by Using the neighbor Command	
2.2.04.	OSPF over a Frame Relay Point-to-Point Network	
2.2.05.	Virtual Links	
2.2.06.	Stub Areas	

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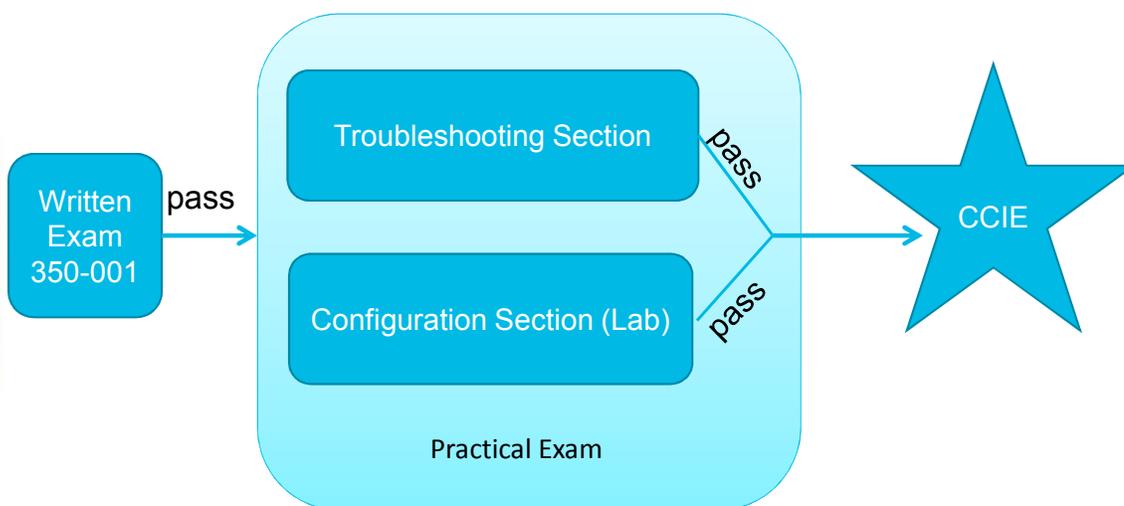
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## CCIE R&Sv4: Certification Process



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## CCIE R&Sv4: Lab Exam Structure

### Modular structure

- **Independent modules:**
  - 2h-Troubleshooting
  - 6h-Configuration
- **Composite cutscore:**
  - Must pass **both** modules, each with min 80%



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## CCIE R&Sv4: TS Module

### 2h Troubleshooting

- Separate topology of ~30 **virtual** routers and switches\*
- Scenario is fully preconfigured but contains faults
- Composed of ~10 independent incidents, worth 22/100 points
- 2h maximum (visible countdown timer + 15min warning)
- Questions are “symptom-based”
- Verifications are “result-based” + constraints

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## CCIE R&Sv4: TS Module

### Virtual infrastructure

- Virtual router = IOU: separate platforms for IOS (Solaris)
- Virtual switch = L2IOU: based on IOU's 12.2 code
- Mixing L2 and L3 links, like in real
- No Ethernet controller but L1 supported in next revision  
Currently: Interfaces will always show up/up, never up/down
- L2IOU: More features under development

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## CCIE R&Sv4: CFG Module

### 6h Configuration

- Separate topology of 9 **hardware** devices
  - 5x ISR routers + 4x 3560 switches
- Unique 6h-scenario based on a static rack
  - Physical cabling is the same for all content
- Composed of ~28 questions\* worth 78/100 points
- Any time gained in TS is granted to CFG

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## CCIE R&Sv4: CFG Module

### Hardware infrastructure

- Similar rack as R&Sv3:
  - No dedicated Frame-relay switch (only back to back serials)
  - 5 ISR routers compared to 6
  - Only 3560 switches (no mix of 3550 and 3560)
- 2x c1841 + 3x c3825 running 12.4T
- 4x c3560 running 12.2S

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## R&S Lab Exam Overview

- Candidates build a network to a series of supplied specifications
- The point values for each question are shown on the exam
- Some questions depend upon completion of previous parts of the network
- Each candidate has his/her own PC and dedicated rack of equipment, which may or may not be located in lab

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## R&S Lab Exam Overview

- Exams do not include hardware configuration or cabling
- Report any suspected equipment issues to the proctor ASAP!
- Adjustments cannot be made once the exam is over

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## Initial configurations

- All devices have a startup configuration:
  - Hostnames
  - Passwords, line setup
  - IP addresses for primary interfaces are already configured
  -
- Do not change the hostname, password and line setup!

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## CCIE R&Sv4: Lab Delivery System

### LDS

- Web GUI delivering all the exam content (questions, diagrams, guidelines, access to devices, documentation ...)
- Transparent servers backend managing the user sessions and holding the IOU instances for each users
- Benefits:
  - Flexibility in content delivery format
  - Content updates effective globally **immediately**
- **No printed exam workbook!**

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## CCIE R&Sv4: Lab Delivery System

### LDS: Example of TS session

The screenshot displays the CCIE R&Sv4 Lab Delivery System (LDS) interface. At the top, there is a navigation bar with the following tabs: "Questions & Diagrams" (circled in red), "All Questions", "Troubleshooting Guidelines", "Manage Devices" (circled in red), "Help", and "End Section". Below the navigation bar, the main content area is divided into two sections. On the left, there is a detailed network diagram showing various routers (R19, R17, R16, R18, R24, R23, R22, R21, R20, R18), switches (S24, S23, S22, S21, S20, S19, S18, S17, S16, S15, S14, S13, S12, S11, S10, S9, S8, S7, S6, S5, S4, S3, S2, S1), and servers (AS 200, AS 101). The diagram is organized into several areas: "EIGRP AS 200", "Nets 172.16.10.n/29", "Nets 172.16.14.n/30", "Nets 172.16.13.n/29", "OSPF Area 0", "Nets 172.16.11.n/30", "Area 101", "Nets 172.16.12.n/30", "OSPF Area 1", "VPN Site-B1", and "VPN Site-A3". On the right, there is a terminal window showing the output of the "show ip ospf" command on a router. The output includes the following information: "R1# show ip ospf", "Password:", "R1# show ip ospf", "Cisco IOS Software (IOS) Software (UNIX-A335-M), Version 12.4(15)T9, DEVELOPMENT TEST SOFTWARE", "System image file is \"file:///iou\_root/iou\_images/Cisco-IOS/Enterprise-12.4.15.T9\"", "OSPF", "R1#".

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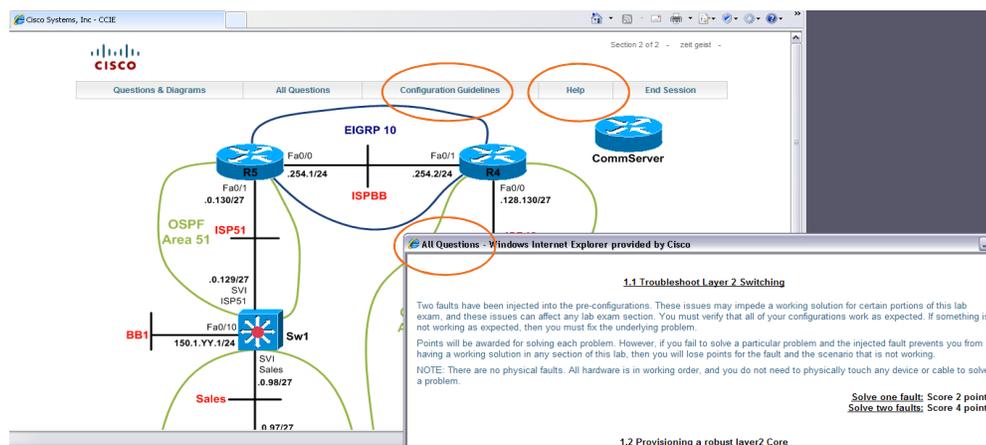
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## CCIE R&Sv4: Lab Delivery System

### LDS: Example of CFG session



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## CCIE Lab Exam: Grading

- Proctors grade all lab exams
- Automatic tools aid proctors with simple grading tasks
- Automatic tools are **never** solely responsible for lab exam grading
- Completed and submitted within **48** hours
- Partial credit is **not** awarded on any questions/items
- Points are awarded for working solutions only
- Many questions have multiple valid solutions

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## CCIE R&Sv4: Automated Grading tool

- Data collection engine :
  - Collects data from any devices in any order (any scenario)
- Grading rules engine :
  - Run grading scripts against collected output (regex)
  - Maintain a detailed report for each candidate attempt
- Benefits :
  - **Faster** and more **consistent** grading due to automation
  - Scalable and supporting expansion objectives
- **Critical point** in Content quality

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## CCIE R&Sv4: Lab exam's General Guidelines

Read them at least once!

- Configuration exam's principles
  - Embedded troubleshooting
  - Questions' inter-dependency and no partial points
- Rules of exam's format
  - Variables due to POD number
- Configuration restrictions
  - Console line and passwords



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## CCIE R&Sv4: Lab exam's General Guidelines

Read them at least once!

- Troubleshooting exam's principles
  - **Do not remove any feature preconfigured!**
  - Resolve the misconfiguration!!
  - Ex. ACL, PBR, CoPP, MQC, etc



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## Study plan: Content topics review

### Approach

- **Quick listing** of the essential concepts for each chapter
  - Organized as per the Configuration exam' sections
- **Sample question** per main topic using a sample topology
  - Discussion on question's reading and interpretation
  - Review of Solution and Verification steps
- Frequently missed topic
- References

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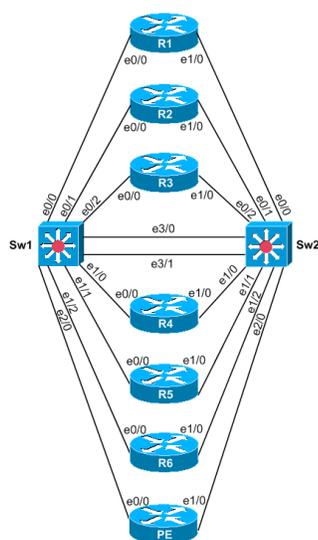
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## Practice Lab: Sample topology

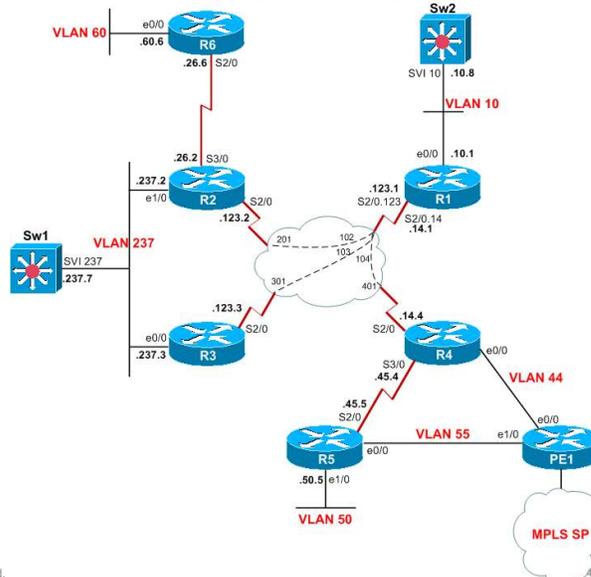
Router-Switch connections



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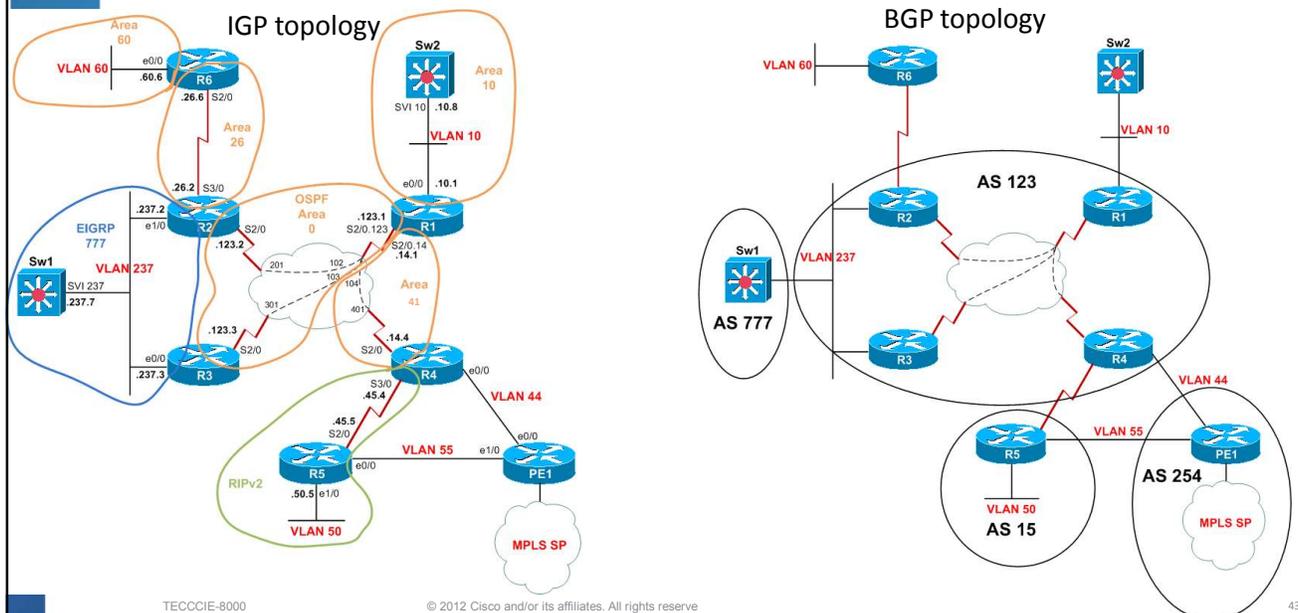
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Logical topology



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## Practice Lab: Sample topology



## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing
Part 3	Advanced Services
Part 4	Optimisation
Part 5	Troubleshooting

## Section 3: Study plan: Content topics

Part 1	Switching:
2.1	<b>Frame-Relay</b>
2.2	LAN Switching
Part 2	Routing
Part 3	Advanced Services
Part 4	Optimisation
Part 5	Troubleshooting

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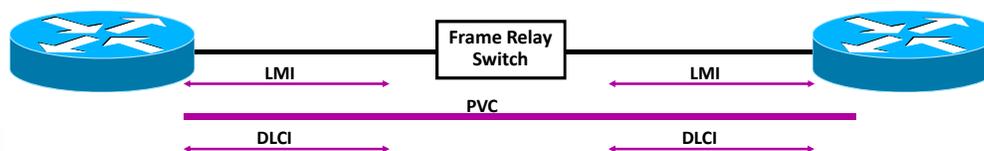
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## Frame Relay Concepts



- **DLCI** Data-link connection identifier
- **LMI** Local Management Interface
- **PVC** Permanent Virtual Circuit
- **CIR** Committed Information Rate
- **Bc** Committed Burst
- **Be** Excess Burst
- **DE** Discard Eligible
- **BECN** Backward Explicit Congestion Notification
- **FECN** Forward Explicit Congestion Notification

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## Frame Relay Concepts

- Layer 2 to Layer 3 mapping
  - Inverse ARP
  - Static Mapping
- Topologies
  - Hub and Spoke
  - Point-to-point
  - Multipoint
- QoS

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## Sample Lab Question – Frame-Relay

### ▪ Frame Relay Configuration

Refer to the network diagram for frame-relay DLCIs and PVC information. Subinterfaces are pre-configured and numbered according to the third octet of the IP address configured on that interface.

