



CCIE Routing and Switching v4.0 Troubleshooting Practice Labs

Martin J. Duggan

Cisco Press



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Luc De Ghein, CCIE No. 1897, has 17 years of experience in networking and is currently employed by Cisco. He is a technical leader in the Technical Assistance Center, focusing on IP routing protocols and Multiprotocol Label Switching (MPLS) technologies. He provides escalation support to Cisco engineers worldwide and teaches others about IP routing, IP multicast, and MPLS technologies.

Dedication

I want to dedicate this publication to my children, Anna and James. You two are my *raison d'être*. The time we get to spend together is extremely valuable to me and will never be enough. I am so proud of you. Anna; your cuddles are priceless. And James, please believe me when I say I really am trying my hardest at tennis; I might hold back a little at Call of Duty, though.

I also want to add a dedication to my lovely Lotte. I know this is not quite as glamorous as your recent TV appearance, but once again you are singled out for your enviable qualities. You make me laugh; you make me happy; you even make me pedal harder. Time spent with you is blissful, and I am extremely privileged to have you in my life.

Mum and Dad, as always, thanks for being there.

Acknowledgments

I want to thank Brett Bartow for again providing me with an opportunity to write for Cisco Press. I must be one of the worst authors in terms of meeting deadlines, so Brett, thank you for your patience and understanding.

To Bruno and Luc, who reviewed the material that comprises this publication, thank you for your suggestions and input. I really value your contributions.

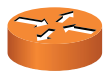
To the guys on the account I work with in Portsmouth: Neil, Ian, Matt, and Andy. Thanks for use of the lab. You are a pleasure to work with, you run the account well, and I know it is always going to be interesting when you need a second opinion on something. I still think about our groundbreaking “Chuckle Brothers” solution to that problem and really grin: from me, to you, to me, to you! We should have implemented it purely for comedy value. Oh, and Richard, thanks for the pizzas while we fixed that issue; that was quality project management.

And thanks to the instructors at Lasham Gliding School. You freely give your time and experience to prevent newbies like me from seeing what it feels like to bail out and pull that enticing rip cord. Thanks for giving me my wings and letting me loose.

To Chris Barney, my CCIE counterpart and Networkers buddy, thanks for standing in for me and keeping me up-to-date about new technology.

To my cricket team (Whitchurch, Hampshire), who still for some unknown and unjustified reason have not put me in as the opening batsman, thanks for having me (and there are plenty more sixes to come).

Icons Used in this Book



Router



Bridge



Hub



DSU/CSU

Catalyst
SwitchMultilayer
SwitchATM
SwitchISDN/Frame Relay
SwitchCommunication
Server

Gateway



Access Server



Token Ring



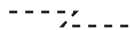
FDDI



Network Cloud

Frame Relay
Virtual Circuit

Line: Ethernet



Line: Switched Serial



Line: Serial

Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

Boldface indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a show command).

Italics indicate arguments for which you supply actual values.

Vertical bars (|) separate alternative, mutually exclusive elements.

Square brackets [] indicate optional elements.

Braces { } indicate a required choice.

Braces within brackets [{ }] indicate a required choice within an optional element.

Introduction

For more than 10 years, the CCIE program has identified networking professionals with the highest level of expertise. Less than 3 percent of all Cisco certified professionals actually achieve CCIE status. The majority of candidates who take the exam fail at the first attempt because they are not fully prepared. They generally find to their own cost that their study plan did not match what was expected of them in the exam. The troubleshooting labs within this publication have been designed to take you as close as possible to actually taking the Troubleshooting section within the real CCIE lab exam.

Exam Overview

The CCIE qualification consists of two exams: a 2-hour written exam followed by an 8-hour hands-on lab exam that includes a Troubleshooting section. Written exams are computer-based, multiple-choice exams lasting 2 hours and available at hundreds of authorized testing centers worldwide. The written exam is designed to test your theoretical knowledge to ensure you are ready to take the lab exam, and so you are eligible to schedule the lab exam only after you have passed the written exam. Because you have purchased this publication, it is assumed that you have passed the written exam and are ready to practice for the lab exam. The lab exam consists of a 5.5-hour hands-on exam that requires you to configure a series of complex scenarios in strict accordance with the questions. You need to secure a minimum score of 80 percent here; and although it is tough, it is achievable. The lab exam also has a Troubleshooting section that lasts 2 hours, and you also face a series of more questions for a 30-minute period of the exam. Again, you need to secure a minimum score of 80 percent here to be successful. You can find current lab blueprint content information at <https://learningnetwork.cisco.com/docs/DOC-4603>.

Study Roadmap

Taking the lab exam is all about experience. You cannot expect to take it and pass after just completing your written exam and relying on just your theoretical knowledge. You must spend countless hours of rack time configuring features and learning how protocols interact with one another. To be confident enough to schedule your lab exam, review the following points.

Assessing Your Strengths

Using the content blueprint, determine your experience and knowledge in the major topic areas. For areas of strength, practicing for speed should be your focus. For weak areas, you might need training or book study in addition to practice.

Study Materials

Choose lab materials that provide configuration examples and take a hands-on approach. Look for material that is approved or provided by Cisco and its Learning Partners.

Hands-On Practice

Build and practice your lab scenarios on a per-topic basis. Go beyond the basics and practice additional features. Learn the show and debug commands along with each topic. If a protocol has multiple ways of configuring a feature, practice all of them.

Cisco Documentation CD

Make sure you can navigate the Cisco documentation CD with confidence because this is the only resource you are allowed during the lab (or restricted access to the same content on Cisco.com). Make the CD part of your regular study; if you are familiar with it, you can save time during the exam.

Home Labs

Although acquiring a personal home lab is ideal, it can be costly to gather all the equipment you may need.

