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Disclaimer

The following publication ***CCIE Service Provider Lab Workbook Volume II***, is designed to assist candidates in the preparation for Cisco Systems' CCIE Service Provider Lab exam. While every effort has been made to ensure that all material is as complete and accurate as possible, the enclosed material is presented on an "as is" basis. Neither the authors nor Internetwork Expert, Inc. assume any liability or responsibility to any person or entity with respect to loss or damages incurred from the information contained in this workbook.

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About IEWB-SP-VOL2

Internetwork Expert's Service Provider CCIE Lab Workbook Volume II (IEWB-SP-VOL2) is designed to be used as a supplement to other self-paced and instructor-led training materials in preparation for Cisco Systems' Service Provider CCIE Lab Exam. IEWB-SP-VOL2 consists of various lab scenarios designed from the ground up based on Cisco Systems' newest specification for the Service Provider CCIE Lab Exam. The labs contained in IEWB-SP-VOL2 are designed to simulate the actual Service Provider CCIE Lab Exam and at the same time illustrate the principles behind the technologies which it covers.

IE's CCIE Service Provider Products

Internetwork Expert's CCIE Service Provider products offer a complete solution designed for candidates who want a structured approach to the CCIE Service Provider certification. These products are targeted for the serious candidate that is willing to invest both the time and effort to pass the CCIE Lab Exam and become a true Internetwork Expert. Internetwork Expert's CCIE Service Provider products consist of both Instructor-Led and Self-Paced materials as follows.

CCIE Service Provider Advanced Technologies Class Online

The CCIE Service Provider Advanced Technologies Class Online (IEATC-SP-ONL) is a five-day instructor-led class delivered through our state-of-the-art online classroom. This class uses a hands-on lecture approach that is designed to provide students with a CCIE-level understanding of the technologies covered in Cisco Systems' CCIE Service Provider Lab Exam.

CCIE Service Provider Advanced Technologies Class-on-Demand

The CCIE Service Provider Advanced Technologies Class-on-Demand (IEATC-SP-COD) is a self-paced version of the Service Provider CCIE Advanced Technologies Class Online. This series uses the exact same hands-on lecture approach seen in the CCIE Service Provider Advanced Technologies Class Online, but is available in a streaming video format. Not only do you hear the instructor's explanation of the technologies in question, you see the configuration live on the IOS command line. This series allows candidates to attend the instructor-led class at their own pace, and gives previous attendants of the live class a convenient way to go back and review the topics covered in the class at a later time.

CCIE Service Provider Lab Workbook Volume I

The CCIE Service Provider Lab Workbook Volume I (IEWB-SP-VOL1) is a hands-on lab series that presents topics in an easy to follow, goal-oriented step-by-step approach. This series is used to isolate topics on their own allowing candidates to see firsthand the various ways to configure each technology, and what the specific implications of a configuration are. By understanding these fundamental operations of the protocols candidates will be able to predict advanced and sometimes subtle interactions when the various technologies are configured together.

CCIE Service Provider Lab Workbook Volume II

Internetwork Expert's CCIE Service Provider Lab Workbook Volume II (IEWB-SP-VOL2) is the most comprehensive self-paced resource available for the CCIE Service Provider Lab exam on the market today. IEWB-SP-VOL2 consists of 10 full-scale 8-hour lab scenarios and a solution guide consisting of hundreds of pages of detailed explanation.

IEWB-SP-VOL2 was designed from the ground up based on the newest CCIE Service Provider Lab Exam specification in order to teach the fundamental principles behind the advanced networking technologies covered in the CCIE Service Provider Lab Exam. In addition, IEWB-SP-VOL2 is designed to simulate the actual CCIE Service Provider Lab Exam.



For More Information

For more information on Internetwork Expert's CCIE Service Provider product line visit us on the web at <http://www.internetworkexpert.com> or call toll free 877-224-8987, +1-775-826-4344 outside the US

How to Use IEWB-SP-VOL2

Internetwork Expert's CCIE Service Provider Lab Workbook Volume II is designed to give candidates practical implementation experience with technologies covered within the CCIE Service Provider Lab Exam. Candidates using this product should already have a theoretical understanding of the majority of the topics covered.

If at any time throughout the progression of these labs you find that you do not fully understand a presented technology, stop where you are and fall back to the fundamental theory for that topic. Using this method will ensure that you are not overlooking key points of the technology that may not be apparent in their application here.

