Encryption

Both WPA and WPA2 improve data encryption by using Temporal Key Integrity Protocol (TKIP), Message Integrity Check (MIC) and IEEE 802.1x. WPA and WPA2 use Advanced Encryption Standard (AES) in the Counter mode with Cipher block chaining Message authentication code Protocol (CCMP) to offer stronger encryption than TKIP.

TKIP uses 128-bit keys that are dynamically generated and distributed by the authentication server. AES (Advanced Encryption Standard) is a block cipher that uses a 256-bit mathematical algorithm called Rijndael. They both include 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.

WPA and WPA2 regularly change and rotate the encryption keys so that the same encryption key is never used twice.

The RADIUS server distributes a Pairwise Master Key (PMK) key to the AP that then sets up a key hierarchy and management system, using the PMK to dynamically generate unique data encryption keys to encrypt every data packet that is wirelessly communicated between the AP and the wireless clients. This all happens in the background automatically.

The Message Integrity Check (MIC) is designed to prevent an attacker from capturing data packets, altering them and resending them. The MIC provides a strong mathematical function in which the receiver and the transmitter each compute and then compare the MIC. If they do not match, it is assumed that the data has been tampered with and the packet is dropped.

By generating unique data encryption keys for every data packet and by creating an integrity checking mechanism (MIC), with TKIP and AES it is more difficult to decrypt data on a Wi-Fi network than WEP and difficult for an intruder to break into the network.

The encryption mechanisms used for WPA(2) and WPA(2)-PSK are the same. The only difference between the two is that WPA(2)-PSK uses a simple common password, instead of user-specific credentials. The common-password approach makes WPA(2)-PSK susceptible to brute-force password-guessing attacks but it's still an improvement over WEP as it employs a consistent, single, alphanumeric password to derive a PMK which is used to generate unique temporal encryption keys. This prevent all wireless devices sharing the same encryption keys. (a weakness of WEP)

User Authentication

WPA and WPA2 apply IEEE 802.1x and Extensible Authentication Protocol (EAP) to authenticate wireless clients using an external RADIUS database. WPA2 reduces the number of key exchange messages from six to four (CCMP 4-way handshake) and shortens the time required to connect to a network. Other WPA2 authentication features that are different from WPA include key caching and pre-authentication. These two features are optional and may not be supported in all wireless devices.

Key caching allows a wireless client to store the PMK it derived through a successful authentication with an AP. The wireless client uses the PMK when it tries to connect to the same AP and does not need to go with the authentication process again.

Pre-authentication enables fast roaming by allowing the wireless client (already connecting to an AP) to perform IEEE 802.1x authentication with another AP before connecting to it.

Wireless Client WPA Supplicants

A wireless client supplicant is the software that runs on an operating system instructing the wireless client how to use WPA. At the time of writing, the most widely available supplicant is the WPA patch for Windows XP, Funk Software's Odyssey client.

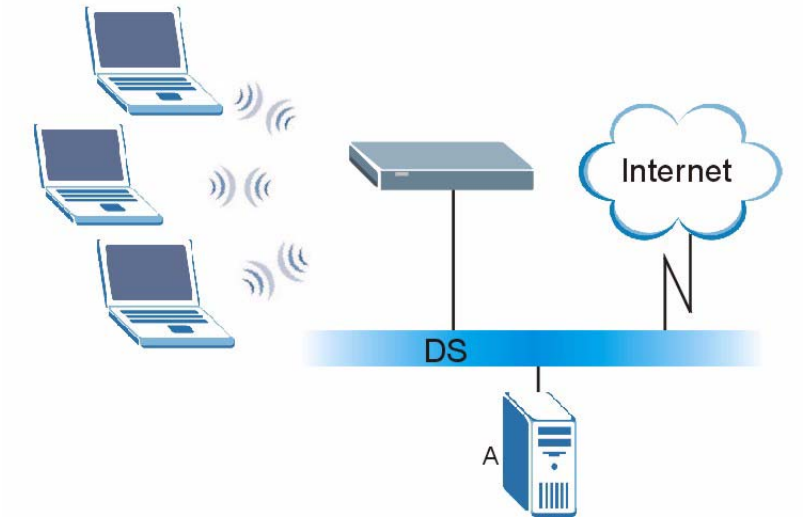
The Windows XP patch is a free download that adds WPA capability to Windows XP's built-in "Zero Configuration" wireless client. However, you must run Windows XP to use it.

WPA(2) with RADIUS Application Example

To set up WPA(2), you need the IP address of the RADIUS server, its port number (default is 1812), and the RADIUS shared secret. A WPA(2) application example with an external RADIUS server looks as follows. "A" is the RADIUS server. "DS" is the distribution system.

