



Fundamentals of Wireless LANs v1.1

Scope and Sequence

The screenshot shows a web interface for the Cisco Networking Academy program. At the top left is the Cisco Systems logo. To its right is a dark green header bar with the text 'CISCO NETWORKING ACADEMY PROGRAM'. Below the header is a navigation bar with a dropdown menu labeled 'Modules'. The main content area is divided into three sections. The left section features a photograph of a man in a blue shirt talking on a mobile phone while working on a laptop. The middle section has a light blue background with the text 'Take the Fundamentals of Wireless LANs Curriculum Tour' and a link 'click here'. The right section has a light gray background with the title 'Fundamentals of Wireless LANs' and a detailed description of the course content, including topics like design, planning, implementation, operation, troubleshooting, security, and various technologies and protocols.

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Target Audience

High School, Community College, Military and University students as well as transitional workers enrolled in the Cisco Networking Academy Program.

Prerequisites

Students should have completed CCNA 2.

Target Certifications

This course will prepare students to achieve the Cisco Wireless LAN Support Specialist designation.

Course Description

This introductory course to Wireless LANs focuses on the design, planning, implementation, operation and troubleshooting of Wireless LANs. It covers a comprehensive overview of technologies, security, and design best practices with particular emphasis on hands on skills in the following areas:

- Wireless LAN setup & troubleshooting
- 802.11 (a, b, and g) technologies, products & solutions
- Radio Technologies
- WLAN applications and site surveys
- Resilient WLAN products, design, installation, configuration and troubleshooting
- WLAN security
- Vendor interoperability strategies
- Emerging wireless technologies

Course Objectives

Upon completion of this course, students will have an understanding of:

- Understand wireless radio technologies and topologies
- Understand IEEE 802.11 wireless standards
- Configure and install wireless access points, bridges, adapters, and antennae
- Wireless design, installation, configuration, monitoring and maintenance using CLI and web-based Device Manager
- Identify wireless security threats and vulnerabilities
- Wireless security using MAC filtering, WEP, LEAP, EAP and 802.1x technologies
- Understand proper site survey techniques and safety practices
- Configure monitoring technologies such as Syslog, SNMP and logging
- Troubleshooting wireless installation and configuration
- Understand vertical and horizontal wireless implementations and uses

Course Outline

Module 1 - 12 Outline

Module 1: Introduction to Wireless LANs

1.1 Introduction to Wireless LANs

- 1.1.1 What is a wireless LAN?
- 1.1.2 No more wires?
- 1.1.3 Why wireless?
- 1.1.4 Evolution of wireless LANs

1.2 Networking Media

- 1.2.1 Physical layer media
- 1.2.2 STP
- 1.2.3 UTP
- 1.2.4 Coaxial cable
- 1.2.5 Optical fiber
- 1.2.6 Atmosphere: the wireless medium
- 1.2.7 Media installation
 - Lab: Wireless Component and Media Identification

1.3 Wireless Technologies

- 1.3.1 Overview
 - Interactive Activity: From LAN to WLAN
- 1.3.2 Digital wireless and cellular

1.4 Components and Topologies

- 1.4.1 Components overview
 - Interactive Activity: Devices Function at OSI Layers
- 1.4.2 Client adapters
- 1.4.3 Access points
- 1.4.4 Bridges
- 1.4.5 Antennas
- 1.4.6 Cables and accessories
- 1.4.7 802.11 enabled devices