- Configure the frame-relay network between R1, R2 and R3 so that you can ping between all routers over the R1-R2-R3 frame-relay cloud.
- Configure the point-to-point link between R1 and R4. Do not create a subinterface on R4. Ping between R1 and R4 when completed.

Score: 2 Points

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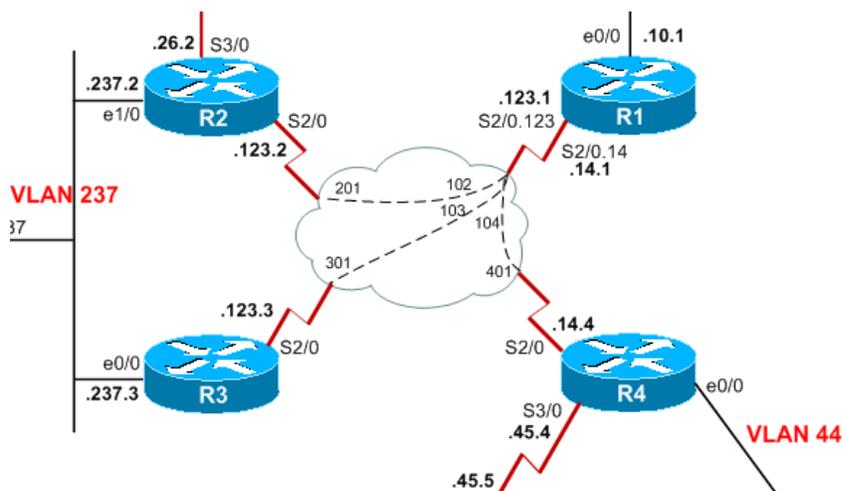
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## Practice Lab: Sample topology

Focus on Frame-Relay cloud



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## Sample Lab Question – Frame-Relay

- **Hints, requirements and constraints in the stem:**
  - Refer to the network diagram for frame-relay DLCIs and PVC information.  
(...)
- Do not change the DLCIs!

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## Sample Lab Question – Frame-Relay

- **Hints, requirements and constraints in the stem:**

- (...) Subinterfaces are pre-configured and numbered according to the third octet of the IP address configured on that interface.(...)

- Do not change the pre-configured IP addresses and sub-interface's numbers!

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## Sample Lab Question – Frame-Relay

- **Hints, requirements and constraints in the stem:**

- Configure the frame-relay network between R1, R2 and R3 so that you can ping between all routers over the R1-R2-R3 frame-relay cloud.(...)

- Only requirement is to be able to ping between the 3 devices!
- Can use inverse-arp or static mapping
- No words about mapping local IP... up to you.

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## Sample Lab Question – Frame-Relay

- **Hints, requirements and constraints in the stem:**

- Configure the point-to-point link between R1 and R4. Do not create a subinterface on R4. Ping between R1 and R4 when completed.
- Notice the constraint about R4's subinterface!
- Can use inverse-arp or static mapping on R4

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## Sample Lab Question – Frame-Relay

- **Verification steps:**

1. Successful ping from/to all devices
2. FR map on R1 and R4: sub-if, IP, DLCI and PVC active

```

R1#sh fram map
Serial2/0.123 (up): ip 172.16.123.2 dlci 102(0x66,0x1860), static,
    broadcast,
    CISCO, status defined, active
Serial2/0.123 (up): ip 172.16.123.3 dlci 103(0x67,0x1870), static,
    broadcast,
    CISCO, status defined, active
Serial2/0.14 (up): point-to-point dlci, dlci 104(0x68,0x1880), broadcast
    status defined, active
R1#

R4#sh fram map
Serial2/0 (up): ip 172.16.14.1 dlci 401(0x191,0x6410), dynamic,
    broadcast,
    CISCO, status defined, active
R4#
  
```

Not checked  
at this point

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## Sample Lab Question – Frame-Relay

- **Frequently missed points:**

- Broadcast statement missing, wrong DLCI

- Requirement missed

- Constraints not respected

- Main guidelines not respected

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- Cisco Frame Relay Solutions Guide, Chin

- Technology Handbook:

- [http://docwiki.cisco.com/wiki/Frame\\_Relay](http://docwiki.cisco.com/wiki/Frame_Relay)

- CCO Documentation:

- [http://www.cisco.com/en/US/tech/tk713/tk237/tsd\\_technology\\_support\\_protocol\\_home.html](http://www.cisco.com/en/US/tech/tk713/tk237/tsd_technology_support_protocol_home.html)

- [http://www.cisco.com/en/US/docs/ios/wan/configuration/guide/wan\\_cfg\\_frm\\_rly\\_ps6441\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/wan/configuration/guide/wan_cfg_frm_rly_ps6441_TSD_Products_Configuration_Guide_Chapter.html)

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## Section 3: Study plan: Content topics

Part 1	Switching:
2.1	Frame-Relay
2.2	LAN Switching
Part 2	Routing
Part 3	Advanced Services
Part 4	Optimisation
Part 5	Troubleshooting

## LAN Switching Concepts & Protocols

- Layer 2 VLAN's (Normal, Extended, Native)
- Layer 2 Ethernet Trunk
  - IEEE 802.1q, ISL (Cisco Proprietary)
- CDP
- DTP (Dynamic Trunking Protocol)
- VLAN Trunk Protocol (VTP)
- EtherChannels
  - Access Ports, L2 Trunks or L3 Links
  - PAgP, IEEE 802.3ad LACP

## LAN Switching Features

- Spanning Tree
  - PVST, MSTP, RSTP
- Spanning Tree Features
  - Portfast
  - Bpduguard, Bpdufilter
  - Uplinkfast, Backbonefast
  - Etherchannelguard
  - Rootguard, Loopguard
- SVI (Switched Virtual Interface)

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## LAN Switching Features

- Private VLAN
- (R)SPAN
- SVI (Switched Virtual Interface)

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## Sample Lab Question – LAN Switching

### ▪ VTP Configuration

Configure VLAN Trunking Protocol (VTP) as per the following requirements:

- The VTP domain name is "CCIE".
- Secure the VTP advertisements to be sent. Use "CCIE" as your key.
- SW1 will propagate all VLAN configuration changes to SW2.
- In the future, these four switches will be configured as VTP transparent hosts. They should NOT inspect the VTP domain name and version, and they should support unrecognised type, length, value (TLV).
- DO NOT Use VTP v3.

Score: 2 Points

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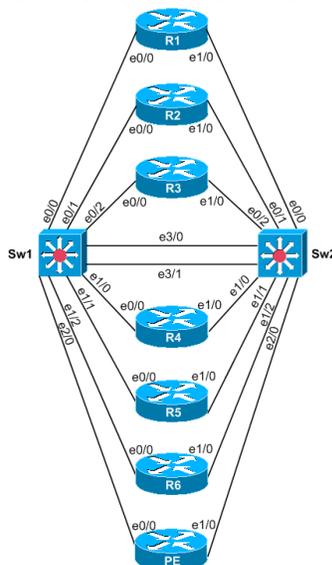
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## Practice Lab: Sample topology

Router-Switch connections



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## Sample Lab Question – LAN Switching

- **Hints, requirements and constraints in the stem:**
  - The VTP domain name is "CCIE".
  - Secure the VTP advertisements to be sent. Use "CCIE" as your key.
  - SW1 will propagate all VLAN configuration changes to SW2.(...)
- Very clear requirements about VTP config !
- SW1 must be VTP server and SW2 VTP client or server

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## Sample Lab Question – LAN Switching

- **Hints, requirements and constraints in the stem:**
  - (...)
  - In the future, these four switches will be configured as VTP transparent hosts. They should NOT inspect the VTP domain name and version, and they should support unrecognized type, length, value (TLV).
  - DO NOT Use VTP v3.
- "In the future" means not yet! This would violate the previous requirement...
- Requirement describes a specificity of VTP version 2

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## Sample Lab Question – LAN Switching

- **Hidden/Implicit requirements in the stem:**  
(...)  
• SW1 must propagate all VLAN configuration changes to SW2
- VTP relies on trunks!
- Configure trunks, either with ISL or DOT1q
- Trigger VTP update with any change in SW1

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## Sample Lab Question – LAN Switching

- **Verification steps: SW1**

Check VTP config: domain, version, password and mode

```
SW1#sh vtp status
VTP Version          : 3 (capable)
Configuration Revision : 6
Maximum VLANs supported locally : 1005
Number of existing VLANs : 11
VTP Operating Mode   : Server
VTP Domain Name     : CCIE
VTP Pruning Mode    : Disabled (Operationally Disabled)
VTP V2 Mode         : Enabled
VTP Traps Generation : Disabled
MD5 digest          : 0xEC 0x05 0x97 0x80 0x3C 0x74 0xF7 0xA1
Configuration last modified by 0.0.0.0 at 2-24-11 14:44:31
Local updater ID is 0.0.0.0 (no valid interface found)
VTP version running  : 2
SW1#
SW1#sh vtp password
VTP Password: CCIE
SW1#
```

Can be any number  
but must match on SW2

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## Sample Lab Question – LAN Switching

### ▪ Verification steps: SW2

Check if VTP config is identical as Sw1 (mode can be client)

```
SW2#sh vtp status
VTP Version      : 3 (capable)
Configuration Revision : 6
Maximum VLANs supported locally : 1005
Number of existing VLANs : 11
VTP Operating Mode : Client
VTP Domain Name   : CCIE
VTP Pruning Mode  : Disabled (Operationally Disabled)
VTP V2 Mode       : Enabled
VTP Traps Generation : Disabled
MD5 digest        : 0xEC 0x05 0x97 0x80 0x3C 0x74 0xF7 0xA1
Configuration last modified by 0.0.0.0 at 2-24-11 14:44:31
Local updater ID is 0.0.0.0 (no valid interface found)
VTP version running : 2
SW2#
SW2#sh vtp password
VTP Password: CCIE
SW2#
```

Can be Client or Server

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## Sample Lab Question – LAN Switching

### ▪ Spanning Tree Protocol

Configure Spanning-tree protocol on SW1 and SW2 as per the following requirements:

- Configure SW1 and SW2 so that SW1 is the root for all even\* VLANs, and SW2 is the root for all odd\* VLANs.
- SW1 and SW2 should also serve as backup root switches for their respective VLANs.
- Ensure that both switches are running one STP instance per VLAN

#### NOTE:

- Your solution must affect only the VLANs used in this topology.
- Odd numbers are not divisible by 2, for example: 1, 3, 5, 7, and so on.
- Even numbers are divisible by 2, for example: 2, 4, 6, 8, and so on.

Score: 2 Points

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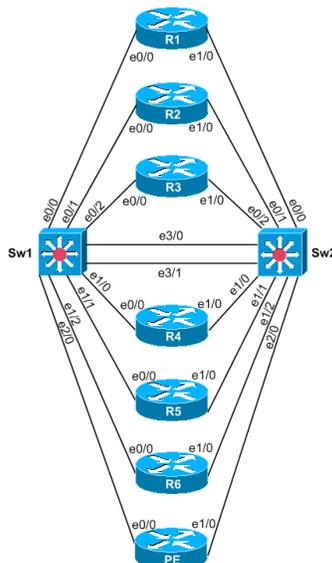
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## Practice Lab: Sample topology

Router-Switch connections



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## Sample Lab Question – LAN Switching

- **Hints, requirements and constraints in the stem:**
  - Configure SW1 and SW2 so that SW1 is the root for all even\* VLANs, and SW2 is the root for all odd\* VLANs.
  - SW1 and SW2 should also serve as backup root switches for their respective VLANs.
  - Ensure that both switches are running one STP instance per VLAN
- Very clear requirements about STP config
- MST not valid solution!

```
spanning-tree vlan [VLAN LIST] root primary
spanning-tree vlan [VLAN LIST] root secondary
```

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## Sample Lab Question – LAN Switching

- **Hints, requirements and constraints in the stem:**

(...)

- Your solution must affect only the VLANs used in this topology.

- Check which VLANs are used

=> VLAN 1, 10, 44, 50, 55, 60, 237

SW1 = root for 10, 44, 50, 60

SW2 = root for 1, 55, 237

DO NOT FORGET VLAN 1 !

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## Sample Lab Question – LAN Switching

- **Verification steps: SW1**

Check current STP Priority for ALL vlans:

```
SW1#sh span s | i Root
Root bridge for: VLAN0010, VLAN0044, VLAN0050, VLAN0060
SW1#
SW1#sh spanning-tree vlan 55 | i Priority
Root ID Priority 24631
Bridge ID Priority 28727 (priority 28672 sys-id-ext 55)
SW1#sh spanning-tree vlan 44 | i Priority
Root ID Priority 24620
Bridge ID Priority 24620 (priority 24576 sys-id-ext 44)
SW1#
```

Both must not match for **odd** VLANs and Bridge ID Priority must be <32768!

Both must match for **even** VLANs

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## Sample Lab Question – LAN Switching

### Verification steps: SW2

Check current STP Priority for ALL vlans:

```
SW2#sh span s | i Root
Root bridge for: VLAN0001, VLAN0055, VLAN0237
SW2#
SW2#sh spanning-tree vlan 55 | i Priority
Root ID Priority 24631
Bridge ID Priority 24631 (priority 24576 sys-id-ext 55)
SW2#
SW2#sh spanning-tree vlan 44 | i Priority
Root ID Priority 24620
Bridge ID Priority 28716 (priority 28672 sys-id-ext 44)
SW2#
```

Both must match  
for **odd** VLANs

Both must not match for  
**even** VLANs and Bridge  
ID Priority must be  
<32768!

## Sample Lab Question – LAN Switching

### Frequently missed points:

- Requirement missed or not fully configured (ex. VLAN 1!)
- Constraints not respected
- Main guidelines not respected
- VTP Configuration revision not matching as expected
- Access ports not configured in proper VLAN
- Ports shut down by software (err-disabled)

## References

- Cisco Press®
  - Cisco LAN Switching, Kennedy Clark
  - Cisco Field Manual: Catalyst Switch Configuration, David Hucaby, Stephen McQuerry
- Interconnections, 2nd edition, Radia Perlman
- CCO Documentation
  - Cisco Catalyst 3560 configuration guide CCO
  - [http://www.cisco.com/en/US/products/hw/switches/ps5528/tsd\\_products\\_support\\_series\\_home.html](http://www.cisco.com/en/US/products/hw/switches/ps5528/tsd_products_support_series_home.html)

## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing:
2.1	Routing Concepts
2.2	Routing Protocols: IGP (EIGRP & OSPF)
2.3	IGP Redistribution
2.4	Routing Protocols: EGP (BGP)
2.5	Multicast Routing
2.6	MPLS-VPN
Part 3	Advanced Services
Part 4	Optimisation
Part 5	Troubleshooting

## IP Routing Concepts

- Classless and Classful
- Static and Dynamic routing
- Policy-based Routing
  - Forwarding decisions based on criteria other than destination IP address
- Administrative Distance
  - Determining the priority of different sources of routing updates
- Passive Interfaces
  - Interfaces that participate in routing to learn but not advertise routes

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## Section 3: Study plan: Content topics

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## Disclaimer—Reminder

- With the time allocated, we can **only review** the cornerstones of the most important IGPs

EIGRP and OSPF

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## EIGRP Topics

- Neighbour Relationships
  - Packet Types
  - Establishment Process
  - Instability
- DUAL (Route Computation)
  - Reported and Feasible Distance
  - (Feasible) Successor
  - Internal vs External Distance

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## EIGRP Topics

- Summarization
  - EIGRP Stub
- Load Balancing
  - Equal Cost
  - Unequal Cost

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## Sample Lab Question – EIGRP

- **EIGRP AS 777**

Configure EIGRP Autonomous System 777 on R2, R3 and SW1 for VLAN 237 as per the following requirements:

- Do not activate EIGRP on the serial interfaces.
- Do not use the passive- interface command on any EIGRP router.
- Disable automatic summarization for EIGRP.
- Without using the network command advertise Loopback0 on SW1 into EIGRP.
- Configure R3 so that it will only accept EIGRP updates from SW1

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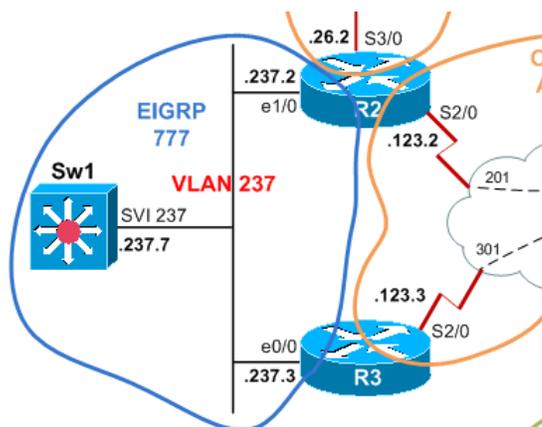
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## Practice Lab: Sample topology

Focus on EIGRP AS777



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## Sample Lab Question – EIGRP

- **Hints, requirements and constraints in the stem:**
  - (...) Disable automatic summarisation for EIGRP.
  - Do not use the passive-interface command on any EIGRP router.
  - Do not activate EIGRP on the serial interfaces. (...)
- These requirements imply that only the VLAN 237 interfaces are running EIGRP

```
router eigrp 777
no auto-summary
network 172.16.237.0 0.0.0.255
```

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## Sample Lab Question – EIGRP

- Hints, requirements and constraints in the stem:

(...)