Each of these lab scenarios presented in IEWB-SP-VOL2 are divided into the following technology sections:

1. Layer 2 Technologies
2. Interior Gateway Routing
3. Exterior Gateway Routing
4. MPLS
5. VPN
6. IP Multicast
7. QoS
8. Security
9. System Management
10. IP Services

Each of the above sections is then further subdivided into particular tasks. For each lab scenario you must configure the presented tasks while conforming to various predefined restrictions.

Diagrams

Internetwork Expert's CCIE Service Provider Lab Workbook Volume II includes 20 color diagrams illustrating a different logical topology for each scenario. These diagrams show the logical layer 2 topology, IP addressing, and IGP & BGP protocol assignments. For the most recent copy of these diagrams see Internetwork Expert's members site at <http://members.internetworkexpert.com>.

Restrictions

For each lab scenario there are explicit general restrictions that you must conform to while configuring the lab. These restrictions are defined in the *Lab Do's and Don'ts* introductory section for each lab scenario. These restrictions may include not using static routes, not using default routes, not adding additional IP addressing, etc.

Caution

Ensure that you always read the *Lab Do's and Don'ts* section carefully as the restrictions may vary from lab to lab.

There may also be certain restrictions for particular tasks within a lab scenario. These restrictions may include not issuing a particular configuration command, not creating a certain type of interface, not using the legacy configuration for a technology, etc.

Note

You may do whatever is necessary to complete a task unless the general requirements for the lab scenario or the specific requirements for the task explicitly prohibit you from doing so. This may include using policy routing, redistributing IGPs or BGP, configuring GRE tunnels, etc.

Difficulty Rating

We have given each lab scenario a difficulty rating. Ratings are on a scale of 1 to 10, with 10 being the hardest. The labs within IEWB-SP-VOL2 are designed to be more technically challenging than the actual CCIE Service Provider Lab Exam. Do not get discouraged if you are scoring low or do not understand a particular set of technologies. If you are having trouble with a certain area fall back to the fundamentals for that topic. Using this method will ensure that you are not overlooking key points of the technology that may not be apparent in their application here.

Point Values

Like the actual CCIE lab exam each task within these labs are assigned a specific point value. Points are only awarded if the presented solution meets all the given requirements and does not violate any preset restrictions. No partial credit is awarded for any task. A minimum score of 80 points is required to 'pass' a particular scenario.

Some tasks may have multiple solutions. As long as the presented solution meets the given requirements points will be awarded for that task. However certain solutions may negatively impact previous or future tasks. Make sure that you carefully read all presented requirements and try your best to come up with an appropriate solution.



Caution

Points will never be awarded for a task for which you have violated the requirements. However keep in mind the relative point value of the task in question as compared to other future tasks. If you cannot come up with an appropriate solution for a task it is advisable to solve the task by whatever means necessary in order to complete future tasks which depend on it.

Solutions Guide

In addition to this workbook a detailed solutions guide for Internetwork Expert's Service Provider CCIE Lab Workbook Volume II is included free of charge. The solutions guide includes the final configurations for each lab scenario along with a thorough explanation of each task. The final configurations for IEWB-SP-VOL2 are broken down on a task by task basis. Therefore you will know exactly which command or commands correspond to which task. There is no need to sort through a long configuration file to guess which commands correspond to which question. The solutions guide for IEWB-SP-VOL2 is as much of an integral part of this product as the workbook itself.

For the most recent copy of the IEWB-SP-VOL2 solutions guide see Internetwork Expert's members site at <http://members.internetworkexpert.com>.

Initial Configurations

Internetwork Expert's CCIE Service Provider Lab Workbook Volume II includes initial configuration scripts for all devices in each lab scenario. These configuration scripts should be loaded on your equipment before beginning the configuration of the scenario. In addition to these initial configuration scripts, it is necessary to load the provided configuration files for the backbone devices.

For more detail on the hardware requirements for the internal and external devices in IEWB-SP-VOL2 see the accompanying *Hardware Specification* section of this document.

For the most recent copy of these configuration scripts see Internetwork Expert's members site at <http://members.internetworkexpert.com>.