Lab: Wireless Lab Setup

1.4.8 Consumer wireless products

1.4.9 Wireless LAN Topologies

1.5 Wireless LAN Market

1.5.1 Implications

1.5.2 WLAN growth and applications

1.5.3 Market requirements

1.6 Challenges and Issues

1.6.1 Radio signal interference and degradation

Lab: Challenges of Wireless Regulations

1.6.2 Power management

1.6.3 Interoperability

1.6.4 Network security

1.6.5 Reliability and connectivity

1.6.6 Installation and site design issues

1.6.7 Health issues

1.6.8 Future directions

Lab: Challenges of Wireless Media

Module Summary

Module Quiz

Module 2: 802.11 (a,b,g) and Network Interface Cards

Module Overview

2.1 802.11 Standards

2.1.1 Overview

2.1.2 IEEE and 802.11

Interactive Activity: IEEE 802 Standards

2.1.3 IEEE 802.2 LLC review

2.1.4 Wireless LAN general description

2.1.5 Logical architecture

Interactive Activity: WLAN Logical Architecture: Acronym Recognition

2.2 802.11 MAC Layer

2.2.1 MAC services

2.2.2 MAC frame structure, architecture, and operation

Interactive Activity: 802.11 MAC Frame Format

2.2.3 Carrier-sense mechanism, MAC-level acknowledgements, and interframe spaces

2.3 Physical Layer (PHY)

2.3.1 Scope and functions

2.3.2 IEEE 802.11b (High-Rate) DSSS PHY specification

2.3.3 802.11b modulation

2.3.4 IEEE 802.11a PHY specification

2.3.5 IEEE 802.11g PHY specification

2.3.6 FHSS and Infrared (IR) PHY specifications

2.4 Client Adapters

2.4.1 Introduction

Photozoom: Cisco Aironet Client Adapters

2.4.2 Parts of the client adapter

2.4.3 Driver types and client support

Lab: Challenges of Wireless Media

2.4.4 Network configurations using the client adapters

2.5 Aironet Client Utility (ACU)

2.5.1 Overview

2.5.2 Installation

Lab: Install Aironet Client Utility (ACU)

2.5.3 Create and select profiles

2.5.4 Edit, import, and export profiles

2.5.5 Manage profiles

Lab: Configure Auto Profiles

2.5.6 Configure the client adapter

Demonstration Activity: The Aironet Client Utility

2.5.7 Aironet Client monitor (ACM)

2.5.8 Configure the client IP address

2.6 ACU Monitoring and Troubleshooting Tools

2.6.1 Overview

2.6.2 Status and statistics

2.6.3 Cisco WLAN troubleshooting

2.6.4 Survey and Link Test Tool

2.6.5 Link Status Meter

Interactive Activity: Link Status Meter and Free Space Loss Simulator

Lab: ACU Utilities

Lab: Creating an Adhoc Network

Module Summary

Module Quiz

Module 3: Wireless Radio Technology

Module Overview

3.1 Waves

3.1.1 Overview of waves

Interactive Activity: Longitudinal Pulse

Interactive Activity: Digital Modulation

3.1.2 Sine waves

Interactive Activity: Amplitude and Frequency

Interactive Activity: Amplitude, Frequency, and Phase

3.1.3 Analog to digital conversion

Interactive Activity: Analog to Digital Conversion

3.2 Mathematics for Studying Radio

3.2.1 Watts

3.2.2 Decibels

3.2.3 Decibel references

Interactive Activity: Calculating Decibels

Interactive Activity: Using Decibels

Lab: Wireless Mathematics

3.3 Electromagnetic (EM) Waves

3.3.1 Basics of EM waves

Interactive Activity: Propagation of Light in Matter

Interactive Activity: Electromagnetic Fields

Interactive Activity: Electromagnetic Calculator

3.3.2 EM spectrum chart

Interactive Activity: Electromagnetic Spectrum

3.3.3 Fourier synthesis

3.3.4 Spectrum uses

3.4 Signals

3.4.1 Viewing signals in time

Lab: Signals in Time

3.4.2 Viewing signals in frequency

3.4.3 Signals in time and frequency

Interactive Activity: Tone Generator Modulation

3.4.4 Noise in time and frequency

3.5 Modulation Techniques

3.5.1 Carrier frequency

Interactive Activity: Modulation: Half Angle Formula

3.5.2 Basic modulation techniques

Interactive Activity: Digital Modulation

3.5.3 FHSS

Interactive Activity: Frequency Hopping Spread Spectrum

3.5.4 DSSS

3.5.5 OFDM

3.6 Multiple Access and Bandwidth

3.6.1 Multiple access to shared medium

3.6.2 WLAN DSSS and CSMA/CA

Interactive Activity: Allocating Communications Resources

3.6.3 Bandwidth

3.7 Radio Wave Propagation

3.7.1 Propagation of RF

3.7.2 Refraction

Interactive Activity: Optical Refraction

3.7.3 Reflection

Interactive Activity: Law of Reflection

3.7.4 Diffraction and scattering

3.7.5 Multipath

Interactive Activity: Multipath

3.7.6 Path-loss

Interactive Activity: The Free-Space Loss (FSL) Equation

Interactive Activity: Free Space Loss Simulation

Lab: Wave Propagation

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Module 4: Wireless Topologies

