Study Guide

Professional Certified Network Administrator

Use this document to direct your study and help you prepare for the PCNA certification exam. These learning outcomes form the basis of the questions and practical application scenarios of the exam.

Learning outcomes are listed under the course and section in which the concepts are explained. When preparing for the certification exam, you can use the menu (☰) in each online course to navigate to the specific section you want to review.

Course 1 Essentials: Build Your First Network

What is a Network?

- Explain why the switch, rather than the router, is the center of a network.
- Define the term *host*.
- Explain the difference between a Wide Area Network (WAN) and a Local Area Network (LAN).
- Define the term *Ethernet*.
- Explain the function of each network device:
  - Switch
  - Router
  - Access Point (AP)
  - Managed Power Unit (MPU)
  - Modem
- Explain the disadvantages of “all-in-one” network devices.

The Language of Networks

- Define the term *protocol*.
- Explain the purpose of the TCP/IP suite.

IP Configuration

- Describe the four network host configuration parameters:
  - IP Address
  - Subnet Mask
  - DNS Server
  - Default Gateway
- Define the term *subnet*.

Dynamic Host Configuration Protocol

- Explain the advantages and disadvantages of manually assigning host configurations on a network versus having the network dynamically assign them.
- Explain how you know if a network host has a self-assigned IP address.

IP Addresses

- Define the term *bits*.
- Define the term *octet*.
- Convert decimal numbers to binary and binary numbers to decimal.
- Explain what is the highest decimal number that can be in an IP address octet.

Subnet Masks

- Explain how network hosts use the subnet mask to determine if another host is on the same network.
- Explain how the subnet mask determines the number of available IP addresses on a network.

CIDR Notation

- Express subnet masks in both dotted-decimal and CIDR (slash) notation.

Default Gateway

- Identify which host on a network is the default gateway.
- Describe when a host on a network communicates with the default gateway.

DNS

- Explain how the Domain Name System converts domain names to IP addresses.
- Use Terminal, Windows PowerShell, or Command Prompt to ping devices both inside and outside the local network with both IP addresses and domain names.

MAC Addresses

- Describe the two main parts of a MAC address.
- Use a website, such as macvendors.com to lookup the manufacturer of a device using the device's MAC address.
- Compare and contrast MAC addresses and IP addresses.
- Explain how MAC addresses facilitate network communication.

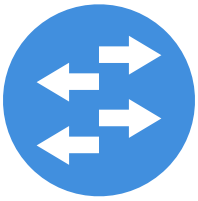
The OSI Model

- Name each layer of the OSI (Five Layer) model and describe what each layer does.
- Define the terms *encapsulation* and *de-encapsulation*.
- Define the term *destination port*.
- Compare and contrast UDP (User Datagram Protocol) and TCP (Transport Control Protocol)

Wireshark

- Capture and analyze network communication using Wireshark.
- Define the term *packet sniffer*.

Course 2 Switches



Category Cables

- Define the term *cable jacket*.
- Compare and contrast the characteristics of each category (CAT rating) of Ethernet cable.
- Define the term *resistance*.
- Define the term *attenuation*.
- Explain the disadvantages of using Ethernet cables made of copper-clad aluminum.
- Explain the advantages, disadvantages, and most common uses of solid core and stranded cables.
- Define the term *interference*.
- List the most common sources of electromagnetic interference.
- Explain the purpose of pairs of wires being twisted around each other in Ethernet cables.

Cable Termination

- List the wire colors in order, from left to right, for the T568-B wiring standard.
- Properly terminate a CAT6 Ethernet cable at both ends.
- Use an Ethernet cable tester to verify that an Ethernet cable has been properly terminated.
- Explain the advantages of labeling Ethernet cables.

Connecting Switches

- What is the maximum length of an Ethernet cable?
- List the reasons to connect switches together.
- Define the term *daisy-chaining*.
- Define the term *latency*.
- List the reasons to limit the number of switches daisy-chained together.
- Define the term *hop*.
- Define the term *bottleneck*.
- Define the term *switch capacity*.
- Define the term *backplane*.
- Define the term *non-blocking*.
- Explain the advantages of using fewer, high-capacity switches over linking several smaller switches together.
- Define the term *switching loop*.
- Explain the symptoms you are likely to observe on a network that has a switching loop.

SFP Connectors

- Define the term *SFP*.
- Compare and contrast single mode and multimode fiber optic cables.
- Explain the situations where using fiber optic cables is preferred over Ethernet cables.