Cisco 360 Program

The Cisco 360 Learning Program encompasses six stages of activity to support successful learning for students.

- **Assessment:** Students take a diagnostic pre-assessment lab to benchmark their knowledge of various networking topics.
- **Planning:** Based on the pre-assessment, students create a learning plan that uses a mix of learning components to focus their study.
- **Learning:** Students learn by participating in lessons and lectures, reading materials, and working with peers and instructors.
- **Practice:** Students use the practice exercises to apply learning on actual network equipment.
- **Mastery:** Students measure their understanding by completing assessments of knowledge and skill for various approaches to solving network problems.
- **Review:** Students review their work with a mentor or instructor and tune their skills with tips and best practices.

You can find detailed information about the 360 program at https://learningnetwork.cisco.com/community/learning_center/cisco_360/360-rs.

Equipment List and IOS Requirements

The lab exam tests any feature that can be configured on the equipment and the IOS versions indicated here:

- 1841 series routers, IOS 12.4(T)–Advanced Enterprise Services
- 3825 series routers, IOS 12.4(T)–Advanced Enterprise Services
- Catalyst 3560 series switches running IOS Version 12.2S–Advanced IP Services

Troubleshooting Information and Technique

During the Troubleshooting section of the exam, you are presented with a series of trouble tickets (incidents) for preconfigured networks and need to diagnose and resolve the network faults. The section lasts for 2 hours, with a visible countdown and a 15-minute warning before the end. The questions are symptom-based, and the verification will be result based with any stipulated con-straints. As with the Configuration section, the network must be up and running to receive credit. If you finish the Troubleshooting section early, you can proceed to the Configuration section, but you will then not be permitted to go back to the Troubleshooting section.

Be aware that the routers and switches within the Troubleshooting section of the CCIE lab are virtual devices; therefore, you will always see interfaces shown as up/up rather than up/down.

Troubleshooting Preparation

- Build a rock-solid knowledge base by studying the theory and completing as many practice labs as possible.
- Create your own troubleshooting strategy. For instance, you might start from Layer 1 and work up; start at Layer 7 and work down; use the split-half method; and so on. If you have a well-tested strategy, you will find tackling the incidents much eas-ier than if you just follow a gung-ho approach and should be able to troubleshoot any scenario presented.

- Spend time with your colleagues or like-minded friends; have them break or introduce configuration errors into a topology you are not familiar with for you to troubleshoot. Each time you complete a practice lab, ask someone to completely sabotage the configurations and see how long it takes you to fix it, all the time enhancing your strategy and speed.

Troubleshooting Approach

- Define the actual problem from the information provided within the incident. Ensure you have a clear and concise problem statement that you can translate to a specific network issue.
- Identify the symptoms. This is where you must call on your hard-earned knowledge and experience. You may be able to identify immediately why a neighbor relationship is failing. If you cannot, use the tools available to you in the form of show and debug commands. When you can clearly see the symptom, the solution should be apparent.
- If you have multiple solutions, work through them according to your strategy and use the full cycle of implement, verify, and investigate to find the correct solution.
- You may find you have strict guidelines related to an incident. These could be easy fixes that you should not apply; they might mask the issue and not actually address the root cause. Stick to the guidelines; otherwise, you risk not earning points for your solution.

Chapter 1

Troubleshooting Lab 1 (The Warm-Up)

The CCIE exam commences with 2 hours of troubleshooting “tickets” followed by 5.5 hours of configuration and then a final 30 minutes of additional questions. This troubleshooting lab has been timed to last for 2 hours and be representative of the format and difficulty of the tasks you are likely to encounter on your CCIE lab exam.

Ideally, you should work on this exercise for 2 hours and score yourself at that point. Of course, you may continue until you believe you have met all the objectives, but you will need to increase your speed as you near your lab exam.

You now are going to be guided through the equipment requirements and pre-lab tasks in preparation for taking this troubleshooting lab.

If you do not own seven routers and three switches (which have been used to create this troubleshooting lab), consider using the equipment available and additional lab exercises and training facilities available within the CCIE R&S 360 program. You can find detailed information about the 360 program and CCIE R&S exam at the following websites, respectively:

- https://learningnetwork.cisco.com/community/learning_center/cisco_360/360-rs
- https://learningnetwork.cisco.com/community/certifications/ccie_routing_switching

NOTE

The 3825s used in this lab were loaded with c3825-adventerprisek9-mz.124-6.T.bin.

You will likely encounter many more devices within your real CCIE Troubleshooting section of the lab.

Equipment List

For this troubleshooting lab, you need the following hardware and software components:

- Seven routers loaded with Cisco IOS Software Release 12.4 Advanced Enterprise image and the minimum interface configuration, as documented in Table 1-1.

NOTE

The 3560s in this lab were loaded with c3560-ipservicesk9-mz.122-25.SEE.bin.

NOTE

The initial configurations supplied should be used to preconfigure your routers and switches before the lab starts.

If your routers have different interface speeds than those used within this book, adjust the **bandwidth** statements on the relevant interfaces to keep all interface speeds in line. Doing so ensures that you do not get unwanted behavior due to differing Interior Gateway Protocol (IGP) metrics.

Consider asking a like-minded colleague or friend to load the configurations onto your equipment on your behalf; this will ensure that you do not spot any of the potential configuration issues before beginning the exercise.

Table 1-1 Hardware Required per Router

Router	Model	Ethernet I/F	Serial I/F
R1	3825	1	1
R2	3825	1	1
R3	3825	1	1
R4	3825	1	2
R5	3825	—	2
R6	3825	—	2
R7	3825	1	2

Three 3560 switches with IOS 12.2 IP Services.