Module Overview

4.1 Components

4.1.1 Laptops and workstations

4.1.2 Mobile computers, PDAs, and barcode readers

4.1.3 Clients and adapters

4.1.4 Access points and bridges

4.1.5 Antennas

4.1.6 Ethernet and wired LANs

Interactive Activity: Layer Launch

Interactive Activity: Devices Function at OSI Layers

4.2 WLAN Topologies

4.2.1 Modularity

Interactive Activity: Cisco Three-Layer Internetwork Design Model

4.2.2 WLAN categories

Interactive Activity: Bridged WLANs

4.2.3 Local area networks (LAN)

4.2.4 Wireless repeater

4.2.5 System redundancy and load balancing

4.2.6 Roaming

4.2.7 Scalability

4.3 Channel Setup

4.3.1 Overview

4.3.2 Access point coverage and comparison

4.3.3 Multirate implementation

4.3.4 Channel usage and interference

4.4 Bridge Topologies

4.4.1 Root modes

4.4.2 Point-to-point configuration

Interactive Activity: Bridge's Line of Sight

4.4.3 Point-to-multipoint configuration

4.4.4 Distance limitations

4.4.5 Bandwidth

4.5 Sample Topologies

4.5.1 Basic topologies

Interactive Activity: Name that Topology

4.5.2 Campus topologies

4.5.3 WLAN addition to AVVID

Interactive Activity: Vocabulary Check

Interactive Activity: Cisco Integrated Solution

Lab: Topology Design with Cisco Network Designer (CND)

4.6 VLAN, QoS, and Proxy Mobile IP

4.6.1 VLAN features

4.6.2 Quality of Service (QoS) feature

4.6.3 eDCF

4.6.4 Proxy mobile IP

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Module 5: Access Points

Module Overview

5.1 Access Point Connection

5.1.1 Introduction

Photozoom: Cisco AP1100 Access Point

Photozoom: Aironet 1200 series

Photozoom: Cisco AP350 Access Point

5.1.2 Radio upgrade

5.1.3 Cable and power the AP

5.1.4 LED Indicators

5.1.5 Connecting to the AP

5.1.6 Reset the AP

5.2 Basic Configuration

5.2.1 Configure IP address and SSID via IPSU

5.2.2 Navigating the GUI

Lab: Configuring Basic AP Settings

5.2.3 Configure basic settings via GUI

5.2.4 Navigating the CLI

Lab: Using features of the Internetworking Operating System (IOS) command line interface (CLI)

5.2.5 Configure basic settings via CLI

Demonstration Activity: VxWorks Menu and the Access Point SSID

Lab: Manage AP Configuration and Image Files

5.3 Verify AP Operation

5.3.1 Overview

5.3.2 Summary status (HOME) page

5.3.3 Network map

5.3.4 Associations

5.3.5 ACM and ACU

Lab: Configure Ethernet/FastEthernet Interface

5.4 Network Interface Configuration

5.4.1 Overview

5.4.2 IP address

5.4.3 Configure the FastEthernet interface

5.4.4 Configure radio interfaces via GUI

Demonstration Activity: AP Radio Advanced

Lab: Configure Radio Interfaces via GUI

5.4.5 Configure radio interfaces via IOS CLI

Lab: Configure Radio Interface via IOS CLI

5.4.6 Verify radio status

5.4.7 Carrier busy test

5.4.8 Debugging the radio

Lab: Configure an AP as a repeater via IOS CLI

5.5 Configure Services

- 5.5.1 Overview
- 5.5.2 Telnet/SSH
- 5.5.3 Hot standby
- 5.5.4 CDP
- 5.5.5 DNS
- 5.5.6 HTTP
- 5.5.7 Proxy Mobile IP
- 5.5.8 QoS
- 5.5.9 NTP