Power over Ethernet

- What is the maximum wattage a standard PoE device requires?
- What is the maximum wattage a PoE+ device requires?
- Given a PoE-capable switch with a power budget of x watts, demonstrate how to use precise budgeting to plan the number of PoE devices you can power through the switch.
- Explain what a PoE injector does.

Managed Switches

- Explain the difference between unmanaged and managed switches.

Angry IP Scanner

- Use Angry IP Scanner to scan a network.
- Find a device's IP address using the device's MAC address.

Managed Switch Interface

- Change the PoE Priority for a specific port on a switch.
- Enable/disable a specific port on a switch.

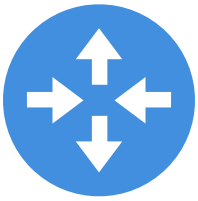
Network Traffic Optimization

- Define the terms *unicast*, *broadcast*, and *multicast*.
- Define the term *broadcast domain*.
- List the IP address range used for multicast traffic.
- Explain how Internet Group Management Protocol (IGMP) can optimize network traffic.
- Explain when you should enable IGMP Snooping on a managed switch.
- Explain what VLANs do on a network.
- Explain what Spanning Tree Protocol (STP) does on a network.
- Define the term *root bridge*.
- Define the term *bridge priority*.
- Describe the election process that switches use to determine which switch in a multi-switch network should be the root bridge.
- Enable STP on a switch and set the bridge priority for the switch to act as the root bridge.
- Configure Common Spanning Tree ports (Referred to as CIST Ports on Araknis switches and CST Ports on Pakedge switches).
- Explain what Link Aggregation Control Protocol (LACP) does on a switch.

Managed Switch Maintenance

- Change a switch's admin username and password.
- Backup a switch's configuration.
- Perform a factory reset on a switch.
- Restore a switch's settings from a backup.
- Explain the importance of firmware updates.

Course 3 Routers



Connecting LAN to WAN

- Explain at which layer routers function in the OSI model.
- Explain the impact routing hops have on a network's performance.
- Use the command traceroute to show routing hops.

Connecting the WAN Port

- Compare and contrast a router's WAN configuration with its LAN configuration.
- Explain how to diagnose if there is an extra, unnecessary routing hop on a network.
- Explain how to manage a "combo unit" from an ISP.

Bridge Mode

- Define the term *bridge mode*.
- Explain when a PPPoE connection may be the required WAN connection configuration for a router.
- Define the term *Demilitarized Zone (DMZ)*.
- Define the term *Network Address Translation (NAT)*.

Dual WAN

- Explain why some routers have more than one WAN port.

Plan the LAN

- Explain how the router "declares" the network.
- List the four steps in the "Plan the LAN" workflow.
- Explain how the subnet mask determines the number of IP addresses available for hosts on a network.
- Compare and contrast static, dynamic, and reserved IP addresses.
- Demonstrate how to plan a network IP addressing strategy.
- Implement an IP addressing strategy on a router.
- Explain how DHCP leases work.
- Change a router's admin username and password.
- Backup a router's configuration.
- Perform a factory reset on a router.
- Restore a router's settings from a backup.

VLANs

- Define the term *Virtual Local Area Network (VLAN)*.
- Explain how unicast and multicast traffic is routed between VLANs.
- Compare and contrast InterVLAN Routing and "multicast routing."
- Define the term *VLAN tagging*.
- Implement a VLAN on a router and managed switch.
- Define the term *trunking*.
- Compare and contrast trunk ports and access ports.

Secure Remote Access

- Define the term *Virtual Private Network (VPN)*.
- Define the term *Dynamic DNS (DDNS)*.
- Implement OpenVPN on a router.
- Connect to a network remotely using VPN.
- Explain why a customer's network must be using a different IP address space than the network you are on in order to connect to the customer's network using VPN.
- Define term *Port Forwarding*.
- Explain the few cases that you may want to use port forwarding on a customer's network.
- Enable and configure port forwarding on a router.

Course 4 Wireless Access Points

Wifi Fundamentals

- Explain the best practice for connecting devices to a network using wireless versus a wired connection.

Radio Signals

- Define the term *frequency*.
- Define the term *Hertz*.
- Define the term *channel*.
- Define the term *co-channel interference*.
- Define the term *adjacent-channel interference*.
- Explain how wireless access points are similar to switches and how they are different.

