

# User's Manual for the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511



## NETGEAR

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202-10041-01  
Version v2.0  
September 2004

## Technical Support

Please refer to the support information card that shipped with your product. By registering your product at [www.netgear.com/register](http://www.netgear.com/register), we can provide you with faster expert technical support and timely notices of product and software upgrades.

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## Statement of Conditions

In the interest of improving internal design, operational function, and/or reliability, NETGEAR reserves the right to make changes to the products described in this document without notice.

NETGEAR does not assume any liability that may occur due to the use or application of the product(s) or circuit layout(s) described herein.

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September 2004

## Certificate of the Manufacturer/Importer

It is hereby certified that the Model WAG511 Wireless PC Card has been suppressed in accordance with the conditions set out in the BMPT- AmtsblVfg 243/1991 and Vfg 46/1992. The operation of some equipment (for example, test transmitters) in accordance with the regulations may, however, be subject to certain restrictions. Please refer to the notes in the operating instructions.

Federal Office for Telecommunications Approvals has been notified of the placing of this equipment on the market and has been granted the right to test the series for compliance with the regulations.

## VCCI Statement

This equipment is in the Class B category (information equipment to be used in a residential area or an adjacent area thereto) and conforms to the standards set by the Voluntary Control Council for Interference by Data Processing

Equipment and Electronic Office Machines aimed at preventing radio interference in such residential areas. When used near a radio or TV receiver, it may become the cause of radio interference. Read instructions for correct handling.

## **FCC Information to User**

This product does not contain any user serviceable components and is to be used with approved antennas only. Any product changes or modifications will invalidate all applicable regulatory certifications and approvals

### **FCC Guidelines for Human Exposure**

In order to comply with RF exposure limits established in the ANSI C95.1 standards, the user is advised to maintain a distance of at least 1 inch (2.5 cm) from the antenna of this device while it is in use.

### **Declaration Of Conformity**

We NETGEAR, Inc., 4500 Great America Parkway, Santa Clara, CA 95054, declare under our sole responsibility that the model WAG511 CardBus Card Wireless Adapter complies with Part 15 of FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

## **Regulatory Compliance Information**

This section includes user requirements for operating this product in accordance with National laws for usage of radio spectrum and operation of radio devices. Failure of the end-user to comply with the applicable requirements may result in unlawful operation and adverse action against the end-user by the applicable National regulatory authority.

NOTE: This product's firmware limits operation to only the channels allowed in a particular Region or Country. Therefore, all options described in this user's guide may not be available in your version of the product.

### **FCC Requirements for Operation in the United States**

#### **Radio Frequency Interference Warnings & Instructions**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following methods:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment into an electrical outlet on a circuit different from that which the radio receiver is connected
- Consult the dealer or an experienced radio/TV technician for help.

#### **NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511**



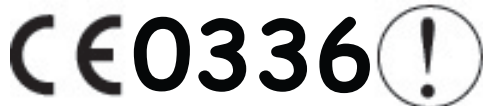
Tested to Comply  
with FCC Standards  
FOR HOME OR OFFICE USE

Modifications made to the product, unless expressly approved by NETGEAR, Inc., could void the user's right to operate the equipment.

### **Export Restrictions**

This product or software contains encryption code which may not be exported or transferred from the US or Canada without an approved US Department of Commerce export license.

### **Europe - EU Declaration of Conformity**



This device is a 2.4 GHz low power RF device intended for home and office use in EU and EFTA member states. In some EU / EFTA member states some restrictions may apply. Please contact local spectrum management authorities for further details before putting this device into operation.

Marking by the above symbol indicates compliance with the Essential Requirements of the R&TTE Directive of the European Union (1999/5/EC). This equipment meets the following conformance standards:

EN300 328, EN301 489-17, EN60950

### **Countries of Operation and Conditions of Use in the European Community**

The user should run the client utility program provided with this product to check the current channel of operation and confirm that the device is operating in conformance with the spectrum usage rules for European Community countries as described in this section.

This product is certified for Switzerland and all countries of the European Community, except France and Spain.

### **Canadian Department of Communications Radio Interference Regulations**

This digital apparatus (NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511) does not exceed the Class B limits for radio-noise emissions from digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications.

Canada ID: 4054A-WAG511v2

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# Chapter 1

## About This Manual

Congratulations on your purchase of the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511. The WAG511 provides connection for multiple personal computers to the Internet through an external broadband access device (such as a cable modem or DSL modem).

### Audience, Conventions, Publication Date

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This reference manual assumes that the reader has basic-to-intermediate computer and Internet skills. However, basic computer network, Internet, firewall, and networking technology tutorial information is provided in the Appendices.

This guide uses the following typographical conventions:

**Table 1.       Typographical conventions**

<i>italics</i>	Emphasis, books, CDs, URL names
<b>bold</b>	User input
<code>fixed font</code>	Screen text, file and server names, extensions, commands, IP addresses


This guide uses the following formats to highlight special messages:

	<b>Note:</b> This format is used to highlight information of importance or special interest.
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This manual is written f according to these specifications.:

**Table 1-1.       Firmware Version and Manual Publication Date**

Manual Publication Date	September 2004
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	<b>Note:</b> Product updates are available on the NETGEAR web site at <a href="http://www.netgear.com/support/main.asp">www.netgear.com/support/main.asp</a> .
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## How to Navigate this Manual

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The HTML version of this manual includes a variety of navigation features as well as links to PDF versions of the full manual and individual chapters.

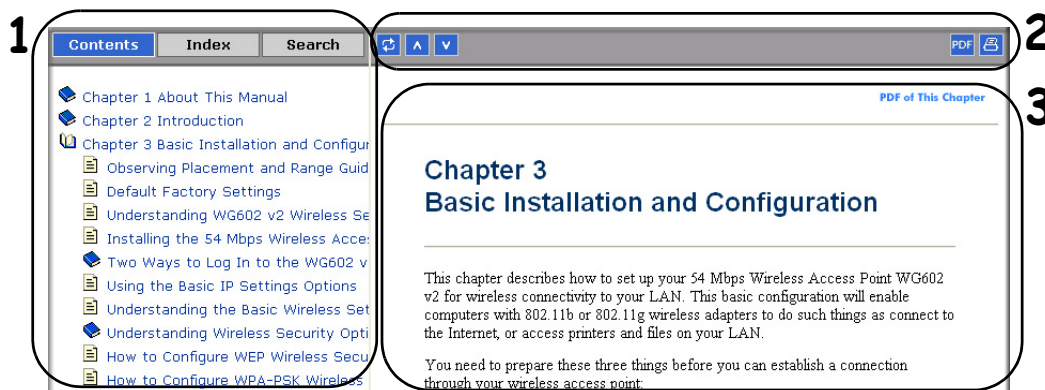


Figure 1-1: HTML version of this manual

1. **Left pane.** Use the left pane to view the Contents, Index, and Search tabs.

To view the HTML version of the manual, you must have a version 4 or later Internet Explorer or Netscape Navigator browser with JavaScript enabled.

2. **Toolbar buttons.** Use the toolbar buttons across the top to navigate, print pages, and more.



The Show in Contents button locates the current topic in the Contents tab.



Previous/Next buttons display the previous or next topic.



The PDF button links to a PDF version of the full manual.




The Print button prints the current topic. Using this button when a step-by-step procedure is displayed will send the entire procedure to your printer--you do not have to worry about specifying the correct range of pages.

3. **Right pane.** Use the right pane to view the contents of the manual. Also, at the top right of each page of the manual is a [PDF of This Chapter](#) link to a PDF file containing just the currently selected chapter of the manual.


## How to Print this Manual

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To print this manual you can choose one of the following several options, according to your needs.

- **Printing a “How To” Sequence of Steps in the HTML View.** Use the *Print* button  on the upper right of the toolbar to print the currently displayed topic. Using this button when a step-by-step procedure is displayed will send the entire procedure to your printer--you do not have to worry about specifying the correct range of pages.
- **Printing a Chapter.** Use the **PDF of This Chapter** link at the top right of any page.
  - Click “PDF of This Chapter” link at the top right of any page in the chapter you want to print. The PDF version of the chapter you were viewing opens in a browser window.

**Note:** Your computer must have the free Adobe Acrobat reader installed in order to view and print PDF files. The Acrobat reader is available on the Adobe web site at <http://www.adobe.com>.
  - Click the print icon in the upper left of the window.

**Tip:** If your printer supports printing two pages on a single sheet of paper, you can save paper and printer ink by selecting this feature.
- **Printing the Full Manual.** Use the PDF button in the toolbar at the top right of the browser window.
  - Click the PDF button  on the upper right of the toolbar. The PDF version of the chapter you were viewing opens in a browser window.
  - Click the print icon in the upper left of the window.

**Tip:** If your printer supports printing two pages on a single sheet of paper, you can save paper and printer ink by selecting this feature.



## Chapter 2

# Introduction

This chapter introduces the features, package contents, and a road map of typical applications for the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.

The WAG511 gives you ultimate mobility in your office or while you are traveling. It frees you from traditional Ethernet wiring and helps you create a wireless network for sharing your broadband Internet access in and around your home. It is designed for notebook computers running Microsoft® Windows®. It is 32-bit CardBus compatible and works in any available CardBus slot.

Its auto-sensing capability allows high packet transfer at up to 108 Mbps for maximum throughput or dynamic range shifting to lower speeds due to distance or operating limitations in an environment with a lot of electromagnetic interference.

The WAG511 provides reliable, standards-based 802.11a/b/g wireless connectivity that is protected with the strongest industry-standard WPA and WEP security. In addition, it offers the faster 54 Mbps speeds of the 802.11a and g standards as well as the 108 Mbps speeds of the proprietary options included with this adapter. It works with Windows 98, Me, 2000, and XP operating systems.

## Key Features and Related NETGEAR Products

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The WAG511 Wireless PC Card provides the following features:

- 802.11a and 802.11b/g standards-based wireless networking.
- AutoCell provides improved roaming between access points, and advanced automated RF management that improves performance and enhances security.



**Note:** AutoCell provides additional valuable benefits that are available in wireless networks that support this technology. Netgear products that support this mode have this icon on the product.

- 108 Mbps high speed data transfer. Wireless nodes negotiate to operate in the optimal data transfer rate. In a noisy environment or when the distance between the wireless nodes is far, the wireless nodes automatically fall back to operate at lower transfer rates.



**Note:** 108 Mbps speed is only available in wireless networks that support this proprietary mode. Netgear products that support this mode have this icon on the product packaging.

- High level of data encryption using WPA, CISCO LEAP, or 128-bit Shared Key WEP data encryption method. A lower level of data encryption or no data encryption is available to simplify your network setup or to improve data transfer rate.

## 802.11a and 802.11b/g Wireless Networking

The WAG511 Wireless PC Card provides 802.11a-, b-, and g-compliant wireless communications, providing continuous, high-speed up to 108 Mbps access to your wireless network. The WAG511 provides:

- 802.11a Standards-based wireless networking at up to 54 Mbps.
- 802.11b Standards-based wireless networking at up to 11 Mbps.
- 802.11g Standards-based wireless networking at up to 54 Mbps.
- WPA enterprise class strong security with RADIUS and certificate authentication as well as dynamic encryption key generation.
- WPA-PSK pre-shared key authentication without the overhead of RADIUS servers but with all of the strong security of WPA.
- IEEE 802.1x offers an effective framework for authenticating and controlling user traffic to a protected network, as well as dynamically varying encryption keys.
- CISCO LEAP protocol support which is used to authenticate access by a wireless client to a wireless access point, typically a Cisco base station.
- 64-bit and 128-bit WEP encryption security.
- WEP keys can be generated manually or by passphrase.

## Related NETGEAR Products

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The following NETGEAR products can be configured to communicate with the WAG511 Wireless PC Card:

- WG302 NETGEAR ProSafe Wireless Access Point 802.11g
- WG102 NETGEAR ProSafe Wireless Access Point 802.11g
- WGU624 Dual 108 Mbps Wireless Firewall Router
- WGT624 108 Mbps Wireless Firewall Router

- WGT634U 108 Mbps Wireless Storage Router
- WG602 54 Mbps Wireless Access Point
- WGR614 54 Mbps Wireless Router
- WAB102 Dual Band Access Point
- WAB501 Dual Band PC Card
- MA101 802.11b Wireless USB Adapter
- ME102 802.11b Wireless Access Point
- MA311 802.11b Wireless PCI Adapter
- MR814v2 802.11b Wireless Routers
- MA701 802.11b Wireless Compact Flash Card

## **What's in the Box?**

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The product package should contain the following items:

- NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511
- Installation Guide for the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511
- *NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD*, including:
  - Driver and Configuration Utility Software
  - User's Manual for the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511
  - Animated Network Properties Configuration Tutorial
  - PC Networking Tutorial
- Warranty card
- Support information card

If any of the parts are incorrect, missing, or damaged, contact your NETGEAR dealer. Keep the carton, including the original packing materials, in case you need to return the product for repair.

## **A Road Map for 'How to Get There From Here'**

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The introduction and adoption of any new technology can be a difficult process. Wireless technology has removed one of the barriers to networking—running wires. It allows more people to try networking while at the same time exposes them to the inherent complexity of networking. General networking concepts, setup, and maintenance can be difficult to understand. In addition, wireless technology adds issues, such as range, interference, signal quality, and security to the

picture.

To help overcome potential barriers to successfully using wireless networks, the table below identifies how to accomplish such things as connecting to a wireless network, assuring appropriate security measures are taken, browsing the Internet through your wireless connection, exchanging files with other computers and using printers in the combined wireless and wired network.

**Table 2-1. A Road Map for How to Get There From Here**

If I Want To?	What's Needed?	What Do I Do?	How Do I?
Connect to a wireless network	<ol style="list-style-type: none"><li>1. A wireless network</li><li>2. A notebook PC within the operating range of the wireless network. For guidelines about the range of wireless networks, see <a href="#">"Observing Location and Range Guidelines" on page 3-2.</a></li></ol>	<ol style="list-style-type: none"><li>1. Identify the wireless network name (SSID) and, if used, the wireless security settings.</li><li>2. Set up the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 with the settings from step 1.</li></ol>	<p>To set up the WAG511, see <a href="#">Chapter 3, "Basic Setup"</a> and follow the instructions provided.</p> <p>To learn about wireless networking technology, see <a href="#">Appendix , "Wireless Networking Overview"</a> for a general introduction.</p>
Protect my wireless connection from snooping, hacking, or information theft.	<ol style="list-style-type: none"><li>1. A wireless network with authentication and encryption enabled.</li><li>2. Wireless networking equipment that supports encryption, such as the WAG511 and all NETGEAR wireless networking products.</li></ol>	<ol style="list-style-type: none"><li>1. Assure that the wireless network has security features enabled.</li><li>2. Configure my WAG511 with the security settings of the wireless network.</li><li>3. Use Windows security features.</li></ol>	<p>To learn about wireless networking security, see <a href="#">"Wireless Networking Overview" on page B-1.</a></p> <p>To understand WEP security features, see <a href="#">"WEP Overview" on page B-7."</a></p> <p>To understand WPA security features, see <a href="#">"WPA Wireless Security" on page B-13."</a></p>
<b>Note:</b> Secure Internet sites such as banks and online merchants use encryption security built into browsers like Internet Explorer and Netscape. Any wireless networking security features you might implement are in addition to those already in place on secure Internet sites.			



**Table 2-1. A Road Map for How to Get There From Here**

If I Want To?	What's Needed?	What Do I Do?	How Do I?
Connect to the Internet over my wireless network.	<ol style="list-style-type: none"> <li>1. An active Internet connection like those from cable or DSL service providers.</li> <li>2. A wireless network connected to an Internet service through a router as illustrated in <a href="#">"Connecting to an Access Point in Infrastructure Mode" on page 4-4.</a></li> <li>3. TCP/IP Internet networking software installed and configured on my notebook PC according to the requirements of the Internet service provider.</li> <li>4. A browser like Internet Explorer or Netscape Navigator.</li> </ol>	<ol style="list-style-type: none"> <li>1. Activate my wireless link and verify my network connection.</li> <li>2. Open an Internet browser such as Internet Explorer or Netscape Navigator.</li> </ol>	<p>To configure your WAG511 in Infrastructure Mode, see <a href="#">"Basic Installation Instructions" on page 3-4</a>, and locate the section for your version of Windows.</p> <p>For assistance with configuring the TCP/IP Internet software on a PC, see <a href="#">"Preparing Your Computers for TCP/IP Networking" on page C-1</a> or refer to the PC Networking Tutorial on the <i>NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD</i> and the Help information provided in the Windows system you are using.</p> <p>.</p>

**Table 2-1. A Road Map for How to Get There From Here**

If I Want To?	What's Needed?	What Do I Do?	How Do I?
Exchange files between a wirelessly connected notebook computer and other computers in a my combined wireless and wired network.	<ol style="list-style-type: none"> <li>1. The notebook computer I am using to connect to the wireless network needs to be configured with the Windows Client and File and Print Sharing.</li> <li>2. The notebook computer I am using to connect to the wireless network needs to be configured with the same Windows Workgroup or Domain settings as the other Windows computers in the combined wireless and wired network.</li> <li>3. Any Windows networking security access rights such as login user name/ password that have been assigned in the Windows network or for sharing particular files must be provided when Windows prompts for such information.</li> <li>4. If so-called Windows 'peer' Workgroup networking is being used, the drive, file system directory, or file need to be enabled for sharing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Use the Windows Network Neighborhood feature to browse for computers in the combined wireless and wired network.</li> <li>2. Browse the hard drive of the target computer in the network in order to locate the directory or files you want to work with.</li> <li>3. Use the Windows Explorer copy and paste functions to exchange files between the computers.</li> </ol>	<p>For assistance with Windows networking software, see <a href="#">Appendix , "Preparing Your Computers for TCP/IP Networking"</a> for configuration scenarios or refer to the Help system included with your version of Windows.</p> <p>Windows Domain settings are usually managed by corporate computer support groups.</p> <p>Windows Workgroup settings are commonly managed by individuals who want to set up small networks in their homes, or small offices.</p> <p>For assistance with setting up Windows networking, refer to the PC Networking Tutorial on the <i>NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD</i> and the Help information provided in the Windows system you are using.</p>

**Table 2-1. A Road Map for How to Get There From Here**

If I Want To?	What's Needed?	What Do I Do?	How Do I?
Use printers in a combined wireless and wired network.	<ol style="list-style-type: none"> <li>1. The notebook computer I am using to connect to the wireless network needs to be configured with the Windows Client and File and Print Sharing.</li> <li>2. The notebook computer I am using to connect to the wireless network needs to be configured with the same Windows Workgroup or Domain settings as the other Windows computers in the combined wireless and wired network.</li> <li>3. Any Windows networking security access rights such as login user name/ password that have been assigned in the Windows network must be provided when Windows prompts for such information.</li> <li>4. If so-called Windows 'peer' networking is being used, the printer needs to be enabled for sharing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Use the Windows Printers and Fax features to locate available printers in the combined wireless and wired network.</li> <li>2. Use the Windows Add a Printer wizard to add access to a network printer from the notebook PC you are using to wirelessly connect to the network.</li> <li>3. From the File menu of an application such as Microsoft Word, use the Print Setup feature to direct your print output to the printer in the network.</li> </ol>	<p>Windows Domain settings are usually managed by corporate computer support groups.</p> <p>Windows Workgroup settings are commonly managed by individuals who want to set up small networks in their homes, or small offices.</p> <p>For assistance with setting up Windows networking, refer to the PC Networking Tutorial on the <i>NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD</i> and the Help information provided in the Windows system you are using.</p> <p>For assistance with setting up printers in Windows, refer to the Help and Support information that comes with the version of the Windows operating systems you are using.</p>



# Chapter 3

## Basic Setup

This chapter describes how to install your NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 and set up basic wireless connectivity on your Wireless Local Area Network (WLAN). Advanced wireless network configuration is covered in [Chapter 4, “Netgear Smart Wireless Wizard”](#) in this manual.



