



NETWORKING & CYBER SECURITY GRADE 12 CURRICULUM OVERVIEW

Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
Goal 1: Describe and apply appropriate health and safety practices.				
GLO 1.1: Describe and apply appropriate health and safety practices.				
Maintain a safe and organized workspace.				
Keep cables safe and uncluttered.				
Demonstrate awareness of health and safety issues related to lighting and glare, including monitors.				
Explain the safe working conditions and safe lab procedures				
Goal 2: Demonstrate an awareness of the evolution, technological progression, and emerging trends in IT.				
GLO 2.1: Describe the evolution, technological progression and emerging trends in IT.				
Describe the evolution, technological progression and emerging trends in IT	Describe the evolution, technological progression and emerging trends in IT	Describe the evolution, technological progression and emerging trends in IT		Describe the evolution, technological progression and emerging trends in IT
Demonstrate understanding of the evolution of Linux and other Popular Operating Systems (LPI 1.1)				
Goal 3: Demonstrate understanding of hardware, operating systems, applications, networking and cyber security.				
GLO 3.1: Demonstrate understanding of concepts related to hardware.				
Understand Computer Hardware (LPI 4.2)				



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
GLO 3.2: Demonstrate a theoretical understanding of operating systems .				
Explain how and where Data is Stored (LPI 4.3)				
Demonstrate understanding of special Directories and Files (LPI 5.4)				
GLO 3.3: Demonstrate a theoretical understanding of applications .				
Demonstrate awareness of major Open Source Applications (LPI 1.2)				
GLO 3.4: Demonstrate a theoretical understanding of networking .				
	Explain how network layer protocols and services support communications across data networks. (Cisco Intro 6.1)			
	Explain how routers enable end-to-end connectivity in a small to medium-sized business network. (Cisco Intro 6.2)			
	Determine the appropriate device to route traffic in a small to medium-sized business network. (Cisco Intro 6.3)			
	Describe the purpose of the transport layer in managing the transportation of data in end-to-end communication. (Cisco Intro 7.1)		Reconnaissance basics. Explanation of the ISO Transport layer with in-depth details around TCP and UDP.	
	Describe characteristics of the TCP and UDP protocols, including port numbers and their uses. (Cisco Intro 7.2)			



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
	Explain how TCP session establishment and termination processes facilitate reliable communication. (Cisco Intro 7.3)		Talk about various scanning methods. (E.g. ack, syn, rst scans)	
	Explain how TCP protocol data units are transmitted and acknowledged to guarantee delivery. (Cisco Intro 7.4)			
	Explain the UDP client processes to establish communication with a server. . (Cisco Intro 7.5)		UDP scan more complicated than TCP. Explain why.	
	Determine whether high-reliability TCP transmissions, or non-guaranteed UDP transmissions, are best suited for common applications. (Cisco Intro 7.6)			
Describe Linux Computers on the Network (LPI 4.4)				
	Describe the structure of an IPv4 address. (Cisco Intro 8.1)			
	Describe the purpose of the subnet mask. (Cisco Intro 8.2)			
	Compare the characteristics and uses of the unicast, broadcast and multicast IPv4 addresses. (Cisco Intro 8.3)			
	Explain the need for IPv6 addressing. (Cisco Intro 8.4)		IPv6 is emerging technology and it will replace IPv4 in the future.	



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
	Describe the representation of an IPv6 address. (Cisco Intro 8.5)			
	Describe types of IPv6 network addresses. (Cisco Intro 8.6)			
GLO 3.5: Demonstrate a theoretical understanding of cyber security .				
Demonstrate understanding of basic Security and Identifying User Types (LPI 5.1)			Basic information security introduction	
Goal 4: Install, configure, manage, secure and troubleshoot devices , operating systems and applications.				
GLO 4.1: Install devices, operating systems, and their associated software.				
		Understand device drivers. (WSAF 1.1)		
		Understand services. (WSAF 1.2)	Disabling the services and alternative solutions	
		Understand server installation options. (WSAF 1.3)		
		Identify application servers. (WSAF 2.1)		
		Understand Web services. (WSAF 2.1)	Basic web server security	
		Understand remote access. (WSAF 2.1)	Remote access options	
		Understand file and print services. (WSAF 2.1)		
		Understand server virtualization. (WSAF 2.1)		
GLO 4.2: Configure devices, operating systems, and their associated software.				
Demonstrate ICT Skills and the ability to work in Linux (LPI 1.4)		Understand accounts and groups. (WSAF 3.1)		



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
Use Linux Command Line Basics (LPI 2.1)		Understand organizational units (OUs) and containers. (WSAF 3.2)		
Use the Command Line to Get Help (LPI 2.2)		Understand Active Directory infrastructure. (WSAF 3.3)		
Use Directories and Listing Files (LPI 2.3)		Understand group policy. (WSAF 3.4)		
Archive Files on the Command Line (LPI 1.1)		Identify storage technologies. (WSAF 4.1)		
Search and Extract Data from Files (LPI 3.2)		Understand RAID. (WSAF 4.2)		
Create scripts from Linux commands. (LPI 3.3)		Understand disk types. (WSAF 4.3)		
GLO 4.3: Manage devices, operating systems, and their associated software.				
Create Users and Groups (LPI 5.2)		Identify major server hardware components. (WSAF 5.1)		
		Understand performance monitoring. (WSAF 5.2)		
		Understand logs and alerts. (WSAF 5.3)		
		Identify steps in the startup process. (WSAF 6.1)		
		Understand business continuity. (WSAF 6.2)		
		Understand updates. (WSAF 6.3)		
		Understand troubleshooting methodology. (WSAF 6.4)		



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
GLO 4.4: Secure devices, operating systems, and their associated software.				
Manage File Permissions and Ownership (LPI 5.3)				
GLO 4.5: Troubleshoot devices, operating systems, and their associated software.				
Goal 5: Design, configure, manage, secure and troubleshoot networks , operating systems and applications.				
GLO 5.1: Design networks and their associated software.				
				Design a network with a minimum of direction.
GLO 5.2: Configure networks and their associated software.				
	Configure a router with basic configurations. (Cisco Intro 6.4)		Some Cisco network academy overview	Configure a network with a minimum of direction.
	Configure global unicast addresses. (Cisco Intro 8.7)			
	Explain why routing is necessary for hosts on different networks to communicate. (Cisco Intro 9.1)			
	Describe IP as a communication protocol used to identify a single device on a network. (Cisco Intro 9.2)			
	Given a network and a subnet mask, calculate the number of host addresses available. (Cisco Intro 9.3)			
	Calculate the necessary subnet mask in order to accommodate the requirements of a network. (Cisco Intro 9.4)			



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
	Describe the benefits of variable length subnet masking (VLSM). (Cisco Intro 9.5)			
	Explain how IPv6 address assignments are implemented in a business network. (Cisco Intro 9.6)			
	Explain how the functions of the application layer, session layer, and presentation layer work together to provide network services to end user applications. (Cisco Intro 10.1)			
	Describe how common application layer protocols interact with end user applications. (Cisco Intro 10.2)		Correlate socket with the process (layer 4 to processes)	
	Describe, at a high level, common application layer protocols that provide Internet services to end-users, including WWW services and email. (Cisco Intro 10.3)			
	Describe application layer protocols that provide IP addressing services, including DNS and DHCP. (Cisco Intro 10.4)			
	Describe the features and operation of well-known application layer protocols that allow for file sharing services, including: FTP, File Sharing Services, SMB protocol. (Cisco Intro 10.5)		Anonymous FTP	



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
	Explain how data is moved across the network, from opening an application to receiving data. (Cisco Intro 10.6)			
	Identify the devices and protocols used in a small network. (Cisco Intro 11.1)			
	Explain how a small network serves as the basis of larger networks. (Cisco Intro 11.2)			
	Explain the need for basic security measures on network devices. (Cisco Intro 11.3)			
	Identify security vulnerabilities and general mitigation techniques. (Cisco Intro 11.4)		Cyber Security vulnerabilities in industry	
	Use the output of ping and tracert commands to establish relative network performance. (Cisco Intro 11.5)			
	Use basic show commands to verify the configuration and status of a device interface. (Cisco Intro 11.6)		CDP, LLDP	
	Explain the file systems on Routers and Switches. (Cisco Intro 11.7)			
	Apply the commands to back up and restore an IOS configuration file. (Cisco Intro 11.8)			