SSIDs and Passwords

- Explain the risks associated with leaving a wireless network "open"—not protected by a password and encryption method.
- Change an access point's admin username and password.
- Define the term *Service Set Identifier (SSID)*.
- Explain the best practices for SSIDs while the wireless network is set up and configured versus when the network is ready to be used by the customer.
- Define the term *band steering* and explain why you shouldn't enable it.
- Explain why you shouldn't hide a customer's SSID.
- Compare and contrast wireless encryption methods and explain the importance of using WPA2-PSK encryption.
- Explain the best practices for wireless network passwords.
- Implement separate SSIDs for the 5 GHz and 2.4 GHz wireless networking bands with a password that complies with best practices.

Channel Selection

- List the channels and channel widths that are available in UNII-1 and UNII-3 for the 5 GHz wireless networking band.
- Define the term *Dynamic Frequency Selection (DFS)*.
- Compare and contrast situations that are ideal for implementing DFS channels and situations when they should be avoided.
- Define the term *data rate*.
- List the channels and channel widths that are available for the 2.4 GHz band and which channels are the best to use as well as which channels to avoid.
- List possible sources of radio interference in the 2.4 GHz band.
- Use an access point's built-in scanning feature to find the least congested channels in the surrounding area.
- Set channel and channel width for the 5 GHz and 2.4 GHz bands on an access point.

Access Point Placement

- Compare and contrast the characteristics of the 5 and 2.4 GHz bands, e.g. number of channels, channel width, attenuation, etc.
- Explain the best practices for placing access points.
- Explain why most access points are designed to be mounted on the ceiling.
- Define the term *antenna propagation pattern* and list the two basic types of propagation patterns used for access point antenna.
- Define the term *Received Signal Strength Indication (RSSI)*.
- Explain the minimum RSSI values you should find for both the 5 and 2.4 GHz bands and still have excellent network coverage throughout a given space.
- Demonstrate how to use a mobile device to measure RSSI for a wireless network.
- Explain what obstructions do to wireless signals.

Transmit Power

- Explain why leaving an access point's transmit power at full strength is usually not a good idea.
- Change an access point's transmit power for the 5 and 2.4 GHz bands.

Multiple Access Point Installation

- Define the terms *coverage* and *capacity*.
- Define the term *roaming*.
- Explain which settings must be the same on every access point in order for devices to be able to roam seamlessly between them.
- Explain how to plan channels for both the 5 and 2.4 GHz bands when implementing multiple access points.
- Give examples of situations when you should consider narrowing channel widths for the 5 GHz band.
- Use RSSI measurements to adjust the transmit power on multiple access points to achieve maximum coverage with minimal wireless signal overlap for both the 5 and 2.4 GHz bands.
- Define the term *fast roaming*.
- Enable Fast Roaming on access points in networks with multiple access points.
- Combine SSIDs on multiple access points to create a single, seamless network for the customer.
- Implement a guest network.

Troubleshooting

- Explain the steps you should follow when troubleshooting a wireless network.

Course 5 Remote Monitoring and Management

Remote Monitoring and Management

- Define the terms *monitoring*, *management*, and *cloud service*.

Introducing OvrC

- Explain how OvrC can help you manage a customer's network.
- Compare and contrast the features of OvrC, OvrC Pro, and OvrC Home.

Setting Up OvrC

- Add a customer and network site to OvrC.
- Add an OvrC Pro device (Araknis Router or OvrC Pro Hub) to a customer's network site in OvrC.
- Use OvrC to do the following:
  - Test a customer's Internet connection speed.
  - Set up an Internet speed test schedule.
  - Set the correct time zone for a network.
  - Edit the default names of network devices.
  - Add notes about the customer's network.
  - Install new firmware on network devices.
  - Transfer a device to Inventory.
  - Transfer a device out of Inventory.
- Add a technician to OvrC.
- Verify and register a technician account.
- Explain how group permissions are organized in OvrC.
- Do the following in OvrC:
  - Create a group and assign permissions.
  - Add customers to groups.
  - Add technicians to groups.
- Do the following in the OvrC mobile app:
  - Enable notifications.

Managing Devices in OvrC

- Do the following in OvrC:
  - Configure the ports on the switch to display the name of the device connected to each port.
  - Disable a port on the switch.

Power Management

- Explain the advantages of using a managed power unit in a network.
- Do the following in OvrC:
  - Name the outlets on a managed power unit.*
  - Create a schedule to reboot an outlet on a managed power unit.*
  - Enable and configure auto-reboot on a managed power unit.*

    *This functionality is available for WattBox managed power units only.

- Define the term *power conditioning*.
- Explain what power conditioners do to the voltage and frequency of electrical current.
- Define the term *power surge*.
- Explain how surge protectors safeguard network equipment.
- Explain the two major considerations for selecting a surge protector.
- Explain when a surge protector should be replaced.
- Explain the purpose and limitations of an Uninterruptible Power Supply (UPS).
- List the order that network devices should be powered on following a power outage.