**Note:** Indoors, computers can easily connect to 802.11 wireless networks at distances of several hundred feet. Because walls do not always block wireless signals, others outside your immediate area could access your network. It is important to take appropriate steps to secure your network from unauthorized access. The NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 provides highly effective security features which are covered in [“Wireless Security Configuration” on page 5-1](#) in this manual. Deploy the security features appropriate to your needs.

### What You Need Before You Begin

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You need to verify your computer meets the minimum system requirements and identify the wireless network configuration settings of the WLAN where you will connect before you can configure your wireless PC card and connect.

### Verifying System Requirements

Before installing the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511, please make sure that these minimum requirements have been met:

- You must have a notebook PC with a Pentium® 300 MHz or higher compatible processor with an available CardBus slot.

**Note:** The WAG511 will not work in a PCMCIA slot. If you are not sure about what type of slot your computer has, consult the documentation or manufacturer’s web site for your computer.

- A CD-ROM drive.
- 5 Mbytes of free hard disk space.

- Windows XP Home, Windows XP Professional, 2000, Me, 98SE or 98
- Some versions of Windows may ask for the original Windows operating system installation files to complete the installation of the WAG511 driver software.

## Observing Location and Range Guidelines

Computers can connect over wireless networks indoors at a range which vary significantly based on the physical location of the computer with the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511. For best results, avoid potential sources of interference, such as:

- Large metal surfaces
- Microwaves
- 2.4 GHz Cordless phones

In general, wireless devices can communicate through walls. However, if the walls are constructed with concrete, or have metal, or metal mesh, the effective range will decrease if such materials are between the devices.

## Two Basic Operating Modes

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The WAG511 Wireless PC Card can operate in the following two basic modes:

- **Infrastructure Mode:** An 802.11 networking framework in which devices and computers communicate with each other by first going through an access point (AP). For example, this mode is used when computers in a house connect to an Access Point that is attached to a router which lets multiple computers share a single Cable or DSL broadband Internet connection.
- **Ad-Hoc Mode:** An 802.11 networking framework in which devices or computers communicate directly with each other, without the use of an AP. For example, Ad-Hoc Mode is used when two Windows computers are configured with file and print sharing enabled and you want to exchange files directly between them.

Both of these configuration options are available with the WAG511 Wireless PC Card. Infrastructure configuration procedures for basic network connectivity are covered below. Advanced infrastructure configuration procedures and ad-hoc configuration are covered in [Chapter 4, “Netgear Smart Wireless Wizard”](#) of this manual.

## **WAG511 Default Wireless Configuration Settings**

---

If this is a new wireless network installation, use the factory default settings to set up the network and verify wireless connectivity. If this is an addition to an existing wireless network, you will need to identify the wireless configuration and security parameters already defined.

Your WAG511 factory default basic settings are:

- Network Name Service Set Identification (SSID): **Any** (First available network)  
**Note:** In order for the WAG511 Wireless PC Card to communicate with a wireless access point or wireless adapter, all devices must be configured with the same wireless network name (SSID).
- Network Mode (Infrastructure or Ad-hoc): **Infrastructure**
- Data security WEP encryption: **Disabled**

The section below provides instructions for setting up the WAG511 for basic wireless connectivity to an access point. The procedures below provide step-by-step installation instructions for Windows PCs. Use the procedure that corresponds to the version of Windows you are using.

## Basic Installation Instructions

---

Use the procedure below that corresponds to the version of Windows you are using.

### For Windows XP Users Installing a WAG511

1

#### Install the WAG511 driver and configuration utility software.

- a. Power on your notebook, let the operating system boot up completely, and log in as needed.
- b. Insert the Resource CD for the WAG511 into your CD-ROM drive. The CD main WAG511 Resource CD page shown at the right will load.
- c. Click **Install Driver and Utility**.
- d. Follow the InstallShield Wizard steps, and click **Finish** when done to restart your computer.



InstallShield Wizard

**Note:** If a Windows XP Certification warning appears, click **Continue Anyway** to proceed.



## 2

### Insert the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.

- a. Locate an available CardBus slot on the side of your notebook. Hold the PC Card with the NETGEAR logo facing up and insert it into the CardBus slot.

After a short delay, the Found New Hardware Wizard displays.

Follow the prompts to complete the wizard.

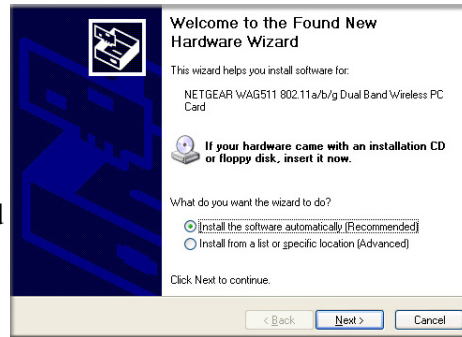
- b. Next you will be prompted to enable the NETGEAR Smart Wireless Settings Utility configuration utility.

Click **Yes** to accept this option.

If you choose No, you must read the Windows XP documentation for an explanation of how to use the Windows XP wireless network configuration utility.

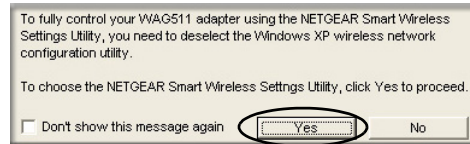
You will also be prompted to choose the country you are located in. Select your location from the list.

- c. Click **Finish** to complete the installation. You will see the WAG511 system tray icon on the lower right portion of the Windows task bar.



Found New Hardware Wizard

**Note:** Click **Continue Anyway** if you are prompted with a Windows XP Logo testing message.




Enable NETGEAR Utility Configuration



WAG511 System Tray Icon

### 3

#### Configure your WAG511.

- a. Click the  icon on the Windows desktop or in the system tray to open the WAG511 Smart Wireless Settings Utility.

The utility opens to the Settings tab page.

- b. For the Network Name (SSID), use the default of **Any** (first available network) or type an SSID for your network.

**Tip:** As an alternative to typing in the SSID, you can use the drop-down list or the Networks tab to view the available wireless networks, and choose the one you want.

- c. Click **Apply** to activate the connection.

The status monitor icons at the bottom of the utility will turn yellow indicating the connection is established, and will also report the speed, signal quality, and if the security requirements are met.

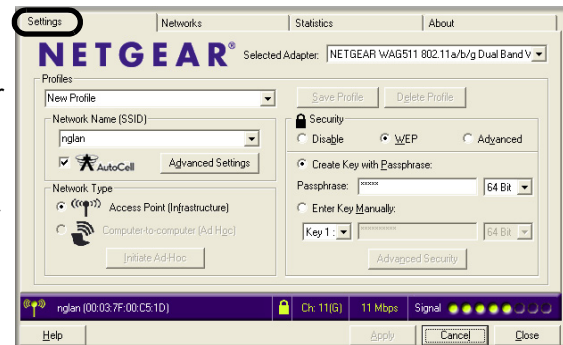
You can also enter a profile name and click Save Profile to store the current settings.

**Tip:** Create profiles called *work* and *home*. Then, activate whichever one you need for your current location.



Click here to open the configuration utility.

WAG511 system tray icon



Smart Wireless Utility Settings page

**Tip:** Click Help to view the context-sensitive help information.

**Note:** The NETGEAR default settings are **Infrastructure mode**, with **Any** (first available network) for the wireless network name SSID, and WEP disabled. If your WLAN settings are different from the NETGEAR default settings, you will not connect. Set up your WAG511 accordingly.

**Note:** This procedure assumes you are connecting to a wireless network which is not using WEP security. If your network includes security settings, configure the WAG511 accordingly. For help with these steps, click the Help button in the WAG511 Configuration Utility to view context-sensitive help information, or see [Chapter 5, "Wireless Security Configuration"](#).

## 4

**Verify wireless connectivity to your network.**

- a. Verify that your Connection and Status Monitor information matches your wireless network.
- b. Check the two LEDs on the WAG511:

**Table 3-1: LED Descriptions**

LED 1	LED 2	Meaning
Slow blink	OFF	Power save mode (default from power up or reset)
Alternate blink	Alternate blink	Looking for network association Power LED goes ON; Network LED is OFF; then Power LED goes OFF and Network LED goes ON
Slow blink	Slow blink	Associated or joined with network; no activity
Fast blink	Fast blink	Associated or joined with network; blink rate increases with activity on the network over the air or locally on the network
OFF	OFF	No power applied to the card

- c. Verify connectivity to the Internet or network resources.

**Note:** If you are unable to connect, see troubleshooting tips in the Basic Installation section of the Reference Manual on the *NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD*.

## For Windows 2000 & 98/Me Users Installing a WAG511

1

### Install the WAG511 driver and configuration utility software.

**Note:** Windows 2000 may require you to be logged on with administrator rights.

- a. Power on your notebook, let the operating system boot up completely, and log in as needed.
- b. Insert the Resource CD for the WAG511 into your CD-ROM drive. The CD main page shown at the right will load.
- c. Click **Install Driver and Utility**.
- d. Follow the InstallShield Wizard steps, click **Finish** when done, and if prompted, restart your computer.



WAG511 Resource CD



InstallShield Wizard

2

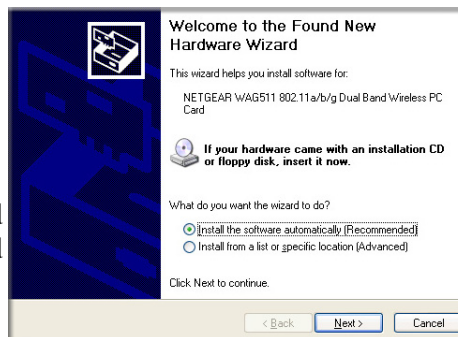
**Insert the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.**

- a. Locate an available CardBus slot on the side of your notebook. Hold the PC Card with the NETGEAR logo facing up and insert it into the CardBus slot.

After a short delay, the Found New Hardware Wizard displays.

- b. Follow the Found New Hardware Wizard steps, click **Finish** when done, and if prompted, restart your computer.
- c. Next, you will be prompted to choose the country where you are located. Select your location from the list.

You should see the WAG511 system tray icon on the right in the lower right portion of the Windows task bar and on the Windows desktop.



Found New Hardware Wizard


**Note:** If Windows warns about a Digital Signature Not Found, click **Yes** to continue.



WAG511 System Tray Icon

3

## Configure your WAG511 and save the Profile.

- a. Click the  icon on the Windows desktop or in the system tray to open the WAG511 Smart Wireless Settings Utility.

The utility opens to the Settings tab page.

- b. For the Network Name (SSID), use the default of **Any** (first available network) or type an SSID for your network.

**Tip:** As an alternative to typing in the SSID, you can use the drop-down list or the Networks tab to view the available wireless networks, and choose the one you want.

- c. Click **Apply** to activate the connection.

The status monitor icons at the bottom of the utility will turn yellow indicating the connection is established, and will also report the speed, signal quality, and if the security requirements are met.

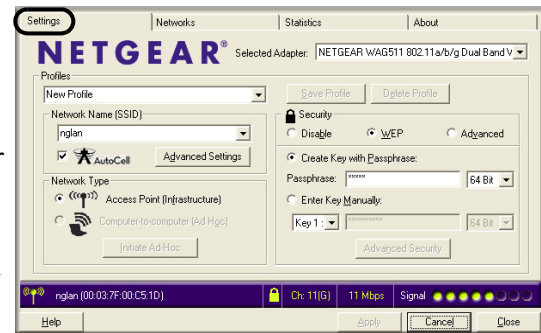
- d. You can also enter a profile name and click Save Profile to store the current settings.

**Tip:** If you use your desktop PC to connect to a wireless network at work and at home, create profiles called *work* and *home*. Then, activate whichever one you need for wherever you are located.



Click here to open the configuration utility.

WAG511 system tray icon



WAG511 Configuration Utility

**Note:** The NETGEAR default settings are **Infrastructure mode**, with **Any** (first available network) for the wireless network name SSID, and WEP disabled. If your WLAN settings are different from the NETGEAR default settings, you will not connect. Set up your WAG511 accordingly.

**Note:** This procedure assumes you are connecting to a wireless network which is not using WEP security. If your network includes security settings, configure the WAG511 accordingly. For help with these steps, click the Help button in the WAG511 Configuration Utility to view context-sensitive help information, or see [Chapter 5, "Wireless Security Configuration"](#).

## 4

**Verify wireless connectivity to your network.**

- a. Verify that your Connection and Status Monitor information matches your wireless network.
- b. Check the two LEDs on the WAG511:

**Table 3-2: LED Descriptions**

LED 1	LED 2	Meaning
Slow blink	OFF	Power save mode (default from power up or reset)
Alternate blink	Alternate blink	Looking for network association Power LED goes ON; Network LED is OFF; then Power LED goes OFF and Network LED goes ON
Slow blink	Slow blink	Associated or joined with network; no activity
Fast blink	Fast blink	Associated or joined with network; blink rate increases with activity on the network over the air or locally on the network
OFF	OFF	No power applied to the card

- c. Verify connectivity to the Internet or network resources.

**Note:** If you are unable to connect, see troubleshooting tips in the Basic Installation section of the Reference Manual on the *NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD*.

## WAG511 Wireless Connection Indicators

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The NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 provides the following three indicators which give you feedback on the status of your wireless connection:

- The two LEDs on the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 indicate the condition of wireless link.
- The color of the SysTray icon is on the System Tray portion of the taskbar in the Microsoft Windows desktop indicates the status of the connection.

### Interpreting the LED on the WAG511



**Figure 3-1: WAG511 LED**

These LEDs are described in this table.




**Table 3-1: LED Descriptions**

LED 1	LED 2	Meaning
Slow blink	OFF	Power save mode (default from power up or reset)
Alternate blink	Alternate blink	Looking for network association Power LED goes ON; Network LED is OFF; then Power LED goes OFF and Network LED goes ON
Slow blink	Slow blink	Associated or joined with network; no activity
Fast blink	Fast blink	Associated or joined with network; blink rate increases with activity on the network over the air or locally on the network
OFF	OFF	No power applied to the card



## Interpreting System Tray Icon Colors


The System Tray (SysTray) resides on one end of the taskbar in the Microsoft Windows desktop.

Color	Condition	Description
<b>Red</b> 	The wireless PC Card has no connection to any other wireless node.	The wireless PC Card is not able to link to any other wireless node or the link is lost. Check your configuration or try moving to a location where the wireless signal quality is better.
<b>Yellow</b> 	The wireless PC Card has a connection with another wireless node.	The wireless link is weak. You may need to move to a better spot, such as closer to the wireless access point. Also, look for possible interference such as a 2.4 GHz cordless phone or large metal surface.
<b>Green</b> 	The wireless PC Card has a connection with another wireless node.	The wireless PC Card has established good communication with an access point and the signal quality is strong.

## Troubleshooting

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Use the information below to solve common problems you may encounter. Also, please refer to the knowledge base on the NETGEAR web site at [www.netgear.com/support/main.asp](http://www.netgear.com/support/main.asp).

	<b>Note:</b> The Windows XP HotFix #Q815485 can prevent wireless adapters from connecting to the Internet and prevent wireless adapters from reloading a working configuration after a restart of the computer. To see if HotFix #Q815485 is installed, look in Add Remove Programs from the Windows Control Panel. If installed, remove it. Future updates to the Windows XP operating systems may correct this problem.
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Also, for problems with accessing network resources, the Windows software might not be installed and configured properly on your computers. Please refer to [Appendix , “Preparing Your Computers for TCP/IP Networking”](#) of the User’s Manual on the *NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD*.

## Basic Tips

If you have problems connected to your wireless network, try the tips below.

Symptom	Cause	Solution
The PC Card LEDs are not lit.	The WAG511 is not inserted into the slot properly or the WAG511 software is not loaded.	Remove and reinsert the WAG511. Check the Windows device manager to see if the PC Card is recognized and enabled. Reload the WAG511 software, if necessary. Try to install the WAG511 in a different slot on your system if one is available.
The LEDs blink alternately and cannot connect to an access point.	The WAG511 is attempting to connect to an access point, but cannot connect.	The access point may not be powered on. Or, the access point and the PC card are not configured with the same wireless parameters. Check the SSID and WEP settings.
I can connect to an access point, but I cannot connect to other computers on the network or the Internet.	This could be a physical layer problem or a network configuration problem.	Check to make sure that the access point is physically connected to the Ethernet network. Make sure that the IP addresses and the Windows networking parameters are all configured correctly. Restart the cable or DSL modem, router, access point, and notebook PC.

## Troubleshooting Frequently Asked Questions

1. Symptom: (XP Professional and XP Home user only) Some WAG511 XP users may experience inability to connect to the Internet, dropped wireless connections, or both after applying the Windows HotFix #Q815485 from the Windows XP Update Service.

Solution: You can delete the Q815485 from the "Add or Remove Program" utility in the Control Panel. (The Official name is "Windows XP Hotfix (SP2) Q815485")

Removal procedure:

- a. Click Start, point to Control Panel, and then double-click

**Add/Remove Programs.**

- b. Click **Windows XP Hotfix (SP2) Q815485**, and then click Remove.

- c. You may receive an error message that states that some program on the computer may not work correctly if the update is removed.
- d. You may ignore this error message, and then click **Yes** to remove the update.
- e. Restart your computer and rerun the Smart Display Setup Wizard.

This should solve your connection issue.

You can restore this hotfix by following the link below:

<http://microsoft.com/downloads/details.aspx?FamilyId=009D8425-CE2B-47A4-ABEC-274845DC9E91&displaylang=en>

2. Question: The product literature says the WAG511 can operate at 108 Mbps. Why do I see no more than 54 Mbps speed on my WAG511 Smart Configuration Utility status line?

Answer: You are probably connecting to standard 802.11g network. If you use a wireless device with the 108 Mbps logo, such as the NETGEAR WGT624 108 Mbps Wireless Firewall Router, you will see network speeds up to 108 Mbps.



**Note:** 108 Mbps speed is only available in wireless networks that support this proprietary mode. Netgear products that support this mode have this icon on the product packaging.

3. Question: Why does the utility kept asking me to Save my settings when I'm trying to close the utility?

Answer: This is because you've made changes to the settings and the utility is offering you the chance to save the changes. If you want to avoid these Profile setting prompts, simply hit **Apply** before you **Close** the utility program.

4. Question: Why doesn't Ad Hoc mode work correctly after I enter a SSID and click **Apply**?

Answer: You need to click the **Initiate Ad Hoc** button before you click **Apply**.

Here is how you start an Ad Hoc network:

- a. Fill in the Network Name (SSID).
- b. Select the Computer-to-Computer (Ad-Hoc) network Type.
- c. Click **initiate Ad Hoc**.
- d. Accept default settings or make proper changes and click **OK**.
- e. Click on **Apply**.

**Note:** Be sure all computers in your Ad Hoc network are configured with static IP address in the same subnet.

5. Question: How do I remove the WAG511 software and utility?

Answer: To remove the WAG511 software, do the following: Run the “Uninstall WAG511 Utility” shortcut in the “Start>Program> NETGEAR WAG511 Adapter” menu.

6. Question: How do I know if my WAG511 card has received a valid IP address from my Wireless Router/AP?

Answer: One easy way is to open up the WAG511 utility program and check the IP Address in the About tab page.

7. Question for XP Professional and XP Home user only: How do I use XP's own Wireless configuration utility that came with the Windows XP?

Answer: The NETGEAR WAG511 software is designed in such way that user will be asked to choose one of the utility programs during initial software installation. Be sure the card is in the notebook and follow these instructions to change your selection. Go to Control Panel> Network Connections> Wireless Network Connection > Properties> Wireless Networks tab> for the wireless card and check or uncheck “Use Windows to configure my wireless network settings”.