5.6 Wireless Services

- 5.6.1 Overview
- 5.6.2 AP
- 5.6.3 WDS

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Module 6: Bridges

Module Overview

6.1 Bridge Connection

- 6.1.1 Introduction
 - Photozoom: Cisco BR350 Wireless Bridge
 - Photozoom: Cisco 1400 Wireless Bridge
- 6.1.2 Bridge roles in the network
- 6.1.3 Cable and power the bridge
- 6.1.4 LED indicators
- 6.1.5 Connecting to the bridge
- 6.1.6 Reset the bridge

6.2 Basic Configuration

- 6.2.1 Configure IP address and SSID via IPSU
- 6.2.2 Navigating the GUI
- 6.2.3 Configure basic settings via GUI
 - Demonstration Activity: Using the IP Setup Utility (IPSU)
- 6.2.4 Navigating the menu

6.2.5 Configure basic settings via menu

6.3 Configuring the radio and Ethernet ports

6.3.1 Basic radio port configuration

6.3.2 Extended radio configuration – hardware page

6.3.3 Extended radio configuration – advanced page

6.3.4 Configuring the Ethernet port – identification page

6.3.5 Configuring the Ethernet port – hardware page

6.3.6 Configuring the Ethernet port – advanced page

Lab: Configure Site-to-Site Wireless Link

6.4 Configuring Services

6.4.1 Configuring time services

6.4.2 Configuring boot services

6.4.3 Configuring name services

6.4.4 Configuring routing setup

Lab: Configure Bridge Services

6.5 Cisco Services

6.5.1 Services overview

6.5.2 CDP

6.5.3 Firmware upgrade and distribution

Lab: Manage Bridge Configuration and Image Files

6.5.4 Hot standby management

6.5.5 Manage system configuration

Lab: Configure Layer 3 Site-to-Site Wireless Link—OPTIONAL Challenge Lab

6.6 1400 Series Bridge

6.6.1 Overview

6.6.2 Models and options

6.6.3 Components and accessories

6.6.4 IOS features

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Module 7: Antennas

Module Overview

7.1 Antennas

7.1.1 Introduction

7.1.2 Variables

7.1.3 Bandwidth

7.1.4 Beamwidth

Lab: Antenna Setup

7.1.5 Gain

7.1.6 Polarization

7.1.7 Radiation patterns

7.1.8 Diversity

Interactive Activity: Diversity

Lab: Configure AP Diversity Settings

Lab: Configure Bridge Diversity Settings

7.2 Omnidirectional Antennas

7.2.1 Introduction

7.2.2 2.2 dBi Dipole “rubber duck” antenna(s)

7.2.3 Ceiling antennas

7.2.4 Mast antennas

7.2.5 Pillar antennas

7.2.6 Integrated antennas

Lab: Omnidirectional Antennas

7.3 Directional Antennas

7.3.1 Introduction

7.3.2 Patch antennas

7.3.3 Yagi

7.3.4 Solid dish

Lab: Directional Antennas

7.3.5 5 GHz sector

7.4 Cable and Accessories

7.4.1 Cable selection

7.4.2 Cable loss

7.4.3 Cable connectors and splitters

- 7.4.4 Amplifiers
- 7.4.5 Lightning arrestor

7.5 Link Engineering and RF Path Planning

- 7.5.1 Overview
- 7.5.2 Earth bulge
- 7.5.3 Site survey and path profiling
- 7.5.4 Alignment and interference

7.6 Antenna Installation

- 7.6.1 Overview
 - Interactive Activity: Antenna's Line of Sight
- 7.6.2 Ladder safety
- 7.6.3 Installation safety
- 7.6.4 Legal issues
- 7.6.5 EIRP rules

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Module 8: Security

Module Overview

8.1 Security Fundamentals

- 8.1.1 What is security?
 - Interactive Activity: Fill Security Holes
- 8.1.2 WLAN vulnerabilities
- 8.1.3 WLAN threats
- 8.1.4 Reconnaissance
- 8.1.5 Access
- 8.1.6 Denial of service

8.2 Basic WLAN Security Technologies

- 8.2.1 The WLAN security wheel
- 8.2.2 First generation wireless security
- 8.2.3 Wired equivalent privacy (WEP)
- 8.2.4 Authentication and association