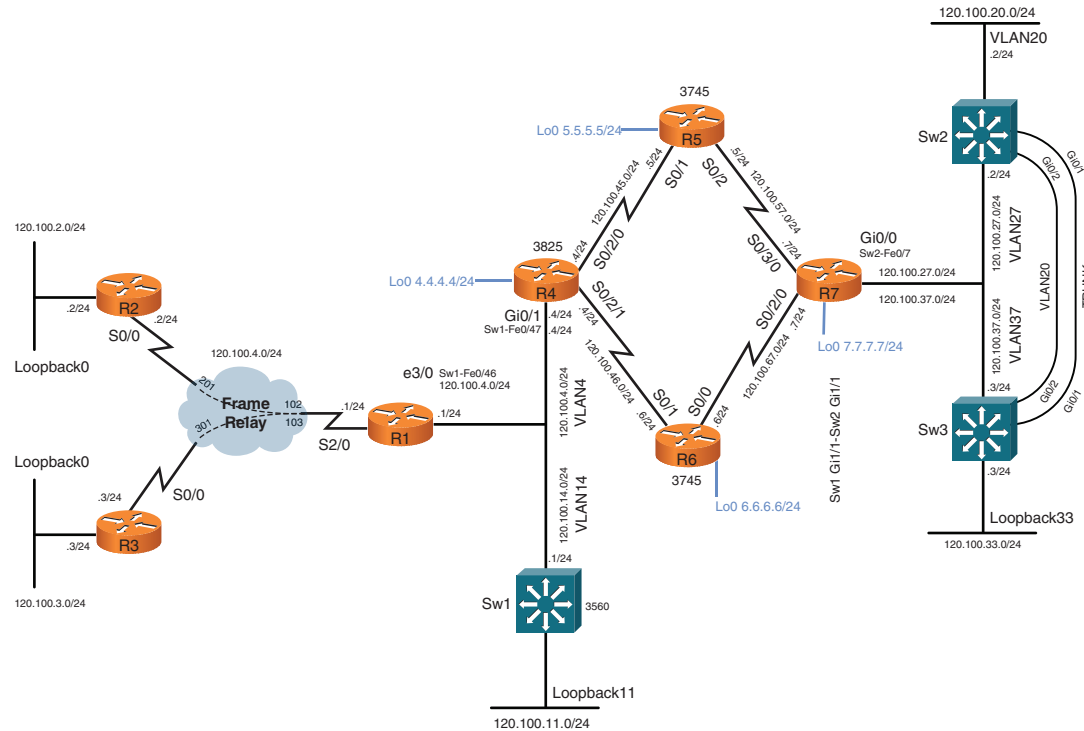
Setting Up the Lab

Feel free to use any combination of routers and switches as long as you fulfill the requirements within the topology diagram, as shown in Figure 1-1. However, it is recommended to use the same model of equipment because doing so will make life easier should you load configurations directly from the supplied configurations into your own devices.

Lab Topology

This troubleshooting exercise uses the topology outlined in Figure 1-1, which you must re-create with your own equipment or by using lab equipment on the CCIE R&S 360 program.

FIGURE 1-1
Lab 1 Topology
Diagram



NOTE

R2, R3, R5, and R6 do not require connectivity to any switches within this troubleshooting lab. R2 and R3 use loopback interfaces to simulate user-connected interfaces and use serial interfaces to connect with the Frame Relay hub router R1. R5 and R6 are P routers within the Multiprotocol Label Switching (MPLS) network and connect to neighboring routers with serial interfaces only.

Switch Instructions

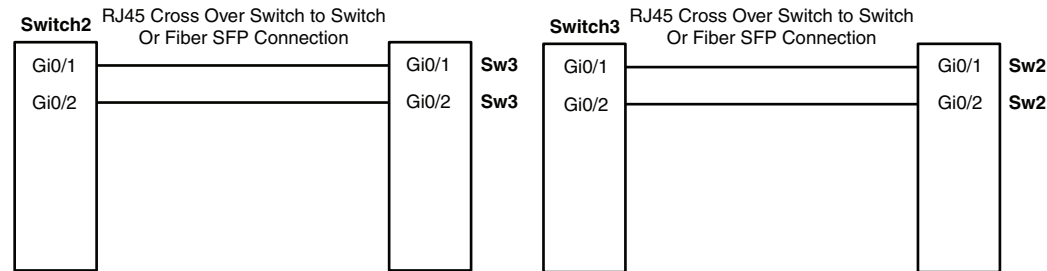
Configure VLAN assignments from the configurations supplied or from Table 1-2.

Table 1-2 VLAN Assignment

VLAN	Switch 1	Switch 2	Switch 3
4	Fa0/46, Fa0/47	—	—
14	Fa0/47	—	—
20	—	Gi0/1, Gi0/2	Gi0/1, Gi0/2
27	—	Gi0/1, Fa0/7	—
37	—	Gi0/1	Gi0/1

Connect your switches together with fiber small form-factor pluggable (SFP) connectors or RJ045 Ethernet crossover cables, as shown in Figure 1-2.

FIGURE 1-2
Switch-to-Switch
Connectivity



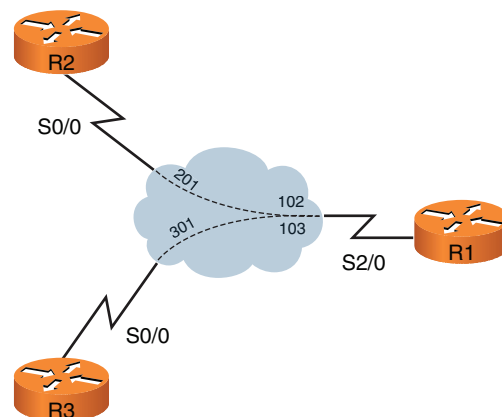
Frame Relay Instructions

Configure one of the routers you are going to use in the troubleshooting lab as a Frame Relay switch, or have a dedicated router assigned solely for this task. This troubleshooting lab uses a dedicated router for the Frame Relay switch. A fully meshed environment is configured between all the Frame Relay routers. Pay attention in the lab as to which permanent virtual circuits (PVC) are actually required.