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
GLO 5.3: Manage networks and their associated software.				
GLO 5.4: Secure networks and their associated software.				
GLO 5.5: Troubleshoot networks and their associated software.				
Goal 6: Document the installation, design, configuration, management, security and troubleshooting of devices, networks, and their associated software				
GLO 6.1:				
Goal 7: Describe and demonstrate the transferable cross-curricular knowledge and skills relevant to IT.				
GLO 7.1: Research, read, interpret and communicate information relevant to IT.				
GLO 7.2: Apply the knowledge and skills from mathematics relevant to IT.				
			Using scientific methods as bases of troubleshooting and discovering approach to the complex systems	
GLO 7.3: Apply the knowledge and skills from the sciences relevant to IT.				
			The same as above	
Goal 8: Demonstrate awareness of sustainability as it pertains to networking and cyber security.				
GLO 8.1: Describe the IT industry's sustainability practices and impact on the environment.				
GLO 8.2: Describe the impact of human sustainability on the well-being of those employed in IT and the users of their services.				
GLO 8.3: Describe sustainable business practices within the IT industry.				
Goal 9: Demonstrate awareness of the ethical and legal standards as they pertain to IT.				
GLO 9.1: Demonstrate an awareness of the ethical and legal standards as they pertain to IT.				
			Very important we will talk about it. Ethics, standards, etc.	
Goal 10: Demonstrate employability skills .				
GLO 10.1: Demonstrate fundamental employability skills .				
Demonstrate regular and punctual attendance.	→	→	We will review business demands	→



Advanced Operating Systems 40S / 40E / 40M	Advanced Networking Technologies 40S / 40E / 40M	Server Administration 40S / 40E / 40M	CCDC Value Add-on	Applied Networking and Cyber Security 40S / 40E / 40M
Demonstrate the ability to communicate respectfully and effectively with teachers, supervisors, co-worker, and students.	→	→	As above	→
Demonstrate accountability by taking responsibility for their actions.	→	→	As above	→
Demonstrate adaptability, initiative and effort.	→	→	As above	→
Demonstrate teamwork skills.	→	→	As above	→
Demonstrate the ability to stay on task and effectively use time in class and work environments.	→	→	As above	→
Demonstrate the responsible use of wireless communication devices.	→	→	As above	→
GLO 10.2: Demonstrate an awareness of cultural proficiency , and its importance in the workplace.				
GLO 10.3: Demonstrate an understanding of the business operation of an IT organization.				
			We will mention this.	
GLO 10.4: Demonstrate critical thinking skills .				
			See scientific method.	
GLO 10.5: Demonstrate project management skills.				
			Please teach the students	
Goal 11: Demonstrate understanding of the IT industry .				
GLO 11.1: Demonstrate an understanding of the scope of the IT industry .				
GLO 11.2: Demonstrate understanding of the educational and career opportunities , as well as industry and professional associations .				
			SANS, CIPS, (ISC)2	
GLO 11.3: Demonstrate understanding of working conditions in IT.				



CURRICULUM DESCRIPTION

Intro to cyber security
Career opportunities

Ethics

CIA concepts

Threat vs vulnerability
Threat overviews and threat realization

OS overviews:

- Windows
- Linux

System hardening:

- How to disable services, and alternative solutions (crontab, firewall, permissions etc)
- Basic web server security

Network remote access options:

- Correlation of process and sockets - layer4 to process

Networking:

- LAN
- WAN
- Internet
- OSI model / TCP/IP model
- IPv4, IPv6 - How addresses work
- Network protocols and communications
- ARP/MAC, other relevant protocols
- Ports and protocols why and how
- Well-known ports and protocols
- Anonymous FTP
- SSH

Basic network security:

- Basic network security how to.

Basic networking with Cisco

- ACL
- Getting help in Cisco
- Basic router configuration

Basic network reconnaissance:

- Reconnaissance basics
- Scanning methods - connect, rset
- UDP scans vs. TCP (why is UDP)
- Wireshark/protocol analysis



IT essentials

Configure and apply BIOS settings
Differentiate between motherboard components, their purposes, and properties.
Compare and contrast RAM types and features.
Install and configure expansion cards.
Install and configure storage devices and use appropriate media.
Differentiate among various CPU types and features and select the appropriate cooling method.
Compare and contrast various connection interfaces and explain their purpose.
Install an appropriate power supply based on a given scenario.
Evaluate and select appropriate components for a custom configuration, to meet customer specifications or needs.
Given a scenario, evaluate types and features of display devices.
Identify connector types and associated cables.
Install and configure various peripheral devices.

Networking

Identify types of network cables and connectors.
Categorize characteristics of connectors and cabling.

Explain properties and characteristics of TCP/IP.
Explain common TCP and UDP ports, protocols, and their purpose.

Compare and contrast wireless networking standards and encryption types.
Install, configure, and deploy a SOHO wireless/wired router using appropriate settings.
Compare and contrast Internet connection types and features.

Identify various types of networks.

Compare and contrast network devices, their functions, and features.

Given a scenario, use appropriate networking tools.

Laptops

Install and configure laptop hardware and components.
Compare and contrast the components within the display of a laptop.
Compare and contrast laptop features.

Printers

Explain the differences between the various printer types and summarize the associated imaging process.
Given a scenario, install, and configure printers.
Given a scenario, perform printer maintenance.

Operational Procedures

Given a scenario, use appropriate safety procedures.

Explain environmental impacts and the purpose of environmental controls.



Given a scenario, demonstrate proper communication and professionalism.
Explain the fundamentals of dealing with prohibited content/activity.

Cyber Patriot

Introduction to cyber security
Cyber security career opportunities

Information classification introduction
Cyber security tips for the day to day activities

Ethics

CIA description

People, processes and technologies that are related to CIA

Threat vs Vulnerability
Threats overview and how it works
IAAA and password security
Computer basics and associated security with it
OS types and associated security

Virtual computing description

Major network components and concept based on Cisco academy
Windows basics and MSDN

Windows security tools

Control Panel
Services
Admin tool
Action Center
Windows firewall and updates
Windows accounts
Windows permissions
Backup practices
Log audit
Performance monitoring

Linux overview

Common Linux terms and definition
Linux system architecture
Differences and similarities with Microsoft
sudo



Linux security

Accounts
Updates
Firewalls
PAM Things
Linux Security commands
Audit Logging and system monitoring

CCDC VALUE ADD-ON

Routing and Switching

1. Introduction to Switched Networks

- 1.0 Introduction
- 1.1 LAN Design
- 1.2 The Switched Environment 1.3 Summary
- 1.3 Basic Switching Concepts and Configuration
- 1.4 VLANs
- 1.5 Routing Concepts
- 1.6 Inter-VLAN Routing
- 1.7 Static Routing
- 2.0 Basic Switching Concepts and Configuration Introduction
- 2.1 Basic Switch Configuration
- 2.2 Switch Security: Management and Implementation
- 3.0 VLANs
- 3.1 VLAN Segmentation Introduction 3.2 VLAN Implementations
- 3.3 VLAN Security and Design
- 3.4 Summary
- 4.0 Routing Concepts Introduction
- 4.1 Initial Configuration of a Router
- 4.2 Routing Decisions
- 4.3 Router Operation
- 4.4 Summary
- 5.0 Inter-VLAN Routing Introduction
- 5.1 Inter-VLAN Routing Configuration
- 5.2 Troubleshoot Inter-VLAN Routing
- 5.3 Layer 3 Switching
- 5.4 Summary



6.0 Static Routing Introduction
6.1 Static Routing Implementation
6.2 Configure Static and Default Routes
6.3 Review of CIDR and VLSM

6.4 Configure Summary and Floating Static Routes
6.5 Troubleshoot Static and Default Route Issues 6.6 Summary

7. Routing Dynamically
7.0 Routing Dynamically Introduction
7.1 Dynamic Routing Protocols
7.2 Distance Vector Dynamic Routing
7.3 RIP and RIPng Routing
7.4 Link-State Dynamic Routing
7.5 The Routing Table
7.6 Summary

8.0 Single-Area OSPF Introduction
8.1 Characteristics of OSPF
8.2 Configuring Single-Area OSPFv2
8.3 Configure Single-Area OSPFv3 8.4 Summary
8. Single-Area OSPF

9.0 Access Control Lists Introduction
9.1 IP ACL Operation
9.2 Standard IPv4 ACLs
9.3 Extended IPv4 ACLs
9.4 Troubleshoot ACLs 9.5 IPv6 ACLs
9.6 Summary

10.0 DHCP Introduction
10.1 Dynamic Host Configuration Protocol v4
10.2 Dynamic Host Configuration Protocol v6 10.3 Summary

