This chapter covers four comprehensive scenarios that draw on several design topics covered in this book:

- Scenario One: Pearland Hospital
- Scenario Two: Big Oil and Gas
- Scenario Three: Beauty Things Store
- Scenario Four: Falcon Communications

The case studies and questions in this chapter draw on your knowledge of CCDA exam topics. Use these exercises to help master the topics as well as to identify areas you still need to review for the exam.

Understand that each scenario presented encompasses several exam topics. Each scenario, however, does not necessarily encompass all the topics. Therefore, you should work through all the scenarios in this chapter to cover all the topics.

CHAPTER 17

Comprehensive Scenarios

Your CCDA exam will probably contain questions that require you to analyze a scenario. This chapter contains four case studies that are similar in style to the ones you might encounter on the CCDA exam. Read through each case study and answer the corresponding questions. You will find the answers to the case study questions at the end of each scenario. Sometimes more than one solution can satisfy the customer's requirements. In these cases, the answers presented represent recommended solutions developed using good design practices. An explanation accompanies the answer where necessary.

Scenario One: Pearland Hospital

Mr. Robertson, the IT director at Pearland Hospital, is responsible for managing the network. Mr. Robertson has requested your help in proposing a network solution that will meet the hospital's requirements. The hospital is growing, and the management has released funds for network improvements.

The medical staff would like to be able to access medical systems using laptops from any of the patient rooms. Doctors and nurses should be able to access patient medical records, x-rays, prescriptions, and recent patient information. Mr. Robertson purchased new servers and placed them in the data center. The wireless LAN (WLAN) has approximately 30 laptops, and about 15 more are due in six months. The servers must have high availability.

Patient rooms are on floors 6 through 10 of the hospital building. Doctors should be able to roam and access the network from any of the floors. A radio-frequency report mentions that a single access point located in each communication closet can reach all the rooms on each floor. The current network has ten segments that reach a single router that also serves the Internet. The router is running Routing Information Protocol Version 1 (RIPv1). The back-end new servers are located in the same segment as those used on floor 1. Mr. Robertson mentions that users have complained of slow access to the servers. He also hands you a table with current IP addresses (see Table 17-1).

Table 17-1 *Current IP Addresses*

Floor	Servers	Clients	IP Network
1	15	40	200.100.1.0/24
2	0	43	200.100.2.0/24
3	0	39	200.100.3.0/24
4	0	42	200.100.4.0/24
5	0	17	200.100.5.0/24
6	0	15	200.100.6.0/24
7	0	14	200.100.7.0/24
8	0	20	200.100.8.0/24
9	0	18	200.100.9.0/24
10	0	15	200.100.10.0/24

Mr. Robertson would like a proposal to upgrade the network with fast switches and to provide faster access to the servers. The proposal should also cover secure WLAN access on floors 6 through 10. Include an IP addressing scheme that reduces the number of Class C networks the hospital uses. Mr. Robertson wants to reduce the number of networks leased from the Internet service provider (ISP).

Scenario One Questions

The following questions refer to Scenario One:

1. What are Pearland Hospital's business requirements?
2. Are there any business-cost constraints?
3. What are the network's technical requirements?
4. What are the network's technical constraints?
5. Prepare a logical diagram of the current network.
6. Does the hospital use IP addresses effectively?
7. What would you recommend to improve the switching speed between floors?
8. Based on the number of servers and clients provided, what IP addressing scheme would you propose?
9. What routing protocols would you recommend?

