



TOMORROW
starts here.

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CCIE Service Provider Techtorial

TECCCIE-3406

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“If you know the enemy and know yourself,
you need not fear the result of a hundred battles.”

Sun Tzu
The Art of War

Agenda

- Certification Program Overview
- CCIE SP - New Blueprint – What Changed?
 - Written Exam
 - Lab Exam
- Demo/Case Study
 - Written
 - Lab
- Preparation Materials, Tips, & Tricks
- What is next?

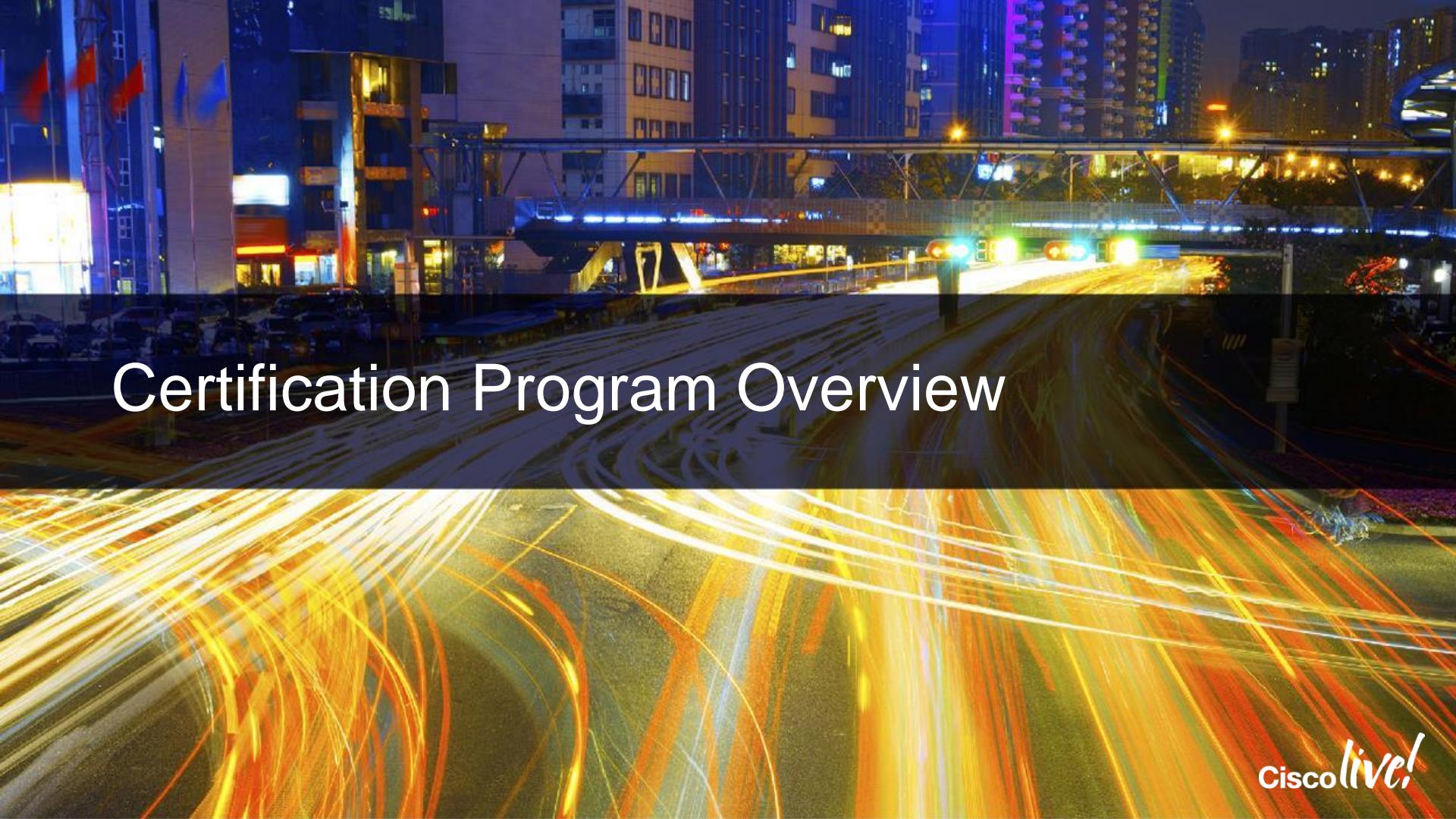


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Disclaimer



- Not all topics discussed today appear on every exam
- Due to time restraints, we are unable to discuss every feature and topic described in the exam blueprint



Certification Program Overview

Certification Tracks



<https://learningnetwork.cisco.com>

Expert Level Tracks

Design

Emphasizes network design principles and theory at the infrastructure level

Collaboration

Collaboration, Unified Communications, or Voice and Video Network for design, implementation and troubleshooting

Data Center

Datacenters infrastructure, storage, compute and virtualization

Routing & Switching

Networking across LAN and WAN interfaces and variety of routers and switches

Security

VPN solutions and security for Layer 2 and Layer 3 network infrastructure, application protocols and OS

Service Provider

IP fundamentals and technologies in building an extensible service provider network

SP Operation

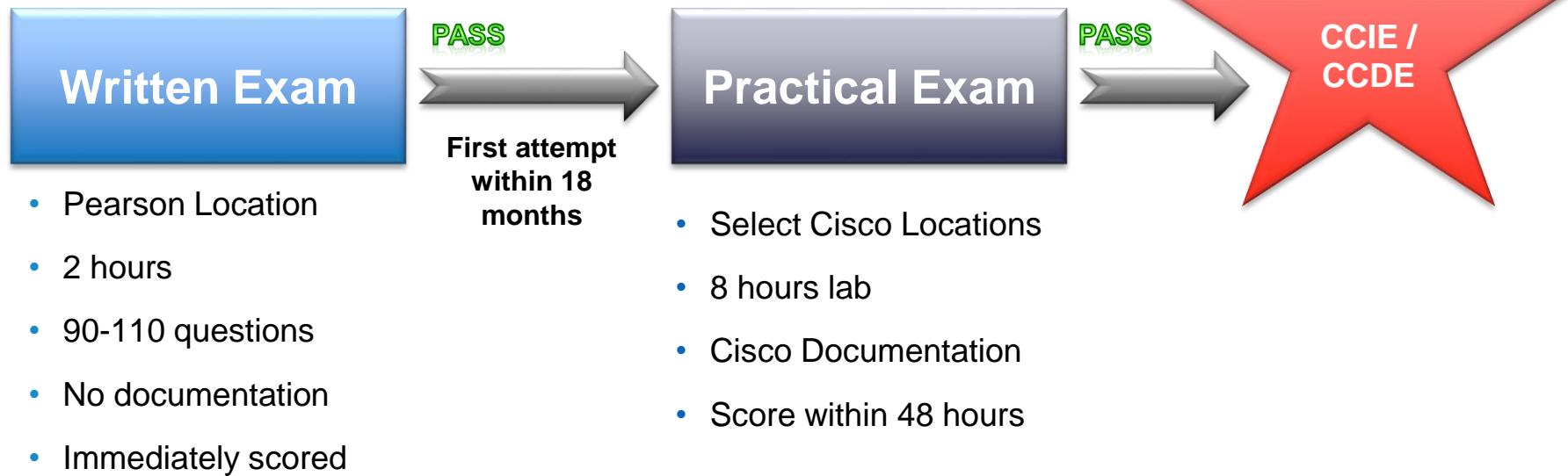
troubleshooting SP networks, managing SP processes and knowledge of NMS technology

RETIRED

Wireless

Wireless networking with solid understanding of WLAN technologies from Cisco

CCIE / CCDE Certification Process



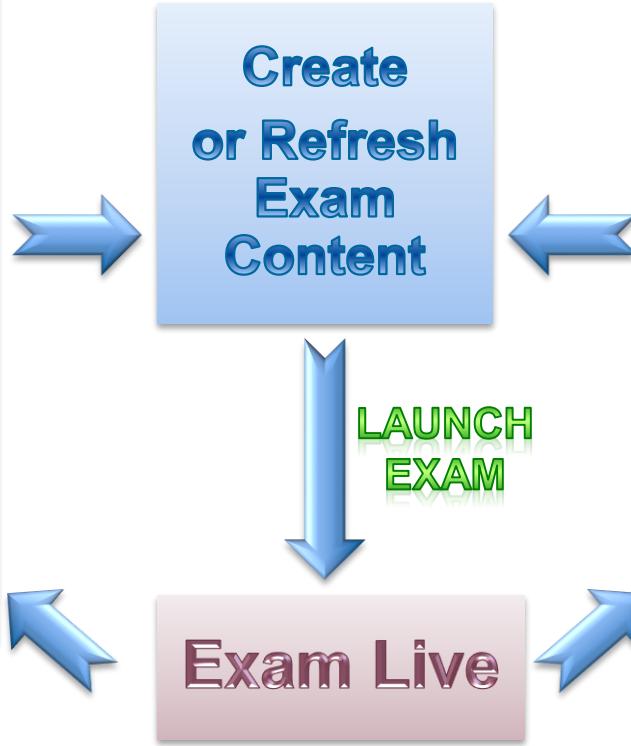
Proactive and Holistic Candidate Feedback

INPUT

- Cisco Business Units
- Cisco Technology groups
- Cisco Technical Support teams (TAC, AS, etc)
- Cisco-internal and Cisco-external Subject Matter Experts
- Customer Advisory Boards
- Customer Focus Groups
- Customer and Cisco field surveys
- Cisco Product Manager, Marketing Manager, and Program Manager

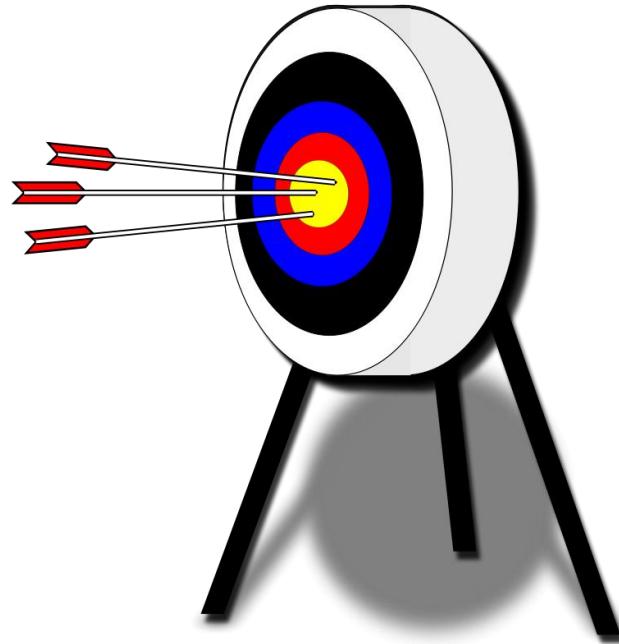
FEEDBACK

- Candidate Exam and item comments
- Candidate Satisfaction Surveys
- Customer Service Cases
- EAG (Exam Advisory Groups)
- Cisco Learning Network
- Blogs



Performance Assessment

- Validity
- Reliability
- Fairness
- Congruency
- Relevancy
- Intended use of the test scores
- Definition of Minimal Qualified Candidate



CCIE Service Provider Program



- Recognizes experts with highest level of technical knowledge
 - Hands-on experience in a Service Provider segment
 - Describe and Design
 - Configure and Optimize
 - Diagnosis and Troubleshoot
 - Extensible Service Provider infrastructure delivering rich services
- There is an **ever-growing** demand for Service Provider experts in the industry
- CCIE SP certification was introduced in 2002
- Currently is in the version 3 of the program
 - Version 4 will be launched in May 2015

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CCIE SP – New Blueprint – What Changed?