9. Access Control Lists
10. DHCP

11. Network Address Translation for IPv4
11.0 Network Address Translation for IPv4 Introduction 11.1 NAT Operation
11.2 Configuring NAT
11.3 Troubleshooting NAT

11.4 Summary



INTRODUCTION TO NETWORKING

Chapter 0 Course Introduction 1

0.0 Welcome to Introduction to Networks 1

- 0.0.1 Message to the Student 1
 - 0.0.1.1 *Welcome 1*
 - 0.0.1.2 *A Global Community 1*
 - 0.0.1.3 *More Than Just Information 1*
 - 0.0.1.4 *How We Teach 2*
 - 0.0.1.5 *Practice Leads to Mastery 2*
 - 0.0.1.6 *Mind Wide Open 2*
 - 0.0.1.7 *Engineering Journals 2*
 - 0.0.1.8 *Explore the World of Networking 2*
 - 0.0.1.9 *Create Your Own Worlds 2*
 - 0.0.1.10 *How Packet Tracer Helps Master Concepts 3*
 - 0.0.1.11 *Course Overview 3*

0.1 Navigating the Course 3

- 0.1.1 Control Your Experience 3
 - 0.1.1.1 *Course GUI Tutorial 3*

Your Chapter Notes 4

Chapter 1 Exploring the Network 5

1.0 Exploring the Network 5

- 1.0.1.1 Introduction 5
 - 1.0.1.2 *Class Activity - Draw Your Concept of the Internet 5*

1.1 Globally Connected 6

- 1.1.1 Networking Today 6
 - 1.1.1.1 *Networks in Our Daily Lives 6*
 - 1.1.1.2 *Technology Then and Now 6*
 - 1.1.1.3 *The Global Community 7*
 - 1.1.1.4 *Networks Support the Way We Learn 7*
 - 1.1.1.5 *Networks Support the Way We Communicate 8*
 - 1.1.1.6 *Networks Support the Way We Work 9*
 - 1.1.1.7 *Networks Support the Way We Play 9*
 - 1.1.1.8 *Lab - Researching Network Collaboration Tools 10*
- 1.1.2 Providing Resources in a Network 10
 - 1.1.2.1 *Networks of Many Sizes 10*
 - 1.1.2.2 *Clients and Servers 11*
 - 1.1.2.3 *Clients and Servers (Cont.) 11*
 - 1.1.2.4 *Peer-to-Peer 11*

1.2 LANs, WANs, and the Internet 12

- 1.2.1 Components of a Network 12
 - 1.2.1.1 *Components of the Network 12*
 - 1.2.1.2 *End Devices 12*
 - 1.2.1.3 *Intermediary Network Devices 13*



- 1.2.1.4 *Network Media* 13
- 1.2.1.5 *Network Representations* 14
- 1.2.1.6 *Topology Diagrams* 14
- 1.2.1.7 *Activity - Network Component Representations and Functions* 15

1.2.2 LANs and WANs 15

- 1.2.2.1 *Types of Networks* 15
- 1.2.2.2 *Local Area Networks* 15
- 1.2.2.3 *Wide Area Networks* 15

1.2.3 The Internet 16

- 1.2.3.1 *The Internet* 16
- 1.2.3.2 *Intranet and Extranet* 16
- 1.2.3.3 *Lab - Researching Converged Network Services* 17

1.2.4 Connecting to the Internet 17

- 1.2.4.1 *Internet Access Technologies* 17
- 1.2.4.2 *Connecting Remote Users to the Internet* 17
- 1.2.4.3 *Connecting Businesses to the Internet* 18
- 1.2.4.4 *Packet Tracer - Network Representation* 19

1.3 The Network as a Platform 19

1.3.1 Converged Networks 19

- 1.3.1.1 *The Converging Network* 19
- 1.3.1.2 *Planning for the Future* 20
- 1.3.1.3 *Lab - Mapping the Internet* 20

1.3.2 Reliable Network 21

- 1.3.2.1 *The Supporting Network Architecture* 21
- 1.3.2.2 *Fault Tolerance in Circuit Switched Networks* 21
- 1.3.2.3 *Fault Tolerance in Packet-Switched Networks* 22
- 1.3.2.4 *Scalable Networks* 23
- 1.3.2.5 *Providing QoS* 23
- 1.3.2.6 *Providing Network Security* 24
- 1.3.2.7 *Activity - Reliable Networks* 25

1.4 The Changing Network Environment 25

1.4.1 Network Trends 25

- 1.4.1.1 *New Trends* 25
- 1.4.1.2 *BYOD* 26
- 1.4.1.3 *Online Collaboration* 27
- 1.4.1.4 *Video Communication* 27
- 1.4.1.5 *Cloud Computing* 28
- 1.4.1.6 *Data Centers* 29

1.4.2 Networking Technologies for the Home 30

- 1.4.2.1 *Technology Trends in the Home* 30
- 1.4.2.2 *Powerline Networking* 30
- 1.4.2.3 *Wireless Broadband* 30

1.4.3 Network Security 31

- 1.4.3.1 *Security threats* 31
- 1.4.3.2 *Security Solutions* 32
- 1.4.3.3 *Activity - Network Security Terminology* 33



- 1.4.4 Network Architectures 33
 - 1.4.4.1 Cisco Network Architectures 33
 - 1.4.4.2 CCNA 33
 - 1.4.4.3 Lab - Researching IT and Networking Job Opportunities 33

1.5 Summary 34

- 1.5.1.1 Class Activity - Draw Your Concept of the Internet Now 34
- 1.5.1.2 Summary 34

Chapter 1 Quiz 36

Chapter 1 Exam 36

Your Chapter Notes 36

Chapter 2 Configuring a Network Operating System 37

2.0 Configuring a Network Operating System 37

- 2.0.1 Introduction 37
 - 2.0.1.1 Introduction to Cisco IOS 37
 - 2.0.1.2 Class Activity - It Is Just an Operating System 38

2.1 IOS Bootcamp 38

- 2.1.1 Cisco IOS 38
 - 2.1.1.1 Operating Systems 38
 - 2.1.1.2 Purpose of OS 39
 - 2.1.1.3 Location of the Cisco IOS 39
 - 2.1.1.4 IOS Functions 40
 - 2.1.1.5 Video Demonstration - CCO Accounts and IOS Image Exploration 40
- 2.1.2 Accessing a Cisco IOS Device 41
 - 2.1.2.1 Console Access Method 41
 - 2.1.2.2 Telnet, SSH, and AUX Access Methods 41
 - 2.1.2.3 Terminal Emulation Programs 42
 - 2.1.2.4 Activity - Accessing Devices 42
- 2.1.3 Navigating the IOS 42
 - 2.1.3.1 Cisco IOS Modes of Operation 42
 - 2.1.3.2 Primary Modes 43
 - 2.1.3.3 Global Configuration Mode and Submodes 44
 - 2.1.3.4 Navigating between IOS Modes 45
 - 2.1.3.5 Navigating between IOS Modes (Cont.) 45
 - 2.1.3.6 Video Demonstration - Navigating the IOS 46
- 2.1.4 The Command Structure 46
 - 2.1.4.1 IOS Command Structure 46
 - 2.1.4.2 Cisco IOS Command Reference 47
 - 2.1.4.3 Context-Sensitive Help 48
 - 2.1.4.4 Command Syntax Check 49
 - 2.1.4.5 Hot Keys and Shortcuts 49
 - 2.1.4.6 IOS Examination Commands 51
 - 2.1.4.7 The show version Command 52
 - 2.1.4.8 Packet Tracer - Navigating the IOS 52
 - 2.1.4.9 Lab - Establishing a Console Session with Tera Term 52



2.2 Getting Basic 53

- 2.2.1 Hostnames 53
 - 2.2.1.1 *Why the Switch* 53
 - 2.2.1.2 *Device Names* 53
 - 2.2.1.3 *Hostnames* 54
 - 2.2.1.4 *Configuring Hostnames* 54
- 2.2.2 Limiting Access to Device Configurations 55
 - 2.2.2.1 *Securing Device Access* 55
 - 2.2.2.2 *Securing Privileged EXEC Access* 56
 - 2.2.2.3 *Securing User EXEC Access* 56
 - 2.2.2.4 *Encrypting Password Display* 57
 - 2.2.2.5 *Banner Messages* 57
- 2.2.3 Saving Configurations 58
 - 2.2.3.1 *Configuration Files* 58
 - 2.2.3.2 *Capturing Text* 60
 - 2.2.3.3 *Packet Tracer - Configuring Initial Switch Settings* 61