10. What solution would you recommend for WLAN access and the network upgrade?

11. Draw the proposed network solution.

Scenario One Answers

1. The hospital needs to provide access to patient records, prescriptions, and information from patient rooms.

2. No cost restrictions were discussed.

3. The technical requirements are as follows:

   WLAN access from rooms on floors 6 through 10

   Redundant access to servers in the data center

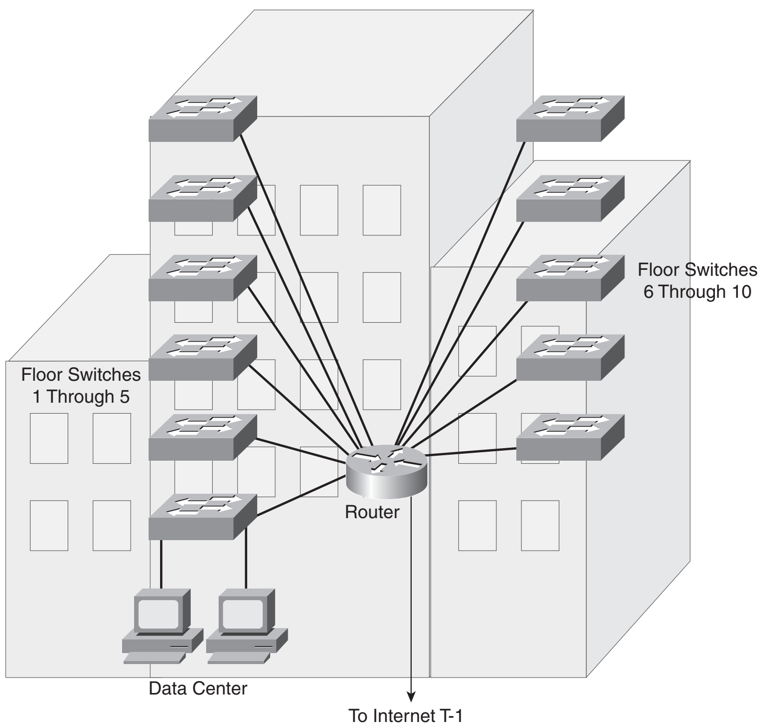
   Fast switching between LAN segments

4. The technical constraint is as follows:

   Servers must be located in the first floor data-center rooms.

5. Figure 17-1 shows the logical diagram of the current network.

Figure 17-1 *Pearland Hospital Current Network*



6. The hospital does not use IP addresses effectively. It uses Class C networks on each floor. Each floor wastes more than 200 IP addresses, because each Class C network provides up to 254 IP addresses.
7. Recommend using a high-speed Layer 3 switch for the building LANs. They can use the router for Internet and WAN access.
8. The primary recommendation is to use private addresses for the network. Using private addresses has been a best-practice policy for private internal networks since 1996. With private addresses, the hospital could release eight of the Class C networks to the ISP, retaining two for ISP connectivity.

   With private addresses, the hospital can choose to use 172.16.0.0/16 for private addressing. The addressing scheme shown in Table 17-2 provides sufficient address space for each network.

Table 17-2 *IP Addressing Scheme Using Private Addresses*

Floor	Servers	Clients	IP Network
1	15	0	172.16.0.0/24
1	0	40	172.16.1.0/24
2	0	43	172.16.2.0/24
3	0	39	172.16.3.0/24
4	0	42	172.16.4.0/24
5	0	17	172.16.5.0/24
6	0	15	172.16.6.0/24
7	0	14	172.16.7.0/24
8	0	20	172.16.8.0/24
9	0	18	172.16.9.0/24
10	0	15	172.16.10.0/24
WLAN: 6, 7, 8, 9, 10	0	40	172.16.20.0/24

Another solution is to retain the public addresses and use them in the internal network. This solution is less preferred than private addressing. Table 17-3 shows the recommended address scheme that would reduce the number of Class C networks.

Table 17-3 *IP Addressing Scheme Using Public Address Space*

Floor	Servers	Clients	IP Network
1	0	40	200.100.1.0/26
1	15	—	200.100.1.64/26
2	0	43	200.100.1.128/26
3	0	39	200.100.1.192/26
4	0	42	200.100.2.0/26
5	0	17	200.100.2.64/26
6	0	15	200.100.2.128/26
7	0	14	200.100.2.192/26
8	0	20	200.100.3.0/26
9	0	18	200.100.3.64/26
10	0	15	200.100.3.128/26
WLAN: 6, 7, 8, 9, 10	0	40	200.100.3.192/26