OvrC for Customers

- Do the following in OvrC:
  - Create a “one-tap” reset command for a network device.
  - Enable OvrC Home.
  - Add a customer as a user to OvrC Home.
  - Enable Wireless Device Profiles and Network Settings for OvrC Home.
- Demonstrate for a customer how to do the following in the OvrC Home app:
  - Create a profile and add a schedule for the profiled device.
  - Enable Security/Content filtering and select a filtering level.

Course 6 Network Design

Phases of Network Design

- List the three phases of successful network planning.
- Explain the importance of a customer interview.
- Explain the importance of a floor plan.
- Explain the importance of site visits.

Network Design

- List the proper order for network device planning.

Designing Wireless

- List the key considerations for selecting an access point.
- Define the term *physical data rate*.
- Define the term *Multiple-User Multiple-Input Multiple-Output (MU-MIMO)*.
- Define the term *spatial diversity*.

Designing the Topology

- List the key considerations for selecting a switch.
- Define the term *network topology*.
- Explain the characteristics of the two main types of network topologies.
- Explain the *Principle of Centralization*.

Selecting the Right Router

- List the key considerations for selecting a router.
- Explain what *WAN to LAN throughput* is.

Power Requirements

- List the key considerations for selecting a managed power unit.

Implementation

- List the proper order for implementing a network.

Practical Exam

Practice Scenario

In Part 2 of the PCNA exam, the practical portion of the exam, you will be given a real-world scenario for which you must design and implement a network using your PCNA equipment. This real-world scenario will be one of several possible scenarios. The following scenario is *similar* to those you might see in Part 2 of the PCNA exam. If you are unsure how to accomplish any of the network configuration tasks below, review the appropriate PCNA course and section.

WARNING: Do not configure your PCNA network for this scenario until you have *completed all of the courses* in the PCNA curriculum. The hands-on activities in later courses are dependent upon changes you make to your PCNA network through hands-on activities in earlier courses. While the hands-on activities prepare you to implement many different types of networks, the network you are required to implement in this scenario will be *different* from the configuration you use from one course to the next in the hands-on activities.

Preparation

Before you configure your PCNA network for this scenario:

- Update each device to the latest firmware.
- In OvrC:
  - Delete the OvrC Pro device (Arankis 310 Router or Ovrc Pro Hub) from your PCNA course customer site.
  - Transfer the other devices to inventory.
  - Delete the PCNA course customer site you created in Course 5.
- Factory-reset each device (including the OvrC Pro Hub, if applicable).

Scenario - B. Cross

B. Cross, the stage name of Branden Krauszieglerhornsauer, the famous drummer of the punk band, Very Putrid, has hired you to install a network in his 1,200 m^2 (12,917 sq. ft.) vacation home on Mustique Island, in the Caribbean. While the home has approximately 230 devices, including computers, tablets, security cameras, smart TVs, media players, and a home automation system, Mr. Cross likes to throw large, elaborate theme parties for as many as 300 guests at a time—all of whom require Wi-Fi to constantly update their Instagram stories with photos of their stay on Mustique. In addition, Mr. Cross also has a detached garage on the property where his private recording studio is located. The recording studio has an IP-controlled security system. In addition, to protect all of the yet-to-be-released music content stored on the computers in the recording studio, Mr. Cross has requested that you set up a VLAN for the recording studio's unmanaged edge switch that is connected to port 8 of the core switch (the switch in your PCNA network).

While a network of this size would likely require more access points and switches than you have available, you are only required to configure the equipment included in your PCNA network.

Network Specifications

Configure the network devices according to these specifications:

- Update the login credentials on the router, switch, and both access points to:
  - Username: **pcnaprep**
  - Password: **practiceforpcna**
- Implement at LAN, using the **10.10.0.0** private network address that will connect 530 devices with some additional IP addresses to prepare for future growth.
- Change the DNS for the LAN to use Google's Public DNS: **8.8.8.8**
- Set aside 100 IP addresses for static or reserved assignments. Designate all remaining available IP addresses in the subnet for dynamic assignment.
- Assign the router the first static IP address.

  IMPORTANT: After you implement the new LAN, power cycle all of your network devices (including the OvrC Pro Hub, if applicable). You will temporarily lose your Internet connection (approximately 3-5 minutes).

- Reserve **10.10.0.10** for the switch and use **Core-Switch-Rack** for the device name.
- Reserve **10.10.0.20** for the WattBox* and use **MPU-Rack** for the device name.