- Without using the network command advertise Loopback0 on SW1 into EIGRP.

- This requirement implies to redistribute the prefix

```
access-list 7 permit 7.7.7.7 0.0.0.0
!
route-map LO0 permit 10
match ip address 7
router eigrp 777
redistribute connected route-map LO0
```

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## Sample Lab Question – EIGRP

- Hints, requirements and constraints in the stem:

(...)

- Configure R3 so that it will only accept EIGRP updates from SW1

- This requirement points to using the gateway option:

```
ip prefix-list ALLOWED-NEIGH seq 5 permit 172.16.237.7/32
ip prefix-list ALLOWED-NEIGH seq 10 deny 0.0.0.0/0 le 32
ip prefix-list ALLOWED-PREF seq 5 permit 0.0.0.0/0 le 32
!
router eigrp 777
distribute-list prefix ALLOWED-PREF gateway ALLOWED-NEIGH in
```

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## Sample Lab Question – EIGRP

- **Verification steps:**

1. Check EIGRP 777 neighbors and interfaces (No Serial seen)

```
R3#sh ip protocol | s eigrp
Automatic network summarization is not in effect
=> NO passive interface section seen at all
```

2. Check for SW1.lo0 to be seen as D EX on R2 and R3

```
R2#sh ip ro 7.7.7.7 | i via
Known via "eigrp 777", distance 170, metric 409600, type external
Redistributing via eigrp 777
* 172.16.237.7, from 172.16.237.7, 00:06:39 ago, via Ethernet1/0
```

1. Check R3 for proper Incoming filter with gateway option

```
R3#sh ip protocol | l gateway
Incoming update filter list for all interfaces is (prefix-list) ALLOWED-PREF gateway ALLOWED-NEIGH
```

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## Sample Lab Question – EIGRP

- **Frequently missed points:**

- Prefix missing
- Requirement not fully configured (ex. Passive-int)
- Requirement missing (ex. Filter with Gateway option)
- Constraints not respected
- Main guidelines not respected

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## References

- CiscoPress®  
Routing TCP/IP Volume I & II, Jeff Doyle
- CCO Documentation
- CCO Whitepapers  
Introduction to EIGRP  
Enhanced Interior Gateway Routing Protocol

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## Section 3: Study plan: Content topics

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2.6	MPLS-VPN
Part 3	Advanced Services
Part 4	Optimization
Part 5	Troubleshooting

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## OSPF Topics

- OSPF Areas
  - Area 0
  - Normal
  - NSSA, Stubby, Totally Stubby
- OSPF Router Types
  - ABR, ASBR
- OSPF Link States
  - Router
  - Network
  - Externals (Type 1 and 2)

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## OSPF Topics

- OSPF over NBMA
  - Point-to-point, point-to-multipoint, broadcast, non-broadcast
- OSPF over broadcast
  - DR & BDR, Wildcard masks
- Virtual link
- OSPF Route Selection
- Summarization
- Authentication
  - Peer and area

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## Sample Lab Questions – OSPF

### OSPF Areas configuration

...Aggregated...

Configure the OSPF domain as per the IGP topology diagram and the following requirements:

- In Area 0, use the OSPF point-to-multipoint network type on the serial interfaces of each router.
- In Area 41, do not change the OSPF network type on R1's S2/0.14 subinterface.
- Change the OSPF network type on R4's S2/0 interface to point-to-multipoint.
- Permit OSPF inter area routing information into Area 41
- Permit external type 7 link state advertisements into Area 41
- Permit OSPF inter area routing information into Area 10 and ensure that external routing information is not flooded into Area 10
- R1 must inject a default route into area 10. Do not use the 'default-information-originate' command.

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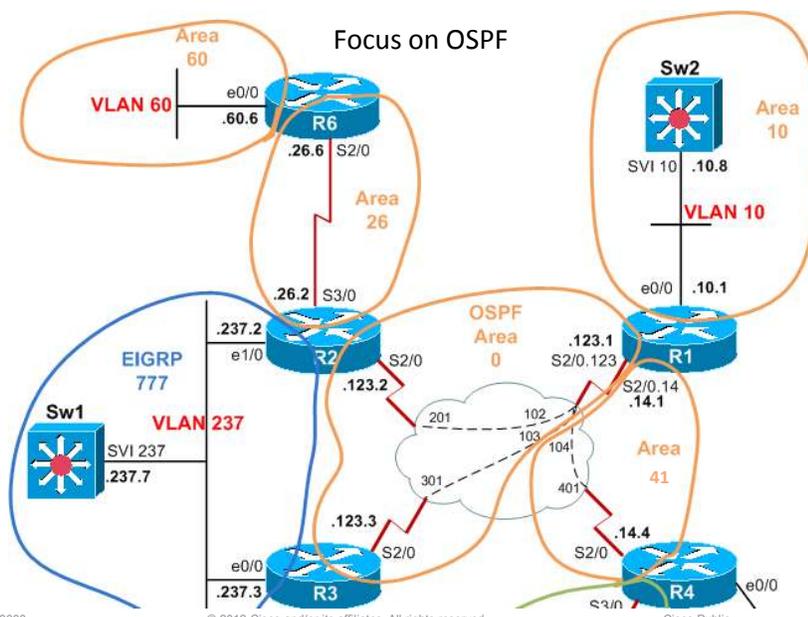
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## Practice Lab: Sample topology



## Sample Lab Question – OSPF

- **Hints, requirements and constraints in the stem:**
  - (...) In Area 0, use the OSPF point-to-multipoint network type on the serial interfaces of each router.(...)
- This requirements is very explicit, no tricks

```
interface Serial2/0
ip ospf network point-to-multipoint
!
router ospf 1
network 172.16.123.0 0.0.0.255 area 0
```

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## Sample Lab Question – OSPF

- **Hints, requirements and constraints in the stem:**
  - (...) In Area 41, do not change the OSPF network type on R1's S2/0.14 subinterface.
  - Change the OSPF network type on R4's S2/0 interface to point-to-multipoint. (...)
- These requirements imply to tune the timer (R1 or R4)

```
R1: interface Serial2/0.14 point-to-point
ip ospf hello-interval 30
```

OR

```
R4: interface Serial2/0
ip ospf hello-interval 10
```

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## Sample Lab Question – OSPF

- **Hints, requirements and constraints in the stem:**
  - (...) Permit OSPF inter area routing information into Area 41
  - Permit external type 7 link state advertisements into Area 41
  - Inject a default route into Area 41
- These requirements imply that Area 41 is NSSA

```
router ospf 1
area 41 nssa default-information-originate
```

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## Sample Lab Question – OSPF

- **Hints, requirements and constraints in the stem:**
  - (...) Permit OSPF inter area routing information into Area 10 and ensure that external routing information is not flooded into Area 10
  - R1 must inject a default route into area 10. Do not use the 'default-information-originate' command.
- These requirements imply that Area 10 is stub

```
router ospf 1
area 10 stub
```

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## Sample Lab Question – OSPF

### ▪ Hidden/Implicit requirements in the stem:

- Area 60 is not connected to Area 0

This implies a Virtual Link via Area 26

```
router ospf 1
area 26 virtual-link <router-id>
```

### No explicit requirements about Loopback interfaces nor router-id

Up to you where to put loopbacks and which router-id to use.

(Usually, this would be specified in the guidelines or in a full reachability statement.)

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## Sample Lab Question – OSPF

### ▪ Verification steps:

1. Check OSPF neighbors, interfaces and area

```
R1#sh ip ospf int bri
Interface  PID Area      IP Address/Mask  Cost State Nbrs F/C
Lo0        1  0        1.1.1.1/32       1  LOOP 0/0
Se2/0.123  1  0        172.16.123.1/24 64  P2MP 2/2
Et0/0      1  10       172.16.10.1/24  10  BDR  1/1
Se2/0.14   1  41       172.16.14.1/24  64  P2P  1/1
R1#
```

2. Check Area types

```
R1#sh run | s ospf
router ospf 1
log-adjacency-changes
area 10 stub
area 41 nssa default-information-originate
network 172.16.10.0 0.0.0.255 area 10
network 172.16.14.0 0.0.0.255 area 41
network 172.16.123.0 0.0.0.255 area 0
```

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## Sample Lab Question – OSPF

### ▪ Verification steps:

#### 3. Check reachability between Area 0 and Area 60

```
R2#ping 172.16.60.6
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 172.16.60.6, timeout is 2 seconds:
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/60/60 ms
```

```
R2#
```

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## Sample Lab Questions – OSPF

### ▪ OSPF Route Control

- Create interface loopback10 on R1 and assign it the address 180.1.1.1/24.
- Advertise the loopback10 interface into OSPF.
- DO NOT use the network command.
- Ensure this network appears in the routing tables of all OSPF routers except R4 and Sw2.
- Do not use any filters on any router to complete this question.

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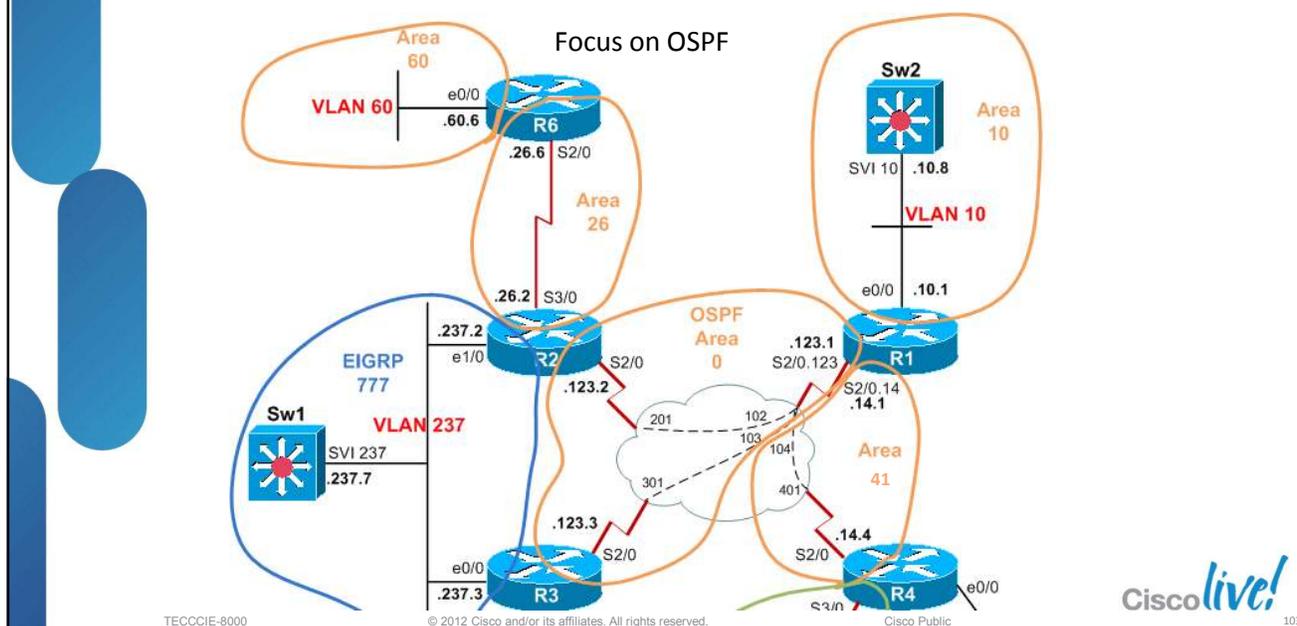
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## Practice Lab: Sample topology



## Sample Lab Question – OSPF

### ▪ Hints, requirements and constraints in the stem:

- (...) Ensure this network appears in the routing tables of all OSPF routers except R4 and Sw2.(...)

This requirement implies to use the NSSA no-redistribution:

```
interface Loopback10
 ip address 180.1.1.1 255.255.255.0
 access-list 1 permit 180.1.1.0 0.0.0.255
 route-map LOOPBACK permit 10
 match ip address 1
 router ospf 1
 area 41 nssa no-redistribution default-information-originate
 redistribute connected subnets route-map LOOPBACK
```

## Sample Lab Question – OSPF

- **Verification steps:**

1. Check if R1.Lo10 is seen as external in all Areas but 41 and 10:

```
R3#sh ip route 180.1.1.0 | i ospf/via
Known via "ospf 1", distance 110, metric 20, type extern 2, forward metric 64
* 172.16.123.1, from 1.1.1.1, 00:05:07 ago, via Serial2/0
R3#
```

```
R6#sh ip route 180.1.1.0 | i ospf/via
Known via "ospf 1", distance 110, metric 20, type extern 2, forward metric 128
* 172.16.26.2, from 1.1.1.1, 00:04:11 ago, via Serial2/0
R6#
```

```
R4#sh ip route 180.1.1.0 | i ospf/via
R4#
>> CHECK FOR NO OUTPUT
```

```
SW2#sh ip route 180.1.1.0 | i ospf/via
SW2#
>> CHECK FOR NO OUTPUT
```

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## Sample Lab Question – OSPF

- **Verification steps:**

2. Check if the nssa no-redistribution was used for area 41

```
R1#sh run | i nssa
area 41 nssa no-redistribution default-information-originate
R1#
```

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## Sample Lab Question – OSPF

- **Frequently missed points:**

- Prefix or interface missing (loopbacks, stub network)

- Requirement not fully configured

- Constraints not respected

- Main guidelines not respected

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## References

- CiscoPress®

- Routing TCP/IP Volume I & II, Jeff Doyle

- Cisco OSPF Command and Configuration Handbook, William R. Parkhurst

- OSPF Network Design Solutions, Thomas M. Thomas

- CCO Whitepapers

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## Section 3: Study plan: Content topics

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## IPv6 Addressing Topics

- Addressing

- Structure

- Types

- Link Local

- Global Unicast

- Unique Local Unicast

- Multicast/Anycast

- IPv4 Compatible/Mapped

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## IPv6 Addressing Topics

- Neighbor Discovery Protocol
  - Router Solicitation/Advertisement
  - Neighbor Solicitation/Advertisement
  - Link layer mapping
  - Duplicate Address Detection
- Address Assignment
  - Static
  - Stateless Autoconfig

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## IPv6 Routing Topics

- OSPFv3
- EIGRPv6
- Filtering and Route redistribution
- Tunneling techniques

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## OSPFv3 Topics

- Adjacency Formation
  - Per-link vs per-subnet
  - Link-local address
  - Multi-topology via instance-id
- LSA Flooding
  - IPv6 specific multicast addresses
  - New LSA types
  - Renamed LSA types
- Configuration
  - Explicit router-id
  - Per-interface vs per-process
  - IPv6 security replaces OSPF security

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## Sample Lab Questions – IPv6

- **IPv6 Addressing**
  - Configure IPv6 on R1, R2, R3 and SW1 using the following addressing structure:
    - Assign an IPv6 address to all IPv4 enabled interfaces except additional loopbacks created in the lab. (enable IPv6 on loopback 0 interfaces and omit the additional loopbacks)
    - Use the assigned prefix of 2001:ABC:123::/48 on all interfaces.
    - All subnets are 64 bits.
    - Use EUI-64 to generate the host portion of the address.
    - Complete the network portion of the address from the third octet in the IPv4 address for that interface. For example, use 237 for SW1 VLAN 237.