If you are using your own equipment, keep the DCE cables at the frame switch end for simplicity and provide a clock rate to all links from this end.

The Frame Relay connectivity will, after configuration, represent the logical Frame Relay network, as shown in Figure 1-3.

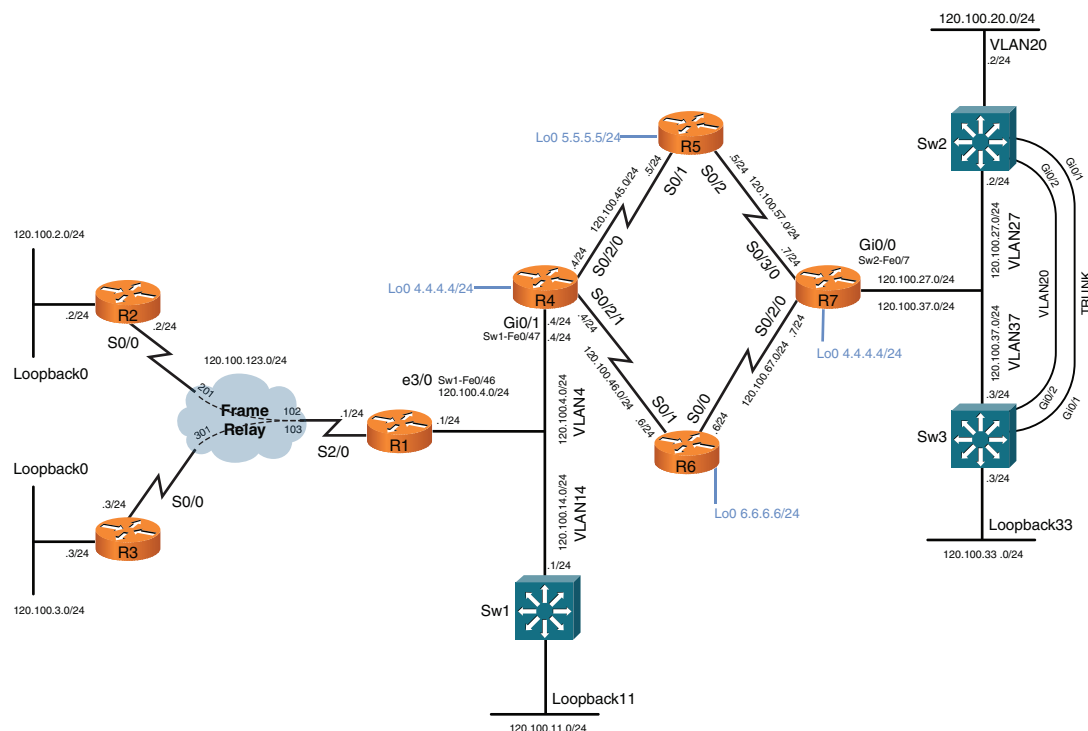
FIGURE 1-3
Frame Relay Logical
Connectivity



IP Address Instructions

For this exercise, you are required to configure your IP addresses, as shown in Figure 1-4, or load the initial router configurations supplied.

FIGURE 1-4
IP Addressing
Diagram



Pre-Lab Tasks

- Build the lab topology as per Figure 1-1 and Figure 1-2.
- Configure your Frame Relay switch router to provide the necessary data link control identifiers (DLCI) as per Figure 1-3.
- Configure the IP addresses on each router, as shown in Figure 1-4. Alternatively, you can load the initial configuration files supplied if your equipment is compatible with that used to create this exercise.

General Guidelines

- Do not configure any static/default routes unless otherwise specified.
- Use only the DLCIs provided in the appropriate figures.
- Your own routing metrics do not need to match exactly those shown in the incidents (unless specifically indicated).
- Tackle questions sequentially. You might find that one trouble ticket needs to be resolved before moving on to the next ticket. (This might not be the case in your real lab exam, however, which will have a much higher number of devices.)
- Get into a comfortable and quiet environment where you can focus for the next 2 hours.
- The incident questions list symptoms, explicit validation tests to confirm you have rectified the incident correctly, and any optional constraints ensure you follow these items correctly to maximize your score.
- When resolving an incident, do not remove any configured feature. You must resolve the misconfiguration instead of removing a whole configuration. (The only exception to this rule is when there is no other choice than removing the faulty configuration to resolve the incident.)
- Have available a Cisco Documentation CD-ROM or access the latest documentation online from <http://www.cisco.com/cisco/web/psa/default.html?mode=prod>.

NOTE

Access just the URL listed here, not the whole Cisco.com website, because if you are permitted to use documentation during your CCIE lab exam, it will be restricted to a limited search function. A well-prepared candidate should not risk losing time during the exam searching for information.

Troubleshooting Lab 1

You now answer questions about network topology and the VPN diagram, as shown in Figures 1-5 and 1-6.