2.3 Address Schemes 61

- 2.3.1 Ports and Addresses 61
 - 2.3.1.1 *IP Addressing of Devices* 61
 - 2.3.1.2 *Interfaces and Ports* 62
- 2.3.2 Addressing Devices 62
 - 2.3.2.1 *Configuring a Switch Virtual Interface* 62
 - 2.3.2.2 *Manual IP Address Configuration for End Devices* 63
 - 2.3.2.3 *Automatic IP Address Configuration for End Devices* 63
 - 2.3.2.4 *IP Address Conflicts* 64
 - 2.3.2.5 *Packet Tracer - Implementing Basic Connectivity* 64
- 2.3.3 Verifying Connectivity 65
 - 2.3.3.1 *Test the Loopback Address on an End Device* 65
 - 2.3.3.2 *Testing the Interface Assignment* 65
 - 2.3.3.3 *Testing End-to-End Connectivity* 65
 - 2.3.3.4 *Lab - Building a Simple Network* 66
 - 2.3.3.5 *Lab - Configuring a Switch Management Address* 66

2.4 Summary 66

- 2.4.1.1 *Class Activity - Tutor Me* 66
- 2.4.1.2 *Packet Tracer - Skills Integration Challenge* 67
- 2.4.1.3 *Summary* 67

Chapter 3 Network Protocols and Communications 69

3.0 Network Protocols and Communications 69

- 3.0.1.1 *Introduction* 69
- 3.0.1.2 *Class Activity - Designing a Communications System* 69

3.1 Rules of Communication 70

- 3.1.1 The Rules 70
 - 3.1.1.1 *What is Communication?* 70
 - 3.1.1.2 *Establishing the Rules* 70



- 3.1.1.3 *Message Encoding 71*
- 3.1.1.4 *Message Formatting and Encapsulation 72*
- 3.1.1.5 *Message Size 72*
- 3.1.1.6 *Message Timing 73*
- 3.1.1.7 *Message Delivery Options 73*

3.2 Network Protocols and Standards 74

- 3.2.1 *Protocols 74*
 - 3.2.1.1 *Protocols: Rules that Govern Communications 74*
 - 3.2.1.2 *Network Protocols 74*
 - 3.2.1.3 *Interaction of Protocols 75*
- 3.2.2 *Protocol Suites 76*
 - 3.2.2.1 *Protocol Suites and Industry Standards 76*
 - 3.2.2.2 *Creation of the Internet and Development of TCP/IP 76*
 - 3.2.2.3 *TCP/IP Protocol Suite and Communication Process 77*
 - 3.2.2.4 *Activity – Mapping the Protocols of the TCP/IP Suite 78*
- 3.2.3 *Standards Organizations 78*
 - 3.2.3.1 *Open Standards 78*
 - 3.2.3.2 *ISOC, IAB, and IETF 78*
 - 3.2.3.3 *IEEE 79*
 - 3.2.3.4 *ISO 79*
 - 3.2.3.5 *Other Standards Organizations 80*
 - 3.2.3.6 *Lab - Researching Networking Standards 81*
 - 3.2.3.7 *Activity - Standards Body Scavenger Hunt 81*
- 3.2.4 *Reference Models 81*
 - 3.2.4.1 *The Benefits of Using a Layered Model 81*
 - 3.2.4.2 *The OSI Reference Model 82*
 - 3.2.4.3 *The TCP/IP Protocol Model 82*
 - 3.2.4.4 *Comparing the OSI Model with the TCP/IP Model 82*
 - 3.2.4.5 *Activity – Identify Layers and Functions 83*
 - 3.2.4.6 *Packet Tracer - Investigating the TCP/IP and OSI Models in Action 83*
 - 3.2.4.7 *Lab - Researching RFCs 83*

3.3 Moving Data in the Network 84

- 3.3.1 *Data Encapsulation 84*
 - 3.3.1.1 *Communicating the Messages 84*
 - 3.3.1.2 *Protocol Data Units (PDUs) 84*
 - 3.3.1.3 *Encapsulation 85*
 - 3.3.1.4 *De-encapsulation 85*
 - 3.3.1.5 *Activity – Identify the PDU Layer 86*
- 3.3.2 *Accessing Local Resources 86*
 - 3.3.2.1 *Network Addresses and Data Link addresses 86*
 - 3.3.2.2 *Communicating with a Device on the Same Network 86*
 - 3.3.2.3 *MAC and IP Addresses 87*
- 3.3.3 *Accessing Remote Resources 88*
 - 3.3.3.1 *Default Gateway 88*
 - 3.3.3.2 *Communicating with a Device on a Remote Network 88*
 - 3.3.3.3 *Packet Tracer - Explore a Network 89*
 - 3.3.3.4 *Lab - Using Wireshark to View Network Traffic 89*



3.4 Summary 89

3.4.1.1 Class Activity - Guaranteed to Work! 89

3.4.1.2 Summary 90

Chapter 3 Quiz 91

Chapter 3 Exam 91

Your Chapter Notes 91

Chapter 4 Network Access 93

4.0 Network Access 93

4.0.1.1 Introduction 93

4.0.1.2 Class Activity - Managing the Medium 93

4.1 Physical Layer Protocols 94

4.1.1 Getting It Connected 94

4.1.1.1 Connecting to the Network 94

4.1.1.2 Network Interface Cards 95

4.1.2 Purpose of the Physical Layer 95

4.1.2.1 The Physical Layer 95

4.1.2.2 Physical Layer Media 96

4.1.2.3 Physical Layer Standards 96

4.1.2.4 Lab - Identifying Network Devices and Cabling 96

4.1.3 Fundamental Principles of Layer 1 97

4.1.3.1 Physical Layer Fundamental Principles 97

4.1.3.2 Bandwidth 98

4.1.3.3 Throughput 98

4.1.3.4 Types of Physical Media 99

4.1.3.5 Activity - Physical Layer Terminology 100

4.2 Network Media 100

4.2.1 Copper Cabling 100

4.2.1.1 Characteristics of Copper Media 100

4.2.1.2 Copper Media 101

4.2.1.3 Unshielded Twisted-Pair Cable 101

4.2.1.4 Shielded Twisted-Pair (STP) Cable 101

4.2.1.5 Coaxial Cable 102

4.2.1.6 Copper Media Safety 102

4.2.1.7 Activity - Copper Media Characteristics 103

4.2.2 UTP Cabling 103

4.2.2.1 Properties of UTP Cabling 103

4.2.2.2 UTP Cabling Standards 103

4.2.2.3 UTP Connectors 104

4.2.2.4 Types of UTP Cable 104

4.2.2.5 Testing UTP Cables 105

4.2.2.6 Activity - Cable Pinouts 105

4.2.2.7 Lab - Building an Ethernet Crossover Cable 105

4.2.3.1 Properties of Fiber Optic Cabling 105

4.2.3.2 Fiber Media Cable Design 106

4.2.3.3 Types of Fiber Media 106



- 4.2.3.4 *Network Fiber Connectors* 107
- 4.2.3.5 *Testing Fiber Cables* 108
- 4.2.3.6 *Fiber versus Copper* 108
- 4.2.3.7 *Activity - Fiber Optics Terminology* 109

4.2.4 *Wireless Media* 109

- 4.2.4.1 *Properties of Wireless Media* 109
- 4.2.4.2 *Types of Wireless Media* 110
- 4.2.4.3 *Wireless LAN* 110
- 4.2.4.4 *802.11 Wi-Fi Standards* 111
- 4.2.4.5 *Packet Tracer - Connecting a Wired and Wireless LAN* 111
- 4.2.4.6 *Lab - Viewing Wired and Wireless NIC Information* 111

4.3 Data Link Layer Protocols 112

4.3.1 Purpose of the Data Link Layer 112

- 4.3.1.1 *The Data Link Layer* 112
- 4.3.1.2 *Data Link Sublayers* 112
- 4.3.1.3 *Media Access Control* 113
- 4.3.1.4 *Providing Access to Media* 113

4.3.2 Layer 2 Frame Structure 114

- 4.3.2.1 *Formatting Data for Transmission* 114
- 4.3.2.2 *Creating a Frame* 114
- 4.3.2.3 *Activity - Generic Frame Fields* 115

4.3.3 Layer 2 Standards 115

- 4.3.3.1 *Data Link Layer Standards* 115
- 4.3.3.2 *Activity - Data Link Layer Standards Organizations* 116