Rack Rentals

We have built Internetwork Expert's CCIE Service Provider Lab Workbook Volume II to the publicly stated hardware specification used in the actual CCIE lab exam. Internetwork Expert offers cost effective equipment rentals specifically designed to be used with our self-paced training product lines in order to eliminate the cost of buying all the equipment used in IEWB-SP-VOL2.

For more information on rack rentals visit Internetwork Expert on the web at <http://www.internetworkexpert.com>.

Discussion Forum

Interact with countless CCIE's, including the actual authors of the workbook, and engineers around the world preparing for the CCIE Lab Exam via our web forum and IRC server. To get the most out of this and other Internetwork Expert products join the IEWB-SP-VOL2 discussion on the Internetwork Expert Online Community Forum at <http://www.ieoc.com> and on our live IRC chat server at irc.internetworkexpert.com, or <http://www.internetworkexpert.com/chat/> via the web.

Feedback

We want to hear from you! Internetwork Expert is committed to your satisfaction and to improving our product lines. If you have any questions, comments, or concerns about this or any other Internetwork Expert product submit feedback to us via email at feedback@internetworkexpert.com.

CCIE Service Provider Hardware Specification

Internetwork Expert's CCIE Service Provider Lab Workbook Volume II uses the same hardware specification that is used in the actual CCIE lab exam. This includes seven routers with Ethernet, FastEthernet, GigabitEthernet, ATM, and Serial interfaces. The routers run a combination of 12.2S, 12.3T, and 12.4 IOS. In addition to the seven routers, two Catalyst 3550 series switches running the enhanced multilayer software image (EMI) are also included.

As per the actual CCIE lab hardware specification IEWB-SP-VOL2 also includes various external devices that are not within the control of the candidate. These devices include a Frame Relay switch, an ATM switch, and three backbone routers to inject routes and facilitate in the testing of configurations.

The physical topology of IEWB-SP-VOL2 remains the same throughout the entire workbook. Therefore once your lab has been physically cabled to meet the workbook's specification there is no need to change the cabling in order to complete each lab.

The generic devices used in IEWB-SP-VOL2 include the following:

Device	Software Version	Software Feature Set	Interfaces
R1	12.2(25)S9	Service Provider Secure Shell 3DES	1 - FastEthernet 2 - Serial 1 - ATM
R2	12.2(25)S9	Service Provider Secure Shell 3DES	1 - FastEthernet 2 - Serial 1 - ATM
R3	12.3(14)T7	Enterprise Plus/H323 MCM	2 - Ethernet 4 - Serial
R4	12.3(14)T7	Enterprise Plus/H323 MCM	2 - Ethernet 2 - Serial
R5	12.3(14)T7	Enterprise Plus/H323 MCM	2 - Ethernet 2 - Serial
R6	12.4(5)	Advanced Enterprise Services	2 - GigabitEthernet 1 - Serial
R7	12.2(25)SEC	EMI	24 - FastEthernet 2 - GigabitEthernet
R8	12.2(25)SEC	EMI	24 - FastEthernet 2 - GigabitEthernet
R9	12.3(14)T7	Enterprise Plus/H323 MCM	1 - ATM