8. Question: I don't understand the LEDs on the WAG511? Which is Power and which is network activity?

Answer: The WAG511 LED's behavior is as follows: both blinking alternately means attempting to connect, both blinking together indicates a good connection (fast blinking means data transmission); off means the card is not plugged in or no power applied to the card.

9. Question: Is this WAG511 IEEE 802.11g standards compliant?

Answer: Yes, the WG511 complies with the IEEE 802.11g/a/b standards.

10. Question: It is nice to have a browser-based type of Manual on the Resource CD, but how do I get a PDF copy of it, like the Installation Guide?

Answer: In the Manual html page, there is a PDF button image at the top right hand corner of the web page. Click on the PDF button brings up the PDF file of the entire manual. You can also Print, Email, Bookmark pages using the appropriate icons next to the PDF button.

# Chapter 4

## Configuration

This chapter describes how to use the Netgear Smart Wireless Wizard configuration, profiles, and monitoring features with your NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.



**Note:** The instructions in this section refer to the NETGEAR WAG511 configuration utility. For Windows XP users to use the NETGEAR configuration utility, the Windows XP wireless configuration utility must be deselected. To deselect the Windows XP wireless configuration utility, open the network connections from the system tray icon, click the Properties button, click the Wireless Networks tab and then clear the “Use Windows to configure my wireless network settings” check box.

### Understanding the Configuration Options

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The WAG511 configuration utility provides a complete and easy to use set of tools to:

- Enable/disable AutoCell.
- Configure wireless settings.
- Monitor wireless network connections.
- Save your settings in configuration profiles.

The section below introduces these capabilities of the configuration utility.

### Understanding the AutoCell Feature

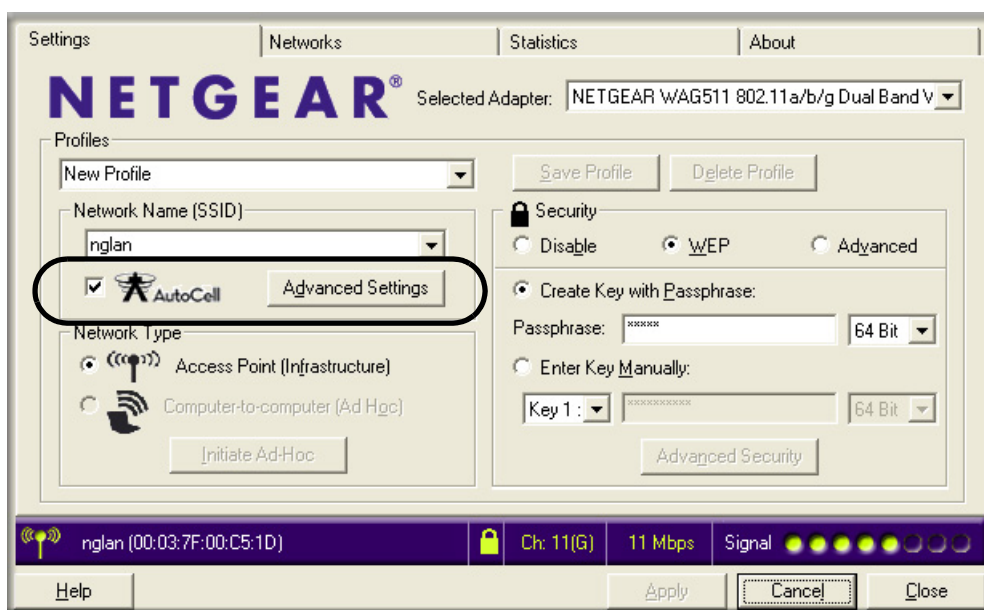
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AutoCell™, an embedded control system for 802.11 WLANs. AutoCell increases available bandwidth and reduces WLAN installation and operating costs significantly.

AutoCell is completely automatic: It is a continuous communication system that relies on a lightweight protocol to monitor changes on the wireless domain while keeping overhead very low. Among AutoCell's inherent advantages:

- Elimination of manual site surveys and channel maps
- Dynamic load balancing
- Plug-and-play-implementation
- Transparent fault recovery and failover

AutoCell is enabled by default.



**Figure 4-1: Settings page AutoCell feature**

### AutoCell AP/Client Interaction

AutoCell's self-organizing micro cells provide performance benefits and an additional level of privacy for enterprises.

- **Rapid Roaming** (does not require AutoCell-enabled APs). An AutoCell-enabled client will accurately and rapidly detect movement as distinguished from RF anomalies such as arbitrary and momentary changes in the surrounding RF domain. When it detects true movement, the client immediately seeks the best available AP at the highest data rate possible instead of waiting for the data rate to decline.
- **Automatic Transmit Power Control** (requires AutoCell-enabled AP). An AutoCell-enabled client's RF transmit power level is automatically coordinated with an AutoCell-enabled AP. This creates client micro-cells and reduces co-channel interference with other clients and APs on the same frequency and improves overall throughput and performance.
- **Automatic Load-Balancing** (requires AutoCell-enabled AP). An AutoCell-enabled client will seek out and associate to the lightest loaded AutoCell-enabled AP available.

## Using Configuration Profiles

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The WAG511 configuration utility uses profiles to store all the configuration settings for a particular wireless network. You can store multiple profiles and recall the one which matches the network you want to join.

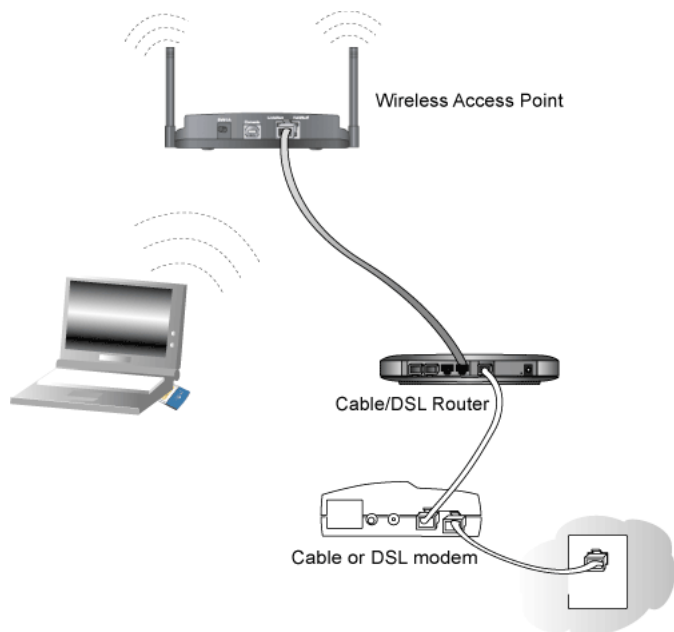
For example, if you use your notebook PC to connect to a wireless network in an office and a wireless network in your home, you can create a profile for each wireless network. Then, you can easily load the profile that has all the configuration settings you need to join the network you are using at the time.

There are two types of wireless network connections you can configure:

- **Infrastructure Mode** — uses the 802.11 infrastructure mode.
- **Ad-hoc Mode** — uses the 802.11 ad-hoc mode

For more information on 802.11 wireless network modes, see [“Wireless Networking Overview” on page B-1](#) of this manual.

## Connecting to an Access Point in Infrastructure Mode




**Figure 4-2: WAG511 Wireless PC Card connecting to a wireless access point.**

This section provides instructions for configuring the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 to connect to a wireless access point.

### How to Configure an Infrastructure Mode Profile

Use these instructions to configure infrastructure mode profiles for connecting to access points.

#### 1. Run the WAG511 Smart Wireless Wizard.

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in an available CardBus slot in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.



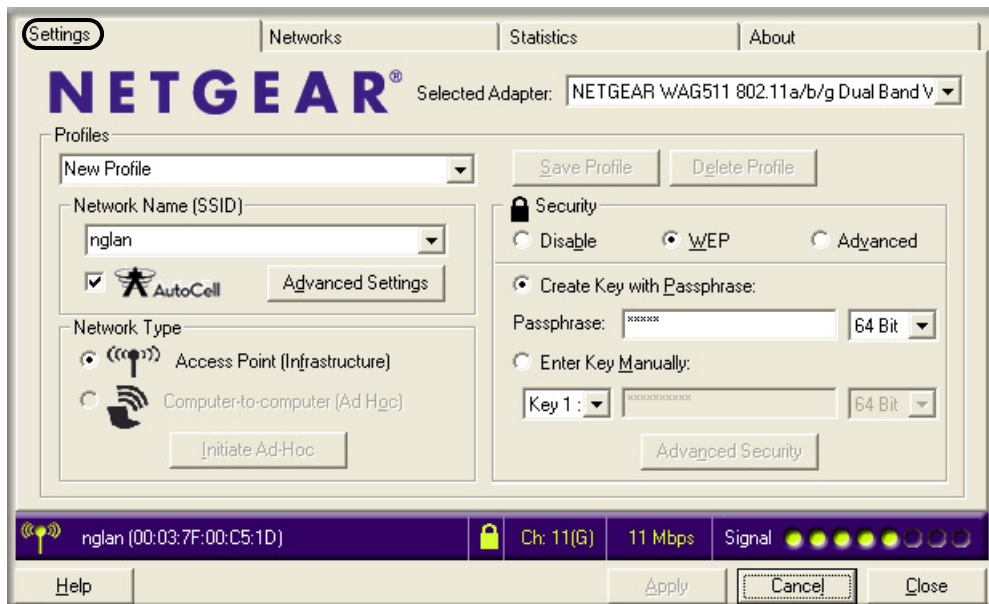


Figure 4-3: Settings page

## 2. Configure the wireless network settings.

- a. In the Network Type section, be sure that Infrastructure is selected.
- b. Enter the SSID. This is also called the Wireless Network Name.

**Note:** You will not get a wireless network connection unless the network SSID matches exactly what is configured in the access point.

**Tip:** You can click the Network tab or use the Network Name drop-down list to view a list of the available wireless networks and their SSIDs at the location where you are.

## 3. Save your settings in a Profile.

- a. Type a descriptive name for the Profile in the Profiles field.
- b. Click **Save Profile**. All the configuration settings are saved in this profile.
- c. Click **Apply**.
- d. Click **Close** to exit the configuration utility or **Cancel** to return to the previous settings

## 4. Verify wireless connectivity to your network.

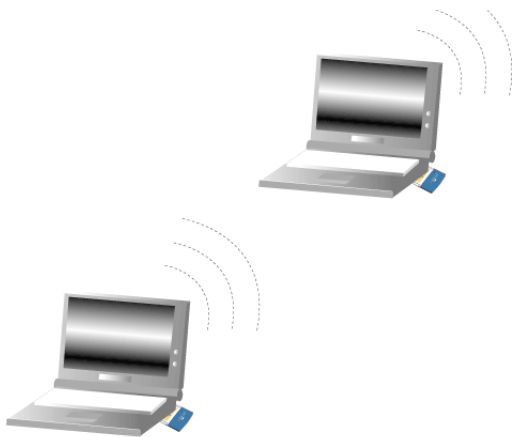
Verify connectivity by using a browser such as Netscape or Internet Explorer to connect to the Internet, or check for file and printer access on your network.

You can check the status bar in the configuration utility for the current connection status.

**Note:** If you cannot connect, see the “[Troubleshooting](#)” on page 3-13. Also, for problems with accessing network resources, the Windows Client and File and Print Sharing software might not be installed and configured properly on your computers. Please refer to “[Preparing Your Computers for TCP/IP Networking](#)” on page C-1.

## Connecting to Another PC in Ad-hoc Mode

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**Figure 4-4: NETGEAR WAG511 Wireless PC Card in Computer-to-Computer Mode**

The Ad-Hoc mode is an 802.11 networking framework in which devices or computers communicate directly with each other, without the use of an access point. For example, this mode is used when two Windows computers are configured with file and print sharing enabled and you want to exchange files directly between them.

## How to Configure an Ad-hoc Mode Network

**Note:** Ad-hoc mode will not work using AutoCell and will not work with DHCP settings. Ad-hoc mode requires disabling AutoCell and configuring a static IP address (such as 192.168.0.100). For instructions on setting up static IP addresses on a Windows PC, refer to the PC Networking Tutorial included on the *NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD*.

Follow the instructions below to configure an Ad-hoc mode network.


**1. Configure the PC network settings.**

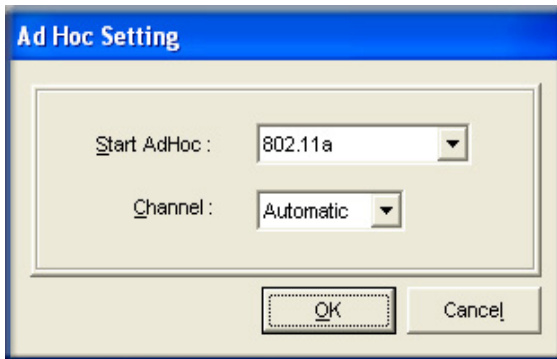
- a. Configure each PC with a static IP address.

**Note:** For instructions on configuring static IP addresses, refer to the networking tutorial on your *NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 Resource CD*.

- b. Restart the PCs.

**2. Run the WAG511 Smart Wireless Wizard.**

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in an available CardBus slot in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.
- c. Uncheck the **AutoCell** option.
- d. Select **Computer-to-Computer (Ad-Hoc)** for the Network Type. Enter the SSID for the Ad-Hoc network.
- e. Click **Initiate Ad-Hoc**. The Ad-Hoc Setting dialog box appears.



**Figure 4-5: Ad-Hoc Setting page**

- In the Start Ad-Hoc field, choose the wireless standard (802.11a, 802.11b, or 802.11g) for your Ad-Hoc computer-to-computer network.
- In the Channel field, Automatic should work. If you notice interference problems with another nearby wireless device, select a channel that is not being used by any other wireless networks near your wireless adapter. Use the Networks tab page to identify the channels in use in your area.

**Note:** The channel number differs depending on the country. The connection speed automatically defaults to the highest speed.

- f. Click **OK**. The WAG511 will scan the area to determine which channel to use.
- g. Click **Apply**.

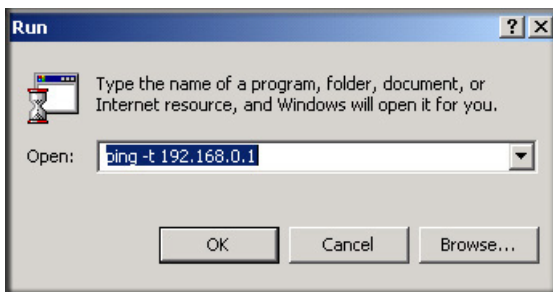
**3. Save your settings in a Profile.**

- a. Type a descriptive name in the “Profiles” field.
- b. Click Save Profile. All the configuration settings are saved in this profile.
- c. Click Apply.
- d. Click Close to exit the configuration utility.

**4. Verify wireless connectivity between your peer devices.**

Verify connectivity by using the Ping program:

- a. On the Windows taskbar click the Start button, and then click Run.



- b. Assuming the target PC is configured with 192.168.0.1 as its IP address, type `ping -t 192.168.0.1` and then click OK.
- c. This will cause a continuous ping to be sent to the device with the 192.168.0.1 static IP address. The ping response should change to “reply.”

```
Request timed out.
Request timed out.
Reply from 192.168.0.1: bytes=32 time=40ms TTL=127
Reply from 192.168.0.1: bytes=32 time=41ms TTL=127
Reply from 192.168.0.1: bytes=32 time=30ms TTL=127
```

At this point the connection is established.

**Note:** If you cannot connect, see the [“Troubleshooting” on page 3-13](#). Also, for problems with accessing network resources, the Windows Client and File and Print Sharing software might not be installed and configured properly on your computers. Please refer to [“Preparing Your Computers for TCP/IP Networking” on page C-1](#).

## What's on the Statistics Page?

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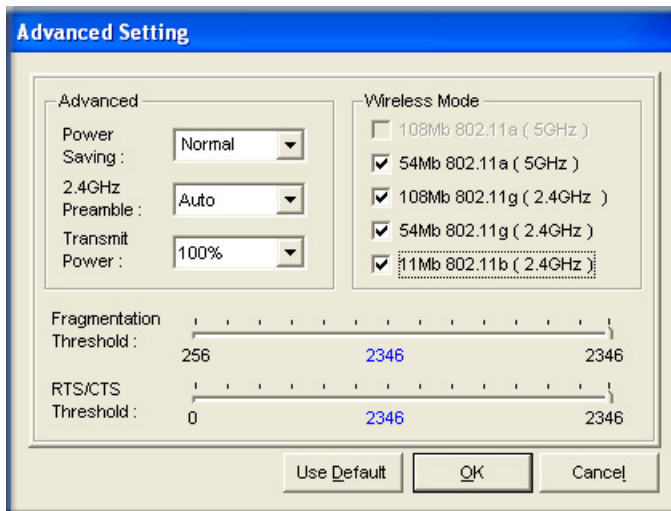
The Statistics page provides real time and historical trend information on the data traffic and performance of your wireless adapter.

- **Transmit/Receive Performance (%):** A real time graph identifying the total, receive, and transmit utilization as a percentage the total possible.
- **Total/Receive/Transmit Graph:** Identifies the trend of transmit/receive data communications over time.
- **Transmit Statistics:** Identifies transmit megabits per second (Mbps), transmit packets per second (Tx Packets/s), total transmitted packets, and transmit errors.
- **Receive Statistics:** Identifies receive megabits per second (Mbps), receive packets per second (Rx Packets/s), total received packets, and received errors.

## Understanding the Advanced Settings Page

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The Advanced settings should not require adjustment. Except for the power saving setting, changing any of the settings incorrectly on this page could cause your wireless connection to fail.



**Figure 4-6: Advanced Settings page**

- **Power Saving:** Select Normal or Max if you are running on battery power.
- **Preamble:** A long preamble may provide a more reliable connection or slightly longer range.

- **Transmit Power:** Lowering the output power level lets you reduce the chance of interference with other nearby access points, but reduces the range of your adapter.
- **Wireless Mode:** Select the wireless protocols you will use. You can choose some or all of the available 802.11 wireless protocols. Note that if the wireless network you are communicating with uses the 108 Mbps 802.11g mode, you must include that in your selection (for example, if you are using the WAG511 with the NETGEAR WGT624 108 Mbps Wireless Firewall Router).
- **Fragmentation Threshold:** This is the maximum packet size used for fragmentation. Packets larger than the size programmed in this field will be fragmented. The Fragmentation Threshold value must be larger than the RTS/CTS Threshold value.
- **RTS/CTS Threshold:** The packet size that is used to determine whether to use the CSMA/CD (Carrier Sense Multiple Access with Collision Detection) mechanism or the CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) mechanism for packet transmission. CSMA/CD is slightly more efficient.

# Chapter 5

## Wireless Security Configuration

This chapter describes how to configure the security features of your NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.



**Note:** These instructions refer to the WAG511 configuration utility. The Windows XP wireless configuration utility must be deselected. Check if this is so by viewing the Properties of the Network Connections for the WAG511. Click the Wireless Networks tab and clear the “Use Windows to configure my wireless network settings” check box.

### Understanding the Security Options

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For a full discussion of wireless security technologies, please see [“Wireless Security Overview” on page B-6](#). The WAG511 configuration utility provides the following security options:

- **WEP**  
Wired Equivalent Privacy is an existing, widely implemented and supported, data encryption protocol for 802.11 wireless networks. All wireless nodes on the network are configured with a static 64-bit or 128-bit Shared Key for data encryption but authentication is optional.
- **WPA**  
Wi-Fi Protected Access (WPA) is a new specification of standards-based, interoperable security enhancements that increase the level of data protection and access control for wireless networks. WPA requires authentication and features strong data encryption that includes dynamic key generation. WPA uses the Extensible Authentication Protocol (EAP) via WPA enabled wireless access points using an updated version of the 802.1x protocols to access RADIUS and certificate servers which enable various authentication schemes such as Transport Layer Security (TLS) and Protected EAP (PEAP).
- **WPA-PSK**  
WPA Pre-Shared Key (WPA-PSK) performs authentication and strong data encryption that includes dynamic key generation based on a pre-shared key. WPA-PSK does not need RADIUS or certificate servers.