CCIE SPv4 – Curriculum Overview

- Certification process unchanged
- Exam curriculum and format changed
- Designed and validated with industry experts around the world
 - Cisco Customer, Cisco Partners, and Cisco Employee Engineers
- Update and Aligned with Service Provider evolution
 - Focus on job role and relevant technologies in the SP market
- Assessment of platform-independent concepts
 - Improved Certification's validity, reliability, integrity and security

https://learningnetwork.cisco.com/community/certifications/ccie_service_provider



Topics

- Emphasis on new technologies
- More emphasis on dual stack IPv4/IPv6 technologies
- More emphasis on troubleshooting methodologies
- Domain based on Service Provider teams and widely SP deployed technologies
 - Core Routing Domain
 - SP Based Services Domain
 - Access and Aggregation Domain
 - High Availability and Fast Convergence
 - SP Security, SP Operation, and Management Domain
- Exclude transport and access technology
 - which have unique essential certification such as Optical and Wireless

CCIE SPv3 – Written Exam Topics (350-029)

Domains	Weight
1. Describe, Implement, Optimize, and Troubleshoot Core IP Technologies	46%
2. Describe, Implement, Optimize, and Troubleshoot Access & Edge Connection Technologies	10%
3. Describe, Implement, Optimize, and Troubleshoot Remote Access Technologies	3%
4. Describe, Implement, Optimize, and Troubleshoot L3VPN Technologies	24%
5. Describe, Implement, Optimize, and Troubleshoot L2VPN Technologies	10%
6. Describe, Implement, Optimize, and Troubleshoot Management Service Traversing the Core	3%
7. Describe Service Provider Network Implement Principles	4%

<https://learningnetwork.cisco.com/docs/DOC-10123>

CCIE SPv4 – Written Exam Topics (400-201)

Domains	Weight
1. Service Provider Architecture and Evolution	10%
2. Core Routing	23%
3. Service Provider Based Services	23%
4. Access and Aggregation	17%
5. High Availability and Fast Convergence	10%
6. Service Provider Security, Service Provider Operation, and Management	17%

<https://learningnetwork.cisco.com/docs/DOC-24915>

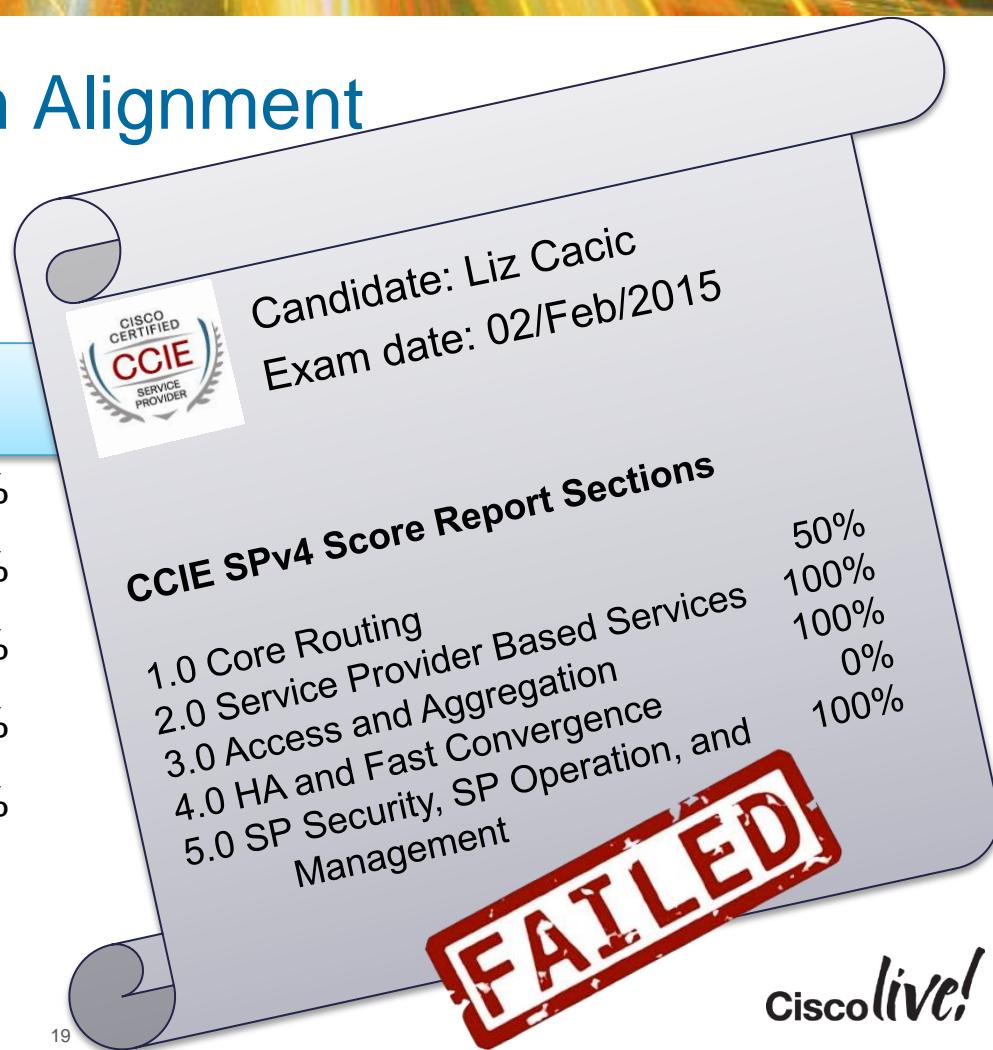
CCIE SPv4 – Curriculum Overview

- Six domains in Written Exam
- Five domains in Lab Exam
- New weighting factors
- Three levels of details, help scoping the expected knowledge
 - Domain
 - Sub-domain
 - Task

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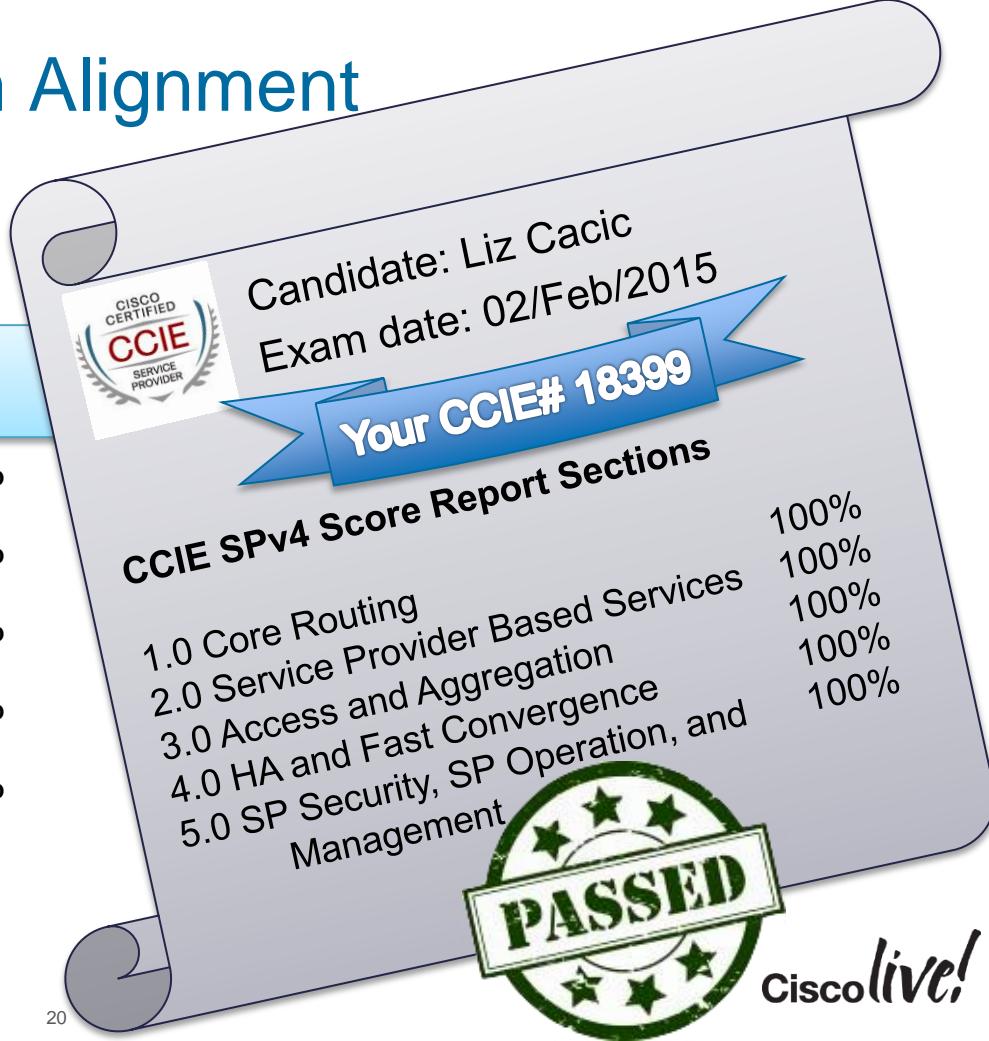
CCIE SPv4 – Curriculum Alignment

CCIE SPv4 Lab Blueprint	Weight
1. Core Routing	27%
2. Service Provider Based Services	26%
3. Access and Aggregation	17%
4. HA and Fast Convergence	13%
5. SP Security, SP Operation, and Management	17%



CCIE SPv4 – Curriculum Alignment

CCIE SPv4 Lab Blueprint	Weight
1. Core Routing	27%
2. Service Provider Based Services	26%
3. Access and Aggregation	17%
4. HA and Fast Convergence	13%
5. SP Security, SP Operation, and Management	17%



CCIE SPv4 – Curriculum Details

ID	Sub Domain	Task	Written Weight	Lab Weight
1		SP Architecture and Evolution	10%	0%
2		Core Routing	23%	27%
	2.1	Interior Gateway Protocol (IGP)		
	2.1.a	Describe, Implement, and Troubleshoot IS-IS		
	2.1.b	Describe, Implement, and Troubleshoot OSPFv2 and OSPFv3		
	2.1.c	Describe and Optimize IGP Scale and Performance		
	2.2	Border Gateway Protocol (BGP)		
	2.2.a	Describe, Implement, and Troubleshoot IBGP, EBGP, and MP-BGP		
	2.2.b	Describe, Implement, and Troubleshoot BGP Route Policy Enforcement		
	2.2.c	Describe BGP Path Attributes		
	2.2.d	Describe and Optimize BGP Scale and Performance		
	2.2.e	Describe, Implement, and Troubleshoot Advance BGP features such as Add-path and BGP LS		
	2.3	Multiprotocol Label Switching (MPLS)		
	2.3.a	Describe MPLS Forwarding and Control Plane Mechanisms		
	2.3.b	Describe, Implement, and Troubleshoot LDP		
	2.3.c	Describe and Optimize LDP Scale and Performance		
	2.4	MPLS Traffic Engineering		
	2.4.a	Describe, Implement, and Troubleshoot RSVP		
	2.4.b	Describe, Implement, and Troubleshoot ISIS and OSPF Extensions		
	2.4.c	Describe, Implement, and Troubleshoot MPLS TE Policy Enforcement		
	2.4.d	Describe MPLS TE Attributes		
	2.4.e	Describe and Optimize MPLS TE Scale and Performance		
	2.4.f	Describe MPLS Advanced features such as Segment Routing, G-MPLS, MPLS-TP, and MPLS TE Inter-AS		

CCIE SPv4 – Key Topic Changes

- New Topics
 - Written Only: SP Architecture and Evolution Domain
 - Written & Lab: SP Security, SP Operation, and Management Domain
- Topics retired/removed
 - Frame Relay and ATM technologies
 - Managed Service Traversing the Core and Network Implementing Principles Domain

https://learningcontent.cisco.com/cln_storage/text/cln/marketing/CCIE_SP_Exam_Updates_v3_v4.pdf

CCIE SPv4 – SP Architecture and Evolution

- SP Architecture Concepts
 - Network Architecture components
 - PE, P, and CE
 - Metro Ethernet Core, and Aggregation
 - Platform Architecture components
 - RP, Line Cards, and Fabric Crossbar
- Virtualization Concepts
 - Router Virtualization
 - Network Function Virtualization
- Mobility Concepts
 - Mobility Infrastructure
 - RAN
 - Backhaul
 - Core