4.4 Media Access Control 116

4.4.1 Topologies 116

- 4.4.1.1 *Controlling Access to the Media* 116
- 4.4.1.2 *Physical and Logical Topologies* 116

4.4.2 WAN Topologies 117

- 4.4.2.1 *Common Physical WAN Topologies* 117
- 4.4.2.2 *Physical Point-to-Point Topology* 117
- 4.4.2.3 *Logical Point-to-Point Topology* 117
- 4.4.2.4 *Half and Full Duplex* 118

4.4.3 LAN Topologies 118

- 4.4.3.1 *Physical LAN Topologies* 118
- 4.4.3.2 *Logical Topology for Shared Media* 119
- 4.4.3.3 *Contention-Based Access* 119
- 4.4.3.4 *Multi-Access Topology* 120
- 4.4.3.5 *Controlled Access* 120
- 4.4.3.6 *Ring Topology* 121
- 4.4.3.7 *Activity - Logical and Physical Topologies* 121

4.4.4 Data Link Frame 121

- 4.4.4.1 *The Frame* 121
- 4.4.4.2 *The Header* 122
- 4.4.4.3 *Layer 2 Address* 123
- 4.4.4.4 *The Trailer* 123
- 4.4.4.5 *LAN and WAN Frames* 124



- 4.4.4.6 Ethernet Frame 125
- 4.4.4.7 PPP Frame 125
- 4.4.4.8 802.11 Wireless Frame 125
- 4.4.4.9 Activity - Frame Fields 127

4.5 Summary 127

- 4.5.1.1 Class Activity - Linked In! 127
- 4.5.1.2 Summary 128

Chapter 4 Quiz 129

Chapter 4 Exam 129

Your Chapter Notes 129

Chapter 5 Ethernet 131

5.0 Ethernet 131

- 5.0.1.1 Introduction 131
- 5.0.1.2 Class Activity - Join My Social Circle! 131

5.1 Ethernet Protocol 132

- 5.1.1 Ethernet Operation 132
 - 5.1.1.1 LLC and MAC Sublayers 132
 - 5.1.1.2 MAC Sublayer 133
 - 5.1.1.3 Media Access Control 134
 - 5.1.1.4 MAC Address: Ethernet Identity 134
 - 5.1.1.5 Frame Processing 135
 - 5.1.1.6 Activity - MAC and LLC Sublayers 136
- 5.1.2 Ethernet Frame Attributes 136
 - 5.1.2.1 Ethernet Encapsulation 136
 - 5.1.2.2 Ethernet Frame Size 136
 - 5.1.2.3 Introduction to the Ethernet Frame 137
 - 5.1.2.4 Activity - Ethernet Frame Fields 138
- 5.1.3 Ethernet MAC 138
 - 5.1.3.1 MAC Addresses and Hexadecimal 138
 - 5.1.3.2 MAC Address Representations 138
 - 5.1.3.3 Unicast MAC Address 139
 - 5.1.3.4 Broadcast MAC Address 139
 - 5.1.3.5 Multicast MAC Address 139
 - 5.1.3.6 Lab - Viewing Network Device MAC Addresses 140
- 5.1.4 MAC and IP 140
 - 5.1.4.1 MAC and IP 140
 - 5.1.4.2 End-to-End Connectivity, MAC, and IP 140
 - 5.1.4.3 Lab - Using Wireshark to Examine Ethernet Frames 141
 - 5.1.4.4 Packet Tracer - Identify MAC and IP Addresses 141

5.2 Address Resolution Protocol 141

- 5.2.1 ARP 141
 - 5.2.1.1 Introduction to ARP 141
 - 5.2.1.2 ARP Functions 142
 - 5.2.1.3 ARP Operation 142
 - 5.2.1.4 ARP Role in Remote Communication 143



- 5.2.1.5 *Removing Entries from an ARP Table* 143
- 5.2.1.6 *ARP Tables on Networking Devices* 144
- 5.2.1.7 *Packet Tracer - Examine the ARP Table* 144
- 5.2.1.8 *Lab - Observing ARP with the Windows CLI, IOS CLI, and Wireshark* 144

- 5.2.2 *ARP Issues* 144
 - 5.2.2.1 *How ARP Can Create Problems* 144
 - 5.2.2.2 *Mitigating ARP Problems* 145

5.3 LAN Switches 145

- 5.3.1 *Switching* 145
 - 5.3.1.1 *Switch Port Fundamentals* 145
 - 5.3.1.2 *Switch MAC Address Table* 145
 - 5.3.1.3 *Duplex Settings* 146
 - 5.3.1.4 *Auto-MDIX* 147
 - 5.3.1.5 *Frame Forwarding Methods on Cisco Switches* 148
 - 5.3.1.6 *Cut-Through Switching* 148
 - 5.3.1.7 *Activity - Frame Forwarding Methods* 149
 - 5.3.1.8 *Memory Buffering on Switches* 149
 - 5.3.1.9 *Activity - Switch It!* 150
 - 5.3.1.10 *Lab - Viewing the Switch MAC Address Table* 150
- 5.3.2 *Fixed or Modular* 150
 - 5.3.2.1 *Fixed versus Modular Configuration* 150
 - 5.3.2.2 *Module Options for Cisco Switch Slots* 151
- 5.3.3 *Layer 3 Switching* 152
 - 5.3.3.1 *Layer 2 versus Layer 3 Switching* 152
 - 5.3.3.2 *Cisco Express Forwarding* 152
 - 5.3.3.3 *Types of Layer 3 Interfaces* 153
 - 5.3.3.4 *Configuring a Routed Port on a Layer 3 Switch* 153
 - 5.3.3.5 *Packet Tracer - Configure Layer 3 Switches* 154

5.4 Summary 154

- 5.4.1.1 *Class Activity - MAC and Choose...* 154
- 5.4.1.2 *Summary* 154

Chapter 5 Quiz 156

Chapter 5 Exam 156

Your Chapter Notes 156

Chapter 6 Network Layer 157

6.0 Network Layer 157

- 6.0.1.1 *Introduction* 157
- 6.0.1.2 *Class Activity - The Road Less Traveled...* 157

6.1 Network Layer Protocols 158

- 6.1.1 *Network Layer in Communication* 158
 - 6.1.1.1 *The Network Layer* 158
 - 6.1.1.2 *Network Layer Protocols* 159
- 6.1.2 *Characteristics of the IP protocol* 159
 - 6.1.2.1 *Characteristics of IP* 159



- 6.1.2.2 *IP - Connectionless* 159
- 6.1.2.3 *IP - Best Effort Delivery* 160
- 6.1.2.4 *IP - Media Independent* 160
- 6.1.2.5 *Encapsulating IP* 161
- 6.1.2.6 *Activity - IP Characteristics* 161

6.1.3 IPv4 Packet 161

- 6.1.3.1 *IPv4 Packet Header* 161
- 6.1.3.2 *IPv4 Header Fields* 162
- 6.1.3.3 *Sample IPv4 Headers* 163
- 6.1.3.4 *Activity - IPv4 Header Fields* 163

6.1.4 IPv6 Packet 163

- 6.1.4.1 *Limitations of IPv4* 163
- 6.1.4.2 *Introducing IPv6* 164
- 6.1.4.3 *Encapsulating IPv6* 164
- 6.1.4.4 *IPv6 Packet Header* 165
- 6.1.4.5 *Sample IPv6 Header* 166
- 6.1.4.6 *Activity - IPv6 Header Fields* 166

6.2 Routing 166

6.2.1 How a Host Routes 166

- 6.2.1.1 *Host Forwarding Decision* 166
- 6.2.1.2 *Default Gateway* 167
- 6.2.1.3 *IPv4 Host Routing Table* 168
- 6.2.1.4 *IPv4 Host Routing Entries* 168
- 6.2.1.5 *Sample IPv4 Host Routing Table* 169
- 6.2.1.6 *Sample IPv6 Host Routing Table* 170
- 6.2.1.7 *Activity - Identify Elements of a Host Routing Table Entry* 170

6.2.2 Router Routing Tables 170

- 6.2.2.1 *Router Packet Forwarding Decision* 170
- 6.2.2.2 *IPv4 Router Routing Table* 171
- 6.2.2.3 *Directly Connected Routing Table Entries* 171
- 6.2.2.4 *Remote Network Routing Table Entries* 172
- 6.2.2.5 *Next-Hop Address* 173
- 6.2.2.6 *Sample Router IPv4 Routing Table* 173
- 6.2.2.7 *Activity - Identify Elements of a Router Routing Table Entry* 175
- 6.2.2.8 *Lab - View Host Routing Tables* 175