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## Sample Lab Questions – IPv6

### ▪ OSPFv3

Configure OSPFv3 on the frame-relay network (R1, R2, R3) for area 0.

- Do not enable OSPFv3 on VLAN 237 but ensure it is advertised as an IPv6 prefix to R1 as an external route
- Ensure that you can IPv6 ping all interfaces and OSPF adjacencies are established.

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## Sample Lab Question – OSPFv3

### ▪ Frequently missed points:

- Typo in IPv6 address
- EUI Addressing mismatch
- Requirement not fully configured
- Constraints not respected
- Main guidelines not respected

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## References

- CiscoPress®
  - Implementing Cisco IPv6 Networks, Regis Desmeules
  - Deploying IPv6 Networks, Popoviciu, Levy-Abengnoli, Grossetete
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## IGP Redistribution topics

- Protocol Metrics
  - Defaults
  - Redistribution
- Filtering
  - Route-maps
  - Tags

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## Sample Lab Question – IGP Redistribution

- **EIGRP AS 777 and OSPF**
  - Mutually redistribute between the RIP and OSPF domains.
  - Mutually redistribute EIGRP AS 777 into the OSPF backbone area on R2 and R3
  - Filter to avoid routing loops and ensure optimal routing
  - Your solution must ensure that any future external EIGRP prefixes redistributed by SW1 will not require configuration changes in R2 and R3

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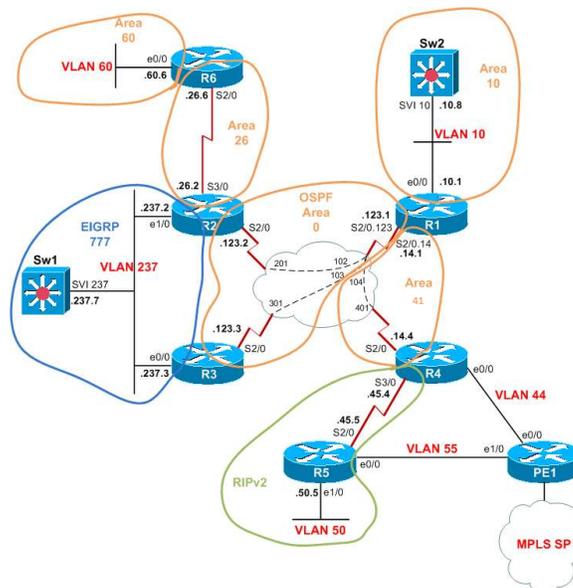
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## Practice Lab: Sample topology



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## Sample Lab Question – IGP Redistribution

- **Hints, requirements and constraints in the stem:**
  - Mutually redistribute between the RIP and OSPF domains.(...)
- No tricks here, don't forget the 'subnet' and 'metric' keywords and VERIFY reachability!

```
router rip
 redistribute ospf 1 metric 1
router ospf 1
 redistribute rip subnet
```

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## Sample Lab Question – IGP Redistribution

- **Hints, requirements and constraints in the stem:**
  - (...) **Mutually** redistribute EIGRP AS 777 into the OSPF (...)
  - Filter to **avoid routing loop**
  - Your solution must ensure that any future external EIGRP prefixes redistributed by SW1 will **not** require **configuration changes** in R2 and R3
- Routing loops easily happen with two redistribution points between the same protocols due to **route feedback**

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## Sample Lab Question – IGP Redistribution

- **Route feedback filtering with tags account for any future EIGRP external prefixes:**
  - Mark EIGRP prefixes before propagating into OSPF
  - Filter prefixes to enter the RIB (due to lower AD)

R2 &amp; R3

```

route-map EIGRP2OSPF deny 10
match tag 88
route-map EIGRP2OSPF permit 20
set tag 77
route-map OSPF2EIGRP deny 10
match tag 77
route-map OSPF2EIGRP permit 20
set tag 88
!
router eigrp 777
redistribute ospf 1 metric 1 1 1 1 route-map OSPF2EIGRP
router ospf 1
redistribute eigrp 777 subnet route-map EIGRP2OSPF

```

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## Sample Lab Question – IGP Redistribution

### ▪ Verification steps:

#### 1. Check if SW1.lo0 is seen tagged in R1

```
R1#sh ip ro 7.7.7.7 | i via|tag
Known via "ospf 1", distance 110, metric 20
 172.16.123.3, from 3.3.3.3, 00:09:29 ago, via Serial2/0.123
Route tag 22
* 172.16.123.2, from 2.2.2.2, 00:10:58 ago, via Serial2/0.123
Route tag 22
R1#
```

#### 2. Check if SW1.lo0 is seen as EIGRP on both R2 and R3

```
R2#sh ip ro 7.7.7.7 | i via
Known via "eigrp 777", distance 170, metric 410603, type external
Redistributing via eigrp 777, ospf 1
* 172.16.237.7, from 172.16.237.7, 00:21:38 ago, via Ethernet1/0
R2#
```

#### 1. Check if OSPF routes are seen as OSPF on both R2 and R3

```
R2#sh ip ro 172.16.60.0 | i via
Known via "ospf 1", distance 110, metric 74, type inter area
Redistributing via eigrp 777
* 172.16.26.6, from 6.6.6.6, 00:22:42 ago, via Serial3/0
R2#
```

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## Sample Lab Question – IGP Redistribution

### ▪ Frequently missed points:

- Optimal routing not achieved
- Requirement missing (ex. Route feedback filter, routing loop)
- Prefix(es) not reachable
- Constraints not respected
- Main guidelines not respected

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## References

- CiscoPress®  
Routing TCP/IP Volume I & II, Jeff Doyle
- CCO Documentation  
Check protocol documentation

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## BGP topics

- Peering
  - iBGP
  - eBGP
  - Directly connected vs multi-hop
  - Neighbour Local-AS
- BGP Path Selection
  - IGP Synchronisation
  - Intra-AS attributes
  - Inter-AS attributes
  - Multipath

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## BGP topics

- BGP Attributes
  - Aggregate
  - Communities
- Filtering
  - Route-maps
  - Prefix-lists
  - AS Path Lists
  - Regular Expressions
- Scaling
  - Route Reflectors
  - Confederations

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## Sample Lab Question – BGP

### ▪ IBGP

- Configure BGP on R2, R3 and R4 for AS 123.
- Use a full mesh.
- Establish all peering sessions using the loopback0 interfaces of each router.
- Do not configure BGP on R1.
- On R4 create a Loopback interface and assign it the IP address 99.99.99.1/24
- Inject the 99.99.99.0/24 prefix into BGP using the network command.
- Verify the route appears in the routing tables of all routers running BGP.

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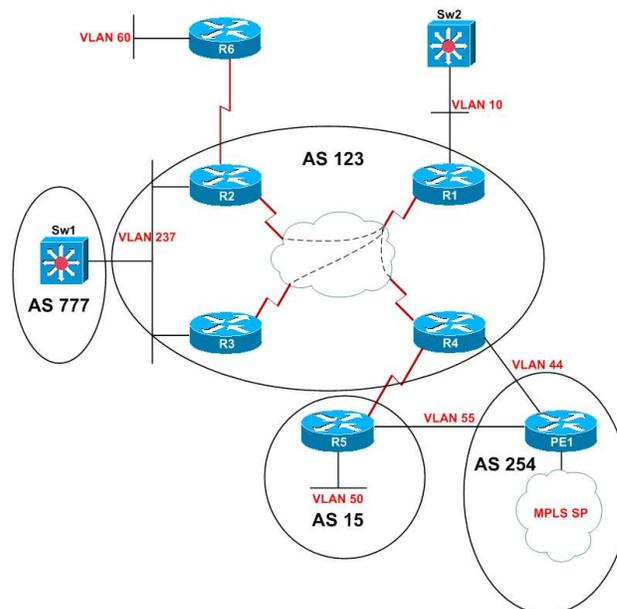
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## Practice Lab: Sample topology



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## Sample Lab Question – BGP

### ▪ EBGP

#### AS 777

- Configure BGP AS 777 on SW1
- Configure SW1 to peer with R2 and R3 in AS 123.

#### AS 15

- Configure BGP AS 15 on R5.
- Configure R5 to peer with R4 in AS 123
- Advertise the loopback0 interface on R5 via BGP.
- Ensure that network 99.99.99.0/24 is in the BGP and routing tables of SW1 and R5

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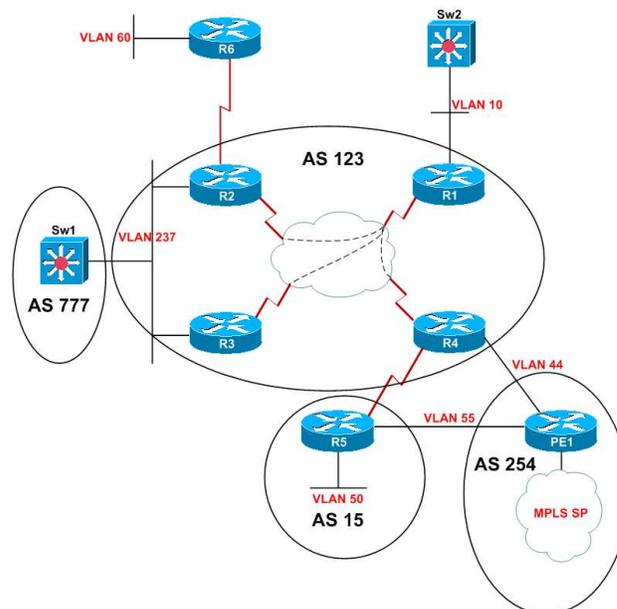
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## Practice Lab: Sample topology



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## Sample Lab Question – BGP

### ▪ BGP Policy

- The administrator of AS 123 wants to influence how traffic from AS 777 enters the network for certain prefixes.
- Configure R2 such that the 99.99.99.0/24 prefix advertised to AS 777 has the AS path ^123 123 123\$.
- Ensure that available and best paths for other prefixes are not affected by this policy.

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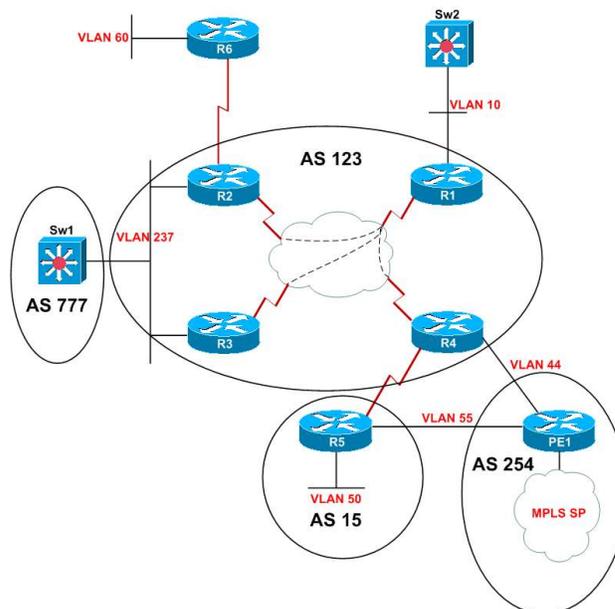
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## Practice Lab: Sample topology



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## Sample Lab Question – BGP

- **Hints, requirements and constraints in the stem:**

- Configure R2 such that the 99.99.99.0/24 prefix advertised to AS 777 has the AS path ^123 123 123\$.
- Ensure that **available and best paths for other prefixes are not affected** by this policy.

!! Watch out for “hidden bombs” !!

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## Sample Lab Question – BGP

- **Solution seems easy...**

```
access-list 100 permit ip 99.99.99.0 0.0.0.255 any
!
route-map BGP_policy permit 10
 match ip address 100
 set as-path prepend 123 123
route-map BGP_policy permit 20
!
router bgp 123
 neighbor 172.16.237.7 route-map BGP_policy out
end
clear ip bgp *
```

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## Sample Lab Question – BGP

- **Before the policy is applied:**

- SW1 points both prefixes to R2 (lowest router-id):

```
SW1#sh ip bgp
BGP table version is 21, local router ID is 77.77.77.77
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network        Next Hop        Metric LocPrf Weight Path
* 5.5.5.5/32      172.16.237.3          0 123 15 i
*>                172.16.237.2          0 123 15 i
* 99.99.99.0/24   172.16.237.3          0 123 i
*>                172.16.237.2          0 123 i
SW1#
```

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## Sample Lab Question – BGP

- **After the policy is applied:**

- SW1 **MUST** point 99.99.99.0 to R3 and 5.5.5.5 to R2!

```
SW1#sh ip bgp
BGP table version is 30, local router ID is 77.77.77.77
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network        Next Hop        Metric LocPrf Weight Path
* 5.5.5.5/32      172.16.237.3          0 123 15 i
*>                172.16.237.2          0 123 15 i
*> 99.99.99.0/24  172.16.237.3          0 123 i
*                 172.16.237.2          0 123 123 123 i
SW1#
```

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## Sample Lab Question – BGP

- **If R2 BGP is hard cleared (clear ip bgp \*):**
  - **SW1 WILL point 5.5.5.5 to R3 as the path is the oldest!**

```
SW1#sh ip bgp
BGP table version is 31, local router ID is 77.77.77.77
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
```

Network	Next Hop	Metric	LocPrf	Weight	Path
* 5.5.5.5/32	172.16.237.2		0	123	15 i
*>	172.16.237.3		0	123	15 i
* 99.99.99.0/24	172.16.237.2		0	123	123 123 i
*>	172.16.237.3		0	123	i

SW1#

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## Sample Lab Question – BGP

- **Solution:**
  1. **ANTICIPATE THE EXPECTED EFFECT OF YOUR SOLUTION**
  2. Configure R2
  3. Clear BGP Soft out on R2!
  4. **Verify resulting state!**

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## Sample Lab Question – BGP

- **Verification steps:**

1. Check best path on SW1's BGP table
2. Check R2 and R3 for expected config

```
R3#sh ip bgp nei 172.16.237.7 | i outgoing
R3#
R2#sh ip bgp nei 172.16.237.7 | i outgoing
Route map for outgoing advertisements is BGP_policy
R2#sh route-map BGP_policy
route-map BGP_policy, permit, sequence 10
Match clauses:
ip address (access-lists): 100
Set clauses:
as-path prepend 123 123
Policy routing matches: 0 packets, 0 bytes
route-map BGP_policy, permit, sequence 20
Match clauses:
Set clauses:
Policy routing matches: 0 packets, 0 bytes
R2#
```

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## Sample Lab Question – BGP

- **Frequently missed points:**

- Requirement missed (ex. Prefix not affected by policy)
- Password not in use (session not cleared after config)
- Constraints not respected
- Main guidelines not respected

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## References

- CiscoPress®
  - Internet Routing Architectures, Bassam Halabi
  - Cisco BGP-4 Command and Configuration Handbook, William Parkhurst
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## Multicast topics

- Multicast Forwarding
  - RPF
  - Shared Tree
  - Source Tree
  - IGMP
- Protocol Independent Multicast (PIM)
  - Messages
  - Dense Mode
  - Sparse Mode

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## Sample Lab Question – Multicast

- Auto RP
  - Configure PIM Sparse-mode on R1, R2, R3, SW1.
  - Multicast servers are located on VLAN 10.
  - Multicast receivers are located on VLAN 237.
  - Use auto RP and define loopback0 on R3 as the rendezvous point (RP) for all multicast groups.
  - Configure the VLAN10 interface on SW1 to join IGMP group 227.1.1.1
  - Ensure you can ping the group address from all PIM routers and VLAN 10.