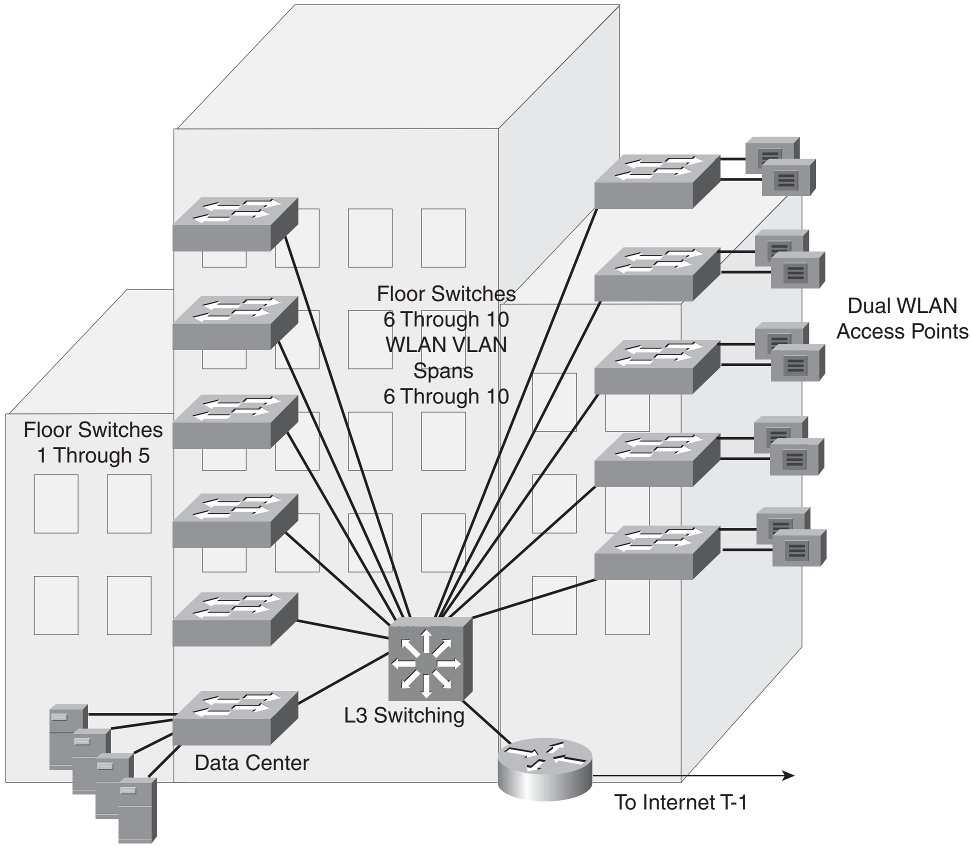
Each subnet has 62 IP addresses for host addressing. Based on the preceding IP addressing scheme, Pearland Hospital does not need networks 200.100.4.0/24 through 200.100.10.0/24.

9. Recommend routing protocols that support variable-length subnet masks (VLSM). The network is small. Recommend RIPv2 or Enhanced Interior Gateway Routing Protocol (EIGRP). Do not recommend Open Shortest Path First (OSPF) because of its configuration complexity.

10. Recommend using two access points on each floor for redundancy. Use a VLAN that spans floors 6 through 10. Change the router to a high-speed Layer 3 switch. Use the router for Internet or WAN access.

11. Figure 17-2 shows the diagram. The router is replaced by the L3 switch to provide high-speed switching between LANs. Each floor has an IP subnet plus a subnet for the WLAN and another for the data center. Each floor has two access points for redundancy. Servers can connect using Fast EtherChannel or Gigabit Ethernet.

Figure 17-2 *Pearland Hospital Proposed Network Solution*



Scenario Two: Big Oil and Gas

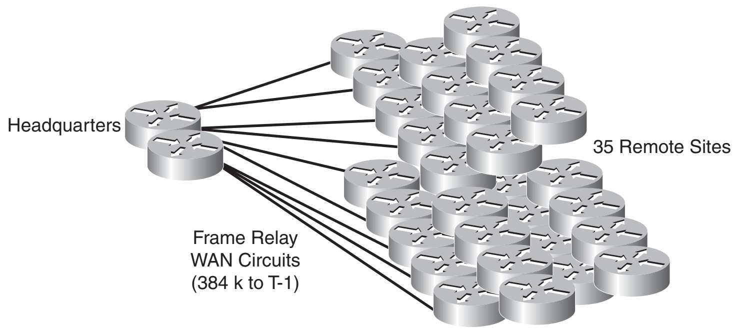
Mr. Drew is an IT director at Big Oil and Gas, a medium-sized petrochemical company based in Houston. It also has operations in the Gulf and in South America. Mr. Drew is in charge of the network infrastructure, including routers and switches. His group includes personnel who can install and configure Cisco routers and switches.