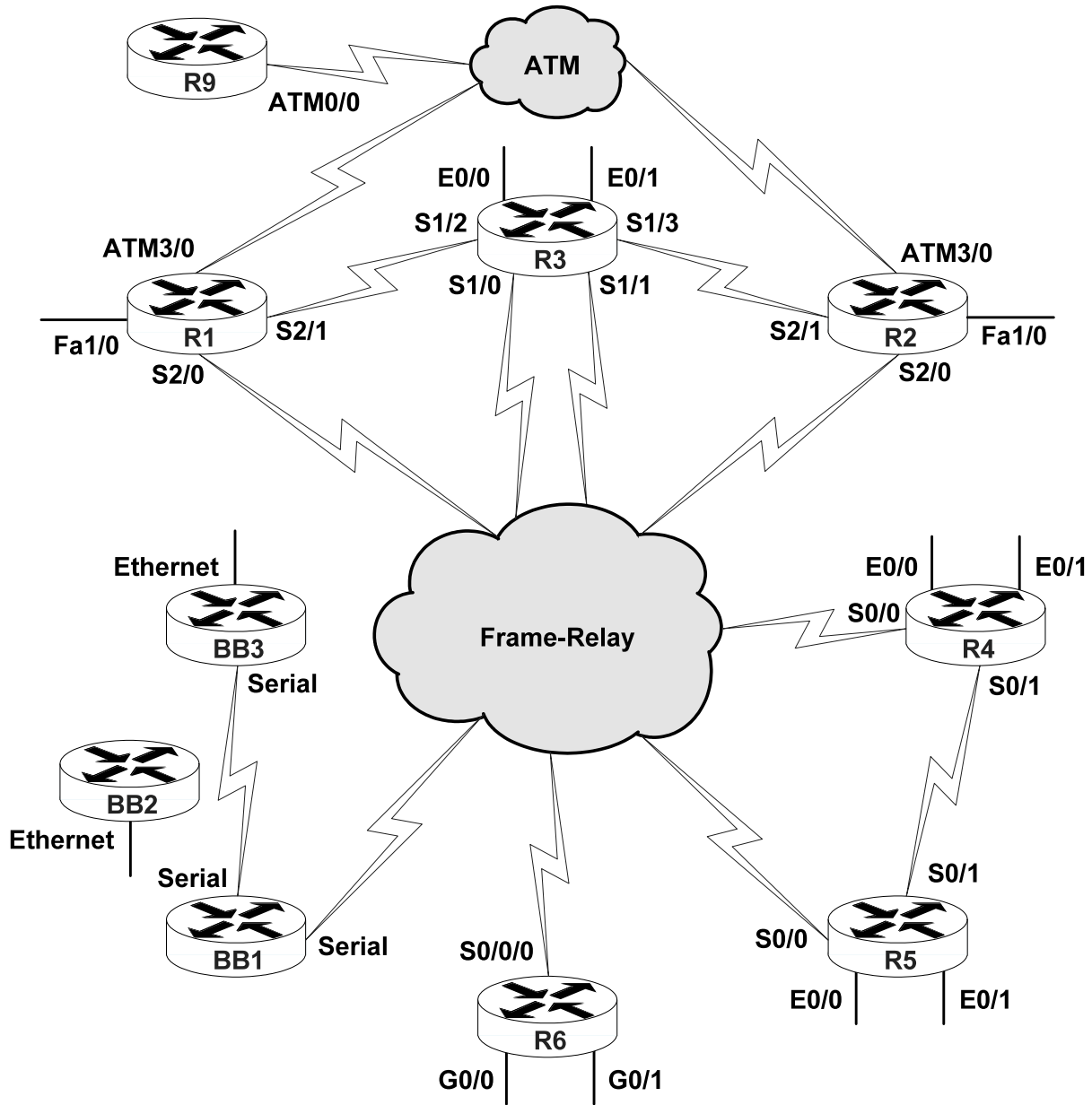
The specific devices used in design of IEWB-SP-VOL2 were the following

Device	Platform	DRAM	Flash	Installed WICs / Modules
R1	7206	128	24	1 - NPE-200 1 - PA-1FE-TX 1 - PA-4T 1 - PA-A1-OC3MM
R1	7206	128	24	1 - NPE-200 1 - PA-1FE-TX 1 - PA-4T 1 - PA-A1-OC3MM
R3	3640	128	32	1 - NM-2E2W 1 - NM-4A/S
R4	3640	128	32	1 - NM-2E2W 2 - WIC-1T
R5	3640	128	32	1 - NM-2E2W 2 - WIC-1T
R6	3825	256	64	1 - WIC-1T
R7	3550-24-EMI	Default	Default	N/A
R8	3550-24-EMI	Default	Default	N/A
R9	3640	128	32	1 - NM-A1-OC3MM

The external core devices used in IEWB-SP-VOL2 include the following

Device	Software Version	Software Feature Set	Interfaces
BB1*	12.2(15)T17	IP Plus	1 - Ethernet
BB2	12.2(15)T17	IP Plus	1 - Ethernet
BB3*	12.2(15)T17	IP Plus	1 - Ethernet
Frame Relay Switch	N/A	N/A	8 - Serial
LS1010 ATM Switch	12.1(27b)E1	N/A	3 - ATM OC3
* BB1 and BB3 will need to peer via iBGP with each other. This can be done over any interface, such as Ethernet, Serial, or even an AUX port to AUX port connection			