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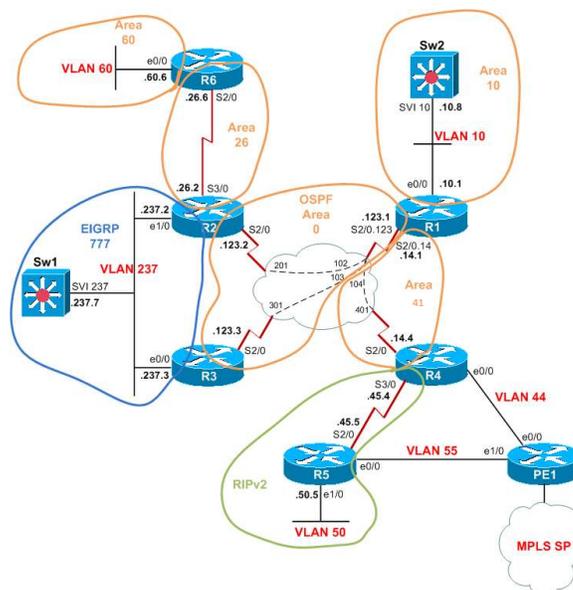
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## Practice Lab: Sample topology



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## Sample Lab Question – Multicast

- **Hints, requirements and constraints in the stem:**
  - Configure **PIM Sparse-mode** on R1, R2, R3, SW1.
  - Multicast servers are located on VLAN 10, receivers are located on VLAN 237.
  - Use **auto RP** and define loopback0 on R3 as the **rendezvous point (RP)** for all multicast groups.
- PIM Sparse-mode and Auto RP are 'exclusive'...

```
ip multicast-routing
(R3)ip pim send-rp-announce Loopback0 scope 16
(Any)ip pim send-rp-discovery Loopback0 scope 16
ip pim autorp listener
interface X/Y
ip pim sparse-mode
(Sw1)ip igmp join-group 227.1.1.1
```

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## Sample Lab Question – Multicast

- **Verification steps:**

1. Check if R1 can ping the group

```
R1#ping 227.1.1.1 source 172.16.10.1
```

```
Type escape sequence to abort.
Sending 1, 100-byte ICMP Echos to 227.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.10.1
```

```
Reply to request 0 from 172.16.237.7, 52 ms
R1#
```

1. Check if R3 is the RP for all groups

```
SW1#sh ip pim rp map | i Group|Auto-RP
PIM Group-to-RP Mappings
Group(s) 224.0.0.0/4
Info source: 3.3.3.3 (?), elected via Auto-RP
SW1#
```

2. Check if Sw1 has joined the group

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## Sample Lab Question – Multicast

- **Frequently missed points:**

Requirement missing

RPF Failure

Constraints not respected

Main guidelines not respected

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- CiscoPress®
  - Developing IP Multicast Networks, Beau Williamson
  - Routing TCP/IP Volume II, Jeff Doyle
- <ftp://ftpeng.cisco.com/ipmulticast/training/index.html>
- CCO Documentation

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2.4	Multicast Routing
2.5	<b>MPLS-VPN</b>
Part 3	Advanced Services
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Part 5	Troubleshooting

## MPLS/VPN topics

- Network devices
  - P (Provider) routers
  - PE (Provider Edge) routers
  - CE (Customer Edge) routers
- Protocols
  - IGP: core routing protocols: OSPF, EIGRP
  - Label Distribution Protocol (LDP)
- MPLS labels
  - Forwarding Equivalence Class (FEC)
  - MPLS label encapsulation
  - MPLS label stacking

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## MPLS/VPN topics

- MPLS planes
  - MPLS control planes
  - MPLS forwarding planes
- Layer 3 VPNs
  - VRFs
  - Route Distinguishers
  - Route Targets
  - Multiprotocol BGP
  - PE-CE routing protocols: eBGP, OSPF, EIGRP, RIPv2

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## Sample Lab Question – MPLS/VPN

Configure the Provider Edge (PE) router and R4/R5 to connect to the MPLS network and receive VPN routes from the service provider (SP) network.

- LDP
  - Configure MPLS label switching on the PE router interface E2/0 and verify an LDP session is established into the SP core.
- Multi-protocol BGP
  - Configure multi-protocol BGP on the PE router to support MPLS Layer 3 VPNs.
  - The service provider is in AS 254 as is the PE router.
  - Peer with address 11.11.11.11
  - Peering source must be loopback 0

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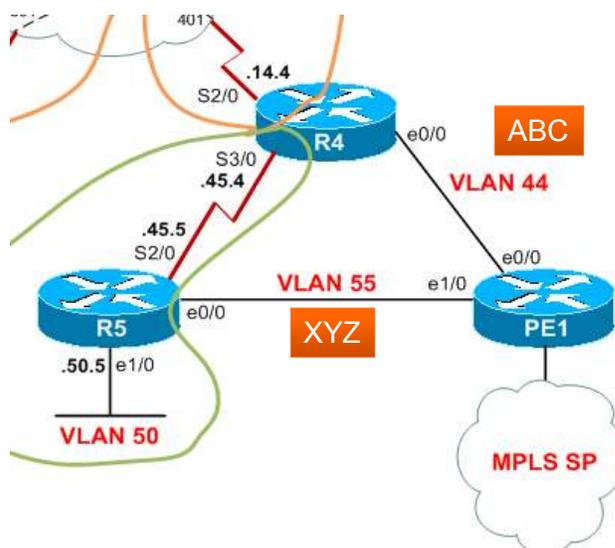
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## Practice Lab: Sample topology

Focus on the PE-CE and MPLS



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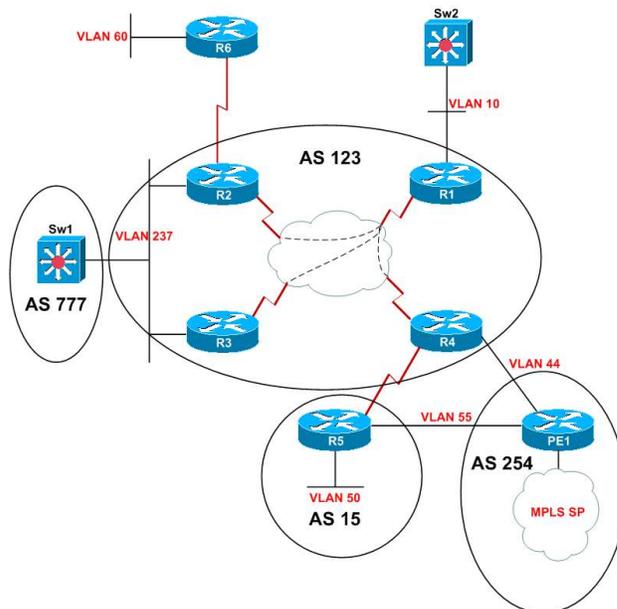
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## Practice Lab: Sample topology



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## Sample Lab Question – MPLS/VPN

- MPLS Layer 3 VPN
  - Configure two VRFs on the PE router with the following parameters:
  - Create VRF ABC and import routes with the RD 5.125.16.1:254 into the VPN
  - Create VRF XYZ and import routes with the RD 254:254 into the VPN.
  - To ensure end-to-end connectivity export using the same route-targets listed above.

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## Sample Lab Question – MPLS/VPN

- What route-target correspond to each RD ?

```

PE#sh ip bgp vpnv4 rd 5.125.16.1:254
BGP table version is 15, local router ID is 9.9.9.9
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network        Next Hop        Metric LocPrf Weight Path
Route Distinguisher: 5.125.16.1:254 (default for vrf ABC)
*> 5.5.5.5/32     192.168.4.1          0 123 15 i
*i>5.125.16.0/24  11.11.11.11          0 100  0 i
*> 99.99.99.0/24  192.168.4.1          0   0 123 i
r> 192.168.4.0    192.168.4.1          0   0 123 i
*> 192.168.5.0    192.168.4.1          0 123 15 i
PE#
PE#sh ip bgp vpnv4 vrf ABC 5.125.16.0 | i RT
Extended Community: RT:5.125.16.1:253
PE#

```

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## Sample Lab Question – MPLS/VPN

- Configure RT import/export for both VRF:

```

ip vrf ABC
rd 5.125.16.1:254
route-target export 5.125.16.1:253
route-target import 5.125.16.1:253
ip vrf XYZ
rd 254:254
route-target export 253:253
route-target import 253:253

```

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## Sample Lab Question – MPLS/VPN

- Provider Edge to Customer Edge
  - Advertise the VPN prefixes to R4 and R5 as follows:
  - Insert the link between PE and R4 into the ABC VPN and advertise the ABC VPN routes to R4 via eBGP
  - Insert the link between PE and R5 into the XYZ VPN and advertise the XYZ routes to R5 via eBGP.
  - Configure PE so that VPN routes do not leak between AS 15 and AS 123, hence the backdoor link between R4 and R5 does not carry traffic reached through the MPLS cloud.

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## Sample Lab Question – MPLS/VPN

- **Hints, requirements and constraints in the stem:**
  - LDP
  - MP-BGP
  - MPLS L3VPN
- Not much tricks here...
- CEF is required but IOS reminds it when configuring VRF:  
  
% Enable CEF globally before configuring VRF on any interface

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## Sample Lab Question – MPLS/VPN

- Hints, requirements and constraints in the stem:
  - PE-CE:
  - **Configure PE** so that VPN routes do **not leak** between AS 15 and AS 123
- If nothing is done: ZYX routes are seen in R4 and vice versa!

```
R4#sh ip ro 10.125.16.0
Routing entry for 10.125.16.0/24
Known via "bgp 123", distance 20, metric 0
Tag 15, type external
Last update from 172.16.45.5 00:46:04 ago
Routing Descriptor Blocks:
* 172.16.45.5, from 172.16.45.5, 00:46:04 ago
  Route metric is 0, traffic share count is 1
  AS Hops 2
  Route tag 15
```

R4#

```
R5#sh ip ro 10.125.16.0
Routing entry for 10.125.16.0/24
Known via "bgp 15", distance 20, metric 0
Tag 254, type external
Last update from 192.168.5.254 00:43:53 ago
Routing Descriptor Blocks:
* 192.168.5.254, from 192.168.5.254, 00:43:53 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
  Route tag 254
```

R5#

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## Sample Lab Question – MPLS/VPN

- If nothing is done: ZYX routes are seen in R4 and vice versa!

```
R4#sh ip bgp
BGP table version is 13, local router ID is 99.99.99.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
```

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 5.5.5.5/32	172.16.45.5	0	0	15	i
*> 5.125.16.0/24	192.168.4.254			254	i
*> 10.125.16.0/24	172.16.45.5			15 254	i <<<<<
*> 99.99.99.0/24	0.0.0.0	0	32768		i
*> 192.168.4.0	0.0.0.0	0	32768		i
*> 192.168.5.0	172.16.45.5	0	0	15	i

R4#

R4#

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## Sample Lab Question – MPLS/VPN

- Configure PE to prevent eBGP routes to be propagated between AS15 and AS123
- Set community no-export on PE!

```
route-map noexport permit 10
set community no-export
!
router bgp 254
address-family ipv4 vrf XYZ
neighbor 192.168.5.1 route-map noexport out
!
address-family ipv4 vrf ABC
neighbor 192.168.4.1 route-map noexport out
```

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## Sample Lab Question – MPLS/VPN

- Verification steps:**

Check if **legitimate** VPN routes are seen in R4

```
R4#sh ip bgp 5.125.16.0
BGP routing table entry for 5.125.16.0/24, version 16
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised to EBGp peer)
Advertised to update-groups:
 2
254
192.168.4.254 from 192.168.4.254 (9.9.9.9)
Origin IGP, localpref 100, valid, external, best
Community: no-export
R4#
```

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## Sample Lab Question – MPLS/VPN

- **Verification steps:**

Check if **legitimate** VPN routes are seen in R5

```
R5#sh ip bgp 10.125.16.0
BGP routing table entry for 10.125.16.0/24, version 16
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised to EBGp peer)
Not advertised to any peer
254
 192.168.5.254 from 192.168.5.254 (9.9.9.9)
   Origin IGP, localpref 100, valid, external, best
   Community: no-export
R5#
```

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## Sample Lab Question – MPLS/VPN

- **Verification steps:**

Check if **non-legitimate** VPN routes are **not** seen

```
R4#sh ip ro 10.125.16.0
% Network not in table
R4#
R4#sh ip bgp 10.125.16.0
% Network not in table
R4#
```

```
R5#sh ip ro 5.125.16.0
% Subnet not in table
R5#
R5#sh ip bgp 5.125.16.0
% Network not in table
R5#
```

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## Sample Lab Question – MPLS/VPN

- **Frequently missed points:**

- Implicit/hidden requirement missed (ex. Shamlink)

- Constraints not respected

- Main guidelines not respected

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- MPLS and VPN Architectures – Jim Guichard, Ivan Pepelnjak

- Traffic Engineering with MPLS – Eric Osborne, Ajay Simha

- Layer 2 VPN Architectures – Wei Luo, Carlos Pignataro, Dmitry Bokotey, Anthony Chan

- MPLS QoS – Santiago Alvarez

- MPLS Fundamentals – Luc Deghein

- CCO Documentation:

- [http://www.cisco.com/en/US/products/ps6557/products\\_ios\\_technology\\_home.html](http://www.cisco.com/en/US/products/ps6557/products_ios_technology_home.html)

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## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing
Part 3	Advanced Services:
3.1	Quality of Services
3.2	Security
3.3	Services
Part 4	Optimisation
Part 5	Troubleshooting

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## Quality of Service topics

- QoS Models
  - Diffserv
  - Intserv/RSVP
- QoS Operations
  - Classification/Marking
  - Queuing
  - Policing/Shaping
- Cisco Implementation
  - Modular QoS Command Line (MQC)
  - Catalyst Switch Specifics

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## Sample Lab Question – Quality of Service

### ▪ Congestion Avoidance

- Configure the E0/0 interface on R7 for congestion avoidance.
- Ensure R7 will drop TCP packets prior to periods of congestion.
- Do not use the modular CLI.
- Change the minimum queue depth for all IP precedence values to 100.
- Change the maximum queue depth for all IP precedence values to 250.
- Use the command show queuing to verify your solution

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## Sample Lab Question – Quality of Service

### ▪ Frequently missed points:

- Policy configured but not applied or wrongly applied
- Requirement missing
- Prefix not reachable
- Constraints not respected
- Main guidelines not respected

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## References

- CiscoPress®  
End-to-End QoS Network Design Quality of Service in LANs, WANs, and VPNs, by Tim Szigeti, Christina Hattingh
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IOS 12.4  
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Catalyst 3560  
[http://www.cisco.com/en/US/products/hw/switches/ps5528/tsd\\_products\\_support\\_series\\_home.html](http://www.cisco.com/en/US/products/hw/switches/ps5528/tsd_products_support_series_home.html)

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## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing
Part 3	Advanced Services:
3.1	Quality of Services
3.2	<b>Security</b>
3.3	Services
Part 4	Optimisation
Part 5	Troubleshooting

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## Network Security topics

- Access-Control List (ACL)
- Unicast Reverse Path Forwarding (uRPF)
- IP Source Guard
- Authentication, Authorization, and Accounting (AAA)
- Control Plane Policing (CoPP)
- Context-Based Access Control (CBAC)
- Zone Based Firewall

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## Network Security topics

- Cisco IOS Intrusion Prevention System (IPS)
- Secure Shell (SSH)
- 802.1x
- Routing Protocol Authentication
- LAN Switching security
  - VLAN Access map
  - Private VLAN
  - DAI
  - DHCP snooping

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## Sample Lab Question – Network Security

### ▪ Access-list

- Configure an out-going access list on the S2/0.123 interface of R1 such that:
- Mail servers on VLAN 237 cannot connect to mail servers on VLAN 10 (SMTP) but mail servers on VLAN 10 can connect to mail servers on VLAN 237
- Restrict UDP traffic from VLAN 10 such that only hosts using source ports in the range 6000 to 7000 (inclusive) can reach hosts on VLAN 237.
- Prevent SW1 from successfully pinging the R4's loopback0 interface. R4 should be able to ping SW1.