The Big Oil and Gas CIO wants to begin migrating from the voice network to an IP telephony solution to reduce circuit and management costs. Existing data WAN circuits have 50 percent utilization or less but spike up to 80 percent when sporadic FTP transfers occur.

Mr. Drew hands you the diagram shown in Figure 17-3. The exiting data network includes 35 sites with approximately 30 people at each site. The network is hub-and-spoke, with approximately 200 people at the headquarters. The WAN links range from 384 kbps circuits to T1 speeds.

Remote-site applications include statistical files and graphical-site diagrams that are transferred using FTP from remote sites to the headquarters.

Figure 17-3 *Big Oil and Gas Current Network*



Mr. Drew wants an IP telephony solution that manages the servers at headquarters but still provides redundancy or failover at the remote site. He mentions that he is concerned that the FTP traffic might impact the VoIP traffic. He wants to choose a site to implement a test before implementing IP telephony at all sites.

Scenario Two Questions

The following questions refer to Scenario Two:

1. What are the business requirements for Big Oil and Gas?
2. Are there any business-cost constraints?
3. What are the network's technical requirements?
4. What are the network's technical constraints?
5. Approximately how many IP phones should the network support?
6. What type of IP telephony architecture should you propose?
7. What quality of service (QoS) features would you propose for the WAN?
8. Would you propose a prototype or a pilot?
9. What solution would you suggest for voice redundancy at the remote sites?
10. Diagram the proposed solution.

Scenario Two Answers

1. The company wants to provide voice services in a converged network.
2. The solution should provide reduced costs over the existing separate voice and data networks.
3. The technical requirements are as follows:

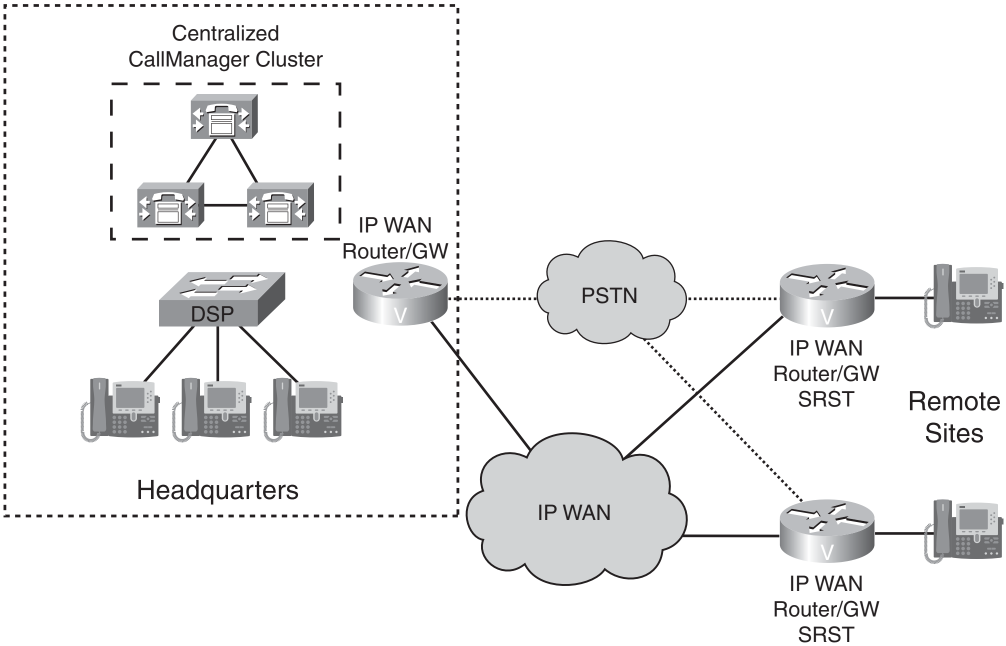
   Provide IP telephony over the data network.