IEWB-SP-VOL2 Physical Cabling Connections



IEWB-SP-VOL2 Physical Interface Connections

Frame Relay Switch Configuration					
Local Router	Local Interface	Local DLCI	Remote Router	Remote Interface	Remote DLCI
R1	S2/0	102	R2	S2/0	201
R1	S2/0	103	R3	S1/0	301
R1	S2/0	113	R3	S1/1	311
R1	S2/0	104	R4	S0/0	401
R1	S2/0	105	R5	S0/0	501
R2	S2/0	202	R1	S2/0	102
R2	S2/0	203	R3	S1/0	302
R2	S2/0	213	R3	S1/1	312
R2	S2/0	204	R4	S0/0	402
R2	S2/0	205	R5	S0/0	502
R3	S1/0	301	R1	S2/0	103
R3	S1/0	302	R2	S2/0	203
R3	S1/0	304	R4	S0/0	403
R3	S1/0	305	R5	S0/0	503
R3	S1/1	311	R1	S2/0	113
R3	S1/1	312	R2	S2/0	213
R3	S1/1	314	R4	S0/0	413
R3	S1/1	315	R5	S0/0	513
R4	S0/0	401	R1	S2/0	104
R4	S0/0	402	R2	S2/0	204
R4	S0/0	403	R3	S1/0	304
R4	S0/0	413	R3	S1/1	314
R4	S0/0	405	R5	S0/0	504
R5	S0/0	501	R1	S2/0	105
R5	S0/0	502	R2	S2/0	205
R5	S0/0	503	R3	S1/0	305
R5	S0/0	513	R3	S1/1	315
R5	S0/0	504	R4	S0/0	405
R6	S0/0/0	51	BB1	S0	51
R6	S0/0/0	100	BB1	S0	100
R6	S0/0/0	101	BB1	S0	101
R6	S0/0/0	201	BB1	S0	201
R6	S0/0/0	301	BB1	S0	301
R6	S0/0/0	401	BB1	S0	401

Ethernet Connections			
Local Router	Local Interface	Remote Router	Remote Interface
R1	Fa1/0	R7	Fa0/1
R2	Fa1/0	R7	Fa0/2
R3	E0/0	R7	Fa0/3
R3	E0/1	R8	Fa0/3
R4	E0/0	R7	Fa0/4
R4	E0/1	R8	Fa0/4
R5	E0/0	R7	Fa0/5
R5	E0/1	R8	Fa0/5
R6	G0/0	R7	Fa0/6
R6	G0/1	R8	Fa0/6
R7	Fa0/1	R1	Fa1/0
R7	Fa0/2	R2	Fa1/0
R7	Fa0/3	R3	E0/0
R7	Fa0/4	R4	E0/0
R7	Fa0/5	R5	E0/0
R7	Fa0/6	R6	G0/0
R7	Fa0/13	R8	Fa0/13
R7	Fa0/14	R8	Fa0/14
R7	Fa0/15	R8	Fa0/15
R7	Fa0/24	BB3	N/A
R8	Fa0/3	R3	E0/1
R8	Fa0/4	R4	E0/1
R8	Fa0/5	R5	E0/1
R8	Fa0/6	R6	G0/1
R8	Fa0/13	R7	Fa0/13
R8	Fa0/14	R7	Fa0/14
R8	Fa0/15	R7	Fa0/15
R8	Fa0/24	BB2	N/A

IEWB-SP-VOL2 Physical Interface Connections

ATM Switch Configuration					
Local Router	Local Interface	Local VPI/VCI	Remote Router	Remote Interface	Remote VPI/VCI
R1	ATM3/0	0/102	R2	ATM3/0	0/201
R1	ATM3/0	0/109	R9	ATM0/0	0/901
R2	ATM3/0	0/201	R1	ATM3/0	0/102
R2	ATM3/0	0/209	R9	ATM0/0	0/902
R9	ATM0/0	0/901	R1	ATM3/0	0/109
R9	ATM0/0	0/902	R2	ATM3/0	0/209

IEWB-SP-VOL2 Lab 1

Difficulty Rating (10 highest): 5

Lab Overview:

The following scenario is a practice lab exam designed to test your skills at configuring Cisco networking devices. Specifically, this scenario is designed to assist you in your preparation for Cisco Systems' CCIE Service Provider Lab exam. However, remember that in addition to being designed as a simulation of the actual CCIE lab exam, this practice lab should be used as a learning tool. Instead of rushing through the lab in order to complete all the configuration steps, take the time to research the networking technology in question and gain a deeper understanding of the principles behind its operation.