6.3 Routers 175

6.3.1 Anatomy of a Router 175

- 6.3.1.1 *A Router is a Computer* 175
- 6.3.1.2 *Router CPU and OS* 176
- 6.3.1.3 *Router Memory* 176
- 6.3.1.4 *Inside a Router* 177
- 6.3.1.5 *Router Backplane* 177
- 6.3.1.6 *Connecting to a Router* 178
- 6.3.1.7 *LAN and WAN Interfaces* 178
- 6.3.1.8 *Activity - Identify Router Components* 179
- 6.3.1.9 *Lab - Exploring Router Physical Characteristics* 179
- 6.3.1.10 *Packet Tracer - Exploring Internetworking Devices* 179



- 6.3.2 Router Boot-up 179
 - 6.3.2.1 Cisco IOS 179
 - 6.3.2.2 Bootset Files 180
 - 6.3.2.3 Router Bootup Process 180
 - 6.3.2.4 Show Version Output 181
 - 6.3.2.5 Video Demonstration - The Router Boot Process 182
 - 6.3.2.6 Activity - The Router Boot Process 182

6.4 Configuring a Cisco Router 182

- 6.4.1 Configure Initial Settings 182
 - 6.4.1.1 Router Configuration Steps 182
 - 6.4.1.2 Packet Tracer - Configure Initial Router Settings 183
- 6.4.2 Configure Interfaces 183
 - 6.4.2.1 Configure LAN Interfaces 183
 - 6.4.2.2 Verify Interface Configuration 184
- 6.4.3 Configuring the Default Gateway 184
 - 6.4.3.1 Default Gateway on a Host 184
 - 6.4.3.2 Default Gateway on a Switch 185
 - 6.4.3.3 Packet Tracer - Connect a Router to a LAN 185
 - 6.4.3.4 Packet Tracer - Troubleshooting Default Gateway Issues 186
 - 6.4.3.5 Lab - Initializing and Reloading a Router and Switch 186

6.5 Summary 186

- 6.5.1.1 Class Activity - Can You Read This Map? 186
- 6.5.1.2 Packet Tracer - Skills Integration Challenge 187
- 6.5.1.3 Summary 187

Chapter 6 Quiz 188

Chapter 6 Exam 188

Your Chapter Notes 188

Chapter 7 Transport Layer 189

7.0 Transportation Layer 189

- 7.0.1.1 Introduction 189
- 7.0.1.2 Class Activity - We Need to Talk - Game 190

7.1 Transport Layer Protocols 190

- 7.1.1 Transportation of Data 190
 - 7.1.1.1 Role of the Transport Layer 190
 - 7.1.1.2 Role of the Transport Layer (Cont.) 191
 - 7.1.1.3 Conversation Multiplexing 191
 - 7.1.1.4 Transport Layer Reliability 192
 - 7.1.1.5 TCP 192
 - 7.1.1.6 UDP 193
 - 7.1.1.7 The Right Transport Layer Protocol for the Right Application 193
 - 7.1.1.8 Activity - TCP, UDP or Both 194
- 7.1.2 Introducing TCP and UDP 194
 - 7.1.2.1 Introducing TCP 194
 - 7.1.2.2 Role of TCP 195



- 7.1.2.3 *Introducing UDP* 196
- 7.1.2.4 *Role of UDP* 196
- 7.1.2.5 *Separating Multiple Communications* 196
- 7.1.2.6 *TCP and UDP Port Addressing* 197
- 7.1.2.7 *TCP and UDP Port Addressing (Cont.)* 198
- 7.1.2.8 *TCP and UDP Port Addressing (Cont.)* 198
- 7.1.2.9 *TCP and UDP Port Addressing (Cont.)* 199
- 7.1.2.10 *TCP and UDP Segmentation* 199
- 7.1.2.11 *Activity - Compare TCP and UDP Characteristics* 200

7.2 TCP and UDP 200

- 7.2.1 *TCP Communication* 200
 - 7.2.1.1 *TCP Reliable Delivery* 200
 - 7.2.1.2 *TCP Server Processes* 200
 - 7.2.1.3 *TCP Connection Establishment and Termination* 201
 - 7.2.1.4 *TCP Three-way Handshake Analysis - Step 1* 202
 - 7.2.1.5 *TCP Three-way Handshake Analysis - Step 2* 202
 - 7.2.1.6 *TCP Three-way Handshake Analysis - Step 3* 203
 - 7.2.1.7 *TCP Session Termination Analysis* 203
 - 7.2.1.8 *Lab - Using Wireshark to Observe the TCP 3-Way Handshake* 204
 - 7.2.1.9 *Activity - TCP Connection and Termination Process* 204
- 7.2.2 *Reliability and Flow Control* 204
 - 7.2.2.1 *TCP Reliability - Ordered Delivery* 204
 - 7.2.2.2 *TCP Reliability - Acknowledgement and Window Size* 205
 - 7.2.2.3 *TCP Reliability - Data Loss and Retransmission* 205
 - 7.2.2.4 *TCP Flow Control - Window Size and Acknowledgements* 206
 - 7.2.2.5 *TCP Flow Control - Congestion Avoidance* 207
- 7.2.3 *UDP Communication* 207
 - 7.2.3.1 *UDP Low Overhead versus Reliability* 207
 - 7.2.3.2 *UDP Datagram Reassembly* 208
 - 7.2.3.3 *UDP Server Processes and Requests* 208
 - 7.2.3.4 *UDP Client Processes* 208
 - 7.2.3.5 *Lab - Using Wireshark to Examine a UDP DNS Capture* 209
- 7.2.4 *TCP or UDP, that is the Question* 209
 - 7.2.4.1 *Applications that use TCP* 209
 - 7.2.4.2 *Applications that use UDP* 209
 - 7.2.4.3 *Lab - Using Wireshark to Examine FTP and TFTP Captures* 210

7.3 Summary 210

- 7.3.1.1 *Class Activity - We Need to Talk, Again - Game* 210
- 7.3.1.2 *Packet Tracer Simulation - TCP and UDP Communications* 211
- 7.3.1.3 *Summary* 211