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CCIE SPv4 – Core Routing & HA and Fast Convergence

New Tasks

- Core Routing Domain
 - Advanced BGP features such as Add-path and BGP LS
 - Advanced MPLS features such as Segment Routing, G-MPLS, and MPLS-TP
 - mLDP (including mLDP Profiles from 0 to 9)
 - Multicast P2MP TE
- High Availability and Fast Convergence
 - IP FRR

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CCIE SPv4 – Based Services & Access and Aggregation

New Tasks

- Based Services Domain
 - E-LINE, E-LAN, EVPN, Q-in-Q, Mac-in-Mac, and ITU G.8032
 - Unified MPLS
 - IPv6 Transition Mechanism
- Access and Aggregation
 - GPON
 - Link Aggregation Techniques
 - Loop Prevention Techniques in Multihomed Environments
 - Broadband Forum TR-101 (Trunk N:1 and Trunk 1:1)

CCIE SPv4 – SP Security, Operation and Management

New Tasks

- Timing and synchronization
 - For example 1588v2 and SyncE
- Network monitoring and troubleshooting
 - EEM and EPC
 - IPFIX
 - IP SLA
 - Ethernet OAM
- Change management
 - rollback

CCIE SPv4 – Topics Removed from v3 Exams

- From the Written and Lab Exams
 - Frame-Relay and ATM connections
 - Describe, Implement, Optimize, and Troubleshooting Managed Service Traversing the Core
 - Describe Service Provider Network Implementing Principles
- From the Lab Exam
 - Packet over SONET and IP over DWDM
 - SONET/SDH connection
 - T1/T3 and E1/E3 connections
 - IP over DSL
 - IP over wireline
 - IP over cable

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Written Exam

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Step 1: CCIE SP Written Exam

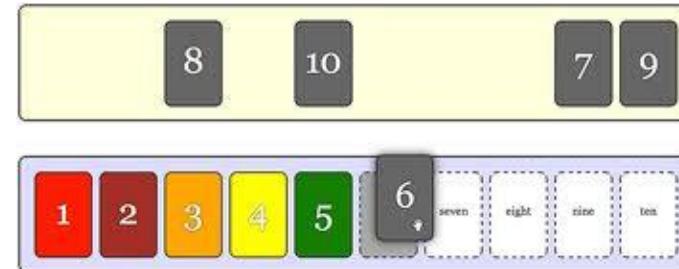
- 350-029: CCIE SPv3
 - Until May 21, 2015
- 400-201: CCIE SPv4
 - From May 22, 2015
- World Wide Location (Pearson VUE)
- 2 hours, 90 – 110 items
 - Multiple Choice / Single Choice / Drag and Drop
 - No “skip-questions”
- English only
- Closed book
- Score directly available



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Written Exam Guidelines

- If MC-SA: Select only one option
- If MC-MA: Select as many options as directed indicated, ex. “Choose two”
- If DnD: Select as many options as there are targets
- If there is an exhibit, use the information provided by ‘click’ in “exhibit”
- No “skip” question functionality



Lab Exam



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Step 2: CCIE SP Lab Exam

- Cisco Location
- English only
- Cisco Online documentation
 - Search function is disabled
- 8 hours
- Score available within 48 hours
- CCIE SPv3, 4 Domains
 - Troubleshooting and Configuration module
- CCIE SPv4, 5 Domains
 - Troubleshooting
 - Diagnostic
 - Configuration



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Location



https://learningnetwork.cisco.com/community/certifications/ccie_service_provider/lab_exam?tab=take-your-lab-exam

Mobile Locations



CCIE SP Lab Exam

Exam Description

- Candidate builds a service provider 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

NOTE:

- It is not a design test
- Nor a test of “Best Practice” for used in the field



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Lab Exam Topics Version 3.0

Domains	Weight
1. Implement, Optimize, and Troubleshoot Core IP Technologies	50%
2. Implement, Optimize, and Troubleshoot Access and Edge Connection Technologies	3%
3. Implement, Optimize, and Troubleshoot L3VPN Technologies	35%
4. Implement, Optimize, and Troubleshoot L2VPN Technologies	12%

<https://learningnetwork.cisco.com/docs/DOC-9991>

Lab Exam Topics Version 4.0

Domains	Weight
1. Core Routing	27%
2. Service Provider Based Services	26%
3. Access and Aggregation	17%
4. High Availability and Fast Convergence	13%
5. Service Provider Security, Service Provider Operation, and Management	17%

<https://learningnetwork.cisco.com/docs/DOC-25172>

Equipment and Software Versions

- CCIE SPv3
 - Cisco XR 12000 series router running IOS-XR 3.9.1
 - Cisco 7200/7600 series router running IOS 12.2(33)SRE
 - Cisco ME3400E series switch running IOS 12.2(54)SE

<https://learningnetwork.cisco.com/docs/DOC-10121>

- CCIE SPv4
 - P and PE role: based on ASR9000 series running IOS-XR 5.2
 - RR and CE role: based on ASR1000 series running IOS-XE 3.13 (15.4S)
 - PE and CE role: based on Cisco7600 series running IOS 15.4S
 - Access and Aggregation: ME3600 series running IOS 15.4S

<https://learningnetwork.cisco.com/docs/DOC-25318>

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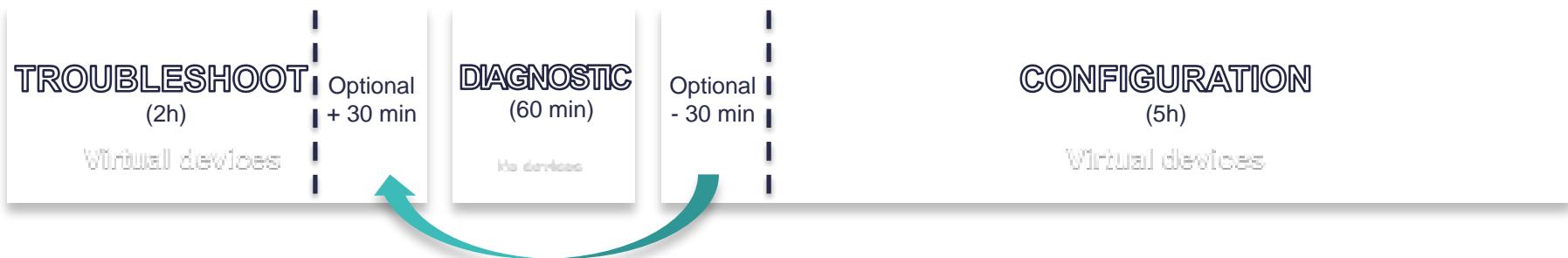


New Lab Format

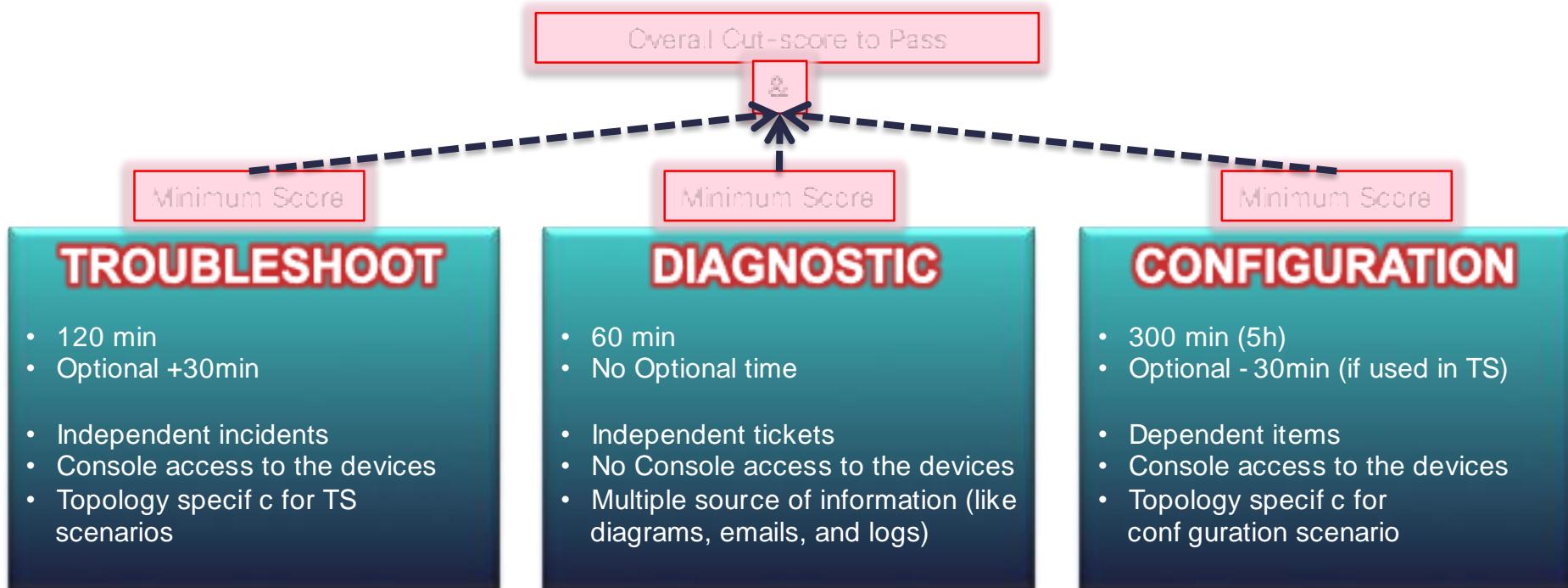
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New Lab Exam Format

- 100% virtual
- New DIAG module
- Flexible time in the Troubleshoot module
- Overall cut-score AND per-module minimum score



New CCIE Lab Format



Troubleshooting Module

- 120 min
- Optional up to 30 min extra
 - Extract from Configuration Module
- Independent incidents
- Console access to the devices
- Topology specific for Troubleshooting scenarios

Skills Tested

- Quickly resolve network issues
- Use of IOS/XR troubleshooting tools
- Troubleshooting methodologies application
- Technology areas listed in the blueprint
- Fix and verify the solution for the network issues

Diagnostic Module

- 60 min
- No Optional time
- Independent tickets
- No Console access to the devices
- Multiple source of information (like diagrams, emails, and logs)

Skills Tested

- Perceive network issues
- Analyze network issues symptoms, identify and describe the root cause
- Correlate information from multiple sources
- Identify appropriate solutions
- Troubleshooting methodologies
- Technology listed in the blueprint

Configuration Module

- 300 min (5 hours)
- Optional time -30 min (if used in TS)
- Dependent items
- Console access to the devices
- Topology specific for configuration scenarios

Skills Tested

- Abstract functional element of the entire network environment
- Understand how the infrastructure components interoperate
- Implement technology areas listed in the blueprint
- Design appropriate solutions to the Service Provider backbone being aware of the design constraints
- Verify functionality

Lab Delivery System

- Web GUI for all the lab content
 - Guidelines
 - Diagrams
 - Questions
 - Access to the devices
 - Documentation
- Backend servers manage the user sessions and holding the virtual device instances for each user
- **No printed exam workbook**

CCIE SPv3 HYBRID LAB: PHYSICAL & VIRTUAL

The screenshot shows a Cisco Learning Lab registration page. At the top is the Cisco logo. Below it is a text input field and a 'Begin Lab' button. The main content area displays the following information:

Hello ,
Our records indicate that you are registered to take the following Cisco Learning Lab:
Title: WSPMPL-2002
Welcome to WSPMPL-2002
Please verify the following information and contact Cisco Certification Support if any of the information is incorrect:
First Name:
Last Name:
Track: Networkers
Location: Kiosk
Date: 2014-05-13
Length (minutes): -1

Begin Lab

Click the "Begin Lab" button on the menu bar above when you are ready to begin your session.
Click [Help](#) to learn about the Cisco Learning Labs before your timed lab begins.
Once you move past this screen the time will automatically start counting down.