1. The AP passes the wireless client's authentication request to the RADIUS server.
2. The RADIUS server then checks the user's identification against its database and grants or denies network access accordingly.
3. A 256-bit Pairwise Master Key (PMK) is derived from the authentication process by the RADIUS server and the client.
4. The RADIUS server distributes the PMK to the AP. The AP then sets up a key hierarchy and management system, using the PMK to dynamically generate unique data encryption keys. The keys are used to encrypt every data packet that is wirelessly communicated between the AP and the wireless clients.

Figure 89 WPA(2) with RADIUS Application Example



WPA(2)-PSK Application Example

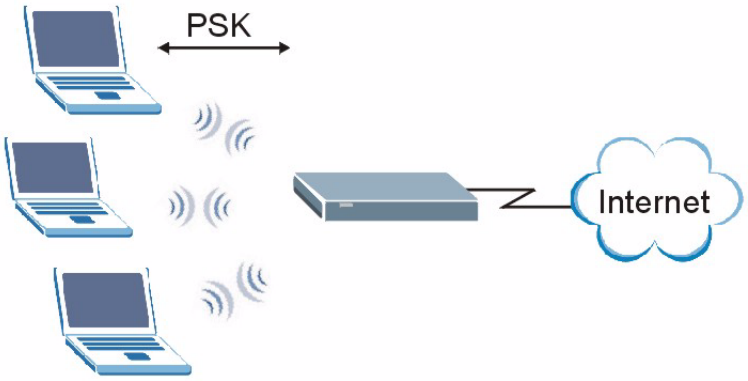
A WPA(2)-PSK application looks as follows.

1. First enter identical passwords into the AP and all wireless clients. The Pre-Shared Key (PSK) must consist of between 8 and 63 ASCII characters or 64 hexadecimal characters (including spaces and symbols).
2. The AP checks each wireless client's password and allows it to join the network only if the password matches.

3 The AP and wireless clients generate a common PMK (Pairwise Master Key). The key itself is not sent over the network, but is derived from the PSK and the SSID.

4 The AP and wireless clients use the TKIP or AES encryption process, the PMK and information exchanged in a handshake to create temporal encryption keys. They use these keys to encrypt data exchanged between them.

Figure 90 WPA(2)-PSK Authentication



Security Parameters Summary

Refer to this table to see what other security parameters you should configure for each authentication method or key management protocol type. MAC address filters are not dependent on how you configure these security features.

Table 25 Wireless Security Relational Matrix

AUTHENTICATION METHOD/ KEY MANAGEMENT PROTOCOL	ENCRYPTION METHOD	ENTER MANUAL KEY	IEEE 802.1X
Open	None	No	Disable
			Enable without Dynamic WEP Key
Open	WEP	No	Enable with Dynamic WEP Key
		Yes	Enable without Dynamic WEP Key
		Yes	Disable
Shared	WEP	No	Enable with Dynamic WEP Key
		Yes	Enable without Dynamic WEP Key
		Yes	Disable
WPA	TKIP/AES	No	Enable
WPA-PSK	TKIP/AES	Yes	Disable
WPA2	TKIP/AES	No	Enable
WPA2-PSK	TKIP/AES	Yes	Disable

Antenna Overview

An antenna couples RF signals onto air. A transmitter within a wireless device sends an RF signal to the antenna, which propagates the signal through the air. The antenna also operates in reverse by capturing RF signals from the air.

Positioning the antennas properly increases the range and coverage area of a wireless LAN.

Antenna Characteristics

Frequency

An antenna in the frequency of 2.4GHz (IEEE 802.11b and IEEE 802.11g) or 5GHz (IEEE 802.11a) is needed to communicate efficiently in a wireless LAN

Radiation Pattern

A radiation pattern is a diagram that allows you to visualize the shape of the antenna's coverage area.

Antenna Gain

Antenna gain, measured in dB (decibel), is the increase in coverage within the RF beam width. Higher antenna gain improves the range of the signal for better communications.

For an indoor site, each 1 dB increase in antenna gain results in a range increase of approximately 2.5%. For an unobstructed outdoor site, each 1dB increase in gain results in a range increase of approximately 5%. Actual results may vary depending on the network environment.

Antenna gain is sometimes specified in dBi, which is how much the antenna increases the signal power compared to using an isotropic antenna. An isotropic antenna is a theoretical perfect antenna that sends out radio signals equally well in all directions. dBi represents the true gain that the antenna provides.

Types of Antennas for WLAN

There are two types of antennas used for wireless LAN applications.

- Omni-directional antennas send the RF signal out in all directions on a horizontal plane. The coverage area is torus-shaped (like a donut) which makes these antennas ideal for a room environment. With a wide coverage area, it is possible to make circular overlapping coverage areas with multiple access points.
- Directional antennas concentrate the RF signal in a beam, like a flashlight does with the light from its bulb. The angle of the beam determines the width of the coverage pattern. Angles typically range from 20 degrees (very directional) to 120 degrees (less directional). Directional antennas are ideal for hallways and outdoor point-to-point applications.