Interactive Activity: IEEE 802.11 Authentication and Association

8.3 Configuring Basic WLAN Security

8.3.1 Basic WLAN security

Lab: Configure Basic AP security via GUI

Lab: Configure Basic AP Security via IOS CLI

8.3.2 Enabling protocol and MAC filters on APs

Lab: Configure Filters on AP

8.3.3 Securing clients and APs

Lab: Configure WEP on AP and Client

Lab: Configure an AP as a repeater using WEP

8.3.4 Monitoring WLAN equipment

8.3.5 Disable unneeded services

8.4 Enterprise WLAN Authentication

8.4.1 Second generation authentication

8.4.2 Authenticating wireless users

8.4.3 802.1x basics

8.4.4 How 802.1x works

Interactive Activity: Security Issues

8.4.5 802.1x authentication types

Demonstration Activity: Cisco VPN Devices

Lab: Configuring LEAP/EAP using Local RADIUS Authentication

Lab: Configuring LEAP/EAP using Cisco Secure ACS (OPTIONAL)

8.4.6 Choosing an 802.1x type

8.5 Enterprise Wireless Encryption

8.5.1 Strengthening WEP

8.5.2 Message integrity check

8.5.3 Broadcast key rotation (BKR)

8.5.4 Second generation encryption

Lab: Configure Enterprise Security on AP

Lab: Configuring Site-to-Site Wireless Link using Enterprise Security

8.5.5 Using VPNs

8.6 Other Enterprise Security Services

8.6.1 VLANs

8.6.2 Spanning tree

Lab: Configure VLANs on the AP

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Module 9: Application Design and Site Survey Prep

Module Overview

9.1 Site Survey

9.1.1 Site survey

9.1.2 Site survey considerations

9.1.3 Standards and topologies

9.1.4 Important considerations

9.2 Applications

9.2.1 Changing technology and applications

Demonstration Activity: WLAN Application Studies

9.3 WLAN Design

9.3.1 Design guidelines

Interactive Activity: Site Survey

9.3.2 Applications and data collection

9.3.3 Load and coverage

9.3.4 Bandwidth and throughput

9.3.5 Mobile users

9.3.6 Power consumption

9.3.7 Interference

9.3.8 Encryption

9.3.9 Fire code and safety issues

Lab: WLAN Design

9.4 Building-to-building Design

9.4.1 Building-to-building overview

9.4.2 Design examples

9.4.3 Path considerations

9.4.4 Installation considerations

9.5 Site Survey Equipment

9.5.1 Equipment

Interactive Activity: Survey Materials

9.5.2 APs and cards

9.5.3 Antennas and attenuators

Lab: Using Bridge Range Calculation Utility

9.5.4 Battery packs, cables, mounting, and markers

9.5.5 Measuring devices and digital cameras

Lab: Link Status Meter and Preferences

9.5.6 Travel case

9.5.7 RF test device

9.6 Site Survey Documentation and Utilities

9.6.1 Site drawing and walkthrough

9.6.2 Bridge range calculation utility

9.6.3 ACU site survey

9.6.4 Link status meter (LSM)

Demonstration Activity: Aironet Client Utility (ACU)

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Module 10: Site Survey

Module Overview

10.1 Infrastructure Awareness

10.1.1 Working with personnel

10.1.2 LAN infrastructure

10.1.3 Network map

10.1.4 LAN media

10.1.5 Firewalls, risers, cable paths, and service loops

10.1.6 Existing Network

10.1.7 Check the existing network health

10.1.8 Network performance baseline

10.2 Survey

10.2.1 Preparation

10.2.2 Getting started

Interactive Activity: Site Survey

10.2.3 Channel selection, data rates, and overlap

10.2.4 Work with existing conditions

10.2.5 Freezers

10.2.6 Multifloor survey

10.2.7 Interference and RF propagation

Lab: Site Survey Active M

Lab: Survey the Facility

10.3 Mounting and Installation

10.3.1 AP mounting

10.3.2 Column mounting

10.3.3 Bridge mounting

10.3.4 Antenna mounting

10.3.5 Power

10.3.6 NEMA enclosures

Lab: Mounting and Installation

10.4 Documentation

10.4.1 Documenting the WLAN design

10.4.2 Request for proposal

Lab: Request for Proposal

Lab: Request for Proposal Response

Lab: Review of Response to the RFP

10.4.3 WLAN site survey specifics

10.4.4 Site survey report

Demonstration Activity: Project Management Checklist

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Module 11: Troubleshooting Management, Monitoring, and Diagnostics