Chapter 7 Quiz 213

Chapter 7 Exam 213

Your Chapter Notes 213



Chapter 8 IP Addressing 215

8.0 IP Addressing 215

8.0.1.1 Introduction 215

8.0.1.2 Class Activity - The Internet of Everything (IoE) 215

8.1 IPv4 Network Addresses 216

8.1.1 IPv4 Address Structure 216

8.1.1.1 Binary Notation 216

8.1.1.2 Binary Number System 217

8.1.1.3 Converting a Binary Address to Decimal 218

8.1.1.4 Activity - Binary to Decimal Conversions 218

8.1.1.5 Converting from Decimal to Binary 218

8.1.1.6 Converting from Decimal to Binary (Cont.) 219

8.1.1.7 Activity - Decimal to Binary Conversion Activity 219

8.1.1.8 Activity - Binary Game 219

8.1.2 IPv4 Subnet Mask 219

8.1.2.1 Network Portion and Host Portion of an IPv4 Address 219

8.1.2.2 Examining the Prefix Length 220

8.1.2.3 IPv4 Network, Host and Broadcast Addresses 220

8.1.2.4 First Host and Last Host Addresses 221

8.1.2.5 Bitwise AND Operation 221

8.1.2.6 Importance of ANDing 222

8.1.2.7 Lab - Using the Windows Calculator with Network Addresses 223

8.1.2.8 Lab - Converting IPv4 Addresses to Binary 223

8.1.2.9 Activity - ANDing to Determine the Network Address 223

8.1.3 IPv4 Unicast, Broadcast, and Multicast 223

8.1.3.1 Assigning a Static IPv4 Address to a Host 223

8.1.3.2 Assigning a Dynamic IPv4 Address to a Host 224

8.1.3.3 Unicast Transmission 224

8.1.3.4 Broadcast Transmission 225

8.1.3.5 Multicast Transmission 226

8.1.3.6 Activity - Unicast, Broadcast, or Multicast 227

8.1.3.7 Activity - Calculate the Network, Broadcast and Host Addresses 227

8.1.3.8 Packet Tracer - Investigate Unicast, Broadcast, and Multicast Traffic 227

8.1.4 Types of IPv4 Addresses 227

8.1.4.1 Public and Private IPv4 Addresses 227

8.1.4.2 Activity - Pass or Block IPv4 Addresses 228

8.1.4.3 Special Use IPv4 Addresses 228

8.1.4.4 Legacy Classful Addressing 229

8.1.4.5 Assignment of IP Addresses 230

8.1.4.6 Assignment of IP Addresses (Cont.) 231

8.1.4.7 Activity - Public or Private IPv4 Addresses 232

8.1.4.8 Lab - Identifying IPv4 Addresses 232

8.2 IPv6 Network Addresses 232

8.2.1 IPv4 issues 232

8.2.1.1 The Need for IPv6 232

8.2.1.2 IPv4 and IPv6 Coexistence 233

8.2.1.3 Activity - IPv4 Issues and Solutions 233



- 8.2.2 IPv6 Addressing 233
 - 8.2.2.1 Hexadecimal Number System 233
 - 8.2.2.2 IPv6 Address Representation 234
 - 8.2.2.3 Rule 1 - Omitting Leading 0s 235
 - 8.2.2.4 Rule 2 - Omitting All 0 Segments 235
 - 8.2.2.5 Activity - Practicing IPv6 Address Representations 236
- 8.2.3 Types of IPv6 Addresses 236
 - 8.2.3.1 IPv6 Address Types 236
 - 8.2.3.2 IPv6 Prefix Length 236
 - 8.2.3.3 IPv6 Unicast Addresses 236
 - 8.2.3.4 IPv6 Link-Local Unicast Addresses 238
 - 8.2.3.5 Activity - Identify Types of IPv6 Addresses 238
- 8.2.4 IPv6 Unicast Addresses 238
 - 8.2.4.1 Structure of an IPv6 Global Unicast Address 238
 - 8.2.4.2 Static Configuration of a Global Unicast Address 239
 - 8.2.4.3 Dynamic Configuration of a Global Unicast Address using SLAAC 240
 - 8.2.4.4 Dynamic Configuration of a Global Unicast Address using DHCPv6 241
 - 8.2.4.5 EUI-64 Process or Randomly Generated 242
 - 8.2.4.6 Dynamic Link-local Addresses 243
 - 8.2.4.7 Static Link-Local Addresses 244
 - 8.2.4.8 Verifying IPv6 Address Configuration 244
- 8.2.5 IPv6 Multicast Addresses 245
 - 8.2.5.1 Assigned IPv6 Multicast Addresses 245
 - 8.2.5.2 Solicited-Node IPv6 Multicast Addresses 246
 - 8.2.5.3 Packet Tracer - Configuring IPv6 Addressing 247
 - 8.2.5.4 Lab - Identifying IPv6 Addresses 247
 - 8.2.5.5 Lab - Configuring IPv6 Addresses on Network Devices 247

8.3 Connectivity Verification 247

- 8.3.1 ICMP 247
 - 8.3.1.1 ICMPv4 and ICMPv6 Messages 247
 - 8.3.1.2 ICMPv6 Router Solicitation and Router Advertisement Messages 249
 - 8.3.1.3 ICMPv6 Neighbor Solicitation and Neighbor Advertisement Messages 249
- 8.3.2 Testing and Verification 250
 - 8.3.2.1 Ping - Testing the Local Stack 250
 - 8.3.2.2 Ping - Testing Connectivity to the Local LAN 250
 - 8.3.2.3 Ping - Testing Connectivity to Remote 251
 - 8.3.2.4 Traceroute - Testing the Path 251
 - 8.3.2.5 Packet Tracer - Verifying IPv4 and IPv6 Addressing 252
 - 8.3.2.6 Packet Tracer - Pinging and Tracing to Test the Path 252
 - 8.3.2.7 Lab - Testing Network Connectivity with Ping and Traceroute 252
 - 8.3.2.8 Packet Tracer - Troubleshooting IPv4 and IPv6 Addressing 252

8.4 Summary 253

- 8.4.1.1 Class Activity - The Internet of Everything...Naturally! 253
- 8.4.1.2 Packet Tracer - Skills Integration Challenge 253
- 8.4.1.3 Summary 253

Chapter 8 Quiz 255

Chapter 8 Exam 255

Your Chapter Notes 255



Chapter 9 Subnetting IP Networks 257

9.0 Subnetting IP Networks 257

9.0.1.1 Introduction 257

9.0.1.2 Class Activity - Call Me! 257

9.1 Subnetting an IPv4 Network 258

9.1.1 Network Segmentation 258

9.1.1.1 Reasons for Subnetting 258

9.1.1.2 Communication Between Subnets 258

9.1.2 IP Subnetting is FUNdamental 259

9.1.2.1 The Plan 259

9.1.2.2 The Plan - Address Assignment 259

9.1.3 Subnetting an IPv4 Network 260

9.1.3.1 Basic Subnetting 260

9.1.3.2 Subnets in Use 261

9.1.3.3 Subnetting Formulas 261

9.1.3.4 Creating 4 Subnets 262

9.1.3.5 Creating 8 Subnets 263

9.1.3.6 Activity - Determining the Network Address - Basic 264

9.1.3.7 Activity - Calculate the Number of Hosts - Basic 264

9.1.3.8 Activity - Determining the Valid Addresses for Hosts - Basics 264

9.1.3.9 Activity - Calculate the Subnet Mask 264

9.1.3.10 Creating 100 Subnets with a /16 prefix 264

9.1.3.11 Calculating the Hosts 265

9.1.3.12 Calculating the Hosts 265

9.1.3.13 Activity - Determining the Network Address - Advanced 266

9.1.3.14 Activity - Calculating the Number of Hosts - Advanced 266

9.1.3.15 Activity - Determining the Valid Addresses for Hosts - Advanced 266

9.1.4 Determining the Subnet Mask 266

9.1.4.1 Subnetting Based on Host Requirements 266

9.1.4.2 Subnetting Network-Based Requirements 267

9.1.4.3 Subnetting to Meet Network Requirements 267

9.1.4.4 Subnetting To Meet Network Requirements, Cont. 267

9.1.4.5 Activity - Determining the Number of Bits to Borrow 268

9.1.4.6 Packet Tracer - Subnetting Scenario 1 268

9.1.4.7 Packet Tracer - Subnetting Scenario 2 268

9.1.4.8 Lab - Calculating IPv4 Subnets 268

9.1.4.9 Lab - Subnetting Network Topologies 268

9.1.4.10 Lab - Researching Subnet Calculators 269

9.1.5 Benefits of Variable Length Subnet Masking 269

9.1.5.1 Traditional Subnetting Wastes Addresses 269

9.1.5.2 Variable Length Subnet Masks (VLSM) 269

9.1.5.3 Basic VLSM 270

9.1.5.4 VLSM in Practice 270

9.1.5.5 VLSM Chart 271

9.1.5.6 Activity - Practicing VLSM 272



9.2 Addressing Schemes 272

9.2.1 Structured Design 272

9.2.1.1 *Planning to Address the Network 272*

9.2.1.2 *Assigning Addresses to Devices 272*

9.2.1.3 *Lab - Designing and Implementing a Subnetted IPv4 Addressing Scheme 274*

9.2.1.4 *Lab - Designing and Implementing a VLSM Addressing Scheme 274*

9.2.1.5 *Packet Tracer - Designing and Implementing a VLSM Addressing Scheme 274*