Lab Instructions:

Prior to starting, ensure that the initial configuration scripts for this lab have been applied. For a current copy of these scripts, see the Internetwork Expert members site at <http://members.internetworkexpert.com>

Refer to the attached diagrams for interface and protocol assignments. Any reference to X in an IP address refers to your rack number, while any reference to Y in an IP address refers to your router number.

Lab Do's and Don'ts:

- Do not change or add any IP addresses from the initial configuration unless otherwise specified
- Do not change any interface encapsulations unless otherwise specified
- Do not change the console, AUX, and VTY passwords or access methods unless otherwise specified
- Do not use any static routes, default routes, default networks, or policy routing unless otherwise specified
- Save your configurations often

Grading:

This practice lab consists of various sections totaling 100 points. A score of 80 points is required to achieve a passing score. A section must work 100% with the requirements given in order to be awarded the points for that section. No partial credit is awarded. If a section has multiple possible solutions, choose the solution that best meets the requirements.

Point Values:

The point values for each section are as follows:

Section	Point Value
Layer 2 Technologies	15
Interior Gateway Routing	8
Exterior Gateway Routing	12
MPLS	12
VPN	20
IP Multicast	9
QoS	9
Security	6
System Management	6
IP Services	3

GOOD LUCK!

1. Layer 2 Technologies

1.1. VLAN Assignments

- Configure the VTP domain CISCO between R7 and R8.
- Authenticate the VTP domain with the password CISCO.
- Create and configure the VLAN assignments on R7 and R8 as follows:

Catalyst Port	Interface	VLAN
R7 Fa1/1	R1 - Fa0/0	13
R7 Fa1/2	R2 - Fa0/0	26
R7 Fa1/3	R3 - E0/0	N/A
R7 Fa1/4	R4 - E0/0	42
R7 Fa1/5	R5 - E0/0	58
R7 Fa1/6	R6 - E0/0	67
R7 Fa1/13	R8 Fa1/13	Trunk
R7 Fa1/14	R8 Fa1/14	Trunk
R7 Fa1/15	R8 Fa1/15	Trunk
R7 Fa1/24	BB3	13
R7	VLAN 67	67
R8 Fa1/3	R3 - E0/1	N/A
R8 Fa1/4	R4 - E0/1	N/A
R8 Fa1/5	R5 - E0/1	5
R8 Fa1/6	R6 - E0/1	26
R8 Fa1/13	R7 Fa1/13	Trunk
R8 Fa1/14	R7 Fa1/14	Trunk
R8 Fa1/15	R7 Fa1/15	Trunk
R8 Fa1/24	BB2	42
R8	VLAN 58	58

3 Points

1.2. Ethernet Security

- A new router will be added to R7's port Fa1/23 in the near future.
- Configure this new device to participate in VLAN 13 between R1 and BB3 in such a way that it cannot communicate directly with BB3.
- Use the minimum number of commands possible to accomplish this task.

3 Points

1.3. Frame Relay PVCs

- Configure the Frame Relay segments between R1 & R2, R1 & R3, and R2 & R3 using the DLCI information provided in the diagram.
- Use point-to-point subinterfaces per the diagram to accomplish this.

2 Points

1.4. Frame Relay PVCs

- Configure the Frame Relay segments between R3 & R4 and R3 & R5 using the DLCI information provided in the diagram.
- Do not use Inverse-ARP or the **frame-relay map** command to accomplish this.

2 Points

1.5. Frame Relay PVCs

- Configure the Frame Relay segment between R6 and BB1 using the DLCI information provided in the diagram.
- Do not use Inverse-ARP or subinterfaces to accomplish this.

2 Points

1.6. Cell Mode MPLS

- Configure MPLS ATM subinterfaces on R1 and R9 per the diagram.
- R1 should use the IP address 150.X.101.1/24 and the VPI/VCI pair of 1/64 to communicate control information with the ATM cloud.
- R9 should use the IP address 150.X.109.9/24.
- R1 should be able to reach the IP address 150.X.101.254 over this link.
- R9 should be able to reach the IP address 150.X.109.254 over this link.

3 Points

2. Interior Gateway Routing

2.1. OSPF

- Configure OSPF area 0 on the Frame Relay network between R1, R2, and R3.
- R3 should be the OSPF DR for both of its segments on this network; do not use the **neighbor** command to accomplish this.
- Configure OSPF area 0 on R1 and R9's connections to the ATM cloud.