CCIE SPv4 LAB: VIRTUAL ONLY

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Exam Workbook



CLICK HERE TO START - Background Info

liz cacic

Questions & Diagrams All Questions Guidelines Manage Devices Help & Settings End Session

Lab Setup
Section 1 - Implement, Optimize and Troubleshoot Core IP Technologies

Section 2 - Implement, Optimize and Troubleshoot Advanced IP Technologies

Troubleshoot Active Connection Tech



Section 3 - Implement, Optimize and Troubleshoot L3!

Section 4 - Implement, Optimize and Troubleshoot L2!



Guidelines

Diagram 1 - CCII

Diagram 2 - CCII

Diagram 3 - IPv4 and VPN

Diagram 4 - IPv6 and VPN

1. Read all qu

Diagram 5 - Frame Connection Setup

2. If you need help soon as pos

Diagram 6 - Switch Scheme

3. Do NOT tell anyone about the exam, including your proctor. A

Table 1 - Loopback

4. You will be informed about those that are

Table 2 - Loopback Group

5. Static and dynamic routes



READ THESE GUIDELINES FIRST

Close

Close

Device	Status	Connect	Clear Console	Power Cycle	Reload Init Cfg
R5	Up	Console	Clear	Pwr Cycle	Reload Cfg
R6	Up	Console	Clear	Pwr Cycle	Reload Cfg
R7	Up	Console	Clear	Pwr Cycle	Reload Cfg
R8	Up	Console	Clear	Pwr Cycle	Reload Cfg
R9	Up	Console	Clear	Pwr Cycle	Reload Cfg
R10	Up	Console	Clear	Pwr Cycle	Reload Cfg
R11	Up	Console	Clear	Pwr Cycle	Reload Cfg
R12	Up	Console	Clear	Pwr Cycle	Reload Cfg
R13	Up	Console	Clear	Pwr Cycle	Reload Cfg

Lab Exam Grading

- **Proctors grade all lab exams**
- Automatic tools aid proctors with simple grading tasks
 - Never solely responsible for the final exam grading
 - Proctors are
- **No Partial** credit awarded on questions
- Points are awarded for **working solutions** only
- Some questions have multiple solutions





Demo / Case Study

Written Exam

Example

Cisco Certification Exam Tutorial

http://www.cisco.com/web/learning/wwtraining/certprog/training/cert_exam_tutorial.html

The screenshot shows a window titled "Task 1: Multiple-Choice, Single Answer". The main area contains the question "How many meters are in a kilometer?" with four options: 100, 454, 600, and 1000, where 1000 is selected. A status bar at the top right shows "Time Remaining 3:19:27". At the bottom, there are navigation buttons: "Previous(P)", "Next(N)" (highlighted with a yellow border), "TRY ME", and "CONTINUE". A copyright notice at the bottom right reads: "© Copyright 2004 Cisco Systems, Inc. All rights reserved. Cisco, Cisco Systems, the Cisco Systems logo, and Empowering the Internet Generation are registered trademarks or trademarks of Cisco Systems, Inc."

**Task 1:
Multiple-Choice,
Single Answer**

This kind of task requires that you choose one and only one option for an answer. Once you decide on your answer, click the radio button beside the option of your choice. If you wish to change your answer, click the desired radio button.

To continue to the next task, you must

How many meters are in a kilometer?

100
 454
 600
 1000

Time Remaining 3:19:27

Previous(P) **Next(N)** TRY ME CONTINUE

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Multiple-choice Single-Answer



Which statement is true about the **Penultimate Hop Popping (PHP)**?

- Reduce performance on the node
- Increase complexity of the hardware implementation significantly
- Used only for directly connected subnets or aggregate routes
- None of the above



Multiple-choice Multiple-Answer

Select the fields specific within the IPv6 header? (Choose five)

- Source and Destination Address
- Flow Label
- Payload Length
- Total Length
- Time to Live
- Traffic Class
- Header Checksum
- Protocol
- Hop Limit
- Next Header
- Type of Service

Drag and Drop

L3/L2 VPN

Drag the items listed on the left to its proper category on the right. Not all items will fit the categories.

Provide connectivity of non-IP protocols

Support IP only

HDLC

802.1Q

RD

L2TPv3

Hierarchical VPLS

AToM

VRF

Route Target

Layer 2 VPN

Layer 3 VPN

Drag and Drop

L3/L2 VPN

Drag the items listed on the left to its proper category on the right. Not all items will fit the categories.

Provide connectivity of non-IP protocols

Support IP only

HDLC

802.1Q

RD

L2TPv3

Hierarchical VPLS

AToM

VRF

Route Target

Layer 2 VPN

Layer 3 VPN

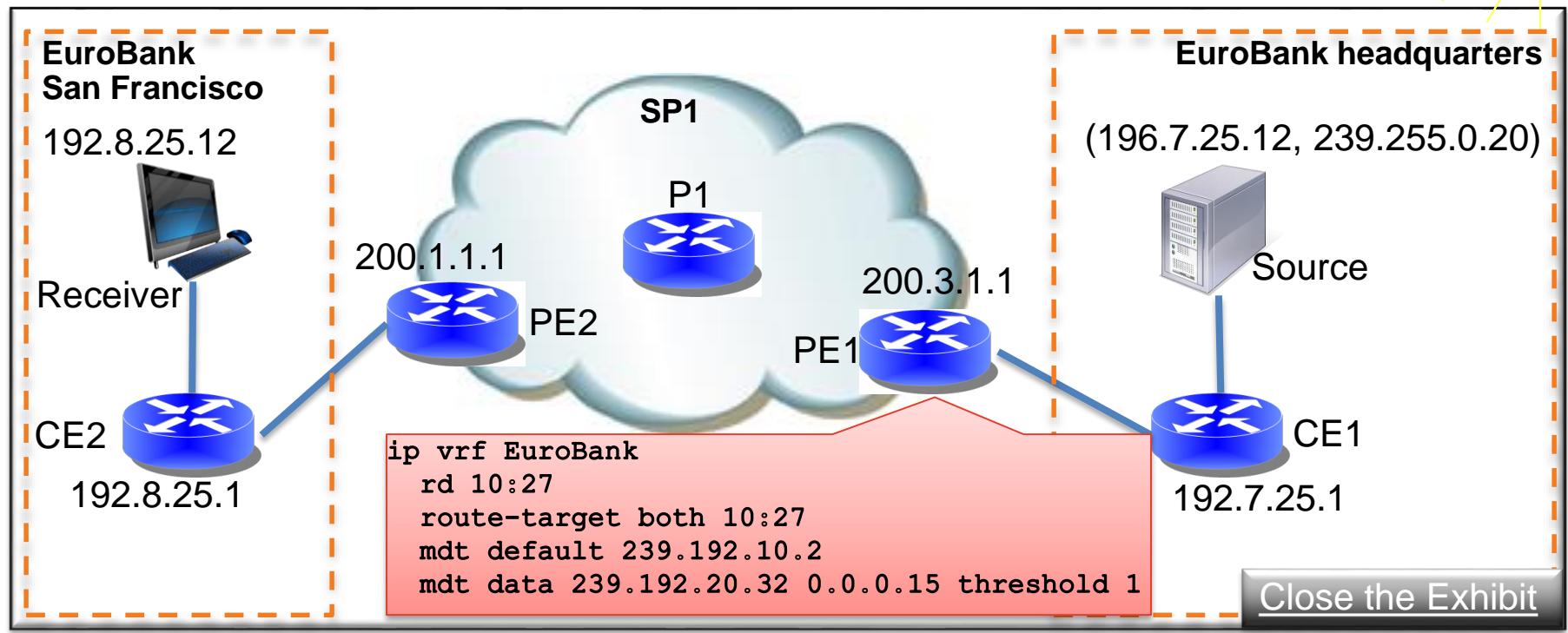
Question with Exhibit



Refer to the **exhibit**. Eurobank has a high bandwidth source located at headquarters servicing the Eurobank multicast group 239.255.0.20. This group has an interested receiver in Eurobank San Francisco. What is the destination address of the outer packet in the p router in SP1 for this multicast data traffic?

- 239.255.0.20
- 200.1.1.1
- 239.192.10.2
- 239.129.20.32
- 196.8.25.1
- 192.8.25.12

Question with Exhibit



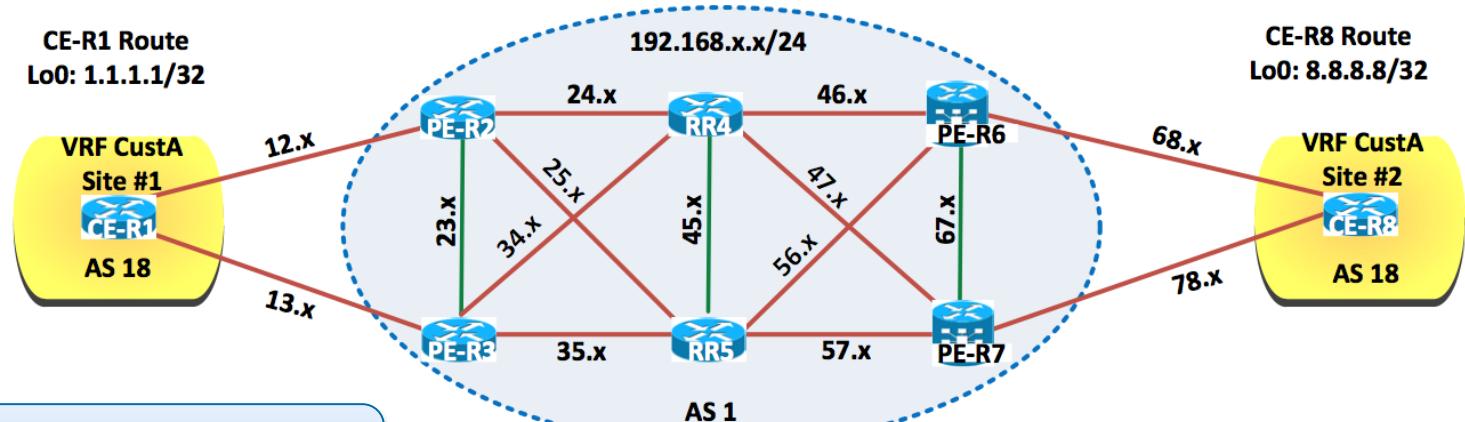
Lab Exam

Example



Scenario 1: CFG - BGP PIC

Topology – BGP PIC



Question:

Configure AS1 related routers to make sure fast convergence can be achieved for both IGP and BGP failure by leveraging diverse paths. (BGP additional-path feature is not supported on RR)

CE1 eBGP dual home with PE-R2 and PE-R3

CE8 eBGP dual home with PE-R6 (XR) and PE-R7 (XR)

All VRF CustA sites are configured with the same RD and RT

AS1 running OSPF/LDP and MP-BGP

RR4 and RR5 are not in the same cluster
(R5 as shadow RR router)

BGP PIC

Highlights

- PIC stands for **Prefix Independent Convergence**
 - It is a method for speeding up convergence of the FIB under failover conditions
- **BGP PIC Core** helps on non-BGP failover scenarios
- **BGP PIC edge** helps on BGP failover scenarios
- BGP Diverse Path Using a **Diverse-Path Route Reflector** feature
 - allows BGP to distribute an alternative path
 - other than the best path
 - between BGP speakers when route reflectors are deployed
- BGP PIC edge syntax is different between IOS and IOS-XR

Configuration

IOS-XR

```
R6 and R7
router bgp 1
!
address-family vpng4 unicast
    advertise best-external
    additional-paths receive
    additional-paths send
    additional-paths selection route-policy add_path_policy
!
route-policy add_path_policy
    set path-selection backup 1 advertise install
end-policy
```

IOS

```
R2, R3 and R4
router bgp 1
!
address-family vpng4
    bgp advertise best-external
    bgp additional-paths select backup
    bgp additional-paths install
```

Configuration

IOS - RR

```
R5
router bgp 1
!
address-family vpnv4
    bgp additional-paths select backup
    bgp additional-paths install
    neighbor 2.2.2.2 advertise diverse-path backup
    ! Advertise BGP Diverse Path using a Diverse-Path Route Reflector
    neighbor 3.3.3.3 advertise diverse-path backup
    neighbor 6.6.6.6 advertise diverse-path backup
    neighbor 7.7.7.7 advertise diverse-path backup
```