- **802.1x**  
802.1x defines port-based, network access control used to provide authenticated network access and automated data encryption key management.
- **Cisco LEAP**  
Light Extensible Authentication Protocol (LEAP) is a proprietary 802.1x EAP method developed by Cisco for use on wireless networks that use Cisco 802.11 wireless devices. It features dynamic per user per session WEP keys.

When you use the WAG511 configuration utility to configure these security options, you can save your settings in a profile. For example, if you use WPA-PSK at work but WEP at home, you can have *work* and *home* profiles that make it easy to switch from one environment to the other. For more information on configuring profiles, see [“Using Configuration Profiles” on page 4-3](#).

## Using WEP Security

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You can strengthen the security of your wireless connection by enabling Wired Equivalent Privacy (WEP) encryption of the wireless data communications. For more information on 802.11 wireless security, see [“Wireless Networking Overview” on page B-1](#).

In addition to the WAG511 wireless security features, configure appropriate LAN network security features such as requiring a user name and password to access shared resources in your network.

Fill in the worksheet and use the procedures below to configure the WEP encryption settings of your NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.

### Basic Requirements for WEP

WEP requires these elements:

1. A wireless adapter with WEP enabled.
2. A wireless access point or another PC with WEP enabled.

Fill in the worksheet and use the procedures below to configure the WEP encryption settings of your WAG511.



## WEP Security Settings Worksheet

Print this form, fill in the configuration parameters and put it in a safe place for possible future reference. For an existing wireless network, the person who set up the network will be able to provide this information.

- **Wireless Network Name (SSID)**

The Service Set Identification (SSID) identifies the wireless local area network. For the access point and wireless nodes to communicate with each other, all must be configured with the same SSID.

**Note:** Some wireless access points will not broadcast their SSID as a security feature. In such a case, you will need to get the SSID from the wireless network administrator.

Wireless network name (SSID): \_\_\_\_\_

- **WEP Security Encryption Key**

The default WEP encryption key number is 1, and the default key size is 64 bits.

**Note:** The key number as well as the key value used by all wireless nodes must be the same. If yours is different, you will not be able to connect.

WEP Encryption Key Size, circle one: **64** or **128** bits

WEP Encryption Passphrase (case sensitive), if used: \_\_\_\_\_

A Passphrase is used to automatically generate the WEP hexadecimal numbers for the key. If the wireless network Access Point uses a Passphrase, you can also use that here. Otherwise, you will have to manually enter the hexadecimal numbers.

**Note:** Not all wireless networks support the Passphrase method of key generation. In such settings, instead of Passphrase, use the Enter Key Manually option.

WEP Hexadecimal Numbers (not case sensitive): \_\_\_\_\_

— 64-bit WEP: enter 10 hexadecimal digits (any combination of 0-9, a-f, or A-F).


— 128-bit WEP: enter 26 hexadecimal digits (any combination of 0-9, a-f, or A-F).

Use the procedures below to configure WEP security settings in the WAG511.

## How to Configure WEP Encryption Security

Follow the steps below to configure WEP Encryption Security.

### 1. Run the WAG511 Smart Wireless Wizard.

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.

### 2. Configure the Network Name (SSID) settings.

Enter the SSID. This is also called the Wireless Network Name.

**Tip:** Click the Networks tab to view a list of the available wireless networks and their SSIDs.

### 3. Configure the WEP settings.

- a. Select the WEP radio button.

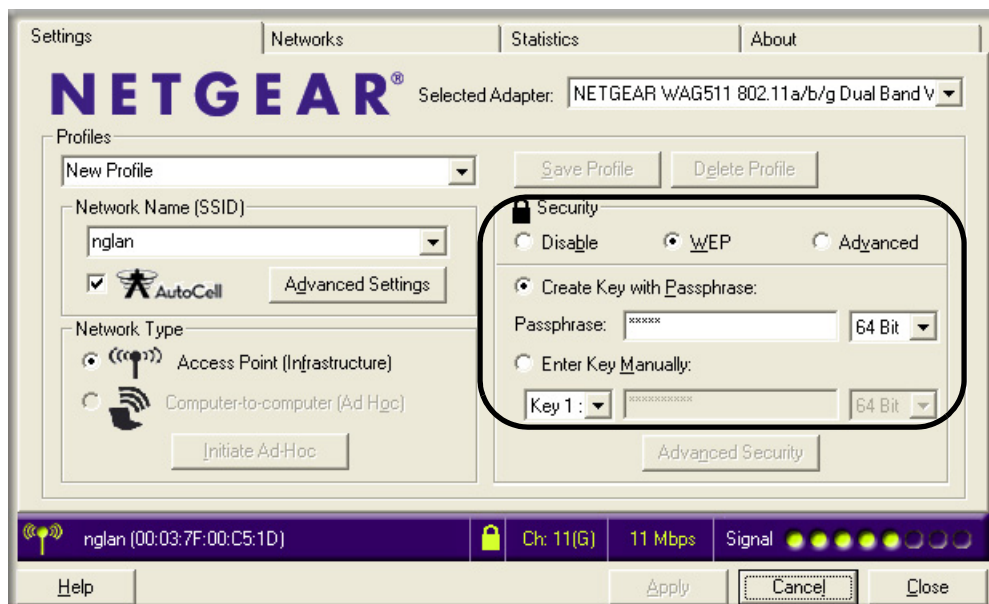


Figure 5-1: WEP settings screen

b. Select how you will enter the Key and the key size. The choices are:

- Create Key with Passphrase. The characters are case sensitive.
- Enter Key Manually

Select the encryption strength choices are:

- 64-bit WEP data encryption
- 128-bit WEP data encryption

**Note:** Larger encryption keys require more processing and may slow the communications response times, and consume more notebook PC battery power.

c. Select the Key number: The Key setting must match what is set in wireless network.

d. Click **Apply** for the changes to take effect. In the status area at the bottom of the screen, you will notice the security lock icon change from open and red to closed and yellow.

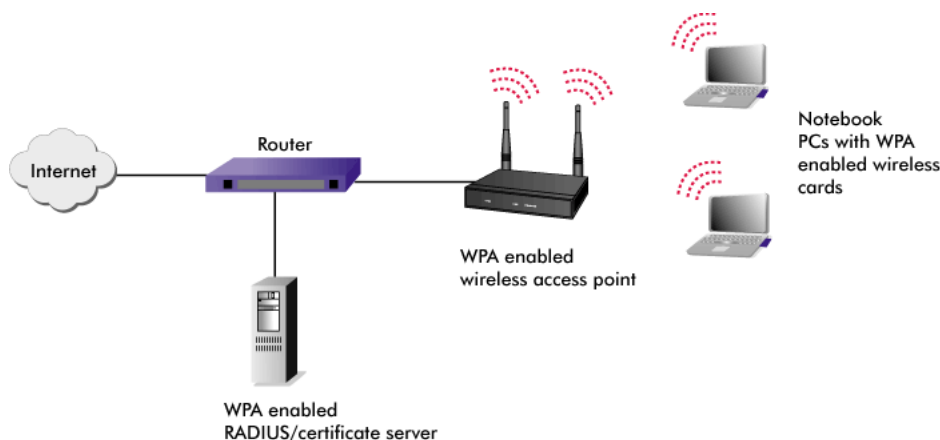
#### **4. Save your settings in a Profile.**

- Type a descriptive name in the Profiles field.
- Click **Save Profile**. All the configuration settings are saved in this profile.
- Click **Apply** and click **Close** to exit the configuration utility.

## **Using WPA Advanced Security**

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You can have very strong security on your wireless connection by enabling WPA. For more information on wireless security, see [“WPA Wireless Security” on page B-13](#).



**Figure 5-2: WPA in a wireless network**

## Basic Requirements for WPA

WPA requires these elements:

1. A WPA enabled wireless adapter with WPA client software such as the WAG511.
2. A WPA enabled wireless access point.
3. WPA enabled RADIUS server with an optional Certificate Server.
  - For the EAP-TLS option, you need a Certificate Authority (CA) such as Windows 2000 server or a public service such as Verisign. Both the RADIUS server and the client need to have a certificate from a certificate server.
  - For the EAP-PEAP option, you need a RADIUS server and a certificate server. The RADIUS server needs to have a certificate installed from a certificate server. The client can dynamically download the certificate from the certificate server. However, depending on how your network is set up, Windows Domain Controller or Active Directory login credentials can be used for authentication.

Fill in the worksheet and use the procedure below to configure the WPA settings of your WAG511.

## WPA Security Settings Worksheet

Print this form, fill in the configuration parameters and put it in a safe place for possible future reference. For an existing wireless network, the person who set up the network will be able to provide this information.

- **Wireless Network Name (SSID)**

The Service Set Identification (SSID) identifies the wireless local area network.

**Note:** Some wireless access points will not broadcast their SSID as a security feature. In such a case, you will need to get the SSID from the wireless network administrator.

Wireless network name (SSID): \_\_\_\_\_

- **WPA EAP Settings**

- TLS

- Certificate: \_\_\_\_\_

- CA Server: \_\_\_\_\_

- For example, CA Server: Netgear Https

- Domain Name: \_\_\_\_\_ Login Name: \_\_\_\_\_

- For example, Domain Name: *netgear.com* Login Name: *webmaster@netgear.com*

- PEAP

- CA Server: \_\_\_\_\_

- For example, CA Server: Netgear Https

- Domain Name: \_\_\_\_\_ Login Name: \_\_\_\_\_

- For example, Domain Name: *netgear.com* Login Name: *webmaster@netgear.com*

- User Name: \_\_\_\_\_ Password: \_\_\_\_\_

- For example, Windows User Name: *netgecko* Password: *likesbugs*

**Note:** While the User Name and Password in this example is the same as the Windows User Name and Password (administered through the Windows Domain controllers or the Windows Active Directory), the User Name and Password in a UNIX network might be the LDAP credentials for this user, or the User Name and Password could simply be the credentials stored in the RADIUS server.


Use the procedures below to configure WPA Advanced security settings in the WAG511.

## How to Configure WPA Advanced Security

**Note:** The EAP-TLS option requires that a certificate from a Certificate Authority be installed on the PC first. When using the EAP-PEAP option, a certificate on the PC can be dynamically downloaded to the client. If you are using the EAP-TLS option, be sure the certificate is installed on the PC before completing this procedure. For assistance with installing a certificate on your PC, consult your network administrator, Windows help, or the documentation for your PC.

Follow the steps below to configure WPA Advanced Security.

### 1. Run the WAG511 Configuration Utility.

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.

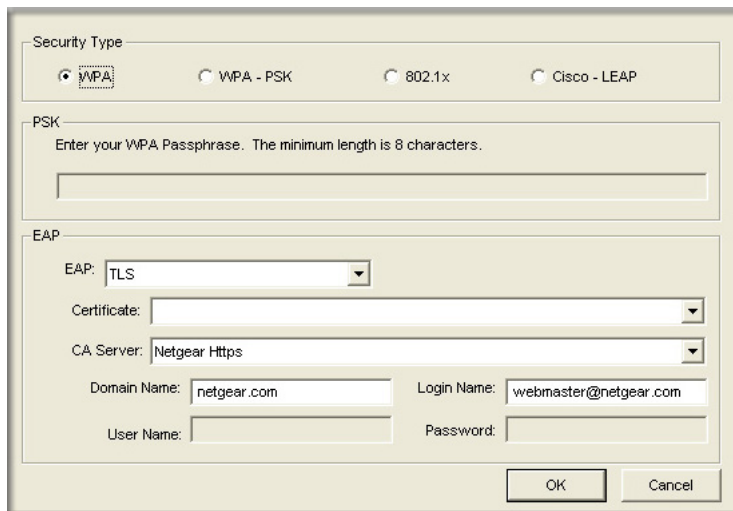
### 2. Configure the Network Name (SSID) settings.

Enter the SSID. This is also called the Wireless Network Name.

**Tip:** Click the Networks tab to view a list of the available wireless networks and their SSIDs.

### 3. Configure the WPA Advanced settings.

- a. Under Security, select the Advanced radio button then click Advanced Security.



The image shows a screenshot of the 'Advanced Security Settings' dialog box. It has a 'Security Type' section with four radio buttons: 'WPA' (selected), 'WPA - PSK', '802.1x', and 'Cisco - LEAP'. Below this is a 'PSK' section with a text field and a note: 'Enter your WPA Passphrase. The minimum length is 8 characters.' The 'EAP' section contains a dropdown menu set to 'TLS', a 'Certificate' dropdown, and a 'CA Server' dropdown set to 'Netgear Https'. At the bottom, there are fields for 'Domain Name' (netgear.com), 'Login Name' (webmaster@netgear.com), 'User Name', and 'Password'. 'OK' and 'Cancel' buttons are at the bottom right.

**Figure 5-3: Advanced Security Settings screen**

- b. Select the **WPA** radio button and choose the EAP option (TLS or PEAP) your wireless network uses. Fill in the EAP parameters.

Whatever Certificate and CA Server options you fill in will automatically also populate the Domain Name and Login Name fields.

- If you are using the EAP-TLS option, be sure the certificate from the CA is already installed on the PC.
- If you are using the EAP-PEAP option, the certificate can be dynamically downloaded to the client.

If the wireless network you are joining is using the Windows login credentials as the EAP-PEAP authentication method, enter your Windows network user name and password. Otherwise, enter the User Name and Password your network administrator provides.

- c. Click **OK**, then click **Apply** for the changes to take effect, and **Close** to exit the utility.

#### 4. Save your settings in a Profile.

## Using WPA-PSK Advanced Security

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You can have very strong security on your wireless connection by enabling WPA-PSK. For more information on wireless security, see [“Wireless Networking Overview”](#) on page B-1.

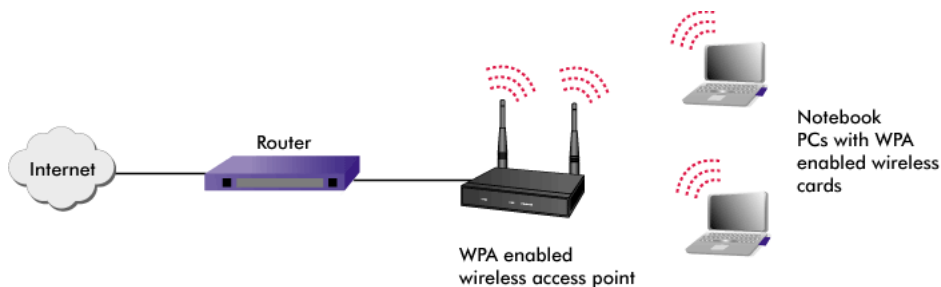


Figure 5-4: WPA-PSK in a Wireless Network

## Basic Requirements for WPA-PSK

WPA-PSK requires these elements:

1. A WPA enabled wireless adapter with WPA client software such as the WAG511.

2. A WPA enabled wireless access point.

Fill in the worksheet and use the procedure below to configure WPA-PSK settings.

## WPA-PSK Security Settings Worksheet

Print this form, fill in the configuration parameters and put it in a safe place for possible future reference. For an existing wireless network, the person who set up the network will be able to provide this information.

- **Wireless Network Name (SSID)**

The Service Set Identification (SSID) identifies the wireless local area network.

**Note:** Some wireless access points will not broadcast their SSID as a security feature. In such a case, you will need to get the SSID from the wireless network administrator.


Wireless network name (SSID): \_\_\_\_\_

- **Passphrase (Pre-Shared Key):** \_\_\_\_\_

## How to Configure WPA-PSK Advanced Security

Follow the steps below to configure WPA-PSK Advanced Security.

1. **Run the WAG511 Smart Wireless Wizard.**

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.

2. **Configure the Network Name (SSID) settings.**

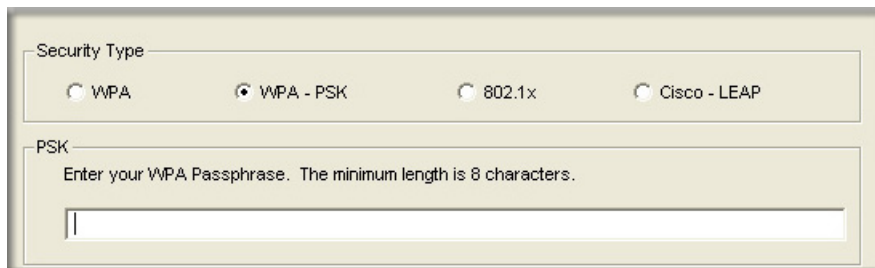
Enter the SSID. This is also called the Wireless Network Name.

**Tip:** Click the Networks tab to view a list of the available wireless networks and their SSIDs.

3. **Configure the WPA-PSK Advanced settings.**

- a. Under Security, select the **Advanced** radio button then click **Advanced Security**.





**Figure 5-5: WPA-PSK settings screen**

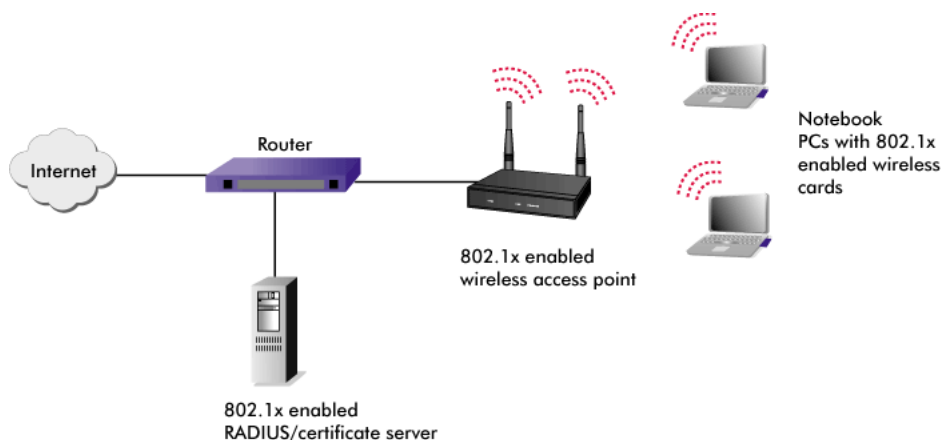
- b. Select the WPA-PSK radio button.
- c. Enter the Passphrase (Pre-Shared Key).
- d. Click **OK**, then click **Apply** for the changes to take effect, and **Close** to exit the utility.

**4. Save your settings in a Profile.**

## Using 802.1x Advanced Security

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You can have very strong security on your wireless connection by enabling 802.1x. For more information on wireless security, see [“Wireless Networking Overview” on page B-1](#).



**Figure 5-6: 802.1x in a wireless network**

## Basic Requirements for 802.1x

802.1x requires these elements:

1. An 802.1x enabled wireless adapter with 802.1x client software such as the WAG511.
2. An 802.1x enabled wireless access point.
3. An 802.1x enabled RADIUS server with an optional Certificate Server.
  - For the EAP-TLS option, you need a Certificate Authority (CA) such as Windows 2000 server or a public service such as Verisign. Both the RADIUS server and the client need to have a certificate from a certificate server.
  - For the EAP-PEAP option, you need a RADIUS server and a certificate server. The RADIUS server needs to have a certificate installed from a certificate server. The client can dynamically download the certificate from the certificate server. However, depending on how your network is set up, Windows Domain Controller or Active Directory login credentials can be used for authentication.

Fill in the worksheet and use the procedure below to configure 802.1x settings of your WAG511.

## 802.1x Security Settings Worksheet

Print this form, fill in the configuration parameters and put it in a safe place for possible future reference. For an existing wireless network, the person who set up the network will be able to provide this information.

- **Wireless Network Name (SSID)**

The Service Set Identification (SSID) identifies the wireless local area network.