9.3 Design Considerations for IPv6 275

9.3.1 Subnetting an IPv6 Network 275

9.3.1.1 *Subnetting Using the Subnet ID 275*

9.3.1.2 *IPv6 Subnet Allocation 275*

9.3.1.3 *Subnetting into the Interface ID 275*

9.3.1.4 *Packet Tracer - Implementing a Subnetted IPv6 Addressing Scheme 276*

9.4 Summary 276

9.4.1.1 *Class Activity - Can you call me now? 276*

9.4.1.2 *Packet Tracer - Skills Integration Challenge 277*

9.4.1.3 *Summary 277*

Chapter 9 Quiz 278

Chapter 9 Exam 278

Your Chapter Notes 278

Chapter 10 Application Layer 279

10.0 Application Layer 279

10.0.1.1 *Introduction 279*

10.0.1.2 *Class Activity - Application Investigation 279*

10.1 Application Layer Protocols 280

10.1.1 Application, Session and Presentation 280

10.1.1.1 *OSI and TCP/IP Models Revisited 280*

10.1.1.2 *Application Layer 280*

10.1.1.3 *Presentation and Session Layers 281*

10.1.1.4 *TCP/IP Application Layer Protocols 281*

10.1.1.5 *Activity - Application Protocols and Standards 282*

10.1.2 How Application Protocols Interact with End-User Applications 282

10.1.2.1 *Peer-to-Peer Networks 282*

10.1.2.2 *Peer-to-Peer Applications 283*

10.1.2.3 *Common P2P Applications 283*

10.1.2.4 *Lab - Researching Peer-to-Peer File Sharing 284*

10.1.2.5 *Client-Server Model 284*

10.2 Well-Known Application Layer Protocols and Services 284

10.2.1 Common Application Layer Protocols 284

10.2.1.1 *Application Layer Protocols Revisited 284*

10.2.1.2 *Hypertext Transfer Protocol and Hypertext Markup Language 285*

10.2.1.3 *HTTP and HTTPS 285*

10.2.1.4 *SMTP, POP, and IMAP 286*

10.2.1.5 *SMTP, POP, and IMAP (cont.) 287*

10.2.1.6 *SMTP, POP, and IMAP (cont.) 287*



10.2.1.7 SMTP, POP, and IMAP (cont.) 287
10.2.1.8 Packet Tracer - Web and Email 288

10.2.2 Providing IP Addressing Services 288
10.2.2.1 Domain Name Service 288
10.2.2.2 DNS Message Format 288
10.2.2.3 DNS Hierarchy 289
10.2.2.4 nslookup 290
10.2.2.5 Syntax Checker - DNS CLI Commands in Windows and UNIX 290
10.2.2.6 Dynamic Host Configuration Protocol 290
10.2.2.7 DHCP Operation 291
10.2.2.8 Packet Tracer - DNS and DHCP 292
10.2.2.9 Lab - Observing DNS Resolution 292

10.2.3 Providing File Sharing Services 292
10.2.3.1 File Transfer Protocol 292
10.2.3.2 Packet Tracer - FTP 293
10.2.3.3 Lab - Exploring FTP 293
10.2.3.4 Server Message Block 293

10.3 The Message Heard Around the World 294

10.3.1 Move It! 294
10.3.1.1 The Internet of Things 294
10.3.1.2 Message Travels Through a Network 294
10.3.1.3 Getting the Data to the End Device 295
10.3.1.4 Getting the Data through the Internetwork 295
10.3.1.5 Getting the Data to the Right Application 296
10.3.1.6 Warriors of the Net 297

10.4 Summary 297

10.4.1.1 Class Activity - Make it happen! 297
10.4.1.2 Packet Tracer Multiuser - Tutorial 298
10.4.1.3 Packet Tracer Multiuser - Implement Services 298
10.4.1.4 Summary 298

Chapter 10 Quiz 300

Chapter 10 Exam 300

Your Chapter Notes 300

Chapter 11 It's a Network 301

11.0 It's a Network 301

11.0.1.1 Introduction 301
11.0.1.2 Class Activity - Did You Notice...? 301

11.1 Create and Grow 301

11.1.1 Devices in a Small Network 301
11.1.1.1 Small Network Topologies 301
11.1.1.2 Device Selection for a Small Network 302
11.1.1.3 IP Addressing for a Small Network 303
11.1.1.4 Redundancy in a Small Network 304
11.1.1.5 Design Considerations for a Small Network 304
11.1.1.6 Identifying Devices in a Small Network 305



- 11.1.2 Protocols in a Small Network 305
 - 11.1.2.1 *Common Applications in a Small Network* 305
 - 11.1.2.2 *Common Protocols in a Small Network* 305
 - 11.1.2.3 *Real-Time Applications for a Small Network* 306

- 11.1.3 Growing to Larger Networks 307
 - 11.1.3.1 *Scaling a Small Network* 307
 - 11.1.3.2 *Protocol Analysis of a Small Network* 307
 - 11.1.3.3 *Evolving Protocol Requirements* 308

11.2 Keeping the Network Safe 309

- 11.2.1 Network Device Security Measures 309
 - 11.2.1.1 *Categories of Threats to Network Security* 309
 - 11.2.1.2 *Physical Security* 309
 - 11.2.1.3 *Types of Security Vulnerabilities* 310
 - 11.2.1.4 *Activity – Security Threats and Vulnerabilities* 310

- 11.2.2 Vulnerabilities and Network Attacks 310
 - 11.2.2.1 *Viruses, Worms, and Trojan Horses* 310
 - 11.2.2.2 *Reconnaissance Attacks* 311
 - 11.2.2.3 *Access Attacks* 311
 - 11.2.2.4 *DoS Attacks* 312
 - 11.2.2.5 *Activity – Types of Attack* 312
 - 11.2.2.6 *Lab - Researching Network Security Threats* 312

- 11.2.3 Mitigating Network Attacks 312
 - 11.2.3.1 *Backup, Upgrade, Update, and Patch* 312
 - 11.2.3.2 *Authentication, Authorization, and Accounting* 313
 - 11.2.3.3 *Firewalls* 314
 - 11.2.3.4 *Endpoint Security* 315

- 11.2.4 Securing Devices 315
 - 11.2.4.1 *Introduction to Securing Devices* 315
 - 11.2.4.2 *Passwords* 315
 - 11.2.4.3 *Basic Security Practices* 316
 - 11.2.4.4 *Enable SSH* 317
 - 11.2.4.5 *Lab - Accessing Network Devices with SSH* 318
 - 11.2.4.6 *Lab - Securing Network Devices* 318

11.3 Basic Network Performance 318

- 11.3.1 Ping 318
 - 11.3.1.1 *Interpreting Ping Results* 318
 - 11.3.1.2 *Extended Ping* 319
 - 11.3.1.3 *Network Baseline* 320

- 11.3.2 Tracert 321
 - 11.3.2.1 *Interpreting Tracert Messages* 321
 - 11.3.2.2 *Packet Tracer - Test Connectivity with Traceroute* 321
 - 11.3.2.3 *Lab - Testing Network Latency with Ping and Traceroute* 321

- 11.3.3 Show Commands 322
 - 11.3.3.1 *Common show Commands Revisited* 322
 - 11.3.3.2 *Viewing Router Settings with the show version Command* 322
 - 11.3.3.3 *Viewing Switch Settings with the show version Command* 323
 - 11.3.3.4 *Packet Tracer - Using show Commands* 323



11.3.4 Host and IOS Commands 323

- 11.3.4.1 ipconfig Command Options 323*
- 11.3.4.2 arp Command Options 324*
- 11.3.4.3 show cdp neighbors Command Options 324*
- 11.3.4.4 Using the show ip interface brief Command 325*
- 11.3.4.5 Activity – Show Commands 326*
- 11.3.4.6 Lab - Using the CLI to Gather Network Device Information.pdf 326*

11.4 Managing IOS Configuration Files 326

- 11.4.1 Router and Switch File Systems 326**
 - 11.4.1.1 Router File Systems 326*
 - 11.4.1.2 Switch File Systems 327*
- 11.4.2 Back up and Restore Configuration files 327**
 - 11.4.2.1 Backing up and Restoring using Text Files 327*
 - 11.4.2.2 Backing up and Restoring using TFTP 328*
 - 11.4.2.3 Using USB Ports on a Cisco Router 329*
 - 11.4.2.4 Backing up and Restoring using a USB 329*
 - 11.4.2.5 Packet Tracer - Backing up Configuration Files 330*
 - 11.4.2.6 Lab - Managing Router Configuration Files with Tera Term 330*
 - 11.4.2.7 Lab - Managing Device Configuration Files Using TFTP, Flash, and USB 330*
 - 11.4.2.8 Lab - Researching Password Recovery Procedures 330*

11.5 Integrated Routing Services 331

- 11.5.1 Integrated Router 331**
 - 11.5.1.1 Multi-Function Device 331*
 - 11.5.1.2 Types of Integrated Routers 331*
 - 11.5.1.3 Wireless Capability 332*
 - 11.5.1.4 Basic Security of Wireless 332*
- 11.5.2 Configuring the Integrated Router 333**
 - 11.5.2.1 Configuring the Integrated Router 333*
 - 11.5.2.2 Enabling Wireless 334*
 - 11.5.2.3 Configure a Wireless Client 334*
 - 11.5.2.4 Packet Tracer - Configuring a Linksys Router 335*

11.6 Summary 335

- 11.6.1.1 Capstone Project - Design and Build a Small Business Network 335*
- 11.6.1.2 Packet Tracer - Skills Integration Challenge 336*
- 11.6.1.3 Summary 336*

Chapter 11 Quiz 338

Chapter 11 Exam 338