Verification

PE-R2

```
R2#sh bgp vpng4 unicast all  
BGP table version is 93, local router ID is 2.2.2.2
```

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 100:1 (default for vrf CustA)					
Import Map: LEAK, Address-Family: IPv4 Unicast, Pfx Count/Limit: 0/1000					
Export Map: LEAKCE, Address-Family: IPv4 Unicast, Pfx Count/Limit: 1/1000					
*bi 1.1.1.1/32	3.3.3.3	0	100	0 18 i	
*>	192.168.12.1	0		0 18 i	
*>i 8.8.8.8/32	6.6.6.6	0	150	0 18 i	
*bi	7.7.7.7	0	100	0 18 i	

Verification

RR-R4

```
R4#sh bgp vpng4 unicast all  
BGP table version is 23, local router ID is 4.4.4.4
```

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 100:1 (default for vrf CustA)					
* i 1.1.1.1/32	2.2.2.2	0	100	0	18 i
*bi	3.3.3.3	0	100	0	18 i
*>i	2.2.2.2	0	100	0	18 i
* i 8.8.8.8/32	6.6.6.6	0	150	0	18 i
*>i	6.6.6.6	0	150	0	18 i
*bi	7.7.7.7	0	100	0	18 i

Verification

PE-R6

```
RP/0/0/CPU0:R6#sh bgp vpng4 unicast
Mon Dec 22 16:51:37.955 UTC
BGP router identifier 6.6.6.6, local AS number 1
BGP generic scan interval 60 secs
BGP table state: Active
Table ID: 0x0    RD version: 0
BGP main routing table version 120
BGP scan interval 60 secs
```

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 100:1 (default for vrf CustA)					
*>i1.1.1.1/32	2.2.2.2	0	100	0 18	i
* i	3.3.3.3	0	100	0 18	i
* i8.8.8.8/32	7.7.7.7	0	100	0 18	i
*>	192.168.68.8	0		0 18	i

Cisco live!

Verification

PE-R6

```
RP/0/0/CPU0:R6#sh bgp vpng4 unicast vrf CustA 1.1.1.1/32
...
Paths: (2 available, best #1)
    Not advertised to any peer
Path #1: Received by speaker 0
    Not advertised to any peer
    18
        2.2.2.2 (metric 12) from 4.4.4.4 (2.2.2.2)
            Received Label 28
            Origin IGP, metric 0, localpref 100, valid, internal, best, group-best, import-candidate,
            imported
Path #2: Received by speaker 0
    Not advertised to any peer
    18
        3.3.3.3 (metric 12) from 5.5.5.5 (3.3.3.3)
            Received Label 20
            Origin IGP, metric 0, localpref 100, valid, internal, backup, add-path, import-candidate,
            imported
```



Demo: CFG – BGP PIC



Scenario 2: Diagnostic – 6PE

Diagnostic Module

- Customer XYZ opened a case regards to IPv6 Internet reachability. IPv4 Internet reachability is perfect. Based on resources provided, you need to diagnose the issue and answer the questions.

[Email thread](#)

[Network Topology](#)

[Logs](#)

[Device Configuration](#)

Diagnostic Module

Email Thread

From: John <jsmith@customer.com>

To: Support <support@isp.com>

Subject: CASE #123456 IPv6 Internet access not working

Hi,

We configured the R20 for IPv6 connectivity as recommended by your ISP design team. IPv4 internet connectivity has not been affected, in other words our CE router can ping the remote PE and have access to the internet webpages. However, we are not able to access internet webpages based on IPv6 addresses. Please resolve this issue as soon as possible.

Kind regards,

John

Diagnostic Module

Email Thread

From: John <jsmith@customer.com>

To: Support <support@isp.com>

Subject: **From:** Support <support@isp.com>

To: John <jsmith@customer.com>

Subject: Re: CASE #123456 IPv6 Internet access not working

Hi,
We conf
ISP des
in othe
to the
webpage
as poss

Kind re
John

Hi John,

Thank you for contacting us. Could you please provide the configuration applied on CE device as well as the logs collected?

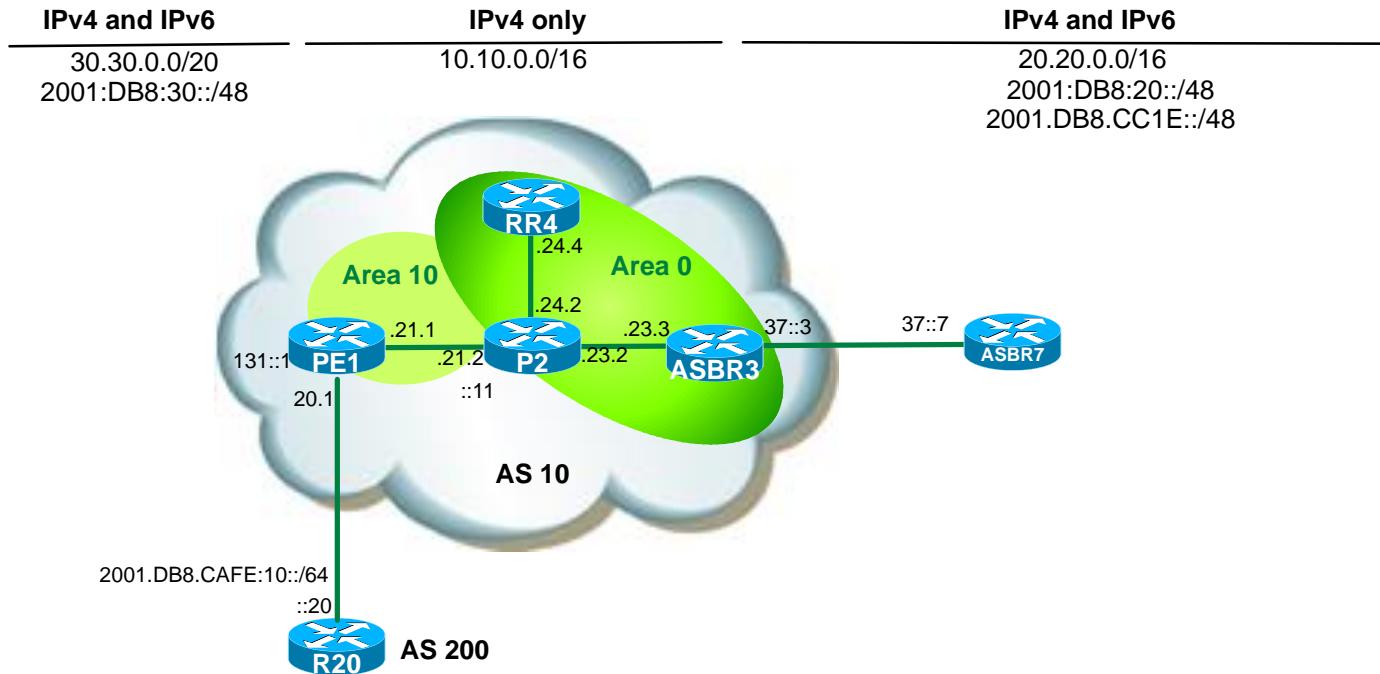
Kind regards,

Andy

Cisco live!

Diagnostic Module

Network Topology



Diagnostic Module

Logs

```
RR4# sh bgp ipv6 uni sum
Load for five secs: 1%/0%; one minute: 1%; five minutes: 0%
Time source is hardware calendar, *20:51:56.781 EST Fri Jan 23 2015
BGP router identifier 10.10.0.4, local AS number 10
BGP table version is 105, main routing table version 105
24 network entries using 3936 bytes of memory
24 path entries using 2400 bytes of memory
4/0 BGP path/bestpath attribute entries using 544 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
2 BGP extended community entries using 64 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 7040 total bytes of memory
BGP activity 110/66 prefixes, 163/119 paths, scan interval 60 secs

Neighbor          V           AS MsgRcvd MsgSent     TblVer  InQ OutQ Up/Down  State/PfxRcd
10.10.0.1         4           10     13      27       105    0     0 00:00:13      11
10.10.0.3         4           10     14      20       105    0     0 00:00:08      13
```

Diagnostic Module

Logs

```
RR4# sh bgp ipv6 uni
...
      Network          Next Hop     Metric LocPrf Weight Path
* i 2001:DB8:20::7/128    ::FFFF:10.10.0.3    0    100      0 20 i
* i 2001:DB8:20::8/128    ::FFFF:10.10.0.3    0    100      0 20 i
* i 2001:DB8:20:37::/64   ::FFFF:10.10.0.3    0    100      0 i
* i 2001:DB8:CAFE::20/128 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:10::/64 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:1000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:2000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:3000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:4000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:5000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:6000::/52 ::FFFF:10.10.0.1    0    100      0 200 I
* i 2001:DB8:CAFE:7000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:8000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CAFE:9000::/52 ::FFFF:10.10.0.1    0    100      0 200 i
* i 2001:DB8:CC1E::30/128   ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:1000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:2000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:3000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:4000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:5000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:6000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:7000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:8000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
* i 2001:DB8:CC1E:9000::/52 ::FFFF:10.10.0.3    0    100      0 20 300 i
```

Diagnostic Module

Logs

```
PE1# sh bgp ipv6 uni sum
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *21:06:58.860 EST Fri Jan 23 2015
BGP router identifier 10.10.0.1, local AS number 10
BGP table version is 94, main routing table version 94
11 network entries using 1804 bytes of memory
11 path entries using 1100 bytes of memory
1/1 BGP path/bestpath attribute entries using 136 bytes of memory
1 BGP rrinfo entries using 24 bytes of memory
3 BGP AS-PATH entries using 72 bytes of memory
2 BGP extended community entries using 64 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3200 total bytes of memory
BGP activity 107/76 prefixes, 139/108 paths, scan interval 60 secs

Neighbor          V           AS MsgRcvd MsgSent     TblVer  InQ OutQ Up/Down  State/PfxRcd
10.10.0.4         4           10    43      29        94     0    0 00:15:15      0
2001:DB8:CAFE:10::20
                           4           200   41      44        94     0    0 00:33:10      11
```

Diagnostic Module

Logs

```
PE1# sh bgp ipv6 uni
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *20:55:31.254 EST Fri Jan 23 2015

BGP table version is 94, local router ID is 10.10.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

      Network          Next Hop            Metric LocPrf Weight Path
*-> 2001:DB8:CAFE::20/128  2001:DB8:CAFE:10::20  0          0 200 i
r-> 2001:DB8:CAFE:10::/64   2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:1000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:2000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:3000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:4000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:5000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:6000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:7000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:8000::/52  2001:DB8:CAFE:10::20  0          0 200 i
*> 2001:DB8:CAFE:9000::/52  2001:DB8:CAFE:10::20  0          0 200 i
```

Diagnostic Module

Logs

```
ASBR3# sh bgp ipv6 uni sum
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *21:08:20.564 EST Fri Jan 23 2015
BGP router identifier 10.10.0.3, local AS number 10
BGP table version is 188, main routing table version 188
13 network entries using 2132 bytes of memory
13 path entries using 1300 bytes of memory
4/4 BGP path/bestpath attribute entries using 544 bytes of memory
1 BGP rrinfo entries using 24 bytes of memory
3 BGP AS-PATH entries using 72 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 4072 total bytes of memory
BGP activity 88/59 prefixes, 178/149 paths, scan interval 60 secs

Neighbor          V           AS MsgRcvd MsgSent     TblVer  InQ OutQ Up/Down  State/PfxRcd
10.10.0.4         4           10    38      34        188    0     0 00:16:32          0
2001:DB8:20:37::7
                    4           20    48      42        188    0     0 00:34:36          12
```