Module Overview

11.1 General Approach to Troubleshooting

- 11.1.1 Overview
- 11.1.2 Symptom - diagnosis - solution
 - Process Chart: Symptom-Diagnosis-Solution
- 11.1.3 Preparing for network failure
- 11.1.4 Network and fault management
 - Lab: Basic Troubleshooting on AP

11.2 OSI Troubleshooting

- 11.2.1 Model overview
- 11.2.2 Troubleshooting layers
- 11.2.3 Layer 1: media, connectors, and devices
- 11.2.4 Layer 2: bridges and switches
- 11.2.5 Layer 3: routers
- 11.2.6 Troubleshooting TCP/IP
 - Lab: Troubleshooting TCP/IP Issues

11.3 Diagnostic Tools

- 11.3.1 Cable testers, multimeters, and network monitors
- 11.3.2 Sniffers
- 11.3.3 Spectrum analyzers
- 11.3.4 Gauss and tesla meters

11.4 WLAN Troubleshooting

- 11.4.1 Firmware
- 11.4.2 Configuration files
- 11.4.3 Unit status and password recovery
- 11.4.4 Antenna cable
- 11.4.5 Placement and obstacles

11.5 System Message Logging

- 11.5.1 Overview
- 11.5.2 Configure event notification via GUI
- 11.5.3 Configure event notification via IOS CLI
- 11.5.4 SNMP
- 11.5.5 Configure SNMP
- 11.5.6 Syslog and SNMP applications

Lab: Configure Syslog on AP

Lab: Configure SNMP on AP

Lab: Configure Syslog and SNMP on the Bridge

11.6 Enterprise Management

11.6.1 Overview

11.6.2 WLSE

Demonstration Activity: Managing with WLSE

11.6.3 Cisco Structured Wireless Aware Network Solution

11.6.4 Aironet Configuration Administration Tool (ACAT)

11.6.5 Wavelink

11.6.6 Airwave

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Module 12: Emerging Technologies

Module Overview

12.1 Ultra-wideband Wireless

12.1.1 Overview of ultra-wideband (UWB) wireless

12.1.2 UWB applications

12.1.3 UWB acceptance

12.1.4 Interference

12.1.5 Avoiding interference from other devices

12.1.6 UWB specifics

12.2 VoIP and Voice over WLANs

12.2.1 Overview of voice over IP (VoIP)

12.2.2 Components of VoIP

Process Chart: How a VoIP Telephone Call is Made

12.2.3 Centralized and distributed VoIP architectures

12.2.4 The ITU-T umbrella protocol: H.323

12.2.5 Session Initiation Protocol (SIP)

12.2.6 MGCP and H.248/Megaco

12.2.7 Miscellaneous VoIP protocols

12.2.8 VoIP and Quality of Service (QoS)

12.2.9 VoIP and WLANs

12.3 Mobile Wireless

- 12.3.1 Brief history of mobile wireless
- 12.3.2 Overview of mobile wireless systems
- 12.3.3 Roaming in a mobile wireless system
- 12.3.4 Mobile wireless middleware
- 12.3.5 Wireless Application Protocol (WAP)
- 12.3.6 The Open Mobile Alliance (OMA)
- 12.3.7 The future of mobile wireless

12.4 Wireless Organizations and Certification

- 12.4.1 The Wireless Fidelity (Wi-Fi) Alliance
- 12.4.2 Wireless LAN Association (WLANA)
- 12.4.3 Federal Communications Commission (FCC)
- 12.4.4 ETSI
- 12.4.5 UL
- 12.4.6 Cisco Wireless Certifications
- 12.4.7 CWNA
- 12.4.8 Case studies of wireless installations
 - Demonstration Activity: Case Studies of Wireless Installations
 - Lab: Wireless Case Study of a School
 - Lab: Wireless Case Study of an Organization

Module Summary

Module Quiz