3 Points

2.2. OSPF

- Configure OSPF area 0 on the Frame Relay segments between R3 & R4 and R3 & R5.
- Configure OSPF area 0 on the Ethernet segment between R2 and R6.
- Advertise the Loopback0 networks of R1, R2, R3, R4, R5, R6, and R9 into OSPF area 0.

2 Points

2.3. IGP Security

- In order to protect the legitimacy of IGP prefixes sent throughout the service provider network configure R2 and R6 so that OSPF adjacencies on VLAN 26 are authenticated with an MD5 hash of the password CISCO.
- Additionally ensure that other devices on this segment are not able to intercept any OSPF traffic between R2 and R6.

3 Points

3. Exterior Gateway Routing

3.1. BGP Peering

- Configure BGP AS 100 on R1, R4, R5, R6, and R9.
- R1 should peer with R4, R5, R6, & R9, and should be responsible for propagating BGP prefixes between these devices.
- Use the Loopback0 interfaces for all of these peering sessions.

3 Points

3.2. BGP Peering

- Configure BGP AS 10000 on R8.
- Configure EBGP peerings between R1 & BB3, R5 & R8, and R6 & BB1.

3 Points

3.3. BGP Communities

- In order to perform internal traffic engineering AS 100 has decided to implement a system of BGP community tagging.
- Configure AS 100 so that BGP updates received from EBGP neighbors are tagged with the community value 100:ASN where ASN is the BGP Autonomous System number of the EBGP neighbor.
- Ensure that these values are propagated end-to-end throughout the service provider network and that the **show ip bgp w.x.y.z** output, where w.x.y.z is a BGP learned prefix, shows the community values in the format 100:ASN.

3 Points

3.4. BGP Bestpath Selection

- Advertise R8's Loopback0 network into BGP.
- Configure the network so that traffic from R8's Loopback going to routes in the community 100:54 uses the link between R6 and BB1.
- In the case that the link between R6 and BB1 is down traffic from R8's Loopback to routes in this community should be rerouted out the connection between R1 and BB3.

3 Points

4. MPLS

4.1. Frame Mode Label Distribution

- Configure MPLS on the Frame Relay segments between R1 & R2, R1 & R3, and R2 & R3.
- Configure MPLS on the Frame Relay segments between R3 & R4 and R3 & R5.
- Configure MPLS on the Ethernet segment between R2 and R6.
- Use a standards based label distribution method on all of these devices.

3 Points

4.2. Cell Mode Label Distribution

- Configure MPLS on R1 and R9's connections to the ATM cloud.
- Use a Cisco proprietary label distribution method on this connection.

3 Points

4.3. MPLS Security

- For added security throughout the service provider network configure R2 and R6 to authenticate the MPLS session between them using an MD5 hash of the password CISCO.

3 Points

4.4. MPLS Traffic Engineering

- In order to avoid over-utilized links throughout the network your design team has requested that an MPLS TE Tunnel with a 10Mbps guarantee be configured between R4 and R6.
- Configure the network so that traffic from R4 to R6 over this tunnel uses the Frame Relay link to R3, the Frame Relay link between R3 & R1, the Frame Relay link between R1 & R2, and the Ethernet link between R2 & R6.
- Traffic from R6 to R4 should use the same path back.
- In the case of a link failure between R1 and R3 this tunnel should be dynamically rerouted through any other available path.
- Assume that all Frame Relay links are DS3 (45Mbps).

3 Points

5. VPN

5.1. VRF Configuration

- AS 100 has been contracted to provide MPLS VPN service between R7 and BB2.
- Configure VRF *VPN_A* on R4 and R6 to accomplish this.
- This VRF should use the route distinguisher 100:1.
- Routes coming from R7 should be assigned a route-target 100:67.
- Routes coming from BB2 should be assigned a route-target of 100:42.

3 Points

5.2. PE-CE Routing

- AS 100 has agreed to run RIPv2 inside *VPN_A* to exchange IPv4 prefixes between R7 and BB2.
- Configure RIPv2 on R7's VLAN 67 and Loopback 0 network.
- Configure RIPv2 for VRF *VPN_A* on R4 and R6.
- All RIPv2 updates should be MD5 authenticated with the password CISCO.