Diagnostic Module

Logs

```
ASBR3# sh bgp ipv6 uni
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *21:08:25.365 EST Fri Jan 23 2015

BGP table version is 188, local router ID is 10.10.0.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:20::7/128    2001:DB8:20:37::7      0          0 20 i
*> 2001:DB8:20::8/128    2001:DB8:20:37::7      0          0 20 i
*> 2001:DB8:20:37::/64   ::                      0          32768 i
*> 2001:DB8:CC1E::30/128 2001:DB8:20:37::7      0          0 20 300 I
*> 2001:DB8:CC1E:1000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:2000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:3000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:4000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:5000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:6000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:7000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:8000::/52 2001:DB8:20:37::7      0          0 20 300 i
*> 2001:DB8:CC1E:9000::/52 2001:DB8:20:37::7      0          0 20 300 i
```

Diagnostic Module

Logs

```
RR4# sh bgp ipv6 uni 2001:DB8:CC1E:1000::/52
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *21:16:16.020 EST Fri Jan 23 2015
BGP routing table entry for 2001:DB8:CC1E:1000::/52, version 0
BGP Bestpath: deterministic-med
Paths: (1 available, no best path)
    Not advertised to any peer
    Refresh Epoch 1
    20 300, (Received from a RR-client)
        ::FFFF:10.10.0.3 (inaccessible) from 10.10.0.3 (10.10.0.3)
            Origin IGP, metric 0, localpref 100, valid, internal
            rx pathid: 0, tx pathid: 0

ASBR3# sh bgp ipv6 uni 2001:DB8:CC1E:1000::/52
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *21:17:24.985 EST Fri Jan 23 2015
BGP routing table entry for 2001:DB8:CC1E:1000::/52, version 240
BGP Bestpath: deterministic-med
Paths: (1 available, best #1, table default)
    Advertised to update-groups:
        7
    Refresh Epoch 1
    20 300
        2001:DB8:20:37::7 (FE80::A8BB:CCFF:FE00:610) from 2001:DB8:20:37::7 (20.20.0.7)
            Origin IGP, localpref 100, valid, external, best
            rx pathid: 0, tx pathid: 0x0
```

Diagnostic Module

Logs

```
R20# ping 2001:db8:cafe:10::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:CAFE:10::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
R20# ping 2001:DB8:20:37::3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:20:37::3, timeout is 2 seconds:
% No valid route for destination
Success rate is 0 percent (0/1)
```

```
R20# ping 10.10.0.3 source loop 0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.0.3, timeout is 2 seconds:
Packet sent with a source address of 200.0.0.20
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Diagnostic Module

Configuration

```
PE1# sh run
```

```
...
router bgp 10
neighbor 10.10.0.4 remote 10
neighbor 10.10.0.4 update-source lo 0
neigh 2001:DB8:CAFE:10::20 remote 200
!
address-family ipv6
  neigh 10.10.0.4 activate
  neigh 10.10.0.4 next-hop-self
  neigh 2001:DB8:CAFE:10::20 activate
```

```
RR4# sh run
```

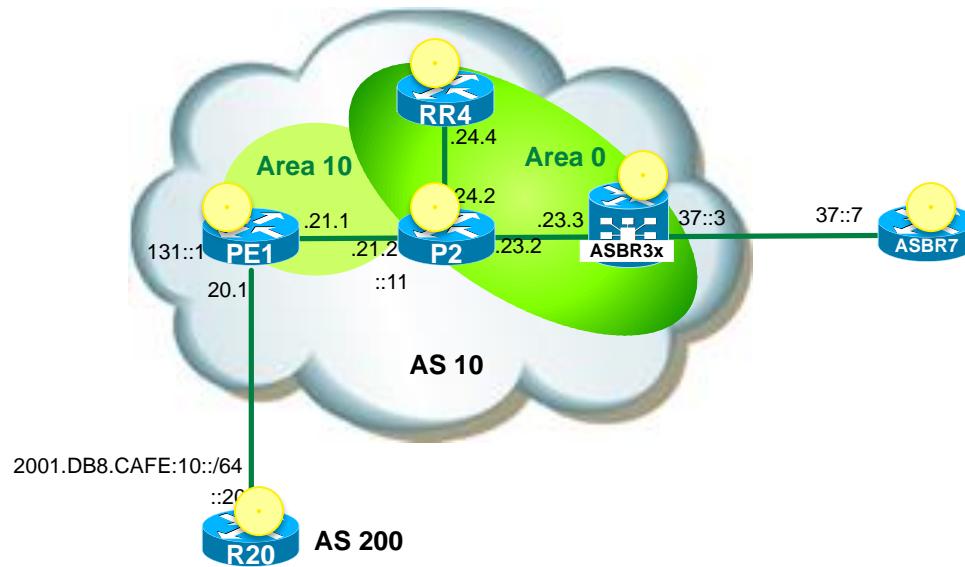
```
...
router bgp 10
  address-family ipv6
    neighbor 10.10.0.1 activate
    neighbor 10.10.0.1 route-reflector-client
    neighbor 10.10.0.3 activate
    neighbor 10.10.0.3 route-reflector-client
```

```
ASBR3# sh run
```

```
...
router bgp 10
neighbor 10.10.0.4 remote 10
neighbor 10.10.0.4 update-source lo 0
neighbor 2001:DB8:20:37::70 remote-as 300
!
address-family ipv6 unicast
  neigh 10.10.0.4 activate
  neigh 10.10.0.4 next-hop-self
  neighbor 2001:DB8:20:37::7 activate
```

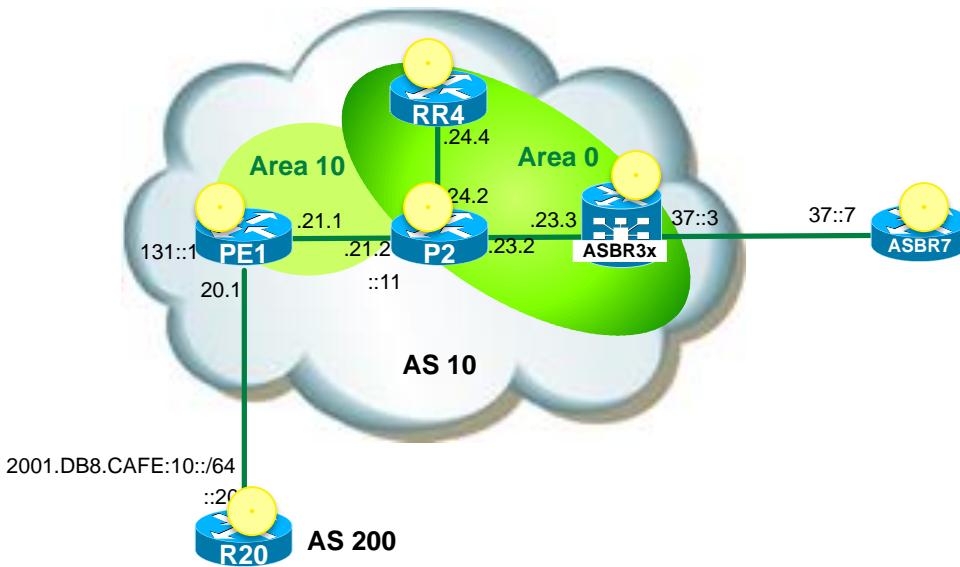
Diagnostic Module

- Which router would you verify to identify the root cause of the issue?



Diagnostic Module

- Which show command would you apply on this device to identify the root cause?



Select one of the show commands

- sh bgp ipv4 uni sum
- sh bgp ipv4 uni label
- sh bgp ipv4 uni neigh 10.10.0.4
- sh bgp ipv4 uni neigh 10.10.0.3
- sh bgp ipv4 uni neigh 10.10.0.1
- sh bgp ipv6 uni label
- sh bgp ipv6 uni neigh 2001:DB8:CAFE:10::20
- sh bgp ipv6 uni neigh 2001:DB8:37::7
- sh bgp ipv6 uni community



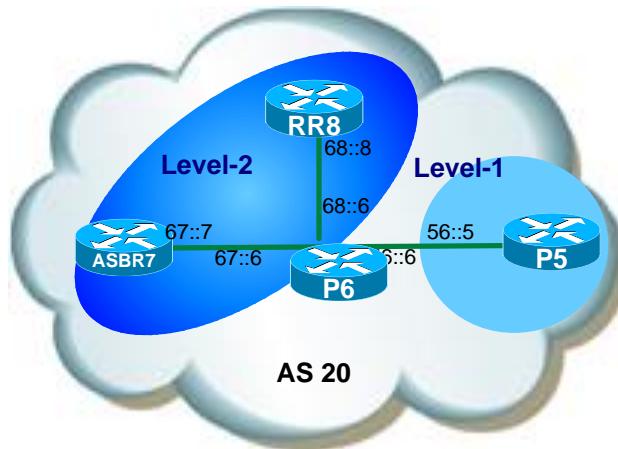
Scenario 3: TS – MPLS TE

MPLS Traffic-Engineering

Highlights

- MPLS TE is based on Link-State Protocol
- Path can be dynamic (IGP) or explicitly defined
- An inter-area tunnel you should configure multiple loosely routed path options
 - Specifying different combinations of ABRs (for OSPF)
or
 - Level-1-2 boundary routers (IS-IS)
- RSVP and MPLS TE support must be enabled in all interfaces along the path
- You must define the IGP area for MPLS TE

Topology



Ticket 1#:

The MPLS TE tunnel interface created on ASBR7 is down. The tail-end of this tunnel is the loopback address of the PE5. Identify the problem and fix it.

Configuration

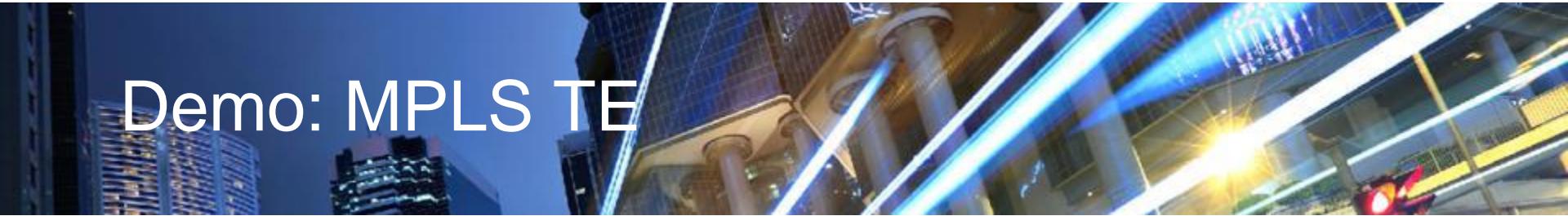
IOS

```
mpls traffic-eng tunnels
!
interface ...
  mpls traffic-eng tunnel
    ip rsvp bandwidth percent 75
...
!
router isis
  mpls traffic-eng router-id Loopback0
  mpls traffic-eng level-2
  mpls traffic-eng level-1
!
interface Tunnel 75
  ip unnumbered Loopback0
  tunnel mode mpls traffic-eng
  tunnel destination 20.20.0.5
  tunnel ...
...
```

XR