  ***Note for P2E Users:** Because the P2E has a statically-assigned IP address that is not part of the 10.x.x.x subnet, you are not required to reserve an IP address for it.

- Reserve **10.10.0.30** for the first access point and use **AP-Office** for the device name; reserve **10.10.0.31** for the other access point and use **AP-Grand-Hall** for the device name.
- Reserve **10.10.0.50** for the IP-controlled studio security system, its MAC address is **D4:85:9D:4B:24:43**, and use **Studio-Security** for the device name.

  IMPORTANT: After you reserve the addresses, you will again have to power cycle all of your network devices. You will temporarily lose your Internet connection (approximately 3-5 minutes).

- Set up a VLAN to isolate the unmanaged edge switch in the recording studio from the rest of the network:
  - Use **2** as the VLAN ID and **Studio** as the name/description.
  - **InterVLAN Routing** should *not* be enabled.
  - For the **LAN1** port on the router, define which VLANs should allow Tagged and Untagged traffic.
  - Implement the next available IP addressing scheme for VLAN2 in the 10.10.x.x subnet and define only 10 IP addresses for the DHCP range.
  - Change the DNS for VLAN2 to use Google's Public DNS: **8.8.8.8**
  - Assign trunk and access ports on the core switch (the switch in your PCNA network) appropriately so that the studio's unmanaged edge switch, connected to Port 8 on the core switch, is on VLAN2.
- Change both access points' PoE priority to **High**.

- Implement a wireless network using the SSID, **Chateaux Cross**; change the wireless password to **cheesburgerinparadise**.
- Implement a guest wireless network using the SSID, **Paradise Promise**; change the guest wireless password to **crossmyheart**.
- Without implementing the DFS channels, adjust the wireless channel and channel width on both access points to avoid co-channel and adjacent-channel interference.
- To ensure that you can achieve -65 RSSI for the 5 GHz band and -70 RSSI for the 2.4 GHz band throughout Mr. Cross' vacation home, with minimal overlap between access points, adjust the transmit power on both access points so that the **5 GHz** band is **3 dBm** lower than the default setting and the **2.4 GHz** band is **5 dBm** lower than the adjusted transmit power for the 5 GHz band.
- Download the configuration files from the router, switch and access points. Store them on your computer as backup files.

Configure your PCNA OvrC account (the owner account you created in Course 5) to manage the customer's network:

- Add Mr. Cross as a customer.
  - Customer Name: ***your name*** **(Cross)** For example, if your name is **Robert Jensen**, type **Robert Jensen (Cross)**
  - Location Name: **Mustique Vacation Home**
- Add the Ovrc Pro Device (Araknis router or Ovrc Pro Hub).
- Scan the network to add the other network devices to OvrC.
- Configure OvrC Pro to scan the network every **24 hours**.
- Rename each device:
  - Router: **Router-Rack**
  - Switch: **Core-Switch-Rack**
  - Access Point 1: **AP-Office**
  - Access Point 2: **AP-Grand-Hall**
  - WattBox*: **MPU-Rack**

    ***Note for P2E Users:** Because the P2E has a statically-assigned IP address that is not part of the 10.x.x.x subnet, it will not display in OvrC. You are not required to add it to OvrC.

- Add a group to your PCNA OvrC account.
  - Group Name: **PCNA Exam Prep**
  - Description: **Group used to prepare for the PCNA Exam.**
  - Global Permissions: **Disabled**
  - Customer Permissions: *Enable* **Delete Actions** and *disable* **Surveillance Actions**
  - Customer Access: ***your name*** **(Cross)**

Use OvrC to configure the WattBox* managed power unit:

***Note for P2E Users:** Only PCNA candidates in North America with a WattBox are required to complete the following WattBox-related tasks.

- Rename and configure the outlets for the WattBox (make sure that you choose the **Outlet Mode** for each outlet that won't prevent you from accessing the network remotely).
  - Outlet 1: **Router** (1 second delay)
  - Outlet 2: **Switch** (60 second delay)
- Enable the WattBox to automatically reboot the router and the switch after **six** failed attempts to contact three specific websites. Use the Google, Amazon, and Microsoft websites (in that order).
  - Ping 1, rename **Google**, www.google.com
  - Ping 2, rename **Amazon**, www.amazon.com
  - Ping 3, rename **Microsoft**, www.microsoft.com
- Enable **OvrC Home**.
- Create a command, called **Fix the Internet**, that uses the WattBox to reset its outlets for the router and the switch using the delays you previously specified.