3 Points

5.3. VPNv4 Exchange

- Redistribute between RIPv2 and BGP on R4 and R6.
- VPNv4 routes between R4 and R6 should first be advertised to R1.

3 Points

5.4. Internet Access from MPLS VPNs

- As part of the MPLS VPN Service Agreement devices in *VPN_A* will need access to the networks attached to R8.
- Configure R5 so that devices in *VPN_A* have routing information about the Loopback of R8.
- The use of one static route is allowed to accomplish this.

3 Points

5.5. VRF Aware NAT

- Since devices in *VPN_A* do not use publicly routable address space AS 100 has agreed to perform address translation for traffic coming from *VPN_A* going to R8.
- Configure R5 so that traffic from the networks attached to R7 is translated to R5's Loopback0 network.
- All other traffic from *VPN_A* should be translated to the 191.X.58.5 address of R5.

3 Points

5.6. VRF Configuration

- Configure VRF *VPN_B* on R5's connection to VLAN 5 using the route distinguisher 100:5.
- Configure the network in such a way that only R7 has connectivity to VLAN 5.
- Do not use an **export-map** or **import-map** to accomplish this.

3 Points

5.7. VRF Configuration

- Configure a new Loopback interface on R9 with the IP address 10.X.9.9/32.
- Configure the network in such a way that R9 has reachability to all destinations in *VPN_A* when sourcing traffic off this new Loopback.

2 Points

6. IP Multicast

6.1. PIM

- In addition to IPv4 unicast traffic AS 100 has been contracted to transport IPv4 multicast traffic between R7 and BB2.
- To facilitate this configuration enable PIM on the following links:

Device	Interface
R1	S2/0.12
R1	S2/0.13
R2	Fa1/0
R2	S2/0.12
R3	S1/0.2
R3	S1/1.13
R4	S1/0.1
R6	E0/1

- Configure PIMv2 so that R3 disseminates RP to group mappings and accepts all PIM register messages throughout the multicast network.

3 Points

6.2. Multicast over MPLS VPNs

- Configure PIM Sparse-Mode for VRF *VPN_A* on R4 and R6.
- R6 should be the Rendezvous Point for this VRF.
- All multicast traffic between R7 and BB2 should use the administratively scoped multicast group address 239.100.0.1.

3 Points

6.3. Multicast Testing

- To facilitate in testing of your multicast network configure the devices in such a way that when R7 sends ICMP echos to the address 224.1.2.3 R4 sends ICMP echo-replies from the IP address 192.10.X.4.

3 Points

7. QoS

7.1. VPN QoS

- The MPLS Service Level Agreement for *VPN_A* dictates that AS 100 must guarantee up to 1Mbps of data transit and 640Kbps of VoIP prioritization throughout the service provider network. In order to fulfill this agreement your design team has asked you to implement the following specification on R4 and R6:
 - VoIP traffic up to 640Kbps received from R7 and BB2 should be marked as MPLS EXP 4.
 - VoIP traffic above 640Kbps should be dropped.
 - All other traffic up to 1Mbps received from R7 and BB2 should be marked as MPLS EXP 3.
 - All other traffic above 1Mbps should be dropped.
- Assume that VoIP traffic uses UDP in the port range of 16384 – 32767.
- Routing protocol traffic should not be affected by this policy.

3 Points

7.2. Congestion Management

- For *VPN_A* data traffic transiting the service provider network your design team has asked you to implement the following specification:
 - Traffic marked as MPLS EXP 3 transiting between R4 and R6 should be guaranteed a minimum of 1Mbps of bandwidth on all links in the transit path.
 - MPLS EXP 3 traffic in excess of 1Mbps should not be subject to drop unless the output queue of the interface is full.
- This policy must stay in effect if the MPLS TE Tunnel between R4 and R6 has been rerouted due to a link failure between R1 and R3.

3 Points

7.3. Prioritization

- For *VPN_A* VoIP traffic transiting the service provider network your design team has asked you to implement the following specification:
 - Traffic marked as MPLS EXP 4 transiting between R4 and R6 should be guaranteed a maximum of 640Kbps of priority on all links in the transit path.
 - MPLS EXP 4 traffic in excess of 640Kbps should not be guaranteed low latency but should not be subject to drop unless the output queue of the interface is full.
- This policy must stay in effect if the MPLS TE Tunnel between R4 and R6 has been rerouted due to a link failure between R1 and R3.

3 Points