```
router isis
  ...
  address-family ipv4 unicast
    mpls traffic-eng level-1
    mpls traffic-eng level-2
    mpls traffic-eng router-id Loopback0
  !
  rsvp
    inter ...
      bandwidth percent 75
    ...
  !
  mpls traffic-eng
    inter ...
  !
  interface tunnel-te 75
    ipv4 unnumbered Loopback0
    destination 20.20.0.5
    path-option 1 explicit name R75
  ...
```

Demo: MPLS TE





Preparation Materials, Tips & Tricks

CCIE Exam Preparation

LEARN

- Read
- Understand
- Remember

PRACTICE

- Basic Scenario
- Increase Difficulty

PRACTICE

- Explore
- Observe
- Invent

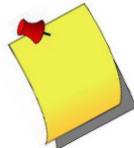
TROUBLESHOOT

- Verify
- Anticipate
- Validate

Lab Exam: Tips & Tricks

Before the exam

- Prepare for the exam!
- Plan your study
 - Do self assessment, “know what I don’t know”
 - Dedicate time per day
 - Always ask “What if”
 - Practice, practice, and practice
- Learn how to browse on Cisco Documentation (sort, don’t search)
- Choose materials from trustworthy source
- Practice for speed and troubleshooting



Build a study plan that works for you

Lab Exam: Tips & Tricks

Practice Labs - Guidelines

- Practice lab exercises with high level of complexity
 - Track your improvements
 - Identify areas requiring extra study
 - Adjust your study plan according to your findings
- Technical skill is not the only thing you need to work on
 - Time management and exam-taking strategy is also important
- Know how to navigate on Cisco documentation without using the search function



Newton's first law:

An object that is at rest will stay at rest unless an external force acts upon it!

Lab Exam: Tips & Tricks

Day Before the Lab Exam

- Arrive in the country, if you have to travel
 - Check Visa requirement in advance
- Survey the lab location
- Plan the trip to the lab location
 - train timetable
 - book a taxi
 - etc



Lab Exam: Tips & Tricks

Night Before the Big Day

- Have a good dinner
- Have a good sleep
- Do whatever you enjoy
 - To have a fit body, and
 - A mental condition for the BIG DAY



Lab Exam: Tips & Tricks

During the exam

- Reduce stress, arrive early, and prepare IDs!
- Listen to the proctor's guidelines
- **Re-draw the topology:** physical, addressing, IGP and BGP topology per address-family
- Manage your time! Stick to your strategy!
- Read the whole module, don't forget the guidelines!
- Don't get stuck at the beginning, build your confidence!
- Read, read and read the questions before asking for clarification to the proctor
- **Save the configuration often!**
- **Avoid last minute change!**
- Plan for “regression tests” and overall validations at the end of each module!

Lab Exam: Tips & Tricks

Lab Exam Proctors

- Proctor's role is to keep exam fair
- Talk to proctor if you don't understand the question
- Report any equipment or technical problems to the proctor as soon as it occurs

Lab Exam: Tips & Tricks

After the Lab Exam

- If you pass
 - CONGRATULATION
 - If you fail
 - Release the anger! Do whatever you have to do
 - Try to switch from “Denial” to “Curious” quickly
 - Start looking for your mistakes
 - Repeat the scenarios in your own lab you have practice
 - Back to lab practice focusing on the failed scenarios
 - Book the next lab exam
- If you are 100% sure the CCIE Program team is wrong ask for review**

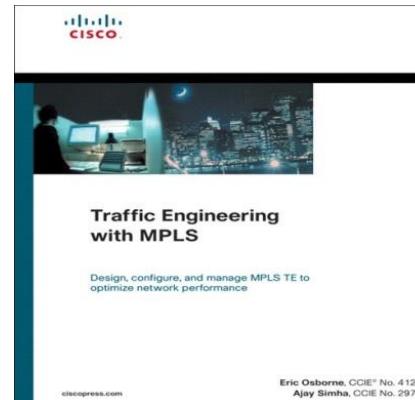
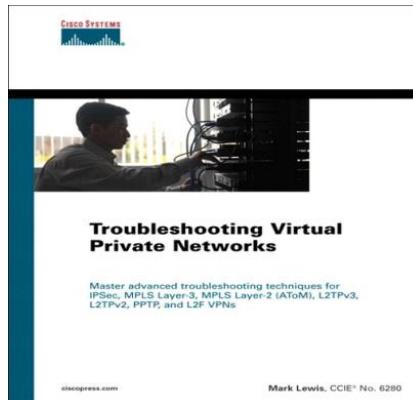
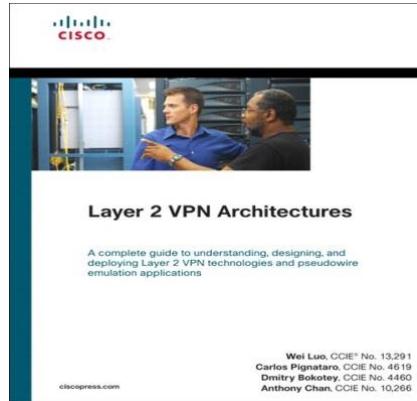
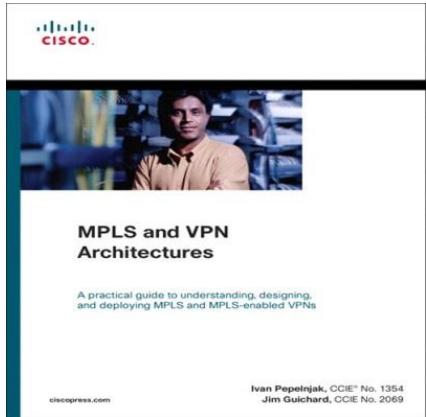


Preparation Materials

- Cisco Learning Network (CLN)
- Cisco Expert-level Training Program for CCIE SP
- New Cisco Press titles
- Cisco.com Products, Technology documentation, configuration guide
- Cisco.com Whitepapers, Design Zone, etc
- Cisco Forums
- Cisco Tools
- External Resources

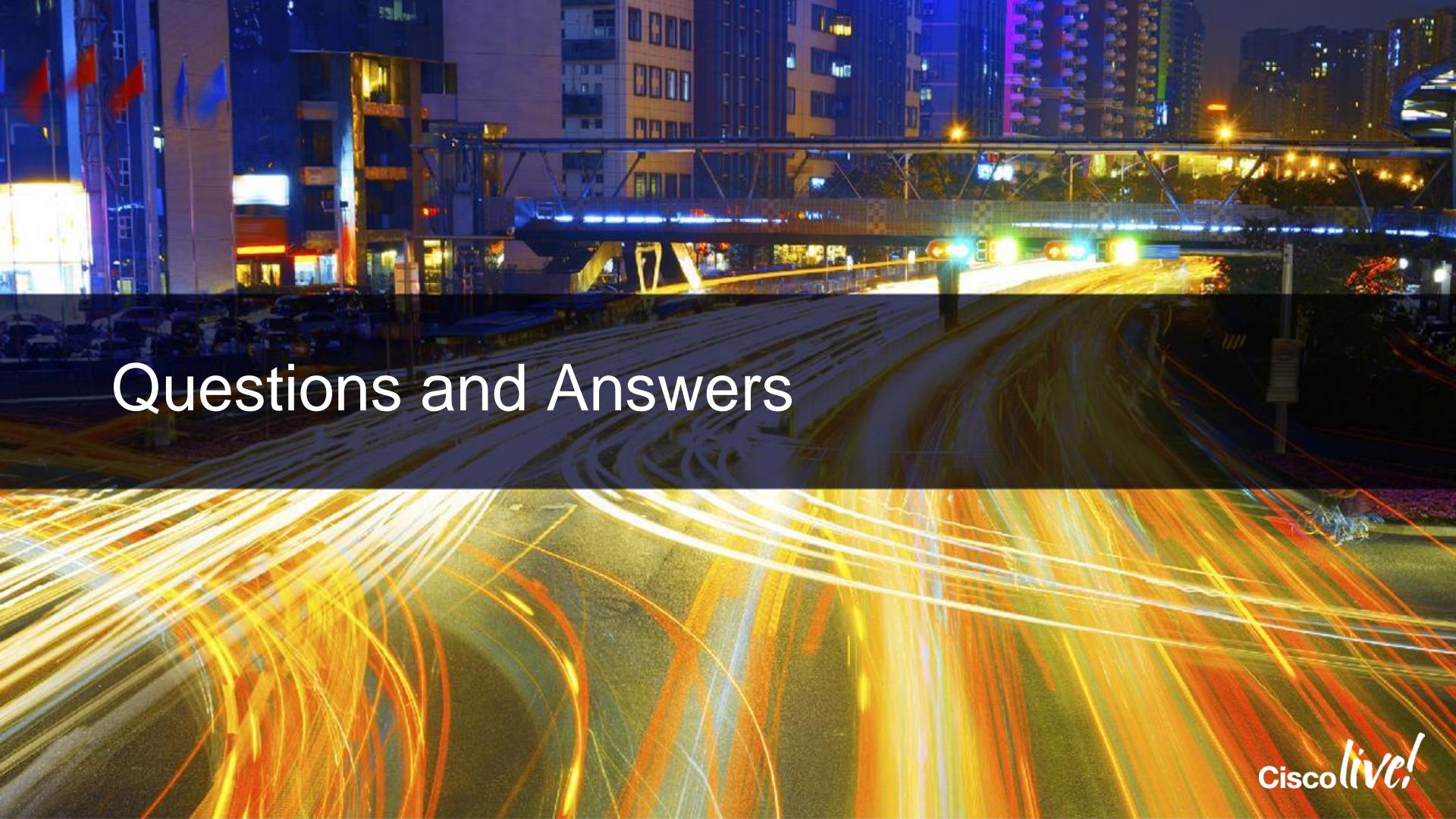
Cisco *live!*

Recommended Reading



On-line Resources, Training, ...

- <https://learningnetwork.cisco.com/docs/DOC-10002>
- <https://learningnetwork.cisco.com/docs/DOC-10144>
- <https://learningnetwork.cisco.com/docs/DOC-10088>
- <https://learningnetwork.cisco.com/groups/ccie-sp-study-group>
- <https://supportforums.cisco.com>
- www.cisco.com/go/documentation
- www.cisco.com/go/tools
- <http://docwiki.cisco.com>



Questions and Answers



What is Next?

Continue Your Education

- Demos in the Cisco Campus
- Walk-in Self-Paced Labs (WISP Labs)
- Table Topics
- Meet the Engineer 1:1 meetings



Become a Cisco Subject Matter Expert

- Do you consider yourself a Subject Matter Expert?
- Would like to lend your expertise to the Cisco Certification Exam?



<http://www.cisco.com/go/certsme>

DESIGN
LAB

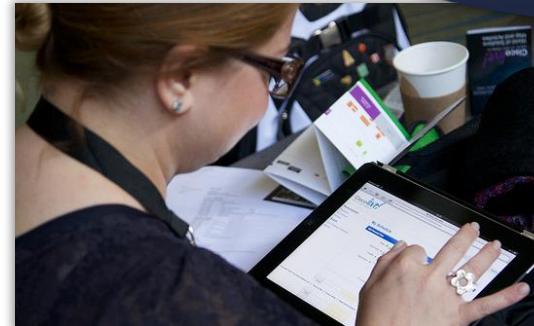


- SMART Goal Setting**
- S**pecific
 - M**easurable
 - A**ttainable
 - R**elevant
 - T**ime-Bound

Cisco *live!*

Complete Your Online Session Evaluation

- Please complete your online session evaluations after each session.
Complete 4 session evaluations & the Overall Conference Evaluation (available from Thursday) to receive your Cisco Live T-shirt.
- All surveys can be completed via the Cisco Live Mobile App or the Communication Stations



Cisco **live!**



Thank you.

Cisco *live!*





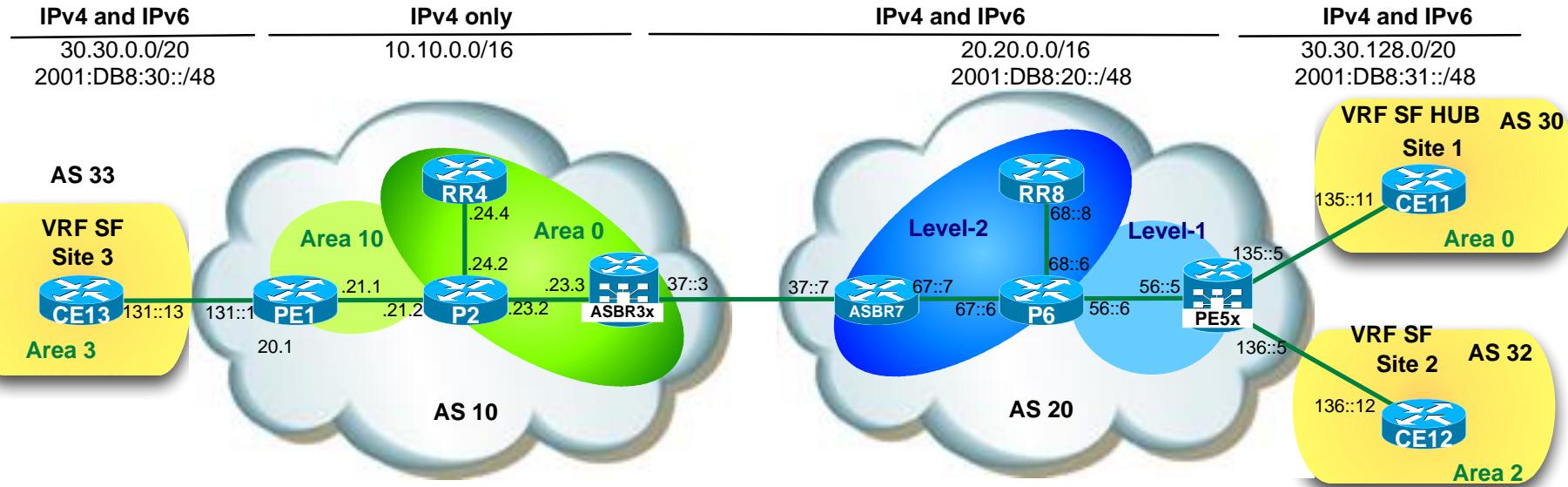
Case 4: Inter-AS L3VPN

Inter-AS L3VPN – RFC 4364

Highlights

- Option (10) A
 - One link per VRF
 - ASBRs exchanges IPv4/IPv6 prefixes per VRF link
 - VPN isolated from each AS domains
- Option (10) B: ASBRs exchanging VPN-IPv4 and VPN-IPv6 addresses
 - ASBR exchanges VPNv4 and VPNv6 prefixes
 - Next-hop changes at ASBRs
 - One LSP per AS domain
- Option (10) C: ASBRs exchanging IPv4 routes and MPLS Labels
 - RR exchanges VPNv4 and VPNv6 prefixes by using multi-hop eBGP peering
 - Next-hop unchanged
 - One LSP end-to-end

Topology – Option B



Question:

Configure Inter-AS VPNv4 and VPNv6 between AS 10 and AS 20. Use ASBR to exchange VPNv4 and VPNv6 prefixes

VRF Configuration

IOS