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## References

### ▪ CiscoPress®

Network Security Technologies and Solutions, Bhajji

CCO Documentation:

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[http://www.cisco.com/en/US/docs/ios/wan/configuration/guide/wan\\_cfg\\_fm\\_rly\\_ps644\\_1\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/wan/configuration/guide/wan_cfg_fm_rly_ps644_1_TSD_Products_Configuration_Guide_Chapter.html)

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## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing
Part 3	Advanced Services:
3.1	Quality of Services
3.2	Security
3.3	Services
Part 4	Optimisation
Part 5	Troubleshooting

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## Network services topics

- Services
  - HSRP
  - GLBP
  - VRRP
  - NTP
  - DHCP
  - WCCP

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## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing
Part 3	Advanced Services
Part 4	Optimization
Part 5	Troubleshooting

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## Network optimisation topics

- Network management
  - SNMP
  - EEM
  - (T)FTP, SCP, HTTP(S), Telnet
- Network monitoring
  - Syslog and logging
  - Netflow
  - (R)SPAN
  - IPSLA
  - RMON

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## Section 3: Study plan: Content topics

Part 1	Switching
Part 2	Routing
Part 3	Advanced Services
Part 4	Optimisation
Part 5	Troubleshooting

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## Network Troubleshooting topics

- Layer 2 network issues
- Layer 3 network issues
- Application response issues
- Network services issues
- Network security issues

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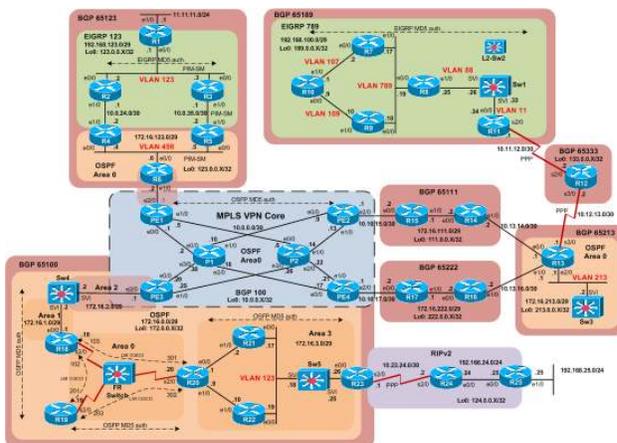
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## Sample Lab Question – Troubleshooting

- TS Exam Topology

See TS Case studies

Large network, allowing numerous independent incidents



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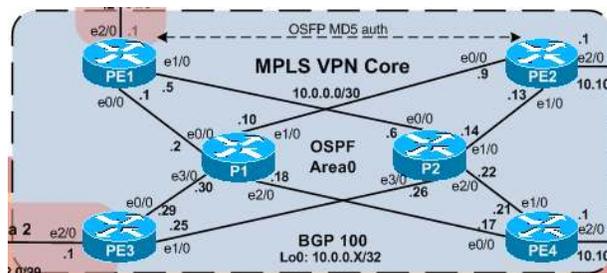


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## Sample Lab Question – Troubleshooting

- Per-question Topology

Mini-diagram showing the scope of the incident



Speeds up finding where to look at in the larger picture

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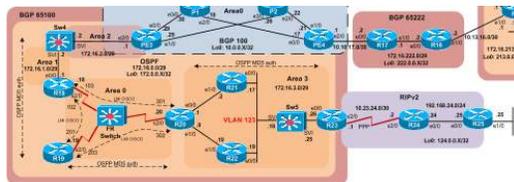
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## Sample Lab Question – Troubleshooting

- Incident 3:



R20 can't use Telnet to connect to R25.

Fix the issue so that the following telnet connection establishes:

```
R20#telnet 10.1.1.25 /source-int lo0
```

While resolving the issue, you are not allowed to create any new interfaces.

Refer to the troubleshooting guidelines to determine if your solution is appropriate

Make sure to disconnect the telnet session after verification.

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## Sample Lab Question – Troubleshooting

- Symptom based question wording**

R20 can't use Telnet to connect to R29.

See TS Case studies

- Explicit validation test**

Fix the issue so that the following telnet connection establishes:

```
R20#telnet 10.1.1.29 /source-int lo0
```

- Optional constraints**

While resolving the issue, you are not allowed to create any new interfaces.

- Pointer to the general guidelines**

Refer to the troubleshooting guidelines...

Make sure to disconnect the telnet session after verification.

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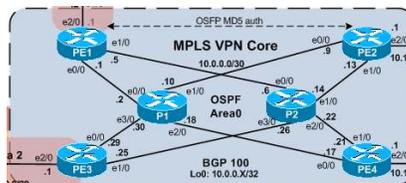
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## Sample Lab question - Troubleshooting

- Incident 1:



- PE1 is the NTP master for the whole MPLS VPN Core.
- Make sure that all devices are synchronized and authenticating the server.

```
<any MPLS router>#sh ntp assoc det | i auth
10.0.0.111 configured, authenticated, our_master, sane, valid, stratum 1
<any MPLS router>#
```

- Use "CCIE" as the MD5 authentication key (without quotes)
- Refer to the Troubleshooting guidelines to determine if your solution is appropriate.

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## Sample Lab Question – Troubleshooting

### REMINDERS

- Mostly real life issues presented with unrealistic conditions & constraints:
  - Cf. Additional constraints
- Some inserted faults are not very realistic but are designed to assess specific topics
- Report any issue to the proctor DURING the TS section! (impossible to grant extra time after its over!)

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Know what you don't know



## Section 3: Study plan: Content topics

Section 1	CCIE Program Overview
Section 2	CCIE Routing and Switching Version 4
Section 3	Study plan: Content topics review and Sample questions
Section 4	<b>Study plan: Preparation materials</b>
Section 5	Lab Exam: Tips and tricks
Section 6	Troubleshooting Case Studies
Section 7	Conclusion

## Study plan: Preparation materials

- Cisco 360 Learning Program for CCIE R&S
- Written exam
- Lab exam
- Troubleshooting

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## Written Exam Preparation

- Study the [CCIE R&S Written Exam Topics](#) posted on the Cisco Learning Network (CLN). Some topics-such as 'planning and evaluating network changes-will only appear on the written exam.
- Reading list is only suggested.
- Refer to online resources and Cisco documentation.

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## Written Exam Preparation

- Use Cisco 360 Learning Program or other training courses to fill holes in your knowledge.
- Written Exam stresses procedures and concepts more than configuration skills.

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## Lab Exam Preparation, General

- Study the [CCIE R&S Lab Exam Topics](#) posted on the Cisco Learning Network (CLN).
- Evaluate your skills against the exam requirements.
- For areas of strength—review and practice for speed. **Speed** and **accuracy** is vital on exam.
- For weaker areas—increase knowledge with training or books first, then practice with equipment.

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## Lab Exam Preparation, General

### LEARN

- READ
- UNDERSTAND
- REMEMBER

### PRACTICE

- BASIC SCENARIO
- INCREASE DIFFICULTY

### PRACTICE

- EXPLORE
- OBSERVE
- INVENT

### TROUBLESHOOT

- VERIFY
- ANTICIPATE
- VALIDATE

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## Troubleshooting Preparation

- Have a solid foundation knowledge first
- Build your own strategy
- Work with experienced peers
- Have them break an unknown topology for you to fix
- Practice for speed !!! Crucial for TS!

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## Section 3: Study plan: Content topics

Section 1	CCIE Program Overview
Section 2	CCIE Routing and Switching Version 4
Section 3	Study plan: Content topics review and Sample questions
Section 4	Study plan: Preparation materials
Section 5	Lab Exam: Tips and tricks
Section 6	Troubleshooting Case Studies
Section 7	Conclusion

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## Lab Exam: D-Day Tips and Tricks

- Build your exam strategy...



...and stick to it!

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## Lab Exam: D-Day Tips and Tricks

- **Just before the exam:**
  - Reduce stress - arrive early (depends on lab location)
  - Sleep & eat well!
  - Listen to the proctor's briefing (avoid lose time later on)

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## Lab Exam: D-Day Tips and Tricks

- **When starting exam's section (TS then CFG):**

Carefully read the section **guidelines!!!**

Quickly **read ALL questions** to get an overview of the exam!

Prepare a **checklist** on the scratch paper

**Manage your time**

Cherry pick questions on which you can gain time

Go back to more challenging questions later on

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## Lab Exam: D-Day Tips and Tricks

- Read the guidelines
- Read the entire exam before starting
- Make no assumptions
- Don't get stuck...
- Work questions as a unit
- Minimize last-minute changes

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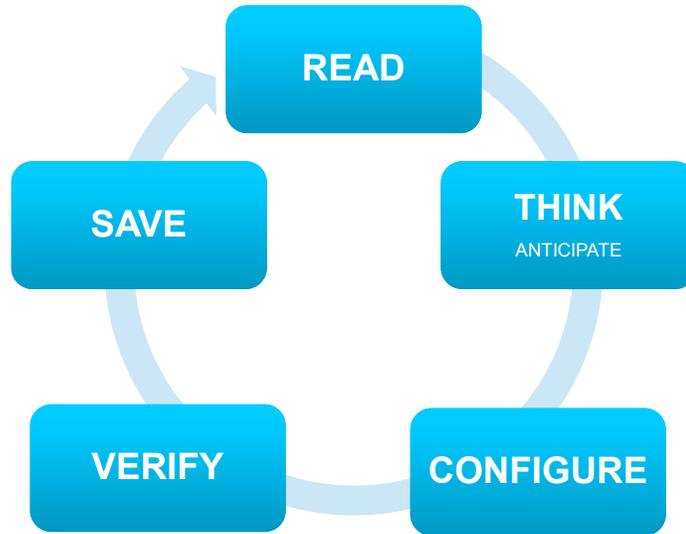
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## Lab Exam: Tips and Tricks



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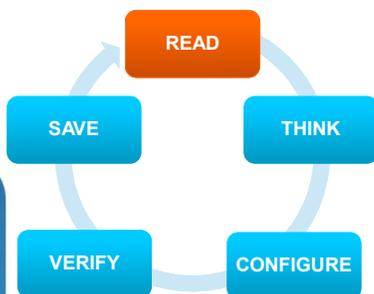
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## Lab Exam: Tips and Tricks



- **READ** the *guidelines!*
- **READ** the *whole exam* before starting anything!
- **READ** the *question carefully*
- **RE-READ** the question
- **ASK** the proctor for clarifications if needed

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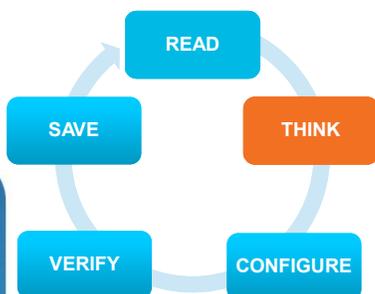
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## Lab Exam: Tips and Tricks



- **ANTICIPATE** the **expected result**
- **THINK** about the possible **solutions**
- **THINK** about **potential impact** on previous questions

**Note:** most of the time, multiple solutions are accepted, chose any

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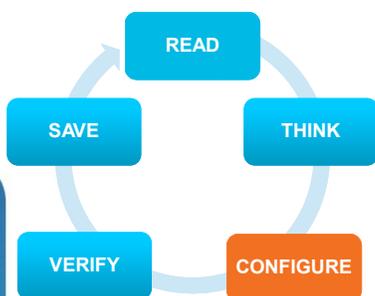
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## Lab Exam: Tips and Tricks



- **Speed up** configuration time
- Use NOTEPAD to build your configurations (copy/paste)
- Use CLI shortcuts and aliases
- Don't lose time with useless additional configuration
- Organize your terminal windows!

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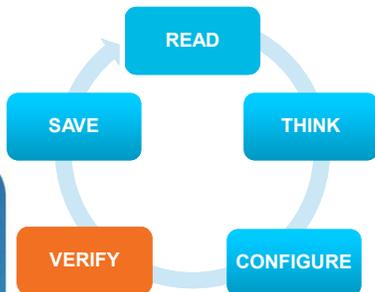
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## Lab Exam: Tips and Tricks



- **VERIFY** the effects of your configuration with 'show' commands! (not just 'sh run')!
- **VERIFY** effects on previous questions!
- Use **DEBUG** when appropriate
- Enable console logging!

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## Lab Exam: Tips and Tricks



- **SAVE** your configurations at **every** changes!

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## Lab Exam: Tips and Tricks

- Don't lose too much time on 1 or 2 points questions
  - Move ahead with topics you are more comfortable with
  - Avoid last minute changes that could break other things (Ex. ACL, ZBF, ...)
  - Better use a prohibited solution and lose one question rather than losing ALL dependent questions (Ex. PPPoE...)

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## Lab Exam: Tips and Tricks

- Beware of **rumors**
- Visit the Cisco Learning Network for more on CCIE R&S certification and interaction with other candidates
  - [www.cisco.com/go/learningnetwork](http://www.cisco.com/go/learningnetwork)
- Contact support:
  - [www.cisco.com/go/certsupport](http://www.cisco.com/go/certsupport)
- Report cheating:
  - [ccie-nda-enforcement@cisco.com](mailto:ccie-nda-enforcement@cisco.com)

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## Lab Exam: Tips and Tricks

- Proctor's first role is to keep exam **fair** and consistent!
- Proctors **do not trick** your rack behind your back!



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## Lab Exam: Tips and Tricks

- Ask the proctor if clarifications are required:  
Don't ask or fish for answers!  
Ask good questions:  
Ex: Ask advises on options based on functional differences!  
(Show understanding, not just CLI)

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## Lab Exam: Tips and Tricks

- Report any equipment or technical problems to proctor

**As soon as it occurs** but expect he will ask for evidences

Useless to report/complain after the exam

(no extra time possible)

Ex: Console excessively slow or inexistent, Device crash, ...

(very rare)

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## Section 3: Study plan: Content topics

Section 1	CCIE Program Overview
Section 2	CCIE Routing and Switching Version 4
Section 3	Study plan: Content topics review and Sample questions
Section 4	Study plan: Preparation materials
Section 5	Lab Exam: Tips and tricks
Section 6	Troubleshooting Case Studies
Section 7	Conclusion

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## Troubleshooting Case Studies



- Big topology allows for **independent** incidents  
Incident X+1 should not depend on Incident X's resolution!
- By nature, **timing** is part of the troubleshooting
- Reminders:  
IOU + L2IOU  
Guidelines!