FIGURE 1-5
Lab Topology
Diagram

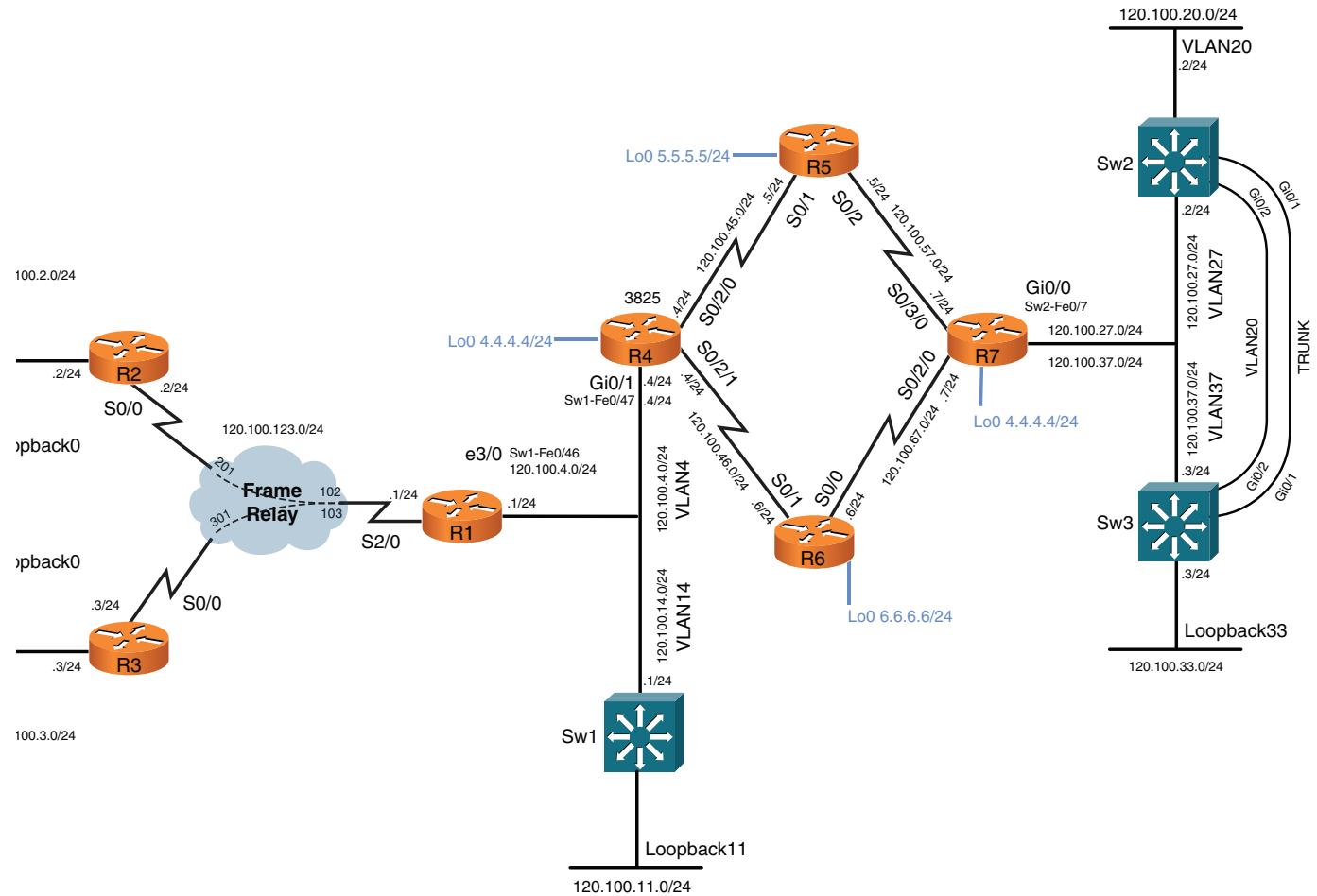
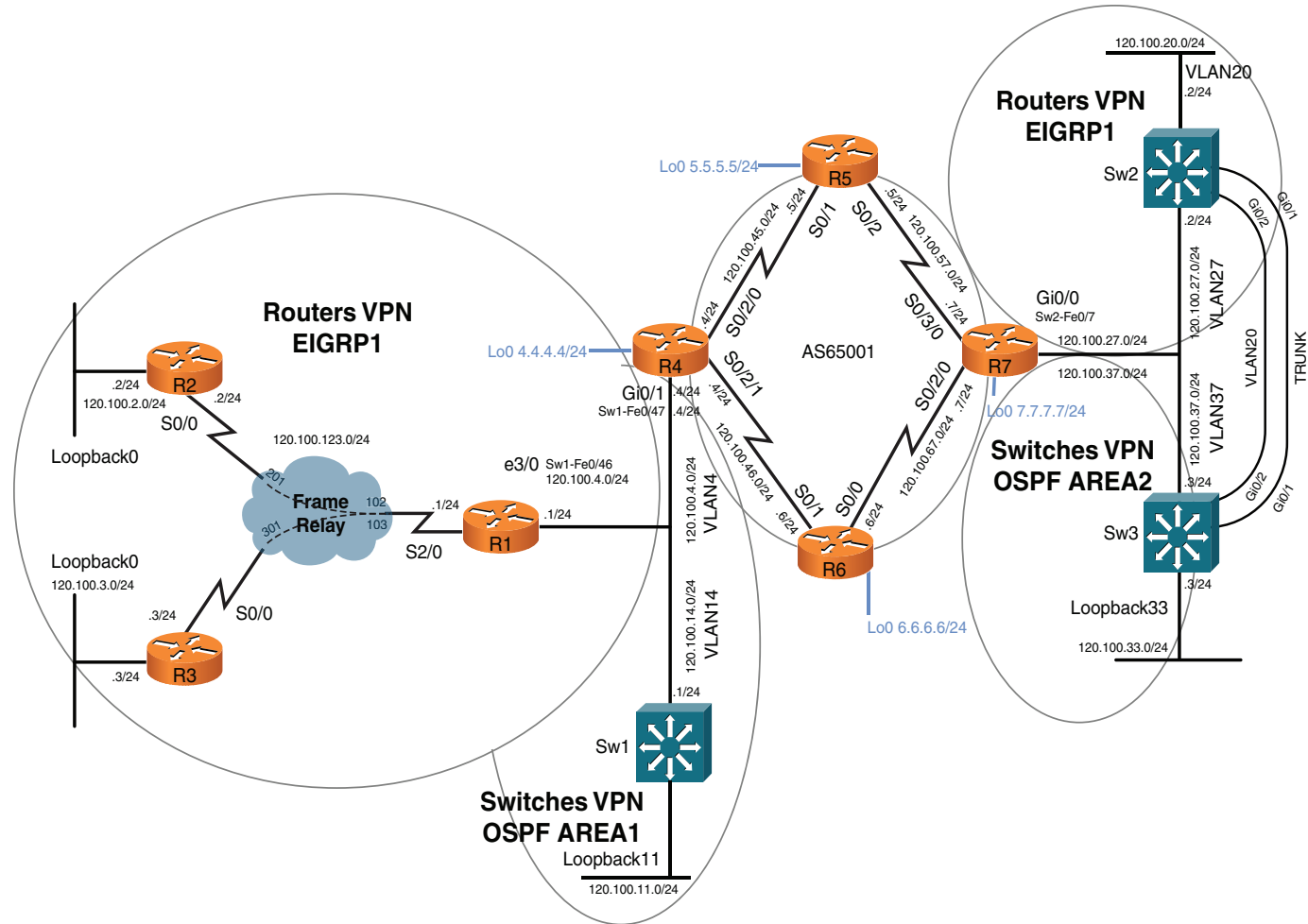
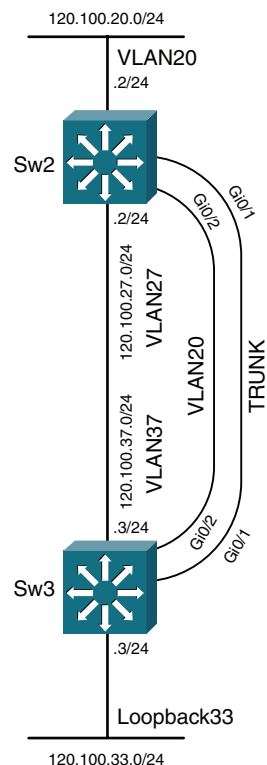