**Note:** Some wireless access points will not broadcast their SSID as a security feature. In such a case, you will need to get the SSID from the wireless network administrator.

Wireless network name (SSID): \_\_\_\_\_

- **802.1x EAP Settings**

— TLS

- Certificate: \_\_\_\_\_
- CA Server: \_\_\_\_\_

For example, CA Server: Netgear Https

- Domain Name: \_\_\_\_\_ Login Name: \_\_\_\_\_

For example, Domain Name: *netgear.com* Login Name: *webmaster@netgear.com*

**Note:** Whatever Certificate and CA Server options you fill in will automatically also populate the Domain Name and Login Name fields.

— PEAP

- CA Server: \_\_\_\_\_

For example, CA Server: Netgear Https

- Domain Name: \_\_\_\_\_ Login Name: \_\_\_\_\_

For example, Domain Name: *netgear.com* Login Name: *webmaster@netgear.com*

**Note:** Whatever Certificate and CA Server options you fill in will automatically also populate the Domain Name and Login Name fields.

- User Name: \_\_\_\_\_ Password: \_\_\_\_\_

For example, Windows User Name: *netgecko* Password: *likesbugs*

**Note:** While the User Name and Password in this example is the same as the Windows User Name and Password (administered through the Windows Domain controllers or the Windows Active Directory), in a UNIX network the User Name and Password might be the LDAP credentials for this user, or the User Name and Password could simply be the credentials stored in the RADIUS server.


Use the procedures below to configure 802.1x security settings in the WAG511.

## How to Configure 802.1x Advanced Security

**Note:** The EAP-TLS option requires that a certificate from a Certificate Authority be installed on the PC first. When using the EAP-PEAP option, a certificate on the PC can be dynamically downloaded to the client. If you are using the EAP-TLS option, be sure the certificate is installed on the PC before completing this procedure. For assistance with installing a certificate on your PC, consult your network administrator, Windows help, or the documentation for your PC.

Follow the steps below to configure 802.1x security.

### 1. Run the WAG511 Smart Wireless Wizard.

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.

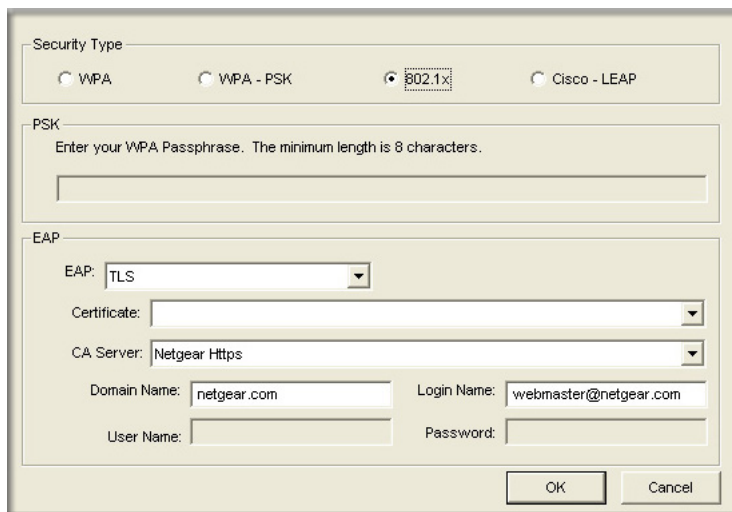
### 2. Configure the Network Name (SSID) settings.

Enter the SSID. This is also called the Wireless Network Name.

**Tip:** Click the Networks tab to view a list of the available wireless networks and their SSIDs.

3. **Configure the 802.1x Advanced Security settings.**

- a. Under Security, select the **Advanced** radio button then click **Advanced Security**.



**Figure 5-7: 802.1x Security Settings screen**

- b. Select the **802.1x** radio button and choose the EAP option (TLS or PEAP) your wireless network uses. Fill in the EAP parameters.

Whatever Certificate and CA Server options you fill in will automatically also populate the Domain Name and Login Name fields.

- If you are using the EAP-TLS option, be sure the certificate from the CA is already installed on the PC.
- If you are using the EAP-PEAP option, the certificate can be dynamically downloaded to the client.

If the wireless network you are joining is using the Windows login credentials as the EAP-PEAP authentication method, enter your Windows network user name and password. Otherwise, enter the User Name and Password your network administrator provides.

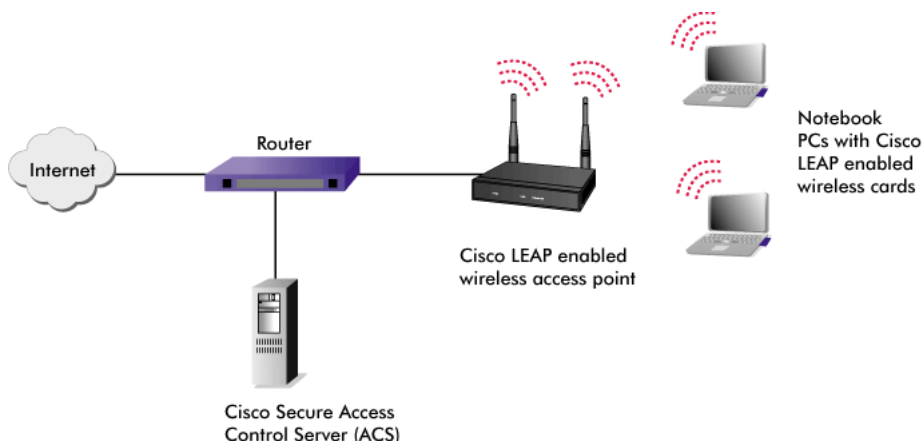
- c. Click **OK**, then click **Apply** for the changes to take effect, and **Close** to exit the utility.

4. **Save your settings in a Profile and restart your computer.**

## Using Cisco-LEAP Advanced Security

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You can have very strong security on your wireless connection by enabling Cisco-LEAP. For more information on wireless security, see [“Wireless Networking Overview”](#) on page B-1.



**Figure 5-8: Cisco LEAP in a wireless network**

## Basic Requirements for Cisco-LEAP

Cisco-LEAP requires these elements:

1. A Cisco-LEAP enabled adapter with Cisco-LEAP client software such as the WAG511.
2. A Cisco-LEAP enabled wireless access point.
3. A Cisco Secure Access Control Server (ACS).

## Cisco-LEAP Security Settings Worksheet

Print this form, fill in the configuration parameters and put it in a safe place for possible future reference. For an existing wireless network, the person who set up the network will be able to provide this information.

- **Wireless Network Name (SSID)**

The Service Set Identification (SSID) identifies the wireless local area network.

**Note:** Some wireless access points will not broadcast their SSID as a security feature. In such a case, you will need to get the SSID from the wireless network administrator.


Wireless network name (SSID): \_\_\_\_\_

- **User Name:** \_\_\_\_\_ **Password:** \_\_\_\_\_

## How to Configure Cisco-LEAP Advanced Security

Follow the steps below to configure Cisco-LEAP.

### 1. Run the WAG511 Smart Wireless Wizard.

- a. Make sure the WAG511 software is installed and the WAG511 is fully inserted in your PC.
- b. Open the configuration utility by clicking on the WAG511 icon  on the Windows desktop or in the system tray. The Settings tab page opens.

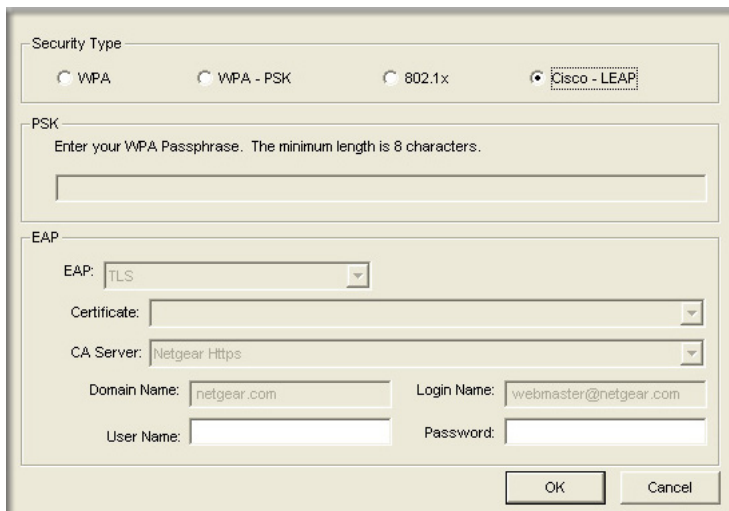
### 2. Configure the Network Name (SSID) settings.

Enter the SSID. This is also called the Wireless Network Name.

**Tip:** Click the Networks tab to view a list of the available wireless networks and their SSIDs.

### 3. Configure the Cisco-LEAP Advanced Security settings.

- a. Under Security, select the **Advanced** radio button then click **Advanced Security**.



The image shows a screenshot of the Cisco-LEAP settings screen. At the top, under 'Security Type', there are four radio buttons: WPA, WPA - PSK, 802.1x, and Cisco - LEAP. The 'Cisco - LEAP' button is selected. Below this is a section for 'PSK' with a text box and a note: 'Enter your WPA Passphrase. The minimum length is 8 characters.' Below that is an 'EAP' section. It contains a dropdown menu for 'EAP' set to 'TLS', a dropdown for 'Certificate', and a dropdown for 'CA Server' set to 'Netgear Https'. At the bottom of the EAP section are two rows of text boxes: 'Domain Name' (set to 'netgear.com') and 'Login Name' (set to 'webmaster@netgear.com') in the first row, and 'User Name' and 'Password' in the second row. At the very bottom right are 'OK' and 'Cancel' buttons.

**Figure 5-9: Cisco-LEAP settings screen**

- b. Select the **Cisco-LEAP** radio button.
- c. Fill in the User Name and Password.
- d. Click **OK**, then click **Apply** for the changes to take effect, and **Close** to exit the utility.

### 4. Save your settings in a Profile.

# Appendix A

## Technical Specifications

This appendix provides technical specifications for the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.

Antennae	2 Integrated internal diversity antennas
Standards	802.11a, 802.11g, 802.11b
Radio Data Rate	Auto Rate Sensing
•802.11a	6, 9, 12, 18, 24, 36, 48, 54, and 108 Mbps
•802.11b	1, 2, 5.5, 6, 11
•802.11g	6, 9, 12, 18, 24, 36, 48, 54, and 108 Mbps
Frequency	2.4-2.5GHz and 5 GHz (DSS, CCK, and OFDM Modulation)
Power	3.3V Bus powered
Emissions	FCC, CE
Bus interface	CardBus
Provided drivers	Microsoft Windows XP, 2000, Me, 98
Weight	46g (1.6 oz)
Operating Environment	Operating temperature: 0 to 55 degree C
Encryption	64-bit and 128-bit WEP data encryption; WPA
Warranty	Limited 1-year warranty





# Appendix B

## Wireless Networking Basics

This chapter provides an overview of wireless networking and security.

### Wireless Networking Overview

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The WAG511 Wireless PC Card conforms to the Institute of Electrical and Electronics Engineers (IEEE) 802.11b standard for wireless LANs (WLANs) and a product update will bring the WAG511 into conformance to the 802.11g standard when it is ratified. On an 802.11b or g wireless link, data is encoded using direct-sequence spread-spectrum (DSSS) technology and is transmitted in the unlicensed radio spectrum at 2.5GHz. The maximum data rate for the 802.11b wireless link is 11 Mbps, but it will automatically back down from 11 Mbps to 5.5, 2, and 1 Mbps when the radio signal is weak or when interference is detected. The 802.11g auto rate sensing rates are 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, and 54 Mbps. Likewise, the 802.11a wireless link offers a maximum data rate of 54 Mbps, but will automatically back down to rates 48, 36, 24, 18, 12, 9, and 6 Mbps.

The 802.11 standard is also called Wireless Ethernet or Wi-Fi by the Wireless Ethernet Compatibility Alliance (WECA, see <http://www.wi-fi.net>), an industry standard group promoting interoperability among 802.11 devices. The 802.11 standard offers two methods for configuring a wireless network - ad hoc and infrastructure.

### Infrastructure Mode

With a wireless access point, you can operate the wireless LAN in the infrastructure mode. This mode provides wireless connectivity to multiple wireless network devices within a fixed range or area of coverage, interacting with wireless nodes via an antenna.

In the infrastructure mode, the wireless access point converts airwave data into wired Ethernet data, acting as a bridge between the wired LAN and wireless clients. Connecting multiple access points via a wired Ethernet backbone can further extend the wireless network coverage. As a mobile computing device moves out of the range of one access point, it moves into the range of another. As a result, wireless clients can freely roam from one access point domain to another and still maintain seamless network connection.

## **Ad Hoc Mode (Peer-to-Peer Workgroup)**

In an ad hoc network, computers are brought together as needed; thus, there is no structure or fixed points to the network - each node can generally communicate with any other node. There is no access point involved in this configuration. This mode enables you to quickly set up a small wireless workgroup and allows workgroup members to exchange data or share printers as supported by Microsoft networking in the various Windows operating systems. Some vendors also refer to ad hoc networking as peer-to-peer group networking.

In this configuration, network packets are directly sent and received by the intended transmitting and receiving stations. As long as the stations are within range of one another, this is the easiest and least expensive way to set up a wireless network.

## **Network Name: Extended Service Set Identification (ESSID)**

The Extended Service Set Identification (ESSID) is one of two types of Service Set Identification (SSID). In an ad hoc wireless network with no access points, the Basic Service Set Identification (BSSID) is used. In an infrastructure wireless network that includes an access point, the ESSID is used, but may still be referred to as SSID.

An SSID is a thirty-two character (maximum) alphanumeric key identifying the name of the wireless local area network. Some vendors refer to the SSID as network name. For the wireless devices in a network to communicate with each other, all devices must be configured with the same SSID.

## **Wireless Channels**

IEEE 802.11g/b wireless nodes communicate with each other using radio frequency signals in the ISM (Industrial, Scientific, and Medical) band between 2.4 GHz and 2.5 GHz. Neighboring channels are 5 MHz apart. However, due to spread spectrum effect of the signals, a node sending signals using a particular channel will utilize frequency spectrum 12.5 MHz above and below the center channel frequency. As a result, two separate wireless networks using neighboring channels (for example, channel 1 and channel 2) in the same general vicinity will interfere with each other. Applying two channels that allow the maximum channel separation will decrease the amount of channel cross-talk, and provide a noticeable performance increase over networks with minimal channel separation.

The wireless frequencies used by 802.11a and 802.11b/g networks are different. These channel frequency options are discussed below.

## 802.11b/g Wireless Channels

IEEE 802.11b/g wireless nodes communicate with each other using radio frequency signals in the ISM (Industrial, Scientific, and Medical) band between 2.4 GHz and 2.5 GHz. Neighboring channels are 5 MHz apart. However, due to spread spectrum effect of the signals, a node sending signals using a particular channel will utilize frequency spectrum 12.5 MHz above and below the center channel frequency. As a result, two separate wireless networks using neighboring channels (for example, channel 1 and channel 2) in the same general vicinity will interfere with each other. Applying two channels that allow the maximum channel separation will decrease the amount of channel cross-talk, and provide a noticeable performance increase over networks with minimal channel separation.

The radio frequency channels used in 802.11b/g networks are listed in [Table B-1](#):

**Table B-1: 802.11b/g Radio Frequency Channels**

Channel	Center Frequency	Frequency Spread
1	2412 MHz	2399.5 MHz - 2424.5 MHz
2	2417 MHz	2404.5 MHz - 2429.5 MHz
3	2422 MHz	2409.5 MHz - 2434.5 MHz
4	2427 MHz	2414.5 MHz - 2439.5 MHz
5	2432 MHz	2419.5 MHz - 2444.5 MHz
6	2437 MHz	2424.5 MHz - 2449.5 MHz
7	2442 MHz	2429.5 MHz - 2454.5 MHz
8	2447 MHz	2434.5 MHz - 2459.5 MHz
9	2452 MHz	2439.5 MHz - 2464.5 MHz
10	2457 MHz	2444.5 MHz - 2469.5 MHz
11	2462 MHz	2449.5 MHz - 2474.5 MHz
12	2467 MHz	2454.5 MHz - 2479.5 MHz
13	2472 MHz	2459.5 MHz - 2484.5 MHz

**Note:** The available channels supported by the wireless products in various countries are different. For example, Channels 1 to 11 are supported in the U.S. and Canada, and Channels 1 to 13 are supported in Europe and Australia.

The preferred channel separation between the channels in neighboring wireless networks is 25 MHz (5 channels). This means that you can apply up to three different channels within your wireless network. There are only 11 usable wireless channels in the United States. It is recommended that you start using channel 1 and grow to use channel 6, and 11 when necessary, as these three channels do not overlap.

## 802.11a Legal Power Output and Wireless Channels

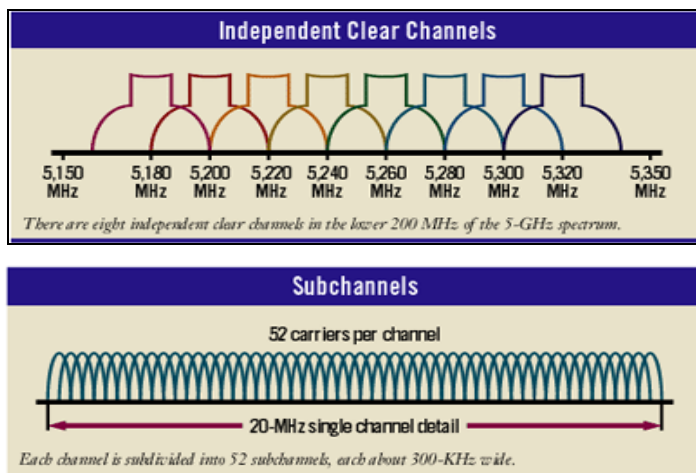
IEEE 802.11a utilizes 300 MHz of bandwidth in the 5 GHz Unlicensed National Information Infrastructure (U-NII) band. Though the lower 200 MHz is physically contiguous, the FCC has divided the total 300 MHz into three distinct domains, each with a different legal maximum power output. Below is a table of summary for different regulatory domains.

**Table B-2: 802.11a Radio Frequency Channels**

U-NII Band	Low	Middle	High
Frequency (GHz)	5.15 – 5.25	5.25 – 5.35	5.725 – 5.825
Max. Power Output	<ul style="list-style-type: none"><li>• 50 mW for US</li><li>• 200 mW for Canada, Europe, and Australia</li></ul>	<ul style="list-style-type: none"><li>• 250 mW for US</li><li>• 200 mW for Europe and Australia</li><li>• 1 W for Canada</li></ul>	<ul style="list-style-type: none"><li>• 1 W for US and Australia</li><li>• 4 W for Canada</li><li>• 25 mW for Europe</li></ul>

**Note:** Please check your local Authority for updated information on the available frequency and maximum power output.

IEEE 802.11a uses Orthogonal Frequency Division Multiplexing (OFDM), a new encoding scheme that offers certain benefits over a spread spectrum in channel availability and data rate. The 802.11a uses OFDM to define a total of 8 non-overlapping 200 MHz channels across the 2 lower bands; each of these is divided into 52 sub carriers and each carrier is approximately 300 KHz wide.



**Figure B-1: IEEE 802.11a Channel Allocations**

The WAG511 user can use thirteen channels in **non-turbo** mode.

**Table B-3: 802.11a Turbo Mode Off Radio Frequency Channels**

Turbo Mode OFF	
Channel	Frequency
36	5.180 GHz
40	5.200 GHz
44	5.220 GHz
48	5.240 GHz
52	5.260 GHz
56	5.280 GHz
60	5.300 GHz
64	5.320 GHz
149	5.745 GHz
153	5.765 GHz
157	5.785 GHz
161	5.805 GHz
165	5.825 GHz

The WAG511 user can use five channels in turbo mode.