DO NOT UNCONFIGURE, FIX IT!



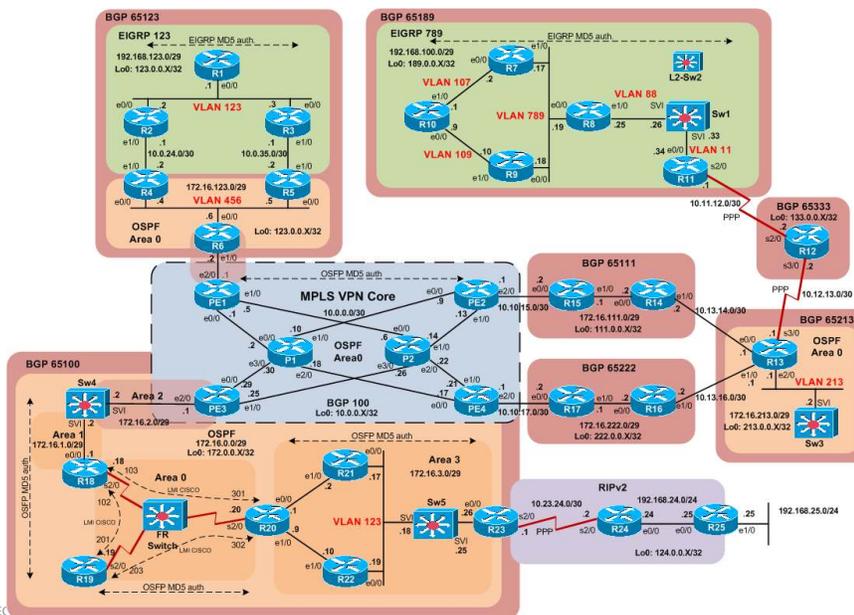
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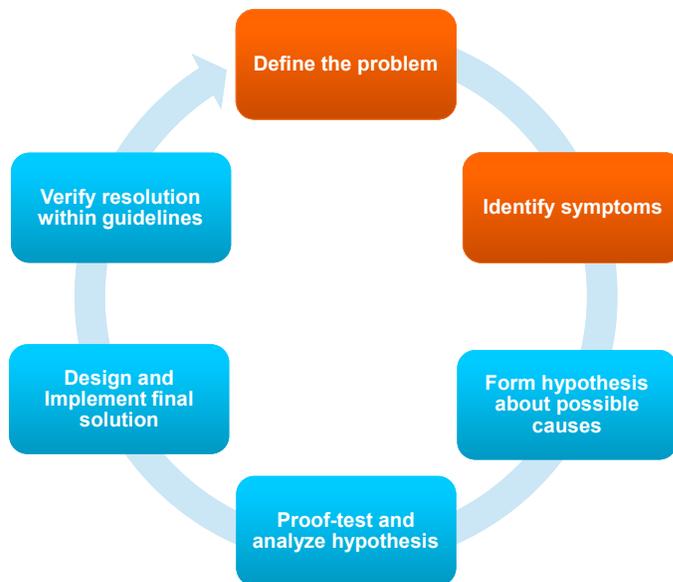
## Troubleshooting Case Studies



TEC

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## Troubleshooting Approach



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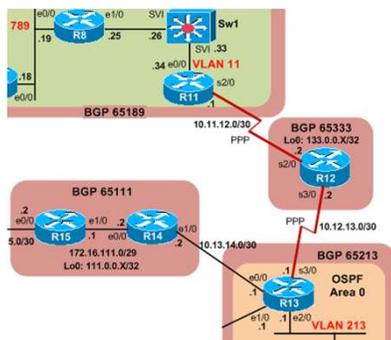
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## Incident#1

Lets start with an easy one ☺



- R15 is not able to use Telnet to connect to R11's loopback0.
- Fix the problem so that the following Telnet establishes:

```
R15#telnet 189.0.0.11 /so lo0
Trying 189.0.0.11 ... Open
```

User Access Verification

```
Password:
R11>
```

- While resolving this issue, you are not allowed to create any new interfaces anywhere.

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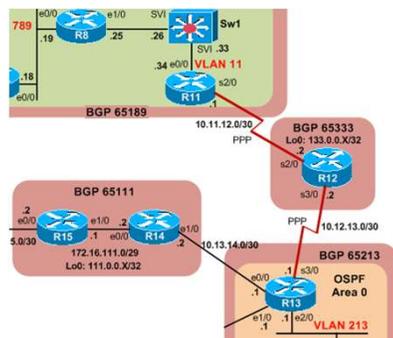
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## Incident#1: Form hypothesis



- What is needed for a prefix to be advertised with the network command ?

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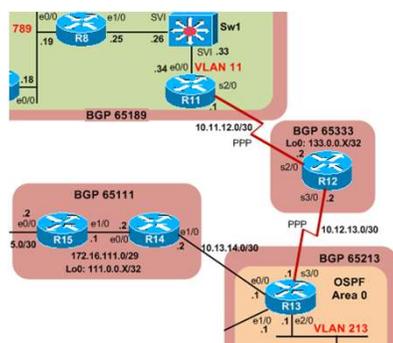
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## Incident#1: Proof-test and Analyze hypothesis



- Correct the mask statement to match the interface's mask...

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## Incident#1: Verify resolution within guidelines

- Check the required Telnet:

```
R15#telnet 189.0.0.11
Trying 189.0.0.11 ... Open
```

```
User Access Verification
```

```
Password:
R11>
```

- Check if initial BGP configuration is still there:

```
R15#sh ip bgp 189.0.0.11
BGP routing table entry for 189.0.0.0/24, version 202
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    2
65213 65333 65189, (aggregated by 65189 189.0.0.11)
  10.13.14.1 (metric 20) from 111.0.0.14 (111.0.0.14)
  Origin IGP, metric 0, localpref 100, valid, internal, atomic-aggregate, best
R15#
```

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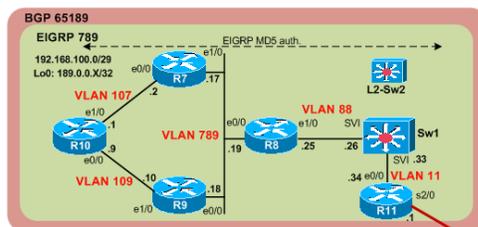
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## Incident#2



- R11 is not able to use Telnet to connect to R8's loopback0.
- Fix the problem so that the following Telnet establishes:

```
R11#telnet 189.0.0.8
Trying 189.0.0.8 ... Open
```

```
User Access Verification
```

```
Password:
R8>
```

- While resolving this issue, you are not allowed to create any new interfaces anywhere.

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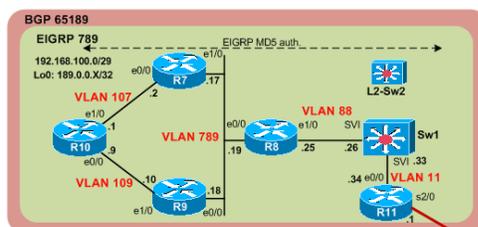
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## Incident#2: Define the problem



- Can R11 ping R8's e1/0? Sw1's SVI 11? Sw1's SVI 88?
- Can Sw1 ping R8's lo0? e1/0?
- Can R7 or R9 ping R8's lo0?

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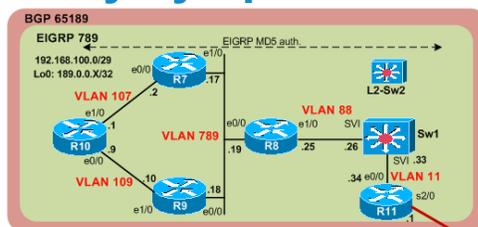
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## Incident#2: Identify symptoms



- Are routes present in R11 for VLAN 88 and vice versa?
- Are EIGRP neighborships established?
- Does ARP resolve in VLAN 11 and 88?
- Are interfaces operational?

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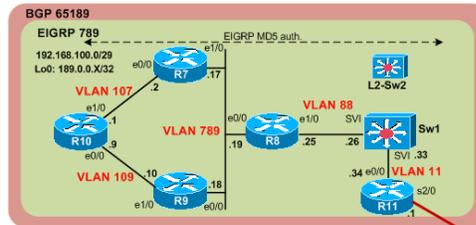
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## Incident#2: Form hypothesis



- What can cause interface down/down ?

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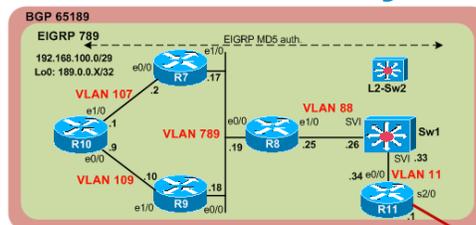
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## Incident#2: Proof-test and Analyze hypothesis



- Hardware or cabling issue?
- Mis-configuration?
- Underlying protocol? (Dot1q, VTP, DTP, STP)

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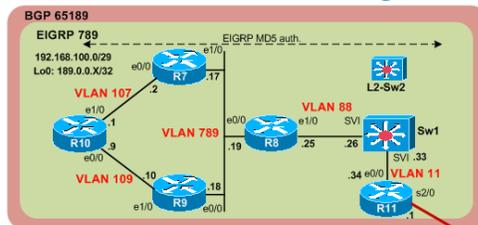
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## Incident#2: Proof-test and Analyze hypothesis



- Underlying protocols:
  - Check VLAN configuration
  - Check Trunk sanity
  - Check STP state

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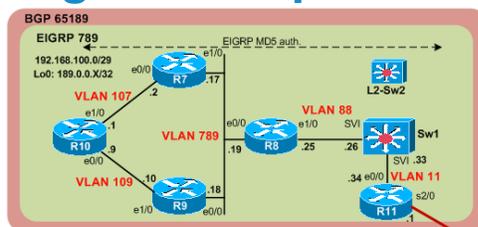
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## Incident#2: Design and Implement solution



- Force Sw1.e2/1 to become root port for MST#2
  - or
- Allow VLAN on trunk

Both valid solutions... pick one ☺

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## Incident#2: Verify resolution within guidelines

- Check the required Telnet:

```
R11#telnet 189.0.0.8
Trying 189.0.0.8 ... Open
```

User Access Verification

```
Password:
R8>
```

Check if initial MST configuration is still there:

```
SW1#sh span mst 1 | i MST|Root
##### MST1   vlans mapped: 1,11,107
Root          this switch for MST1
SW1#
```

```
L2-SW2#sh span mst 2 | i MST|Root
##### MST2   vlans mapped: 88,109,789
Root          this switch for MST2
L2-SW2#
```

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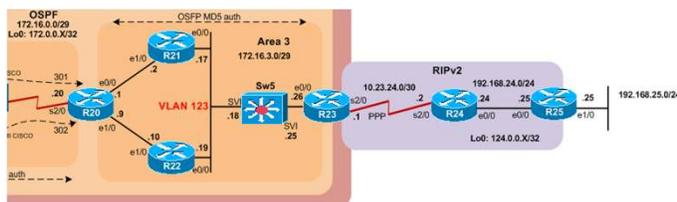
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## Incident#3



- R20 is not able to use Telnet to connect to R25's loopback0.
- Fix the problem so that the following Telnet and Traceroute establish:

```
R20#telnet 124.0.0.25 /source lo0
Trying 124.0.0.25 ... Open
```

User Access Verification

```
Password:
R25>
```

```
R20#traceroute 124.0.0.25
```

```
Type escape sequence to abort.
Tracing the route to 124.0.0.25
```

```
 1 172.16.3.10 0 msec
 2 172.16.3.18 0 msec 0 msec 4 msec
 3 172.16.3.26 0 msec 4 msec 0 msec
 4 10.23.24.2 16 msec 20 msec 20 msec
 5 192.168.24.25 20 msec * 20 msec
R20#
```

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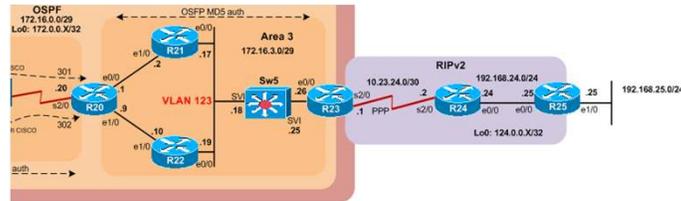
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## Incident#3: Define the problem



- Can R20 ping R25's e0/0? R23's s2/0?
- Can R23 ping R25's lo0? R25's e0/0?
- Can R21 ping R25's lo0? R25's e0/0?

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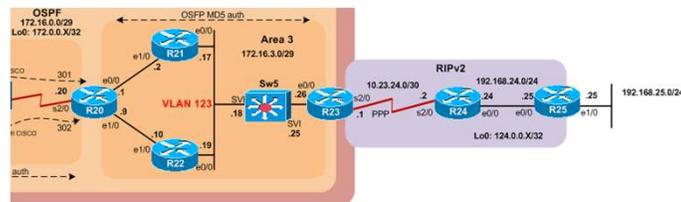
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## Incident#3: Identify symptoms



- Are RIP routes present in R20?
- Are OSPF routes present in R25?
- Are RIP routes seen anywhere in OSPF domain?

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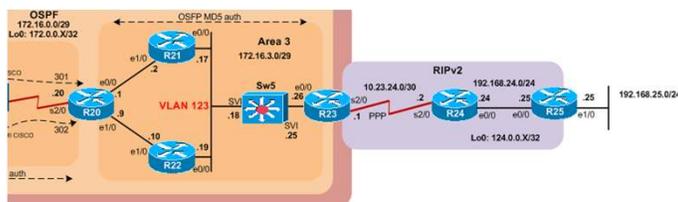
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## Incident#3: Form hypothesis



- What can cause a prefix to be stuck in OSPF DB?

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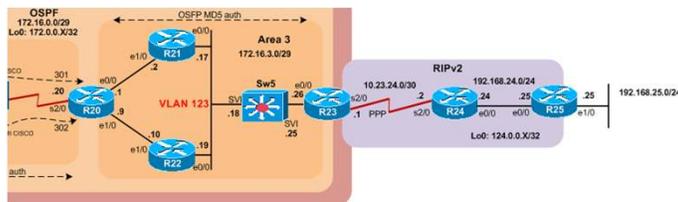
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## Incident#3: Proof-test and Analyze hypothesis



- Is FA set for the Type5 LSA ?
- How is the FA seen by OSPF ?
- Why ?

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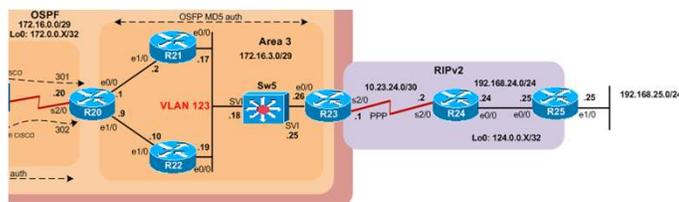
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## Incident#3: Design and Implement solution



- Resolve the Type5 LSA known via another Type5 How?
- Are the Type5 LSA now seen in R20's Routing table?

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## Incident#3: Verify resolution within guidelines

- Check the required Telnet and Traceroute:

```
R20#telnet 124.0.0.25 /source lo0
Trying 124.0.0.25 ...
% Destination unreachable; gateway or host down
R20#
R20#telnet 124.0.0.25 /source e0/0
Trying 124.0.0.25 ... Open
```

User Access Verification

```
Password:
R25>
```

```
R20#traceroute 124.0.0.25 source lo0
```

```
Type escape sequence to abort.
Tracing the route to 124.0.0.25
```

```
 1 172.16.3.10 4 msec
   172.16.3.2 0 msec
   172.16.3.10 0 msec
  2 172.16.3.18 4 msec
   172.16.3.10 !H
   172.16.3.18 0 msec
R20#
```

- Partial success is not acceptable!

