Fundamentals of Wireless LANs

Version 1.2

Scope and Sequence

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 areas of Wireless LAN setup and troubleshooting, 802.11a and 802.11b technologies, products and solutions, Site Surveys, Resilient WLAN design, installation and configuration, WLAN Security – 802.1x, EAP, LEAP, WEP, SSID and Vendor interoperability strategies.
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Target Audience

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

Prerequisites

Continuing Academy students should have completed at least CCNA module 3. Students without previous Academy experience should have equivalent knowledge and experience, specifically fundamental knowledge of modern computer networks.

Target Certifications

This course will prepare students to take the Wireless LAN for Field Engineers (WLANFE) exam 642-582. This exam is one of several requirements for Field Engineers supporting a Partner Wireless LAN Specialization. Full details of the exam can be found at:


A current CCNA certification is a pre-requisite to taking the Wireless LAN for Field Engineers (WLANFE) target certification exam.

Course Description

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

- Wireless LAN setup and troubleshooting
- 802.11 (a, b, and g) technologies, products and 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 be able to:

- demonstrate an understanding of wireless radio technologies and topologies
- discriminate between and describe the IEEE 802.11 wireless standards
- configure and install various Cisco wireless access points, bridges, adapters, and antennae
- demonstrate the concepts of wireless LAN design and installation
- configure, monitor and maintain a WLAN using both CLI and web-based Device Manager tools
- identify wireless security threats and vulnerabilities
- configure wireless LAN security using MAC filtering, WEP, LEAP, EAP and 802.1x technologies
- demonstrate an understanding of proper site survey techniques and safety practices
- configure various network monitoring technologies including Syslog, SNMP and logging
- troubleshoot wireless installations and configurations
- demonstrate an understanding of vertical and horizontal wireless implementations and uses

Lab Equipment Requirements

Lab Bundles:

The equipment required for this curriculum is fully described in the Lab Configuration and Pricing Guide to be found in the FWL Course catalog section of the Cisco Networking Academy web site. This is kept up to date in terms of pricing and equipment changes.

Click here to go to the latest version:

http://cisco.netacad.net/cnams/content/FWLlab.jsp

(you will need a valid Academy logon)

This spreadsheet is specific to the United States Networking Academies. Other countries and domains have different licensing and regulatory requirements for radio and wireless equipment. You may need to work with your local Academy Technical Manager to determine specific equipment bundles and pricings for your country.

Minimum System Requirements

In order to view and deliver the FWL curriculum, an Academy will need to have the following equipment:

Curriculum Requirements: 1 PC per student and 1 curriculum server

Lab Requirements: 4 Lab PCs or laptops (Win 2000 or Win XP (recommended))

2 Lab Handhelds (Windows CE) (optional)

1 Lab Server (Win Server 2000 or better is recommended, but other configurations can be utilized eg Linux, Unix)
Curriculum Requirements

Student PC

The curriculum may be viewed on a wide range of computers that use various operating systems – Windows; MAC OS; Linux; Unix etc. The machine and associated OS must host a browser such as Netscape 7.0x or 7.1 (only); Internet Explorer 5.5 (SP2); or Firefox 1.x. Other browsers may work but are not supported.

Java, Javascript and StyleSheets must be enabled in the browser preference setting.

The Macromedia Flash 7 plugin should be downloaded and enabled. The computer should also have the free Adobe Acrobat Reader software loaded.

The monitor should support, as a minimum, 800 x 600 resolution with a video card supporting a color depth of 256 colors. The minimum size monitor recommended for a desktop machine is 15 inch (38 cm). If available, a 17 inch (43 cm) monitor with a 16 bit color depth video card is preferred.

The computer will require a sound card, speakers or headphones (preferred) and a mouse. In addition, it should be fitted with a network interface card (NIC) that supports a minimum of 10MB/s Ethernet.

Curriculum Server

As with the curriculum viewing computers, a wide range of computers and operating systems are available to host the curriculum locally. However, consideration needs to be given to the number of students that may be accessing the machine when considering suitability.

The recommended operating system is Microsoft Windows 2000 Server (SP2) or later.

The server computer will require 5 to 10GB of hard disk space for the curriculum. The minimum recommended memory requirement is 256MB.

Lab Computer Requirements (Student Pod)

PC / Laptop (2 students per machine)

Recommended OS - Windows2000 or Windows XP (recommended)

600Mhz processor or better

Minimum 256MB of RAM

Available PCI slot

10GB of available hard-disk space for all applications

Color Monitor with 256-color (8-bit) or better video card

Monitor resolution 800x600 dpi or better

CD-ROM drive

IE 5.0, Netscape Navigator 4.7 or Firefox 1.x (or later versions)
Cisco Demo and Freeware Applications for Lab Exercises

- Cisco Secure ACS v3.1.1 or better (to deliver the optional 802.1x security labs)
- A 90 day trial version of Cisco Secure ACS is available via CCO software center.
- The instructor may have to update the CCO account by completing the high encryption license agreement
- Cisco VPN Client (3.6 or later) (Optional)
  - The instructor may have to update the CCO account by completing the high encryption license agreement.