Turbo Mode ON	
Channel	Frequency
42	5.21 GHz
50	5.25 GHz
58	5.29 GHz
152	5.76 GHz
160	5.8 GHz

The available channels supported by the wireless products in various countries are different.

## Wireless Security Overview

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Wireless technology is evolving rapidly to accommodate the need for stronger security. The following security schemes are supported in Netgear products:

- **WEP**

Wired Equivalent Privacy is an existing, widely implemented and supported, data encryption protocol for 802.11 wireless networks. All wireless nodes on the network are configured with a static 64-bit or 128-bit Shared Key for data encryption but authentication is optional.

- **WPA**

Wi-Fi Protected Access (WPA) is a new specification of standards-based, interoperable security enhancements that increase the level of data protection and access control for wireless networks. WPA requires authentication and features strong data encryption that includes dynamic key generation. WPA uses the Extensible Authentication Protocol (EAP) via WPA enables wireless access points using a modified version of the 802.1x protocols to access RADIUS and certificate servers which enable various authentication schemes such as Transport Layer Security (TLS) and Protected EAP (PEAP).

- **WPA-PSK**

WPA-Pre-Shared Key (WPA-PSK) performs authentication and encryption with a only a wireless access point based on a preshared key without needing to access RADIUS or certificate servers via the 802.1x protocols.

- **802.1x**

802.1x defines port-based, network access control used to provide authenticated network access and automated data encryption key management.

- **Cisco LEAP**

Light Extensible Authentication Protocol (LEAP) is a proprietary 802.1x EAP method developed by Cisco for use on wireless networks that use Cisco 802.11 wireless devices. It features dynamic per user per session WEP keys.

These security technologies are discussed below.

## **WEP Overview**

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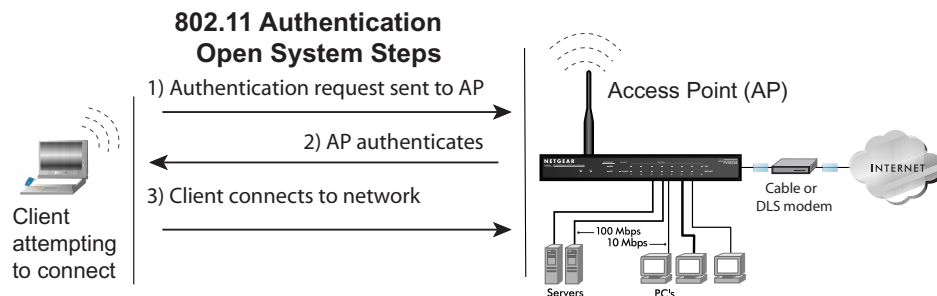
The absence of a physical connection between nodes makes the wireless links vulnerable to eavesdropping and information theft. To provide a certain level of security, the IEEE 802.11 standard has defined two types of authentication methods, Open System and Shared Key. With Open System authentication, a wireless PC can join any network and receive any messages that are not encrypted. With Shared Key authentication, only those PCs that possess the correct authentication key can join the network. By default, IEEE 802.11 wireless devices operate in an Open System network. Recently, Wi-Fi, the Wireless Ethernet Compatibility Alliance (<http://www.wi-fi.net>) developed the Wi-Fi Protected Access (WPA), a new strongly enhanced Wi-Fi security. WPA will soon be incorporated into the IEEE 802.11 standard. WEP and WPA are discussed below.

## **WEP Authentication**

An access point must authenticate a station before the station can associate with the access point or communicate with the network. The IEEE 802.11 standard defines two types of WEP authentication: Open System and Shared Key.

- Open System Authentication allows any device to join the network, assuming that the device SSID matches the access point SSID. Alternatively, the device can use the “ANY” SSID option to associate with any available access point within range, regardless of its SSID.
- Shared Key Authentication requires that the station and the access point have the same WEP Key to authenticate. These two authentication procedures are described below.

The WEP Open System authentication process is illustrated in below.

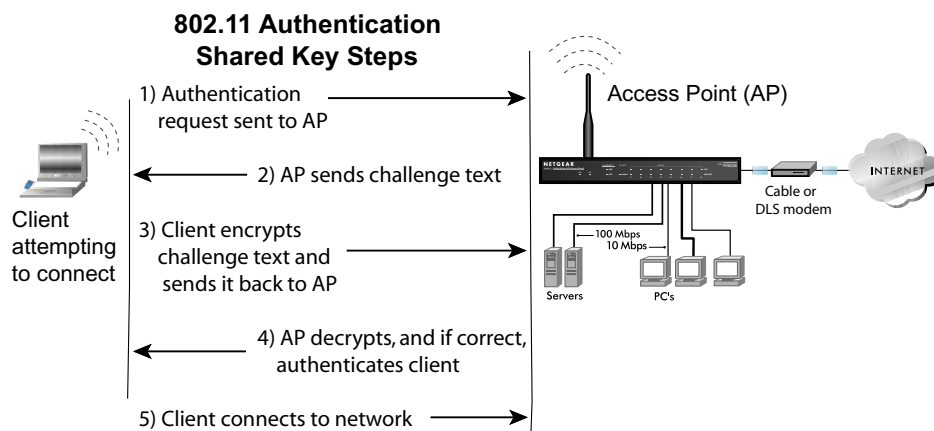


**Figure B-2: 802.11 open system authentication**

The following steps occur when two devices use Open System Authentication:

1. The station sends an authentication request to the access point.
2. The access point authenticates the station.
3. The station associates with the access point and joins the network.

The WEP Shared Key authentication process is illustrated in below.



**Figure B-3: 802.11 shared key authentication**

The following steps occur when two devices use Shared Key Authentication:

1. The station sends an authentication request to the access point.



2. The access point sends challenge text to the station.
3. The station uses its configured 64-bit or 128-bit default key to encrypt the challenge text, and sends the encrypted text to the access point.
4. The access point decrypts the encrypted text using its configured WEP Key that corresponds to the station's default key. The access point compares the decrypted text with the original challenge text. If the decrypted text matches the original challenge text, then the access point and the station share the same WEP Key and the access point authenticates the station.
5. The station connects to the network.

If the decrypted text does not match the original challenge text (i.e., the access point and station do not share the same WEP Key), then the access point will refuse to authenticate the station and the station will be unable to communicate with either the 802.11 network or Ethernet network.

## **WEP Keys**

The IEEE 802.11 standard supports two types of WEP encryption: 64-bit and 128-bit. 128-bit encryption is stronger than 64-bit encryption, but 128-bit encryption may not be available outside of the United States due to U.S. export regulations.

- **64-bit WEP**

The 64-bit WEP data encryption method, allows for a five-character (40-bit) input. Additionally, 24 factory-set bits are added to the forty-bit input to generate a 64-bit encryption key. (The 24 factory-set bits are not user-configurable). This encryption key will be used to encrypt/decrypt all data transmitted via the wireless interface. Some vendors refer to the 64-bit WEP data encryption as 40-bit WEP data encryption since the user-configurable portion of the encryption key is 40 bits wide.

When configured for 64-bit encryption, 802.11 products typically support up to four WEP Keys. Each 64-bit WEP Key is expressed as 5 sets of two hexadecimal digits (0-9 and A-F). For example, "12 34 56 78 90" is a 40-bit WEP Key.

- **128-bit WEP**

The 128-bit WEP data encryption method consists of 104 user-configurable bits. Similar to the forty-bit WEP data encryption method, the remaining 24 bits are factory set and not user configurable. Some vendors allow passphrases to be entered instead of the cryptic hexadecimal characters to ease encryption key entry.

When configured for 128-bit encryption, 802.11 products typically support four WEP Keys but some manufacturers support only one 128-bit key. The 128-bit WEP Key is expressed as 13 sets of two hexadecimal digits (0-9 and A-F). For example, "12 34 56 78 90 AB CD EF 12 34 56 78 90" is a 128-bit WEP Key.

Typically, 802.11 access points can store up to four 128-bit WEP Keys but some 802.11 client adapters can only store one. Therefore, make sure that your 802.11 access and client adapters configurations match.

- **WEP Key Configuration**

Whatever keys you enter for an AP, you must also enter the same keys for the client adapter in the same order. In other words, WEP key 1 on the AP must match WEP key 1 on the client adapter, WEP key 2 on the AP must match WEP key 2 on the client adapter, etc.

**Note:** The AP and the client adapters can have different default WEP Keys as long as the keys are in the same order. In other words, the AP can use WEP key 2 as its default key to transmit while a client adapter can use WEP key 3 as its default key to transmit. The two devices will communicate as long as the AP's WEP key 2 is the same as the client's WEP key 2 and the AP's WEP key 3 is the same as the client's WEP key 3.

## **How to Use WEP Parameters**

Wired Equivalent Privacy (WEP) data encryption is used when the wireless devices are configured to operate in Shared Key authentication mode. There are two shared key methods implemented in most commercially available products, 64-bit and 128-bit WEP data encryption.

Before enabling WEP on an 802.11 network, you must first consider what type of encryption you require and the key size you want to use. Typically, there are three WEP Encryption options available for 802.11 products:

1. **Does Not Use WEP:** The 802.11 network does not encrypt data. For authentication purposes, the network uses Open System Authentication.
2. **Uses WEP for Encryption:** A transmitting device encrypts the data portion of every packet it sends using a configured WEP Key. The receiving device decrypts the data using the same WEP Key. For authentication purposes, the network uses Open System Authentication.
3. **Uses WEP for Authentication and Encryption:** A transmitting device encrypts the data portion of every packet it sends using a configured WEP Key. The receiving device decrypts the data using the same WEP Key. For authentication purposes, the network uses Shared Key Authentication.

**Note:** Some 802.11 access points also support **Use WEP for Authentication Only** (Shared Key Authentication without data encryption). However, the WAG511 does not offer this option.

## **802.1x Port Based Network Access Control**

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Securing any kind of network involves allowing authorized parties to access traffic and networked resources (e.g., servers, hosts) while blocking outsiders. One essential ingredient in this recipe: permitting or denying physical attachment to the underlying communications medium.

In Ethernet LANs, this has long been accomplished by disabling unused RJ-45 jacks and controlling access to Ethernet switch ports according to the Media Access Control (MAC) addresses of the attached device. Early wireless LANs followed suit by using access control lists (ACLs) to permit associations by known MAC addresses while rejecting all others. MAC ACLs are quite easy to understand and configure. However, ACLs become difficult to manage in large dynamic networks and are easily circumvented by network interface cards (NICs) with programmable addresses.

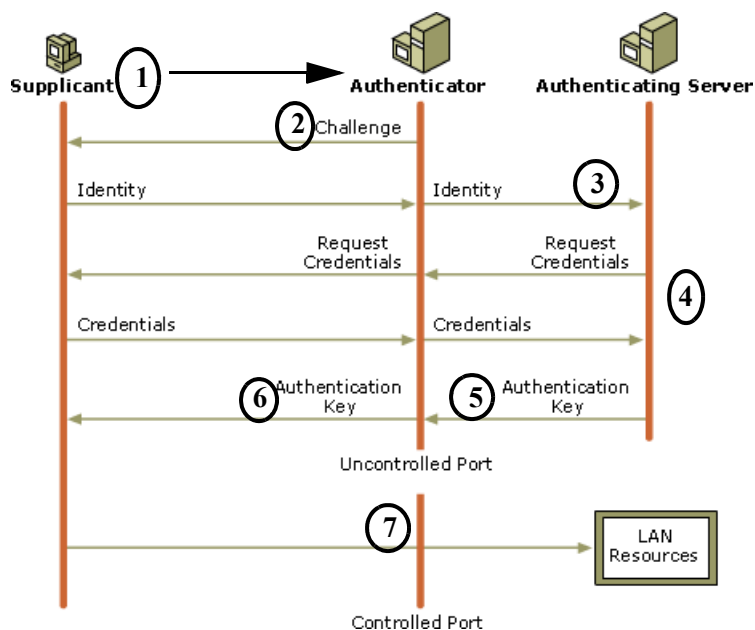
The LAN Port Access Control framework defined by the IEEE 802.1X standard addresses these needs.

With 802.11 WEP, all wireless access points and client wireless adapters on a particular wireless LAN must use the same encryption key. Each sending station encrypts data with a WEP key before transmission, and the receiving station decrypts it using an identical key. This process reduces the risk of someone passively monitoring the transmission and gaining access to the data transmitted over the wireless connections.

However, a major problem with the 802.11 wireless standard is that the keys are cumbersome to change. If you don't update the WEP keys often, an unauthorized person with a sniffing tool can monitor your network for less than a day and decode the encrypted messages. In order to use different keys, you must manually configure each access point and wireless adapter with new keys.

Products based on the 802.11 standard alone offer system administrators no effective method to update the keys. This might not be too much of concern with a few users, but the job of renewing keys on larger networks can be a monumental task. As a result, companies either don't use WEP at all or maintain the same keys for weeks, months, and even years. Both cases significantly heighten the wireless LAN's vulnerability to eavesdroppers.

IEEE 802.1x offers an effective framework for authenticating and controlling user traffic to a protected network, as well as dynamically varying encryption keys. 802.1x ties a protocol called EAP (Extensible Authentication Protocol) to both the wired and wireless LAN media and supports multiple authentication methods, such as token cards, Kerberos, one-time passwords, certificates, and public key authentication. For details on EAP specifically, refer to IETF's RFC 2284.



**Figure B-4: 802.1x authentication**

1. After associating with a wireless access point, the client sends an EAP-start message. This begins a series of message exchanges to authenticate the client.
2. The access point replies with an EAP-request identity message.
3. The client sends an EAP-response packet containing the identity to the authentication server.
4. The authentication server uses a specific authentication algorithm to verify the client's identity. This could be through the use of digital certificates or other EAP authentication type.
5. The authentication server will either send an accept or reject message to the access point.
6. The access point sends an EAP-success packet (or reject packet) to the client.

7. If the authentication server accepts the client, then the access point will transition the client's port to an authorized state and forward additional traffic.

Initial 802.1x communications begin with an unauthenticated supplicant (i.e., client device) attempting to connect with an authenticator (i.e., 802.11 access point). The access point responds by enabling a port for passing only EAP packets from the client to an authentication server located on the wired side of the access point. The access point blocks all other traffic, such as HTTP, DHCP, and POP3 packets, until the access point can verify the client's identity using an authentication server (e.g., RADIUS). Once authenticated, the access point opens the client's port for other types of traffic.

The basic 802.1x protocol provides effective authentication and can offering dynamic key management using 802.1x as a delivery mechanism. If configured to implement dynamic key exchange, the 802.1x authentication server can return session keys to the access point along with the accept message. The access point uses the session keys to build, sign and encrypt an EAP key message that is sent to the client immediately after sending the success message. The client can then use contents of the key message to define applicable encryption keys. In typical 802.1x implementations, the client can automatically change encryption keys as often as necessary to minimize the possibility of eavesdroppers having enough time to crack the key in current use.

It's important to note that 802.1x doesn't provide the actual authentication mechanisms. When using 802.1x, you need to choose an EAP type, such as Transport Layer Security (EAP-TLS) or Protected EAP (PEAP), which defines how the authentication takes place.

The important part to know at this point is that the software supporting the specific EAP type resides on the authentication server and within the operating system or application software on the client devices. The wireless access point acts as a “pass through” for 802.1x messages. As a result, you can update the EAP authentication type as newer types become available and your requirements for security change.

802.1x is well on its way to becoming an industry standard, and provides an effective wired and wireless LAN security solution. Windows XP implements 802.1x natively, and the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511 supports 802.1x. The 802.11i committee is specifying the use of 802.1x to eventually become part of the 802.11 standard.

## **WPA Wireless Security**

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Wi-Fi Protected Access (WPA) is a specification of standards-based, interoperable security enhancements that increase the level of data protection and access control for existing and future wireless LAN systems.

The IEEE introduced the WEP as an optional security measure to secure 802.11 (Wi-Fi) WLANs, but inherent weaknesses in the standard soon became obvious. In response to this situation, the Wi-Fi Alliance announced a new security architecture in October 2002 that remedies the short comings of WEP. This standard, formerly known as Safe Secure Network (SSN), is designed to work with existing 802.11 products and offers forward compatibility with 802.11i, the new wireless security architecture being defined in the IEEE.

WPA offers the following benefits:

- Enhanced data privacy
- Robust key management
- Data origin authentication
- Data integrity protection

The Wi-Fi Alliance is now performing interoperability certification testing on Wi-Fi Protected Access products. As of August of 2003, all new Wi-Fi certified products have to support WPA. Existing Wi-Fi certified products will have one year to add WPA support or they will lose their Wi-Fi certification. While the new IEEE 802.11i standard is being ratified, wireless vendors have agreed on WPA as an interoperable interim standard.

## **How Does WPA Compare to WEP?**

WEP is a data encryption method and is not intended as a user authentication mechanism. WPA user authentication is implemented using 802.1x and the Extensible Authentication Protocol (EAP). Support for 802.1x authentication is required in WPA. In the 802.11 standard, 802.1x authentication was optional. For details on EAP specifically, refer to IETF's RFC 2284.

With 802.11 WEP, all access points and client wireless adapters on a particular wireless LAN must use the same encryption key. A major problem with the 802.11 standard is that the keys are cumbersome to change. If you don't update the WEP keys often, an unauthorized person with a sniffing tool can monitor your network for less than a day and decode the encrypted messages. Products based on the 802.11 standard alone offer system administrators no effective method to update the keys.

For 802.11, WEP encryption is optional. For WPA, encryption using Temporal Key Integrity Protocol (TKIP) is required. TKIP replaces WEP with a new encryption algorithm that is stronger than the WEP algorithm, but that uses the calculation facilities present on existing wireless devices to perform encryption operations. TKIP provides important data encryption enhancements including a per-packet key mixing function, a message integrity check (MIC) named Michael, an extended initialization vector (IV) with sequencing rules, and a re-keying mechanism. Through these enhancements, TKIP addresses all of known WEP vulnerabilities.

## **How Does WPA Compare to IEEE 802.11i?**

WPA will be forward compatible with the IEEE 802.11i security specification currently under development. WPA is a subset of the current 802.11i draft and uses certain pieces of the 802.11i draft that are ready to bring to market today, such as 802.1x and TKIP. The main pieces of the 802.11i draft that are not included in WPA are secure IBSS (Ad-Hoc mode), secure fast handoff (for specialized 802.11 VoIP phones), as well as enhanced encryption protocols such as AES-CCMP. These features are either not yet ready for market or will require hardware upgrades to implement.

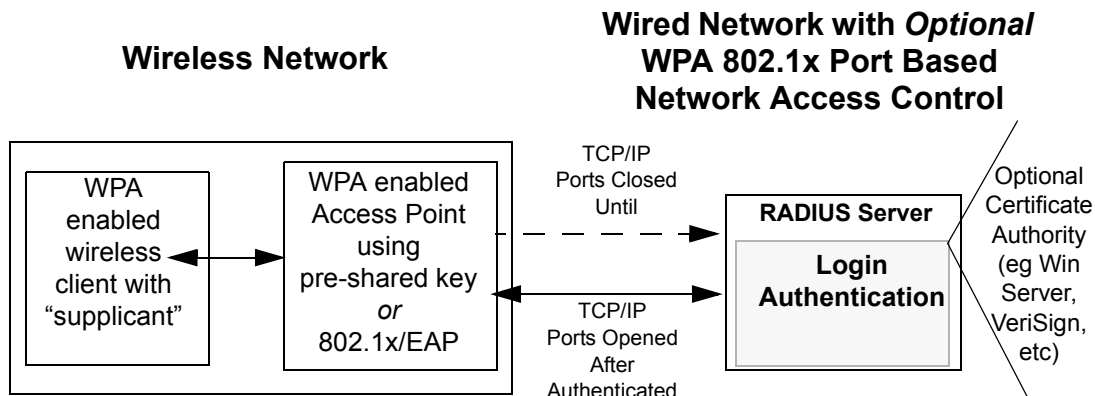
## **What are the Key Features of WPA Security?**

The following security features are included in the WPA standard:

- WPA Authentication
- WPA Encryption Key Management
  - Temporal Key Integrity Protocol (TKIP)
  - Michael *message integrity code* (MIC)
  - AES Support
- Support for a Mixture of WPA and WEP Wireless Clients

These features are discussed below.