```
vrf definition SF
  rd 20:12
!
address-family ipv4
  route-target export 30:30
  route-target import 30:31
!
address-family ipv6
  route-target export 30:30
  route-target import 30:31
!
interface ...
  vrf forwarding SF
  ip address ...
  ipv6 address ...
...

```

XR

```
vrf SF
  address-family ipv4 unicast
    import route-target
      30:31
    export route-target
      30:30
!
  address-family ipv6 unicast
    import route-target
      30:31
    export route-target
      30:30
!
  interface ...
    vrf SF
    ipv4 address ...
    ipv6 address ...

```

MP-BGP Configuration

IOS

```
router bgp 20
neighbor 20.20.20.8 remote-as 20
...
neighbor 20.20.37.3 remote-as 10
...
address-family vpnv4
neighbor 20.20.20.8 activate
neighbor 20.20.20.8 send-community ext
...
!
neighbor 20.20.37.3 activate
neighbor 20.20.37.3 send-community ext
```

XR

```
router bgp 20
address-family vpnv4 unicast
address-family vpnv6 unicast
!
neighbor 20.20.20.8
remote-as 20
address-family vpnv4 unicast
address-family vpnv6 unicast
...
!
neighbor 20.20.37.3
remote-as 10
...
address-family vpnv4 unicast
route-policy ALL in
route-policy ALL out
address-family vpnv6 unicast
...
```

PE – CE Routing Configuration

IOS

```
interface ...
  vrf forwarding SF
  ip ospf 3 area 0
  ...
!
router ospf 3 vrf SF
  router-id 30.30.136.5
  ...
router bgp 20
  address-family ipv4 vrf SF
    redistribute ospf ...
  !
  address-family ipv6 vrf SF
    neighbor 2001:db8:31:136::12 remote-as 32
    neighbor 2001:db8:31:136::12 activate
  ...
...
```

XR

```
route ospf 3
  vrf SF
    address-family ipv4
      area 3
      interface ...
      ...
router bgp 20
  vrf SF
    rd 20:12
    address-family ipv4 unicast
      redistribute ospf ...
  !
  address-family ipv6 unicast
    neighbor 2001:db8:31:136::12
      remote-as 32
    address-family ipv6 unicast
      route-policy ALL in
      route-policy ALL out
  ...
...
```

Demo Inter-AS L3VPN



6PE – Troubleshooting

Highlights

- IPv6 service delivery without enabling IPv6 in the MPLS core
- Leverage the MPLS services already enabled in the core
 - Free BGP core, per example
- Require configuration only on PE devices

6PE – Troubleshooting

Problem Analysis

- Cisco 6PE requires that Multi-protocol BGP be further extended to be able to bind an MPLS label to the IPv6 route.
- The label binding information is piggybacked along the prefix advertisement in the same MP_REACH_NLRI attribute with SAFI value of 4.
- Under IPv6 address-family, use IPv4 address for BGP peering
 - Adding “send-label”
- Check to make sure proper labels are allocated
 - “show bgp ipv6 unicast labels”

Solution Reference

IOS – PE1

```
router bgp 10
neighbor 10.10.0.4 remote 10
neighbor ...
neigh 2001:DB8:CAFE:10::20 remote 200
neigh ...
!
address-family ipv6
  neigh 10.10.0.4 activate
  neigh 10.10.0.4 send-label
  neigh ...
!
neigh 2001:DB8:CAFE:10::20 activate
neigh ...
```

XR – ASBR3

```
Router bgp 10
  address-family ipv4 unicast
  !
address-family ipv6 unicast
  allocate-label all
  !
  neighbor 10.10.0.4
  ...
address-family ipv6 label-unicast
  !
  neighbor 2001:DB8:CAFE:10::20
    remote-as 200
  ...
```

Verification

PE1

```
PE1#sh bgp ipv6 unicast labels
      Network          Next Hop          In label/Out label
2001:10:10::20/128
              2001:DB8:CAFE:10::20
                      23/nolabel
2001:20:20::7/128
              ::FFFF:10.10.0.3
                      nolabel/16009
2001:DB8:CAFE:10::/64
              ::
                      24/nolabel
2001:DB8:CAFE:37::/64
              ::FFFF:10.10.0.3
                      nolabel/16010
```

Verification

RR4

```
RR4#sh bgp ipv6 unicast labels
      Network          Next Hop          In label/Out label
2001:10:10::20/128
                  ::FFFF:10.10.0.1
                               nolabel/23
2001:20:20::7/128
                  ::FFFF:10.10.0.3
                               nolabel/16009
2001:DB8:CAFE:10::/64
                  ::FFFF:10.10.0.1
                               nolabel/24
2001:DB8:CAFE:37::/64
                  ::FFFF:10.10.0.3
                               nolabel/16010
```

Verification

ASBR3

```
RP/0/0/CPU0:ASBR3#sh bgp ipv6 unicast labels
Fri Jan  2 14:25:15.856 UTC
Status codes: s suppressed, d damped, h history, * valid, > best
               i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop        Rcvd Label      Local Label
*>i2001:10:10::20/128 10.10.0.1      23            nolabel
*> 2001:20:20::7/128  2001:db8:cafe:37::7
                                         nolabel      16009
*>i2001:db8:cafe:10::/64
                           10.10.0.1      24            nolabel
*> 2001:db8:cafe:37::/64
                           ::             nolabel      16010
```

Processed 4 prefixes, 4 paths

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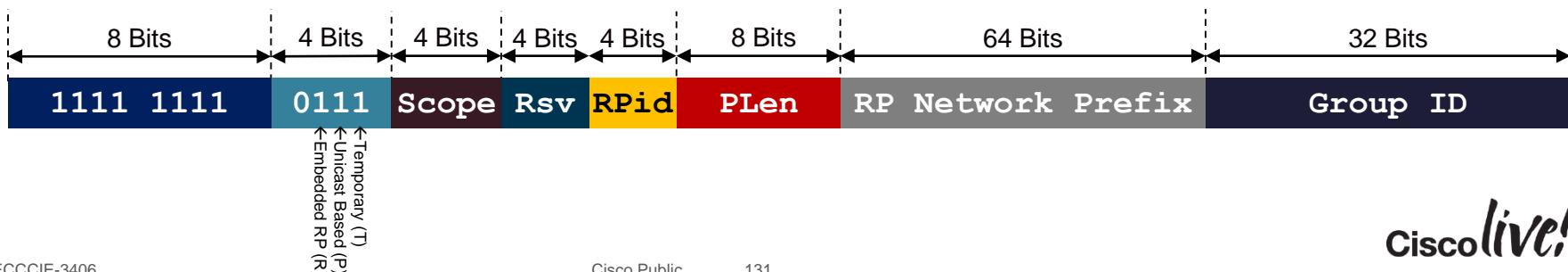


Scenario 5: IPv6 Multicast – Embedded RP

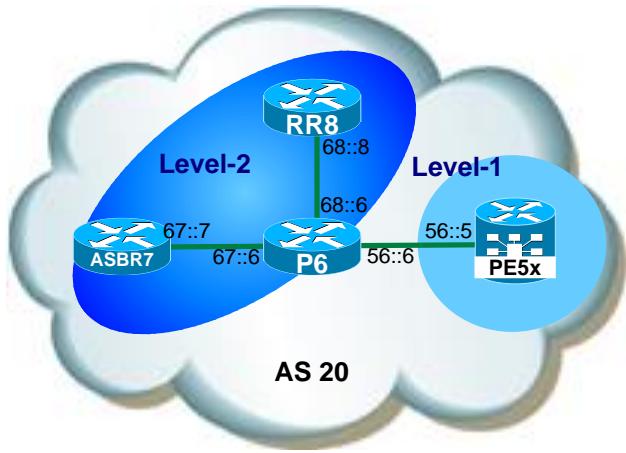
IPv6 Embedded RP Multicast Address (RFC 3956)

Highlights

- No change in actual PIM-SM protocol operation
- Made possible due to large IPv6 address space
- Based on IPv6 Unicast Based Multicast Address (RFC 3306)
- RP-id field can be 1 -15 (1-F HEX)
 - There can be 15 RPs per scope per prefix
 - Total of 256 RP addresses per unicast prefix
- Embedded RP start with FF7x::/12



Topology



P6's Loopback 0: 2001:db8:6::6/64

Question:

Enable IPv6 Multicast on AS 20. Make P6 to be the RP (use Loopback 0 address). You are not allowed to use static RP method, neither BSR.

Configuration

IOS

```
! All routers
ipv6 multicast-routing
!
! RP router
ipv6 pim rp-address 2001:db8:6::6 GROUP
!
ipv6 access-list GROUP
    permit ipv6 any FF75:640:2001:DB8:6::/96
    permit ipv6 any FF7E:640:2001:DB8:6::/96
!
!
! Join group for
interface Loopback 0
    ipv6 mld join-group FF75:640:2001:DB8:6::5
```

XR

```
! All Routers
multicast-routing
    address-family ipv6
        interface all enable
    !
    ! RP routers
    router pim
        address-family ipv6
            embedded-rp 2001:DB8:6::6 GROUP
    !
    ipv6 access-list GROUP
        permit ipv6 any FF75:640:2001:DB8:6::/96
        permit ipv6 any FF7E:640:2001:DB8:6::/96
    !
    Join group
    interface Loopback 0
        ipv6 mld join-group FF75:640:2001:DB8:6::5
```

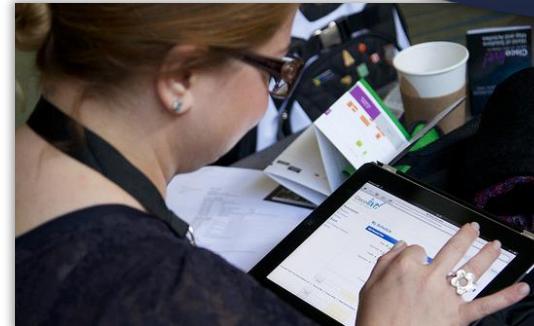
Demo IPv6 Multicast – Embedded RP

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