FIGURE 1-6
VPN Diagram



Incident 1

FIGURE 1-7
Incident 1 Diagram



Users on Sw3 VLAN 20 are complaining that they experience poor connectivity to VLAN 20 on Sw2. A variable response is seen when pinging from Sw3 VLAN 20 to Sw2 VLAN 20 interface.

Investigate the issue and rectify it. Confirm by proving a successful ping from Sw3 VLAN 20 interface 120.100.20.3 to Sw2 VLAN 20 interface 120.100.20.2 with a stable response time, as follows:

```
Sw3# ping 120.100.27.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.27.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

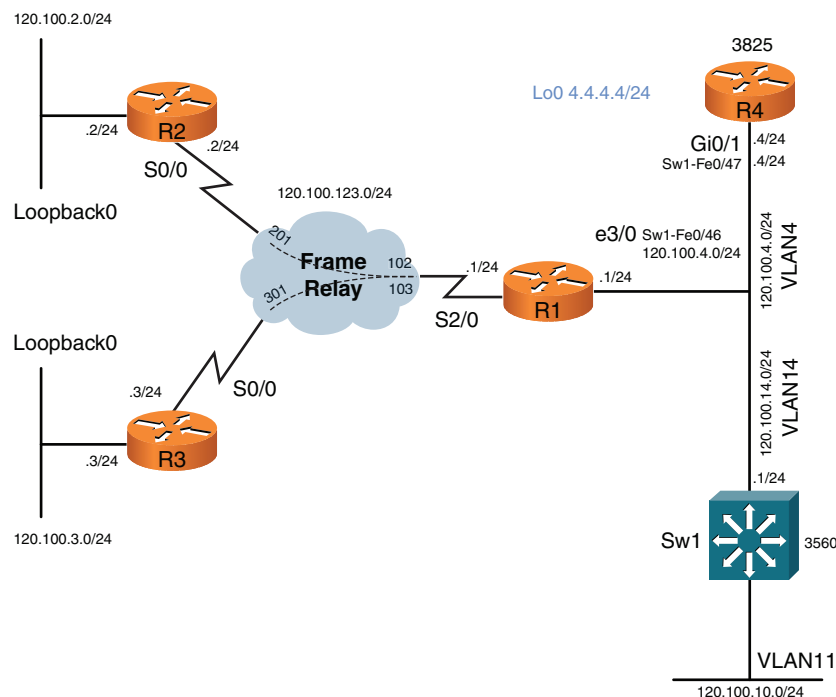
```
Sw3# ping 120.100.27.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.27.2, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
Sw3# ping 120.100.27.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.27.2, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

3 points

Incident 2

FIGURE 1-8
Incident 2 Diagram



Users on R3's 120.100.3.0/24 subnet are complaining that they cannot access resources located on their remote virtual private network (VPN) site on VLAN 20 (switch 2). Initial investigations have led first-line support personnel to think that there is an issue with connectivity up to the provider edge (PE) router R4, which was recently replaced because the subnet 120.100.4.0/24 is not present in R3's routing table.