WPA addresses most of the known WEP vulnerabilities and is primarily intended for wireless infrastructure networks as found in the enterprise. This infrastructure includes stations, access points, and authentication servers (typically RADIUS servers). The RADIUS server holds (or has access to) user credentials (e.g., user names and passwords) and authenticates wireless users before they gain access to the network.



**Figure B-5: WPA Overview**

The strength WPA comes from an integrated sequence of operations that encompass 802.1X/EAP authentication and sophisticated key management and encryption techniques. Its major operations include:

- **Network security capability determination.** This occurs at the 802.11 level and is communicated through WPA information elements in Beacon, Probe Response, and (Re) Association Requests. Information in these elements includes the authentication method (802.1X or Pre-shared key) and the preferred cipher suite (WEP, TKIP, or AES).

The primary information conveyed in the Beacon frames is the authentication method and the cipher suite. Possible authentication methods include 802.1X and Pre-shared key. Pre-shared key is an authentication method that uses a statically configured pass phrase on both the stations and the access point. This eliminates the need for an authentication server, which in many home and small office environments will not be available nor desirable. Possible data encryption options include: WEP, TKIP, and AES (Advanced Encryption Standard). We'll talk more TKIP and AES when addressing data privacy below.

- **Authentication.** EAP over 802.1X is used for authentication. Mutual authentication is gained by choosing an EAP type supporting this feature and is required by WPA. 802.1X port access control prevents full access to the network until authentication completes. 802.1X EAPOL-Key packets are used by WPA to distribute per-session keys to those stations successfully authenticated.



The supplicant in the station uses the authentication and cipher suite information contained in the information elements to decide which authentication method and cipher suite to use. For example, if the access point is using the Pre-shared key method then the supplicant need not authenticate using full-blown 802.1X. Rather, the supplicant must simply prove to the access point that it is in possession of the pre-shared key. If the supplicant detects that the service set does not contain a WPA information element then it knows it must use pre-WPA 802.1X authentication and key management in order to access the network.

- **Key management.** WPA features a robust key generation/management system that integrates the authentication and data privacy functions. Keys are generated after successful authentication and through a subsequent 4-way handshake between the station and Access Point (AP).
- **Data Privacy (Encryption).** Temporal Key Integrity Protocol (TKIP) is used to wrap WEP in sophisticated cryptographic and security techniques to overcome most of its weaknesses.
- **Data integrity.** TKIP includes a message integrity code (MIC) at the end of each plaintext message to ensure messages are not being spoofed.

Client with a WPA-enabled wireless adapter and supplicant

For example, a WPA-enabled AP

For example, a RADIUS server

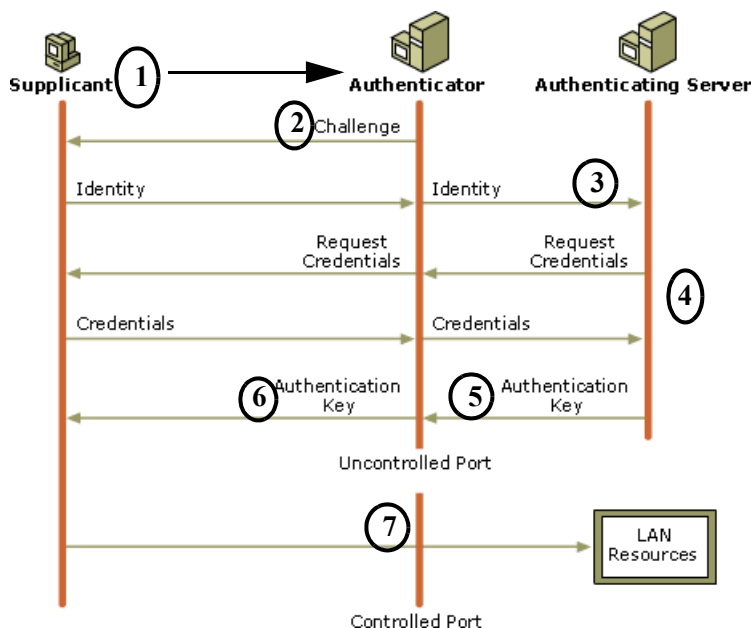


Figure B-6: WPA/802.1X Authentication Sequence

The AP sends Beacon Frames with WPA information element to the stations in the service set. Information elements include the required authentication method (802.1x or Pre-shared key) and the preferred cipher suite (WEP, TKIP, or AES). Probe Responses (AP to station) and Association Requests (station to AP) also contain WPA information elements.

1. Initial 802.1x communications begin with an unauthenticated supplicant (i.e., client device) attempting to connect with an authenticator (i.e., 802.11 access point). The client sends an EAP-start message. This begins a series of message exchanges to authenticate the client.
2. The access point replies with an EAP-request identity message.
3. The client sends an EAP-response packet containing the identity to the authentication server. The access point responds by enabling a port for passing only EAP packets from the client to an authentication server located on the wired side of the access point. The access point blocks all other traffic, such as HTTP, DHCP, and POP3 packets, until the access point can verify the client's identity using an authentication server (e.g., RADIUS).
4. The authentication server uses a specific authentication algorithm to verify the client's identity. This could be through the use of digital certificates or some other EAP authentication type.
5. The authentication server will either send an accept or reject message to the access point.
6. The access point sends an EAP-success packet (or reject packet) to the client.
7. If the authentication server accepts the client, then the access point will transition the client's port to an authorized state and forward additional traffic.

The important part to know at this point is that the software supporting the specific EAP type resides on the authentication server and within the operating system or application “supplicant” software on the client devices. The access point acts as a “pass through” for 802.1x messages, which means that you can specify any EAP type without needing to upgrade an 802.1x-compliant access point. As a result, you can update the EAP authentication type to such devices as token cards (Smart Cards), Kerberos, one-time passwords, certificates, and public key authentication or as newer types become available and your requirements for security change.

IEEE 802.1x offers an effective framework for authenticating and controlling user traffic to a protected network, as well as providing a vehicle for dynamically varying data encryption keys via EAP from a RADIUS server, for example. This framework enables using a central authentication server, which employs mutual authentication so that a rogue wireless user does not join the network.

It's important to note that 802.1x doesn't provide the actual authentication mechanisms. When using 802.1x, the EAP type, such as Transport Layer Security (EAP-TLS) or EAP Tunneled Transport Layer Security (EAP-TTLS) defines how the authentication takes place.

**Note:** For environments with a Remote Authentication Dial-In User Service (RADIUS) infrastructure, WPA supports Extensible Authentication Protocol (EAP). For environments without a RADIUS infrastructure, WPA supports the use of a preshared key.

Together, these technologies provide a framework for strong user authentication.

## **WPA Data Encryption Key Management**

With 802.1x, the rekeying of unicast encryption keys is optional. Additionally, 802.11 and 802.1x provide no mechanism to change the global encryption key used for multicast and broadcast traffic. With WPA, rekeying of both unicast and global encryption keys is required.

For the unicast encryption key, the Temporal Key Integrity Protocol (TKIP) changes the key for every frame, and the change is synchronized between the wireless client and the wireless access point (AP). For the global encryption key, WPA includes a facility (the Information Element) for the wireless AP to advertise the changed key to the connected wireless clients.

If configured to implement dynamic key exchange, the 802.1x authentication server can return session keys to the access point along with the accept message. The access point uses the session keys to build, sign and encrypt an EAP key message that is sent to the client immediately after sending the success message. The client can then use contents of the key message to define applicable encryption keys. In typical 802.1x implementations, the client can automatically change encryption keys as often as necessary to minimize the possibility of eavesdroppers having enough time to crack the key in current use.

- **Temporal Key Integrity Protocol (TKIP)**

WPA uses TKIP to provide important data encryption enhancements including a per-packet key mixing function, a message integrity check (MIC) named Michael, an extended initialization vector (IV) with sequencing rules, and a re-keying mechanism. TKIP also provides for the following:

- The verification of the security configuration after the encryption keys are determined.
- The synchronized changing of the unicast encryption key for each frame.
- The determination of a unique starting unicast encryption key for each preshared key authentication.

- **Michael**

With 802.11 and WEP, data integrity is provided by a 32-bit *integrity check value* (ICV) that is appended to the 802.11 payload and encrypted with WEP. Although the ICV is encrypted, you can use cryptanalysis to change bits in the encrypted payload and update the encrypted ICV without being detected by the receiver.

With WPA, a method known as *Michael* specifies a new algorithm that calculates an 8-byte *message integrity code* (MIC) using the calculation facilities available on existing wireless devices. The MIC is placed between the data portion of the IEEE 802.11 frame and the 4-byte ICV. The MIC field is encrypted together with the frame data and the ICV. Michael also provides replay protection. A new frame counter in the IEEE 802.11 frame is used to prevent replay attacks.

- **AES Support**

One of the encryption methods supported by WPA beside TKIP is the advanced encryption standard (AES), although AES support will not be required initially for Wi-Fi certification. This is viewed as the optimal choice for security conscience organizations, but the problem with AES is that it requires a fundamental redesign of the NIC's hardware in both the station and the access point. TKIP was a pragmatic compromise that allows organizations to deploy better security while AES capable equipment is being designed, manufactured, and incrementally deployed.

## **Is WPA Perfect?**

WPA is not without its vulnerabilities. Specifically, it is susceptible to denial of service (DoS) attacks. If the access point receives two data packets that fail the Message Integrity Code (MIC) check within 60 seconds of each other then the network is under an active attack, and as a result, the access point employs counter measures, which includes disassociating each station using the access point. This prevents an attacker from gleaning information about the encryption key and alerts administrators, but it also causes users to lose network connectivity for 60 seconds. More than anything else, this may just prove that no single security tactic is completely invulnerable. WPA is a definite step forward in WLAN security over WEP and has to be thought of as a single part of an end-to-end network security strategy.

# Appendix C

## Preparing Your PCs for Network Access

This appendix describes how to prepare your PCs to connect to the Internet through the NETGEAR Dual Band Wireless PC Card 32-bit CardBus WAG511.

For adding file and print sharing to your network, please consult the Windows help information included with the version of Windows installed on each computer on your network.

### Preparing Your Computers for TCP/IP Networking

---

Computers access the Internet using a protocol called TCP/IP (Transmission Control Protocol/Internet Protocol). Each computer on your network must have TCP/IP installed and selected as its networking protocol. If a Network Interface Card (NIC) is already installed in your PC, then TCP/IP is probably already installed as well.

Most operating systems include the software components you need for networking with TCP/IP. Windows 95 or later includes the software components for establishing a TCP/IP network.

In your TCP/IP network, each PC and the wireless access point must be assigned a unique IP addresses. Each PC must also have certain other TCP/IP configuration information such as a subnet mask (netmask), a domain name server (DNS) address, and a default gateway address. In most cases, you should install TCP/IP so that the PC obtains its specific network configuration information automatically from a DHCP server during startup.

### Configuring Windows 98 and Me for TCP/IP Networking

---

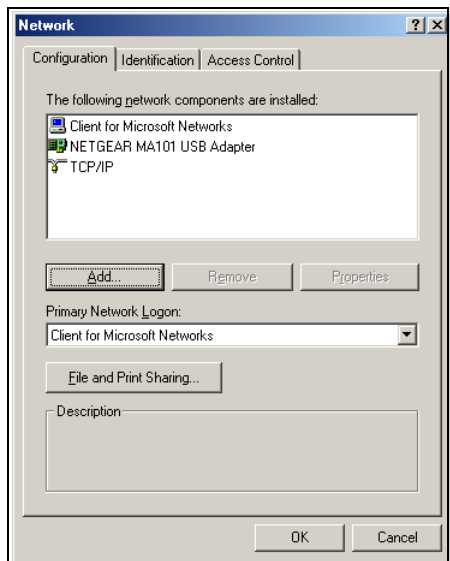
As part of the PC preparation process, you may need to install and configure TCP/IP on your PC. Before starting, locate your Windows CD; you may need to insert it during the TCP/IP installation process.

### Install or Verify Windows Networking Components

To install or verify the necessary components for IP networking:

1. On the Windows taskbar, click the Start button, point to Settings, and then click Control Panel.
2. Double-click the Network icon.

The Network window opens, which displays a list of installed components:



You must have an Ethernet adapter or an WAG511, the TCP/IP protocol, and the Client for Microsoft Networks.



**Note:** It is not necessary to remove any other network components shown in the Network window in order to install the adapter, TCP/IP, or Client for Microsoft Networks.

If you need to add TCP/IP:

- a. Click the Add button.
- b. Select Protocol, and then click Add.
- c. Select Microsoft.
- d. Select TCP/IP, and then click OK.

If you need to add the Client for Microsoft Networks:

- a. Click the Add button.
- b. Select Client, and then click Add.
- c. Select Microsoft.
- d. Select Client for Microsoft Networks, and then click OK.

If you need to add File and Print Sharing for Microsoft Networks:

- a. Click the Add button.
  - b. Select Client, and then click Add.
  - c. Select Microsoft.
  - d. Select File and Print Sharing for Microsoft Networks, and then click OK.
3. Restart your PC for the changes to take effect.

## **Enabling DHCP to Automatically Configure TCP/IP Settings in Windows 98 and Me**

After the TCP/IP protocol components are installed, each PC must be assigned specific information about itself and resources that are available on its network. The simplest way to configure this information is to allow the PC to obtain the information from a DHCP server in the network.

You will find there are many similarities in the procedures for different Windows systems when using DHCP to configure TCP/IP.

The following steps will walk you through the configuration process for each of these versions of Windows.

**1**

Locate your **Network Neighborhood** icon.

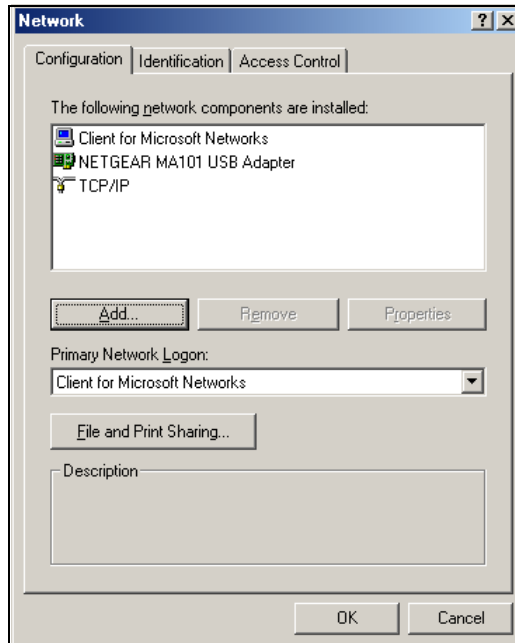
- If the Network Neighborhood icon is on the Windows desktop, position your mouse pointer over it and right-click your mouse button.
- If the icon is not on the desktop,
  - Click **Start** on the task bar located at the bottom left of the window.
  - Choose **Settings**, and then **Control Panel**.
  - Locate the **Network Neighborhood** icon and click on it. This will open the Network panel as shown below.

## 2

Verify the following settings as shown:

- Client for Microsoft Network exists
- Ethernet adapter is present
- TCP/IP is present
- **Primary Network Logon** is set to Windows logon

Click on the **Properties** button. The following TCP/IP Properties window will display.





3

By default, the **IP Address** tab is open on this window.

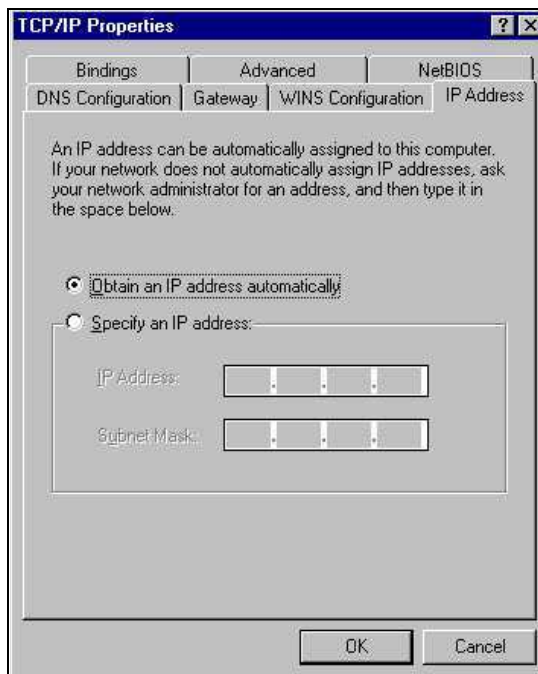
- Verify the following:

**Obtain an IP address automatically** is selected. If not selected, click in the radio button to the left of it to select it. This setting is required to enable the DHCP server to automatically assign an IP address.

- Click **OK** to continue.

Restart the PC.

Repeat these steps for each PC with this version of Windows on your network.



## Selecting Windows' Internet Access Method

1. On the Windows taskbar, click the Start button, point to Settings, and then click Control Panel.
2. Double-click the Internet Options icon.
3. Select "I want to set up my Internet connection manually" or "I want to connect through a Local Area Network" and click Next.
4. Select "I want to connect through a Local Area Network" and click Next.
5. Uncheck all boxes in the LAN Internet Configuration screen and click Next.
6. Proceed to the end of the Wizard.

## Verifying TCP/IP Properties

After your PC is configured and has rebooted, you can check the TCP/IP configuration using the utility *winnpcfg.exe*:

1. On the Windows taskbar, click the Start button, and then click Run.

2. Type **winipcfg**, and then click OK.

The IP Configuration window opens, which lists (among other things), your IP address, subnet mask, and default gateway.

3. From the drop-down box, select your Ethernet adapter.

The window is updated to show your settings, which should match the values below if you are using the default TCP/IP settings that NETGEAR recommends for connecting through a router or gateway:

- The IP address is between 192.168.0.2 and 192.168.0.254
- The subnet mask is 255.255.255.0
- The default gateway is 192.168.0.1

## **Configuring Windows 2000 or XP for TCP/IP Networking**

---

As part of the PC preparation process, you may need to install and configure TCP/IP on each networked PC. Before starting, locate your Windows CD; you may need to insert it during the TCP/IP installation process.

### **Install or Verify Windows Networking Components**

To install or verify the necessary components for IP networking:

1. On the Windows taskbar, click the Start button, point to Settings, and then click Control Panel.
2. Double-click the Network and Dialup Connections icon.
3. If an Ethernet adapter is present in your PC, you should see an entry for Local Area Connection. Double-click that entry.
4. Select Properties.
5. Verify that 'Client for Microsoft Networks' and 'Internet Protocol (TCP/IP)' are present. If not, select Install and add them.
6. Select 'Internet Protocol (TCP/IP)', click Properties, and verify that "Obtain an IP address automatically is selected.
7. Click OK and close all Network and Dialup Connections windows.
8. Then, restart your PC.

## DHCP Configuration of TCP/IP in Windows XP or 2000

You will find there are many similarities in the procedures for different Windows systems when using DHCP to configure TCP/IP.

The following steps will walk you through the configuration process for each of these versions of Windows.

## DHCP Configuration of TCP/IP in Windows XP

1

Locate your **Network Neighborhood** icon.