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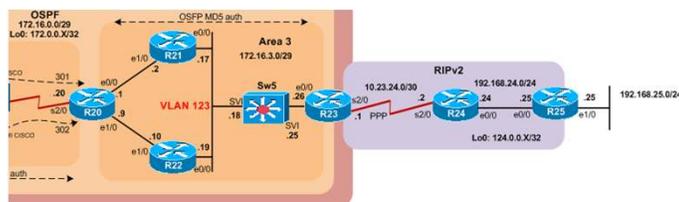
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## Incident#3: Design and Implement solution



- Resolve the Type5 LSA known via another Type5 in R22  
How?
- Are the Type5 LSA seen in R22's Routing table?

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## Incident#3: Verify resolution within guidelines

- Check the required Telnet and Traceroute:

```
R20#telnet 124.0.0.25 /source lo0
Trying 124.0.0.25 ... Open
```

```
User Access Verification
```

```
Password:
R25>
```

```
R20#traceroute 124.0.0.25 source lo0
```

```
Type escape sequence to abort.
Tracing the route to 124.0.0.25
```

```
 1 172.16.3.10 4 msec
 2 172.16.3.2 0 msec
 3 172.16.3.18 0 msec 4 msec 0 msec
 4 172.16.3.26 4 msec 0 msec 0 msec
 5 10.23.24.2 24 msec 20 msec 20 msec
 6 192.168.24.25 20 msec * 20 msec
R20#
```

- Incident is resolved! 😊

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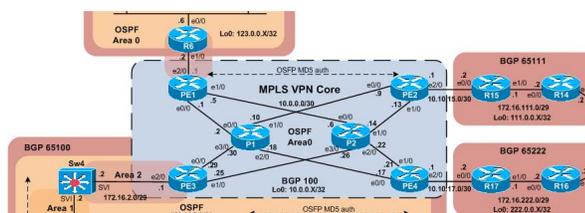
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## Incident#4



- In VPN-B, host 6.6.6.6 attached to R6 is not able to reach host 17.17.17.17 attached to R17.
- Fix the problem so that the following Ping results in 100 percents:

R6#ping 17.17.17.17 so lo1

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 17.17.17.17, timeout is 2 seconds:
Packet sent with a source address of 6.6.6.6
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
R6#
```

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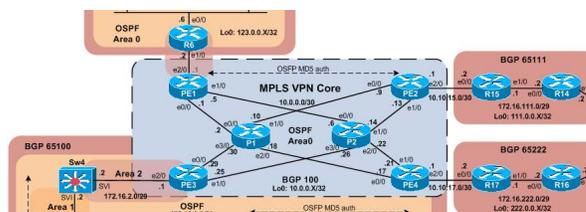
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## Incident#4: Define the problem



- Is there a route in R6 to R17?
- Is there a route in R17 to R6?
- Do the pings arrive at R17?

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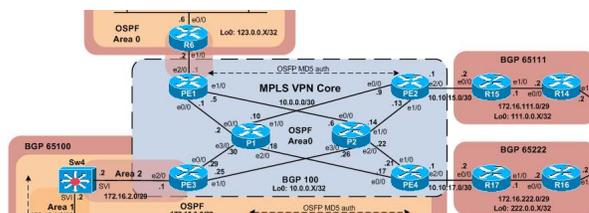
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## Incident#4: Identify symptoms



- How traffic is being forwarded inside the MPLS cloud?
- Is the LSP complete from PE1 to PE4?

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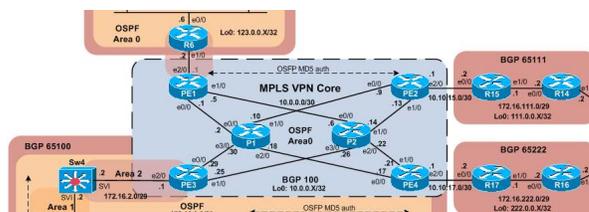
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## Incident#4: Form hypothesis



- What can prevent labels to be assigned to prefixes?

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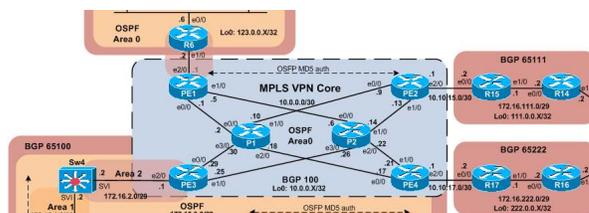
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## Incident#4: Proof-test and Analyze hypothesis



- How are LDP neighborships established ?

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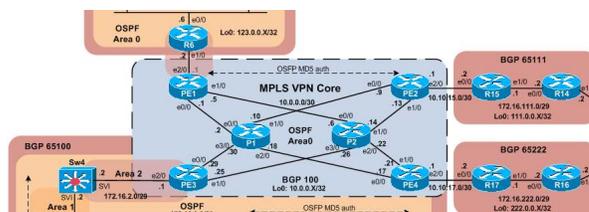
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## Incident#4: Design and Implement solution



- Bring LDP up between PE4 and P1/P2

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## Incident#4: Verify resolution within guidelines

- Check the required Ping:

```
R6#ping 17.17.17.17 so lo1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 17.17.17.17, timeout is 2 seconds:
Packet sent with a source address of 6.6.6.6
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
R6#
```

- Incident is resolved! ☺

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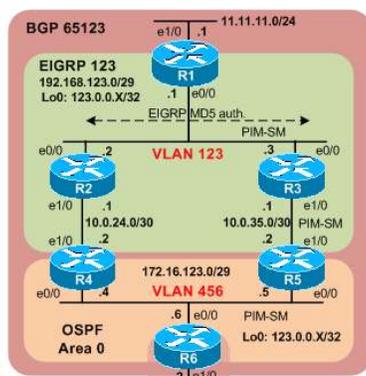
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## Incident#5



- Clients located behind R1 e1/0 must be able to receive Multicast traffic for the group 231.1.1.1 from a server located in VLAN 456.
- Fix the problem so that the following ping receives replies:

```
R6#ping 231.1.1.1

Type escape sequence to abort.
Sending 1, 100-byte ICMP Echos to 231.1.1.1, timeout is 2 seconds:

Reply to request 0 from 192.168.123.1, 20 ms
Reply to request 0 from 192.168.123.1, 20 ms
R6#
```

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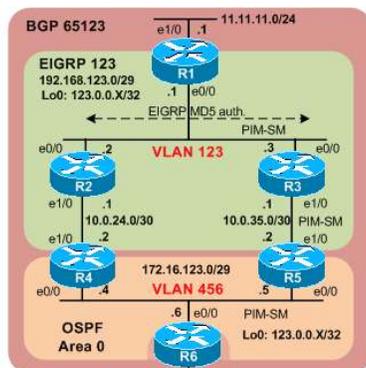
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## Incident#5: Define the problem



- Does ping fail consistently?
- Did R1 join the required group?

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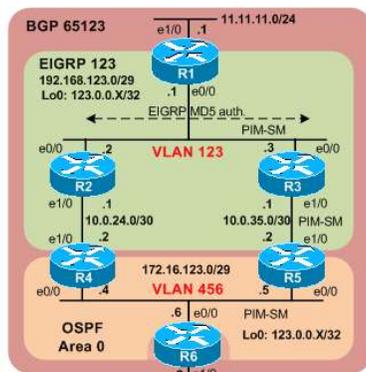
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## Incident#5: Identify symptoms



- Are all PIM neighborships established?
- Are the RP announcements propagated in OSPF?
- Are the RP announcements propagated in EIGRP?

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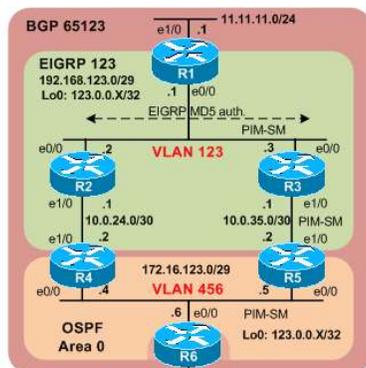
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## Incident#5: Form hypothesis



- What can prevent the RP announcements to be propagated?

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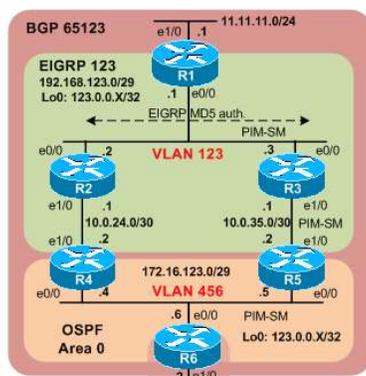
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## Incident#5: Proof-test and Analyze hypothesis



- How to ensure RP announces are flooded in Dense-mode as expected?

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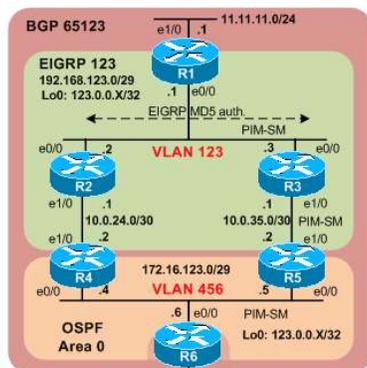
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## Incident#5: Implement solution



- Add the 'ip pim autorp listener' in R4 and R5;
- Increase scope to min 4 in R6's announcements

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## Incident#5: Verify resolution within guidelines

- Check the Auto-RP is seen in R1:

```
R1#sh ip pim rp map
PIM Group-to-RP Mappings

Group(s) 224.0.0.0/4
  RP 123.0.0.6 (?), v2v1
    Info source: 123.0.0.6 (?), elected via Auto-RP
    Uptime: 00:04:41, expires: 00:02:14
R1#
```

- Check if required Ping succeeds:

```
R6#ping 231.1.1.1 rep 5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 231.1.1.1, timeout is 2 seconds:
.....
R6#
```

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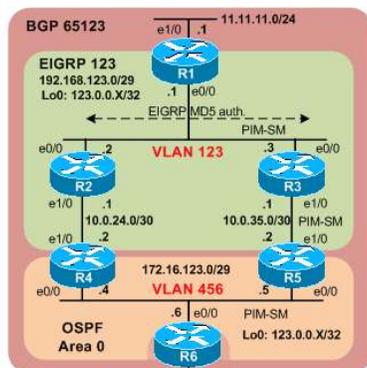
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## Incident#5: Form hypothesis



- What could prevent multicast traffic to flow while the control plane is converged?

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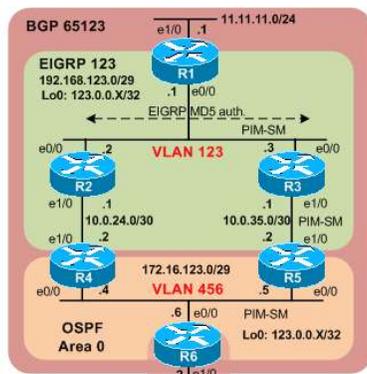
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## Incident#5: Implement solution



- Resolve ACL in R4 and R5...

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## Incident#5: Verify resolution within guidelines

- Check the required Ping:

```
R6#ping 231.1.1.1
```

```
Type escape sequence to abort.
Sending 1, 100-byte ICMP Echos to 231.1.1.1, timeout is 2 seconds:
```

```
Reply to request 0 from 192.168.123.1, 4 ms
Reply to request 0 from 192.168.123.1, 4 ms
R6#
```

- Check if initial ACL is still there but resolved:

```
R4#sh ip int e1/0 | i Outgoing
Outgoing access list is 199
R4#
```

```
R5#sh ip int e1/0 | i Outgoing
Outgoing access list is 199
R5#
```

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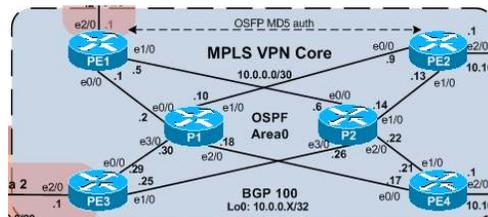
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## Incident#6



- PE1 is the NTP master for the whole MPLS VPN Core.
- Make sure that all devices are synchronized and authenticating the server.

```
<any MPLS router>#sh ntp assoc det | i auth
10.0.0.111 configured, authenticated, our_master, sane, valid, stratum 1
<any MPLS router>#
```

- Use "CCIE" as the MD5 authentication key (without quotes)
- Refer to the Troubleshooting guidelines to determine if your solution is appropriate.

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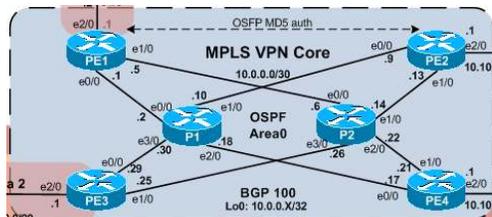
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## Incident#6: Define the problem



- Which device(s) are and are not synchronized and authenticated?

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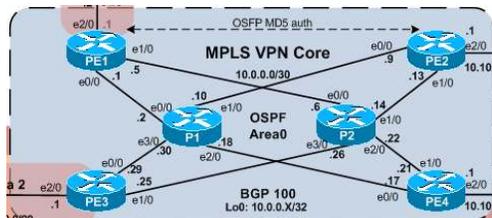
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## Incident#6: Identify symptoms



- How is NTP configured?

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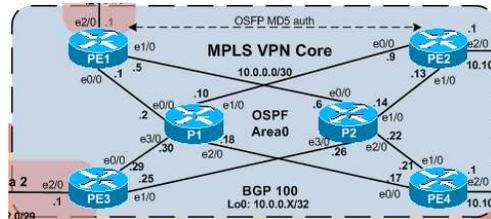
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## Incident#6: Form hypothesis



- What can prevent NTP to be synchronized and authenticated in one device only?

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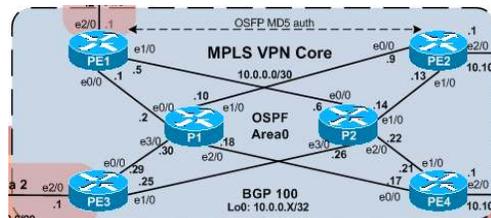
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## Incident#6: Proof-test and Analyze hypothesis



- How is NTP transported?
- What could prevent it to happen?

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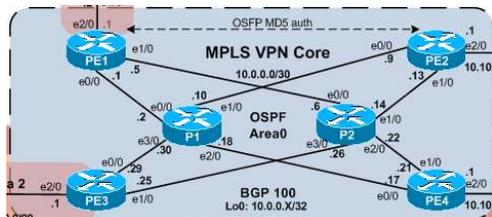
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## Incident#6: Design and Implement solution



- How to permit NTP in the current config?

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## Incident#6: Verify resolution within guidelines

- Check NTP association on PE3:

```
PE3#sh ntp assoc det | i auth
10.0.0.111 configured, authenticated, our_master, sane, valid, stratum 1
PE3#
```

- Incident is resolved! ☺

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## Section 3: Study plan: Content topics

Section 1	CCIE Program Overview
Section 2	CCIE Routing and Switching Version 4
Section 3	Study plan: Content topics review and Sample questions
Section 4	Study plan: Preparation materials
Section 5	Lab Exam: Tips and tricks
Section 6	Troubleshooting Case Studies
Section 7	Conclusion

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## Final Thoughts

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