   Provide voice redundancy or failover for the remote sites.

   Prevent FTP traffic from impacting the voice traffic.
4. The technical constraint is as follows:

   Call-processing servers need to be located at headquarters.
5. There are 200 IP phones at headquarters, and 35 * 30 = 1050 remote IP phones, for a total of 1250 IP phones.
6. Propose the WAN centralized call-processing architecture with a CallManager (CM) cluster at headquarters.
7. Use low-latency queuing (LLQ) on the WAN links to give the highest priority to voice traffic. Then define traffic classes for regular traffic and FTP traffic. Make bandwidth reservations for the voice traffic and maximum bandwidth restrictions for the FTP traffic. Call Admission Control (CAC) is recommended to limit the number of calls from and to a remote site.
8. To prove that calls can run over the WAN links, implement a pilot site. The pilot would test the design's functionality over the WAN with or without FTP traffic.
9. Recommend the use of Survivable Remote Site Telephony (SRST) to provide voice services in the event of WAN failure, and reroute calls to the Public Switched Telephone Network (PSTN).
10. Figure 17-4 shows the diagram, which shows headquarters and two remote sites for clarity. This architecture is duplicated for all remote sites. Each site uses a voice router that is connected to both the IP WAN and the PSTN. SRST provides voice survivability in the case of WAN failure. A CM cluster is implemented at the headquarters. The CM servers are in the data center in a redundant network.

Figure 17-4 *Headquarters and Two Remote Sites for Clarity*



Scenario Three: Beauty Things Store

Beauty Things is a chain of stores that sell beauty supplies. Headquarters is in Houston, Texas, and more than 60 stores are located throughout the U.S. The CIO tells you that they are in the middle of a WAN migration from Frame Relay to MPLS. It will be completed in two months. Most WAN links are less than 384 kbps.

After the WAN migration is complete, the CIO wants to use VoIP for voice calls between stores. He wants to complete the VoIP project within the next six months and within the established budget. Each store will have five concurrent calls back to headquarters.

The WAN provider has four priority queues for traffic: blue, red, green, and yellow. Each is assigned the DSCP codepoints listed in Table 17-4.

Table 17-4 *DSCP Codepoints for Beauty Things*

Priority Queue	DSCP Codepoint
Blue	AF31
Red	EF
Green	AF21
Yellow	Default

Scenario Three Questions

The following questions refer to Scenario Three:

1. What are the business constraints for this project?
2. Is MPLS technology appropriate for VoIP?
3. Assuming a g.729 codec, how much bandwidth must be allocated for VoIP packets per store?
4. Assuming a g.729 codec, how much bandwidth must be reserved for VoIP traffic on the WAN link of the headquarters router?
5. Which MPLS priority queue is assigned for VoIP traffic?
   a. Blue
   b. Red
   c. Green
   d. Yellow
6. Which MPLS priority queue is assigned for FTP traffic?
   a. Blue
   b. Red
   c. Green
   d. Yellow
7. What WAN interface solution must be used to prevent large file transfers from interfering and causing delays of VoIP packets?
   a. Priority queuing
   b. Policy routing
   c. Link fragmentation and interleaving
   d. Serialization delay

8. What is the recommended queuing technique for the WAN interfaces?
   a. PQ
   b. Policy queuing
   c. LLQ
   d. Custom queuing