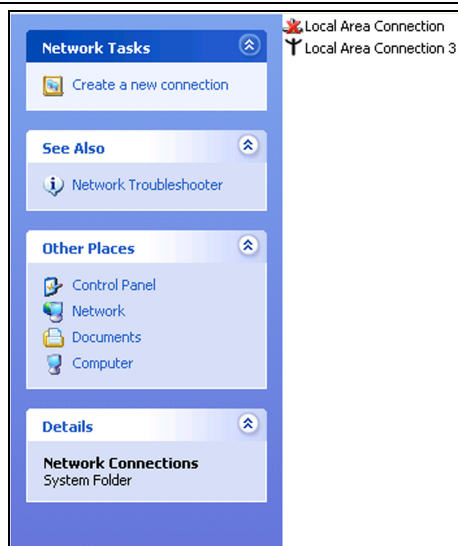
- Select **Control Panel** from the Windows XP Start Menu.
- Select the **Network Connections** icon on the Control Panel. This will take you to the next step.

2

Now the Network Connection window displays.

The Connections List that shows all the network connections set up on the PC, located to the right of the window.

- Right-click on the **Connection with the wireless icon** and choose **Status**.

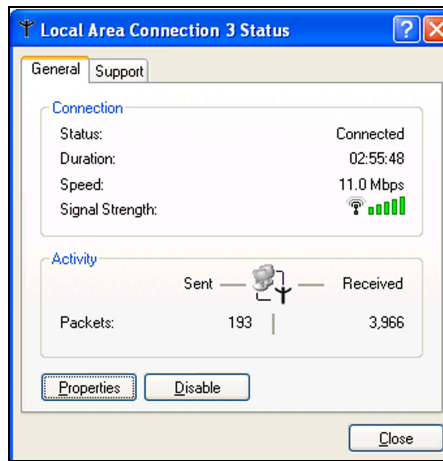


3

Now you should be at the Local Area Network Connection Status window. This box displays the connection status, duration, speed, and activity statistics.

Administrator logon access rights are needed to use this window.

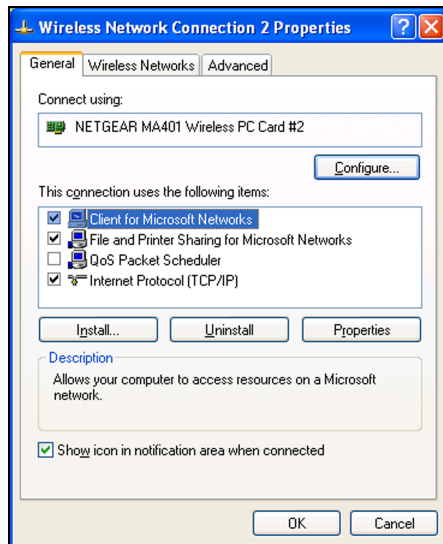
- Click the **Properties** button to view details about the connection.



4

The TCP/IP details are presented on the Support tab page.

- Select **Internet Protocol**, and click **Properties** to view the configuration information.



Verify that **Obtain an IP address**

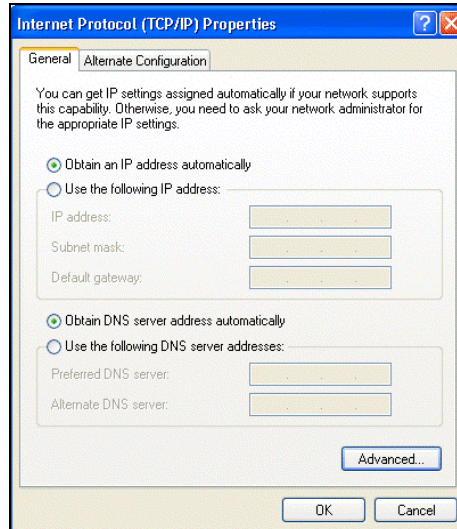
**5**

**automatically** radio button is selected and that the **Obtain DNS server address automatically** radio button is selected.

- Click the **OK** button.

This completes the DHCP configuration in Windows XP.

Repeat these steps for each PC with this version of Windows on your network.



## DHCP Configuration of TCP/IP in Windows 2000

After you install a network card, TCP/IP for Windows 2000 is configured and set to DHCP without your having to configure it. However, if there are problems, following the steps below to configure TCP/IP with DHCP for Windows 2000.

**1**

Click on the **My Network Places** icon on the Windows desktop. This will bring up a window called Network and Dial-up Connections.

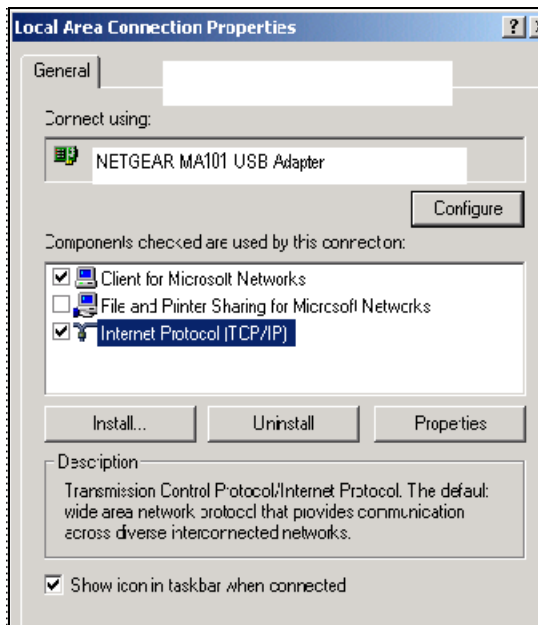
- Right click on **Local Area Connection** and select **Properties**.

2

The **Local Area Connection Properties** dialog box appears. Verify that you have the correct Ethernet card selected in the **Connect using:** box and that the following two items are displayed and selected in the box of “Components checked are used by this connection:”

- Client for Microsoft Networks and
- Internet Protocol (TCP/IP)

Click **OK**.



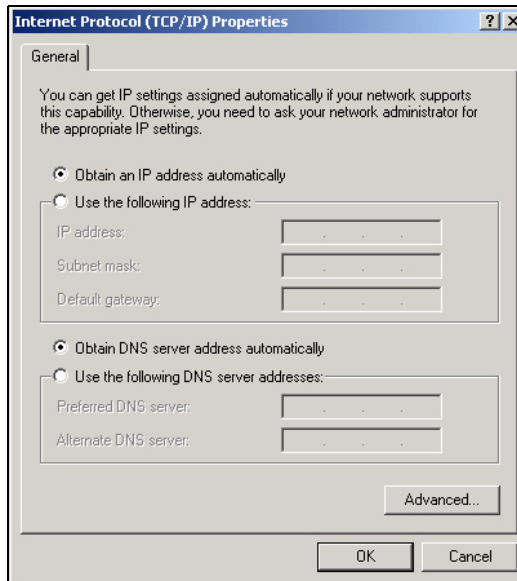
3

With Internet Protocol (TCP/IP) selected, click on **Properties** to open the Internet Protocol (TCP/IP) Properties dialogue box. Verify that

- **Obtain an IP address automatically** is selected.
- **Obtain DNS server address automatically** is selected.

Click **OK** to return to Local Area Connection Properties. Click **OK** again to complete the configuration process.

Restart the PC. Repeat these steps for each PC with this version of Windows on your network.



## **Verifying TCP/IP Properties for Windows XP or 2000**

To check your PC's TCP/IP configuration:

1. On the Windows taskbar, click the Start button, and then click Run.

The Run window opens.

2. Type `cmd` and then click OK.

A command window opens

3. Type `ipconfig /all`

Your IP Configuration information will be listed, and should match the values below if you are using the default TCP/IP settings that NETGEAR recommends for connecting through a router or gateway:

- The IP address is between 192.168.0.2 and 192.168.0.254
- The subnet mask is 255.255.255.0
- The default gateway is 192.168.0.1

4. Type `exit`





## List of Glossary Terms

---

Use the list below to find definitions for technical terms used in this manual.

### **10BASE-T**

IEEE 802.3 specification for 10 Mbps Ethernet over twisted pair wiring.

### **100BASE-Tx**

IEEE 802.3 specification for 100 Mbps Ethernet over twisted pair wiring.

### **802.1x**

802.1x defines port-based, network access control used to provide authenticated network access and automated data encryption key management. The IEEE 802.1x draft standard offers an effective framework for authenticating and controlling user traffic to a protected network, as well as dynamically varying encryption keys. 802.1x uses a protocol called EAP (Extensible Authentication Protocol) and supports multiple authentication methods, such as token cards, Kerberos, one-time passwords, certificates, and public key authentication. For details on EAP specifically, refer to IETF's RFC 2284.

### **802.11a**

IEEE specification for wireless networking at 54 Mbps operating in unlicensed radio bands over 5GHz.

### **802.11b**

IEEE specification for wireless networking at 11 Mbps using direct-sequence spread-spectrum (DSSS) technology and operating in the unlicensed radio spectrum at 2.5GHz.

### **802.11g**

A soon to be ratified IEEE specification for wireless networking at 54 Mbps using direct-sequence spread-spectrum (DSSS) technology and operating in the unlicensed radio spectrum at 2.5GHz. 802.11g is backwards compatible with 802.11b.

### **Ad-hoc Mode**

An 802.11 networking framework in which devices or stations communicate directly with each other, without the use of an access point (AP). Ad-hoc mode is also referred to as peer-to-peer mode or an Independent Basic Service Set (IBSS). Ad-hoc mode is useful for establishing a network where wireless infrastructure does not exist or where services are not required.

## **ADSL**

Short for asymmetric digital subscriber line, a technology that allows data to be sent over existing copper telephone lines at data rates of from 1.5 to 9 Mbps when receiving data (known as the downstream rate) and from 16 to 640 Kbps when sending data (known as the upstream rate).

ADSL requires a special ADSL modem. ADSL is growing in popularity as more areas around the world gain access.

## **CA**

A Certificate Authority is a trusted third-party organization or company that issues digital certificates used to create digital signatures and public-private key pairs.

### **Certificate Authority**

A Certificate Authority is a trusted third-party organization or company that issues digital certificates used to create digital signatures and public-private key pairs. The role of the CA in this process is to guarantee that the individual granted the unique certificate is, in fact, who he or she claims to be. Usually, this means that the CA has an arrangement with a financial institution, such as a credit card company, which provides it with information to confirm an individual's claimed identity. CAs are a critical component in data security and electronic commerce because they guarantee that the two parties exchanging information are really who they claim to be.

## **DHCP**

An Ethernet protocol specifying how a centralized DHCP server can assign network configuration information to multiple DHCP clients. The assigned information includes IP addresses, DNS addresses, and gateway (router) addresses.

## **DNS**

Short for Domain Name System (or Service), an Internet service that translates domain names into IP addresses. Because domain names are alphabetic, they're easier to remember. The Internet however, is really based on IP addresses. Every time you use a domain name, therefore, a DNS service must translate the name into the corresponding IP address. For example, the domain name `www.example.com` might translate to `198.105.232.4`. The DNS system is, in fact, its own network. If one DNS server doesn't know how to translate a particular domain name, it asks another one, and so on, until the correct IP address is returned.

## **Domain Name**

A descriptive name for an address or group of addresses on the Internet. Domain names are of the form of a registered entity name plus one of a number of predefined top level suffixes such as `.com`, `.edu`, `.uk`, etc. For example, in the address `mail.NETGEAR.com`, `mail` is a server name and `NETGEAR.com` is the domain.

## **DSL**

Short for digital subscriber line, but is commonly used in reference to the asymmetric version of this technology (ADSL) that allows data to be sent over existing copper telephone lines at data rates of from 1.5 to 9 Mbps when receiving data (known as the downstream rate) and from 16 to 640 Kbps when sending data (known as the upstream rate).

ADSL requires a special ADSL modem. ADSL is growing in popularity as more areas around the world gain access.

### **Dynamic Host Configuration Protocol**

DHCP. An Ethernet protocol specifying how a centralized DHCP server can assign network configuration information to multiple DHCP clients. The assigned information includes IP addresses, DNS addresses, and gateway (router) addresses.

### **EAP**

Extensible Authentication Protocol is a general protocol for authentication that supports multiple authentication methods. EAP, an extension to PPP, supports such authentication methods as token cards, Kerberos, one-time passwords, certificates, public key authentication and smart cards. In wireless communications using EAP, a user requests connection to a WLAN through an AP, which then requests the identity of the user and transmits that identity to an authentication server such as RADIUS. The server asks the AP for proof of identity, which the AP gets from the user and then sends back to the server to complete the authentication. EAP is defined by RFC 2284.

### **EAP-TLS**

EAP-TLS provides strong security through mutual authentication and automatic key exchange between the two endpoints. Periodic updates are performed using public-key cryptography through a certificate server and a Remote Authentication Dial-In User Service (RADIUS) server. *See TLS.*

### **ESSID**

The Extended Service Set Identification (ESSID) is a thirty-two character (maximum) alphanumeric key identifying the wireless local area network.

### **Gateway**

A local device, usually a router, that connects hosts on a local network to other networks.

### **IETF**

Internet Engineering Task Force. Working groups of the IETF propose standard protocols and procedures for the Internet, which are published as RFCs (Request for Comment) at [www.ietf.org](http://www.ietf.org). An open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.

### **IP**

Internet Protocol is the main internetworking protocol used in the Internet. Used in conjunction with the Transfer Control Protocol (TCP) to form TCP/IP.

**IP Address**

A four-byte number uniquely defining each host on the Internet, usually written in dotted-decimal notation with periods separating the bytes (for example, 134.177.244.57). Ranges of addresses are assigned by Internic, an organization formed for this purpose.

**IPX**

Short for Internetwork Packet Exchange, a networking protocol used by the Novell NetWare operating systems. Like UDP/IP, IPX is a datagram protocol used for connectionless communications. Higher-level protocols, such as SPX and NCP, are used for additional error recovery services.

**ISP**

Internet service provider.

**Infrastructure Mode**

An 802.11 networking framework in which devices communicate with each other by first going through an Access Point (AP). In infrastructure mode, wireless devices can communicate with each other or can communicate with a wired network. When one AP is connected to wired network and a set of wireless stations it is referred to as a Basic Service Set (BSS). An Extended Service Set (ESS) is a set of two or more BSSs that form a single subnetwork. Most corporate wireless LANs operate in infrastructure mode because they require access to the wired LAN in order to use services such as file servers or printers.

**Internet Protocol**

The main internetworking protocol used in the Internet. Used in conjunction with the Transfer Control Protocol (TCP) to form TCP/IP.

**IP**

See "TCP/IP"

**IP Address**

A four-byte number uniquely defining each host on the Internet, usually written in dotted-decimal notation with periods separating the bytes (for example, 134.177.244.57). Ranges of addresses are assigned by Internic, an organization formed for this purpose.

**ISP**

Internet service provider.

**LAN**

A communications network serving users within a limited area, such as one floor of a building.

**local area network**

LAN. A communications network serving users within a limited area, such as one floor of a building. A LAN typically connects multiple personal computers and shared network devices such as storage and printers. Although many technologies exist to implement a LAN, Ethernet is the most common for connecting personal computers.

**MAC address**

The Media Access Control address is a unique 48-bit hardware address assigned to every network interface card. Usually written in the form 01:23:45:67:89:ab.

**Mbps**

Megabits per second.

**NetBIOS**

The Network Basic Input Output System is an application programming interface (API) for sharing services and information on local-area networks (LANs). Provides for communication between stations of a network where each station is given a name. These names are alphanumeric names, up to 16 characters in length.

**Network Address Translation**

NAT. A technique by which several hosts share a single IP address for access to the Internet.

**NIC**

Network Interface Card. An adapter in a computer which provides connectivity to a network.

**packet**

A block of information sent over a network. A packet typically contains a source and destination network address, some protocol and length information, a block of data, and a checksum.

**PEAP**

Protected EAP (PEAP) are Internet Drafts that have been proposed to simplify 802.1X deployment. PEAP requires certificate-based RADIUS server authentication, but supports an extensible set of user authentication methods. Organizations that have not yet issued certificates to every station and don't want to just for 802.1X can use Windows logins and passwords instead. RADIUS servers that support EAP-TTLS and PEAP can check LAN access requests with Windows Domain Controllers, Active Directories, and other existing user databases. From a sniffing perspective, these options are just as strong as EAP-TLS. However, user passwords are still more likely to be guessed, shared, or disclosed through social engineering than client-side certificates.

**RADIUS**

Short for Remote Authentication Dial-In User Service, RADIUS is an authentication system. Using RADIUS, you must enter your user name and password before gaining access to a network. This information is passed to a RADIUS server, which checks that the information is correct, and then authorizes access. Though not an official standard, the RADIUS specification is maintained by a working group of the IETF.

**router**

A device that forwards data between networks. An IP router forwards data based on IP source and destination addresses.

### **Routing Information Protocol**

RIP. A protocol in which routers periodically exchange information with one another so that they can determine minimum distance paths between sources and destinations.

### **router**

A device that forwards data between networks. An IP router forwards data based on IP source and destination addresses.

### **SSID**

A Service Set Identification is a thirty-two character (maximum) alphanumeric key identifying a wireless local area network. For the wireless devices in a network to communicate with each other, all devices must be configured with the same SSID. This is typically the configuration parameter for a wireless PC card. It corresponds to the ESSID in the wireless Access Point and to the wireless network name. *See also* Wireless Network Name and ESSID.

### **Subnet Mask**

A mask used to determine what subnet an IP address belongs to. Subnetting enables a network administrator to further divide an IP address into two or more subnets.

### **TCP/IP**

The main internetworking protocols used in the Internet. The Internet Protocol (IP) used in conjunction with the Transfer Control Protocol (TCP) form TCP/IP.

### **TLS**

Short for Transport Layer Security, a protocol that guarantees privacy and data integrity between client/server applications communicating over the Internet. The TLS protocol is made up of two layers:

- The TLS Record Protocol -- layered on top of a reliable transport protocol, such as TCP, it ensures that the connection is private by using symmetric data encryption and it ensures that the connection is reliable. The TLS Record Protocol also is used for encapsulation of higher-level protocols, such as the TLS Handshake Protocol.
- The TLS Handshake Protocol -- allows authentication between the server and client and the negotiation of an encryption algorithm and cryptographic keys before the application protocol transmits or receives any data.

TLS is application protocol-independent. Higher-level protocols can layer on top of the TLS protocol transparently. Based on Netscape's SSL 3.0, TLS supercedes and is an extension of SSL. TLS and SSL are not interoperable.

### **WAN**

A long distance link used to extend or connect remotely located local area networks. The Internet is a large WAN.

### **WEB Proxy Server**

A Web proxy server is a specialized HTTP server that allows clients access to the Internet from behind a firewall.

The proxy server listens for requests from clients within the firewall and forwards these requests to remote Internet servers outside the firewall. The proxy server reads responses from the external servers and then sends them to internal client clients.

### **WEP**

Wired Equivalent Privacy is a data encryption protocol for 802.11 wireless networks. All wireless nodes and access points on the network are configured with a 64-bit or 128-bit Shared Key for data encryption.

### **wide area network**

WAN. A long distance link used to extend or connect remotely located local area networks. The Internet is a large WAN.

### **Wi-Fi**

A trade name for the 802.11b wireless networking standard, given by the Wireless Ethernet Compatibility Alliance (WECA, see <http://www.wi-fi.net>), an industry standards group promoting interoperability among 802.11b devices.

### **Windows Internet Naming Service**

WINS. Windows Internet Naming Service is a server process for resolving Windows-based computer names to IP addresses. If a remote network contains a WINS server, your Windows PCs can gather information from that WINS server about its local hosts. This allows your PCs to browse that remote network using the Windows Network Neighborhood feature.

### **WINS**

WINS. Windows Internet Naming Service is a server process for resolving Windows-based computer names to IP addresses.

### **Wireless Network Name (SSID)**

Wireless Network Name (SSID) is the name assigned to a wireless network. This is the same as the SSID or ESSID configuration parameter.

### **WPA**

Wi-Fi Protected Access (WPA) is a specification of standards-based, interoperable security enhancements that increase the level of data protection and access control for existing and future wireless LAN systems.

### **WPA-PSK**

For environments without a RADIUS infrastructure, the WPA PSK option supports the use of a pre-shared key.





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