Investigate the issue and prove connectivity solely to their PE connection (R4's VLAN 4 interface) as follows:

```
R3# ping 120.100.4.4 source 120.100.3.1
```

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

```
Sending 5, 100-byte ICMP Echos to 120.100.4.4, timeout is 2 seconds:
```

```
Packet sent with a source address of 120.100.3.1
```

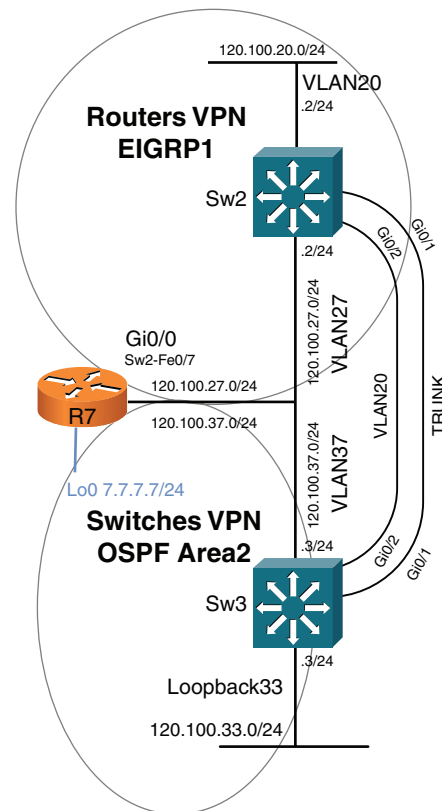
```
!!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/32 ms
```

2 points

Incident 3

FIGURE 1-9
Incident 3 Diagram



Users on switch 2 VLAN 20 are complaining that they have no connectivity through their VPN to services located on R2 and R3 (120.100.2.0/24 and 120.100.3.0/24). A traceroute to destination networks shows timeouts immediately, and it appears that an EIGRP neighbor adjacency between Sw2 and R7 is not present.

Investigate the issue by proving connectivity purely between Switch 2 and the local PE router R7. Establishment of an EIGRP adjacency between devices suffices at this point, as follows:

```

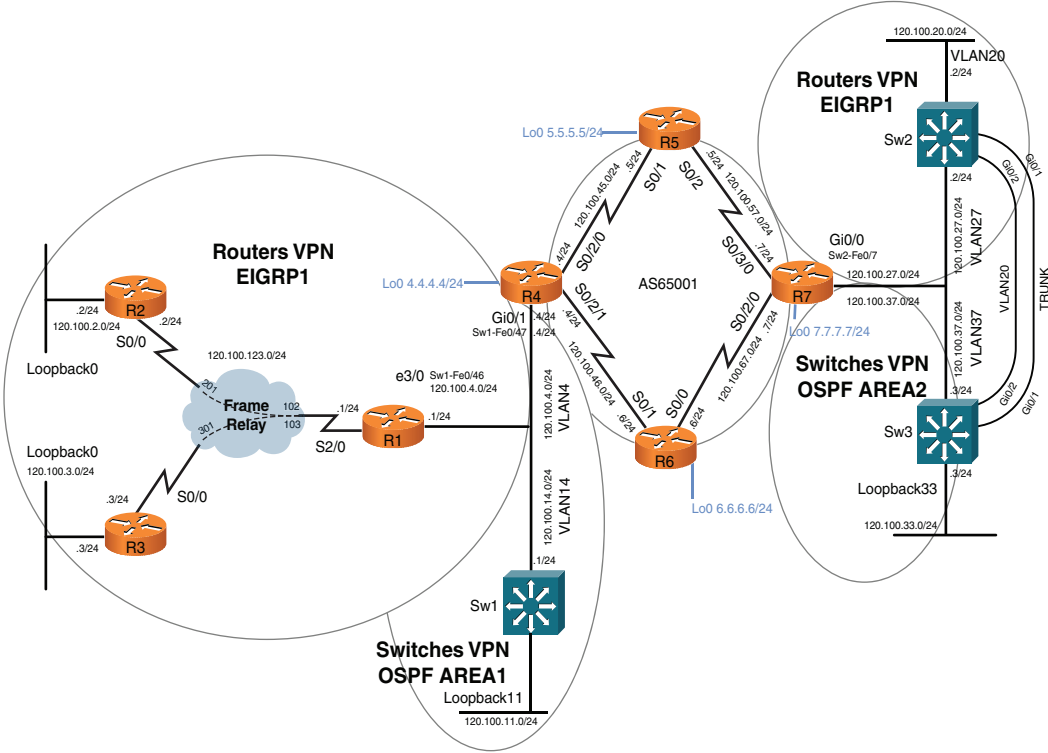
Sw2# show ip eigrp neighbors
EIGRP-IPv4:(1) neighbors for process 1
H   Address                Interface           Hold Uptime    SRTT    RTO   Q   Seq
0   120.100.27.7            Vlan27             12      00:01:11      1       300    0  92

```

3 points

Incident 4

FIGURE 1-10
Incident 4 Diagram



Users on R3's 120.100.3.0/24 subnet are still complaining that they cannot access resources located on their remote VPN site on VLAN 20 (switch 2). It appears that the MPLS VPN is not functioning correctly.

Investigate the issue and prove connectivity between PE routers via extended ping from R4 VLAN 4 interface and R7 VLAN 27 interface to prove MPLS functionality, as follows:

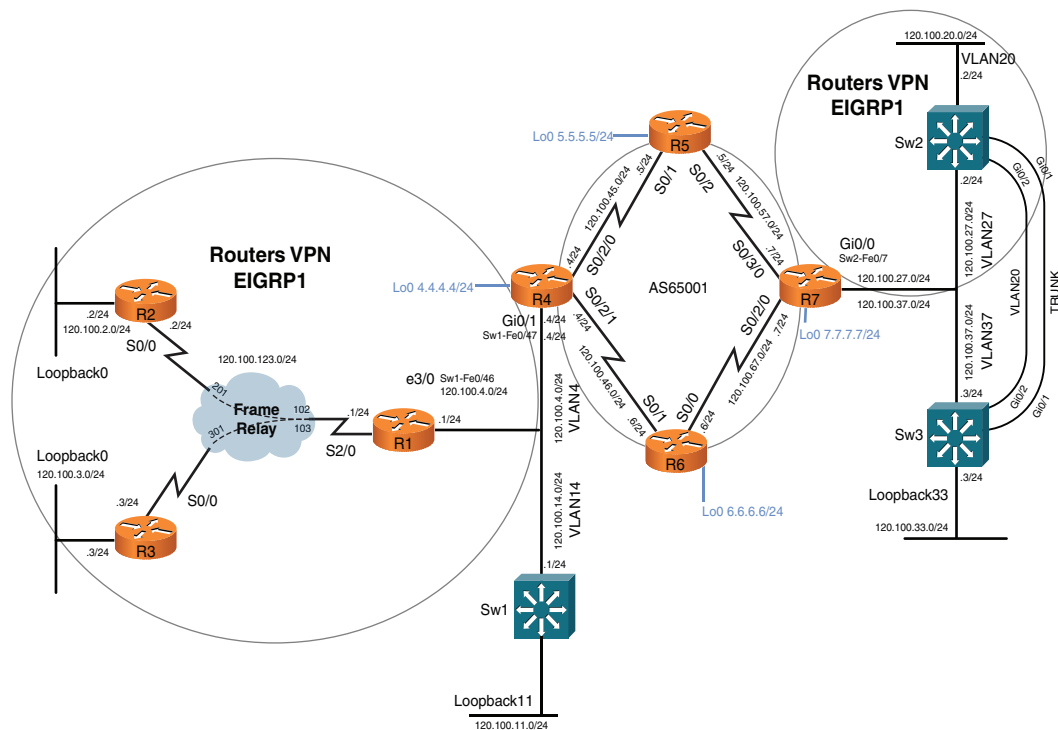
```
R4# ping vrf ROUTERS 120.100.27.7 source 120.100.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.27.7, timeout is 2 seconds:
Packet sent with a source address of 120.100.4.4
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
```

```
R7# ping vrf ROUTERS 120.100.4.4 source 120.100.27.7
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.4.4, timeout is 2 seconds:
Packet sent with a source address of 120.100.27.7
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

6 points

Incident 5

FIGURE 1-11
Incident 5 Diagram



Now that the MPLS issues appear to have been fixed, users on vrf ROUTERS on R2 and R3 are complaining that they cannot see the route to VLAN 27.

Investigate and prove connectivity with a valid route and successful ping from R2 and R3 user subnets to the Sw2 VLAN 27 interface as follows:

```
R2# ping 120.100.27.2 source 120.100.2.2
Type escape sequence to abort
Sending 5, 100-byte ICMP Echos to 120.100.27.2, timeout is 2 seconds:
Packet sent with a source address of 120.100.2.2
!!!!
```

Success rate is 100 percent (5/5), round-trip min/avg/max = 28/31/36 ms

R3# **ping 120.100.27.2 source 120.100.3.3**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 120.100.27.2, timeout is 2 seconds:

Packet sent with a source address of 120.100.3.3

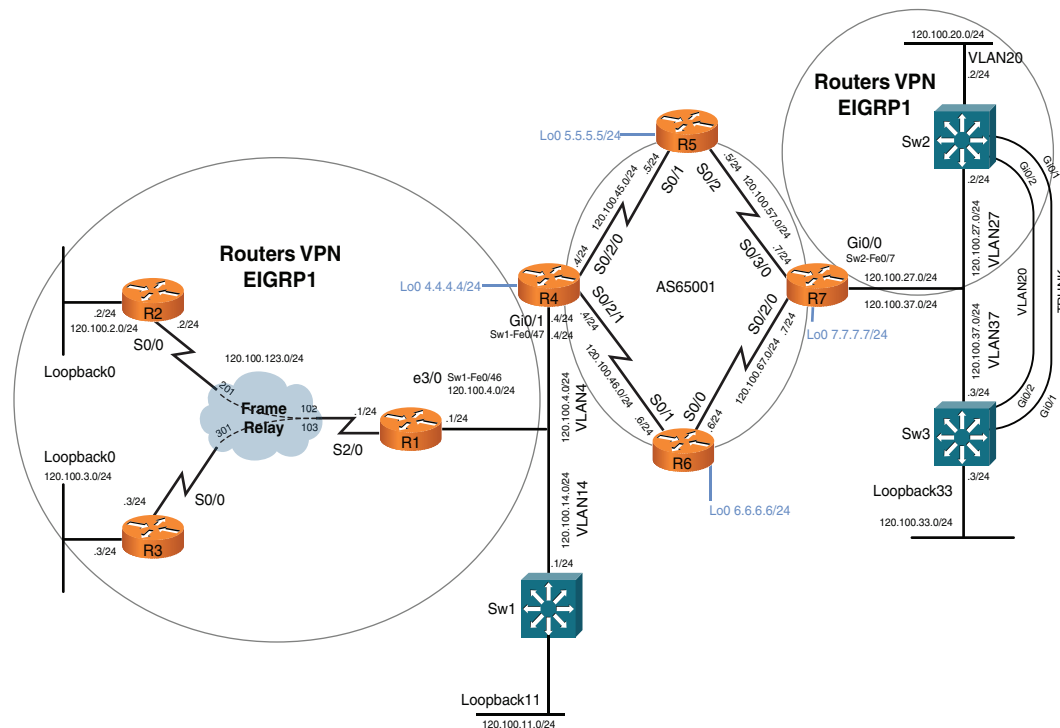
!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/36 ms

3 points

Incident 6

FIGURE 1-12
Incident 6 Diagram



Users on vrf ROUTERS on R2 and R3 are complaining they can see only the route to VLAN 27 on Sw2 and not VLAN 20. Investigate the issue and rectify it.

Prove connectivity by extended ping from user subnets on R2 and R3 to Sw2 VLAN 20 as follows:

```
R2# ping 120.100.20.2 source 120.100.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.20.2, timeout is 2 seconds:
Packet sent with a source address of 120.100.2.2
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/32/36 ms

R3# ping 120.100.20.2 source 120.100.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 120.100.20.2, timeout is 2 seconds:
Packet sent with a source address of 120.100.3.3
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/32 ms
```

2 points