Scenario Three Answers

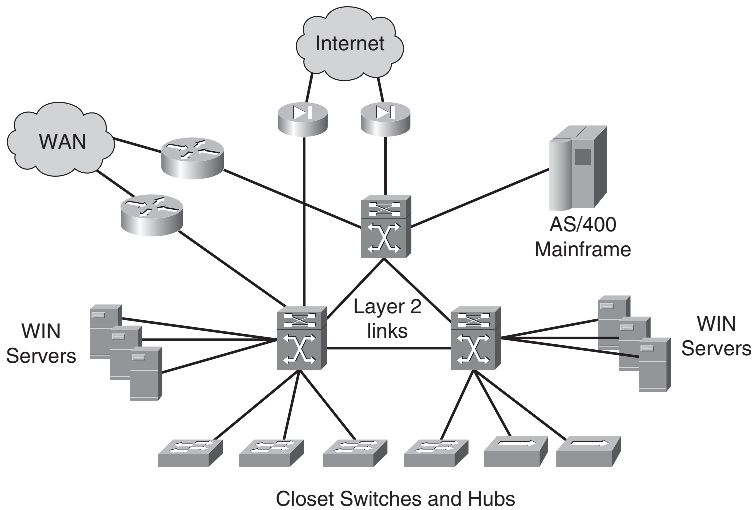
1. The WAN project is to be completed in two months. The VoIP project is to be completed in six months and within budget.
2. Yes, MPLS technology is the preferred WAN technology to support VoIP packets. MPLS provides QoS prioritization and guarantees.
3. 130 kbps. This is calculated by taking five concurrent calls times 26 kbps per call.
4. 7.8 Mbps. This is the sum of VoIP traffic per store multiplied by 60 remote stores.
5. B. VoIP traffic is marked with DSCP expedited forwarding, which corresponds to the Red queue.
6. D. FTP traffic does not require prioritization and thus is assigned to the default Yellow queue.
7. C. LFI should be used on WAN links that are less than 768 kbps. It is used to reduce the serialization delay of large packets.
8. C. LLQ is the recommended queuing technique when VoIP packets are present on WAN links.

Scenario Four: Falcon Communications

Falcon Communications has requested an assessment of its current network infrastructure. You are given the diagram shown in Figure 17-5. The current infrastructure contains three 6500 Catalyst switches connected using Layer 2 links. Building access switches, WAN routers, Internet firewalls, the mainframe, and Windows servers all connect to the 6500 switches. Some Fast Ethernet hubs are used on the network.

The IT manager mentions that they experience sporadic network outages several times during the day, and users are complaining that the network is slow. The CIO states that they want to prepare the network, because the company expects to double in size in three years. They also want to prepare the network for IP telephony.

Figure 17-5 *Falcon Communications Current Network*



Scenario Four Questions

The following questions refer to Scenario Four:

1. Is this network scalable?
2. What would you recommend for the core switches?
3. What changes are required in the closet switches and hubs?
4. What would you recommend for the WAN routers and Internet firewalls?
5. What would you recommend for the AS/400 and WIN server?
6. What is the role of the distribution layer in the architecture?
7. What are your recommendations for IP addressing?
8. Falcon Communications has a VLAN with a /22 IP subnet that is experiencing network delays. What would you recommend?
9. Diagram your proposed solution.

Scenario Four Answers

1. No. The current Falcon network is not scalable. It is a flat network architecture using Layer 2 links in the core with no hierarchy. It does not have core, distribution, and access layers.
2. Recommend inserting a distribution layer to create a hierarchy between the core and access layers. Use Layer 3 links instead of Layer 2 links to prevent spanning-tree loop broadcast storms.
3. All hubs need to be replaced with switches. All switches should be replaced with PoE switches to provide power to future IP phones and wireless access points. All new switch purchases should be PoE-capable LAN switches.

4. Create an enterprise edge layer that separates the campus LAN and the enterprise edge.
5. Create a server distribution and access layer on which to place all servers and the AS/400 mainframe.
6. The distribution layer has several functions:

   Address summarization

   Security access lists

   Broadcast domain definition

   VLAN routing

   Media translation
7. Recommend allocating /30 subnets for the links between the core and distribution switches. Allocate separate IP subnets for the future IP phones and servers. This lets you apply security policies. Also allocate separate IP subnets for wireless LAN networks.
8. Recommend splitting the IP subnet into four separate /24 IP subnets.
9. The solution shown in Figure 17-6 is a hierarchical network with core, distribution, and access layers. Building access and separate server farms are used. Distribution switches are used to allocate security policies and route summarization. The solution is scalable and will support Falcon Communications' growth plans. PoE switches are deployed to support the future IP telephony deployment.

Figure 17-6 *Falcon Communications Proposed Network Solution*