### Demo and Freeware Applications for Lab Exercises

- PUTTY SSH Client or equivalent
  - [http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html](http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html)
- SolarWinds TFTP Server or equivalent
  - [http://www.solarwinds.net/Tools/Free_tools/TFTP_Server](http://www.solarwinds.net/Tools/Free_tools/TFTP_Server)
- Kiwi Enterprises Syslog Server or equivalent
  - [http://www.kiwisyslog.com/products.htm#syslog](http://www.kiwisyslog.com/products.htm#syslog)
- SNMP Trap Watcher or equivalent
  - [http://www.btsoftware.co.uk/snmptrap.html](http://www.btsoftware.co.uk/snmptrap.html)

**Server:** (to deliver optional 802.1x Security Labs)

### Software Platforms

- Windows 2000 Server with Service Pack 3 installed (eval version or standard 5 or 10 user versions)
- Windows 2000 Advanced Server, with these additional requirements:
  - 120 day evaluation copy may be available via Microsoft
  - without Microsoft Clustering Services installed
  - with Service Pack 3 installed
- Microsoft products can be economically acquired in the United States under the MSDN Academic Alliance program for $799 USD. See [http://www.msdnaa.net](http://www.msdnaa.net) for more information.

**COST CALCULATOR**

The Wireless Networks Cost Calculator may help to estimate the costs for offering the course.
ORDERING

Your Cisco Account Manager can help you when placing an order for equipment.

If your Academy is in the United States and you are having difficulty contacting your Cisco Account Manager, please email lab-bundle@external.cisco.com and we will have someone contact you.

If your Academy is outside the United States, please contact your Area Academy Manager. To find out who your Area Academy Manager is, go to your homepage and click on “View Information” under the “Teach” section.

Please include the following information in your email:

- Your full name
- Your username/userid
- Academy Name
- Academy Address
- Academy City, State/Province, Country, and Postal Code
- Academy Contact Name and Telephone Number

Course Overview

1. Introduction to Wireless LANs
2. 802.11(a, b, & g) and Network Interface Cards
3. Wireless Radio Technology
4. Wireless Topologies
5. Access Points
6. Bridges
7. Antennas
8. Security
9. Application Design and Site Survey Prep
10. Site Survey
11. Troubleshooting, Management, Monitoring and Diagnostics
12. Emerging Technologies
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

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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
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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: Install a WLAN adapter card
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
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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
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3.3 Electromagnetic (EM) Waves

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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
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

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   Interactive Activity: Allocating Communications Resources
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3.7.2 Refraction
   Interactive Activity: Optical Refraction
3.7.3 Reflection
   Interactive Activity: Law of Reflection
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   Interactive Activity: Multipath
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   Interactive Activity: The Free-Space Loss (FSL) Equation
   Interactive Activity: Free Space Loss Simulation
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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

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4.2.1 Modularity
  Interactive Activity: Cisco Three-Layer Internetwork Design Model
4.2.2 WLAN categories
  Interactive Activity: Bridged WLANs
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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)

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4.6.3 eDCF
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5.2.2 Navigating the GUI
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5.2.3 Configure basic settings via GUI

5.2.4 Navigating the CLI
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5.3.3 Network map

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Demonstration Activity: WLAN Application Studies

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9.6.2 Bridge range calculation utility

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9.6.3 ACU site survey
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11.1.2 Symptom - diagnosis - solution

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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

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11.4.3 Unit status and password recovery

11.4.4 Antenna cable

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Module Summary
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### Course Labs

The Fundamentals of Wireless LAN course contains labs that are designed to teach students how to create secure, reliable wireless access. Some labs are based on skills learned in previous labs. Furthermore, labs increase in difficulty as the course progresses.

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**Fundamentals of Wireless LANs 802.11g Labs**

The purpose of these additional labs is to allow FWL Academies to practice the use of 802.11g equipment. Specifically, these labs were designed to support the 802.11a/b/g client adapter and the Aironet Desktop Utility (ADU) software as well as the Aironet 1310 Outdoor AP/BR. Each of these labs was created from an existing in FWL 1.2 and covers the same skills. There are no rewritten labs for the 1200 series access point with the dot11g radio upgrade, as the current labs can be used with the upgraded AP.

The labs can be divided into 2 main categories:

1. labs to support the 802.11a/b/g client adapter and
2. labs to support the 1310 bridge.

There is also a document intended as additional help when installing the G radio upgrade in the 1200 series access.