Positioning Antennas

In general, antennas should be mounted as high as practically possible and free of obstructions. In point-to–point application, position both antennas at the same height and in a direct line of sight to each other to attain the best performance.

For omni-directional antennas mounted on a table, desk, and so on, point the antenna up. For omni-directional antennas mounted on a wall or ceiling, point the antenna down. For a single AP application, place omni-directional antennas as close to the center of the coverage area as possible.

For directional antennas, point the antenna in the direction of the desired coverage area.

C

Windows Wireless Management

This appendix shows you how to manage your NWD210N using the Windows Vista and Windows XP wireless configuration tools.

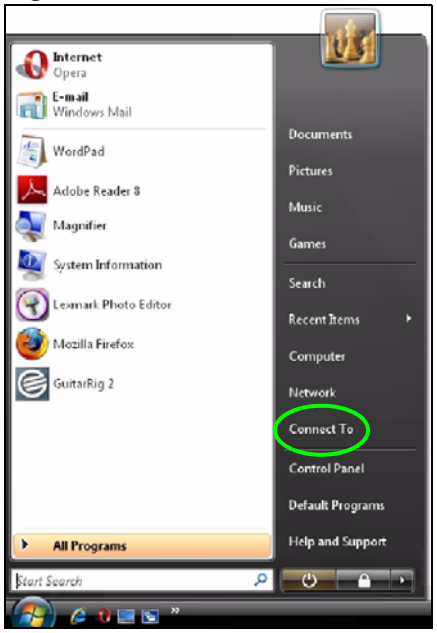
Windows Vista

Take the following steps to connect to a wireless network using the Windows Vista wireless configuration tool (WLAN AutoConfig).

Connecting to a Wireless Network

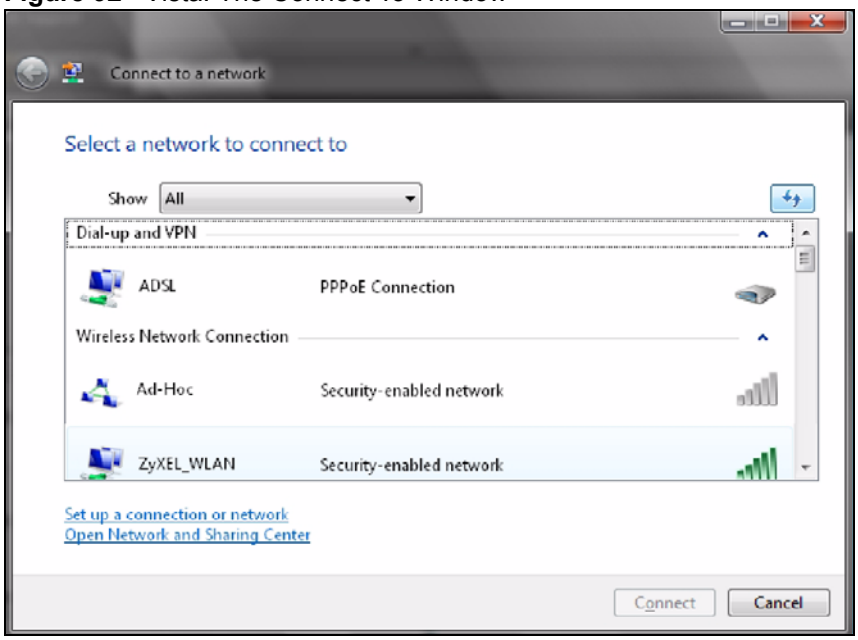
1 In the Windows Vista taskbar, click **Start** ( ) > **Connect To**.

Figure 91 Vista: Start Menu



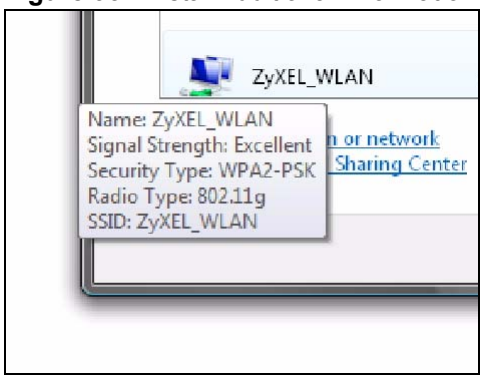
The **Connect To** window displays, showing all available networks.

Figure 92 Vista: The Connect To Window



The security status of each wireless network displays, as well as an indication of its signal strength. If you use the mouse pointer to hover over a network's entry, additional information about the network displays.

Figure 93 Vista: Additional Information

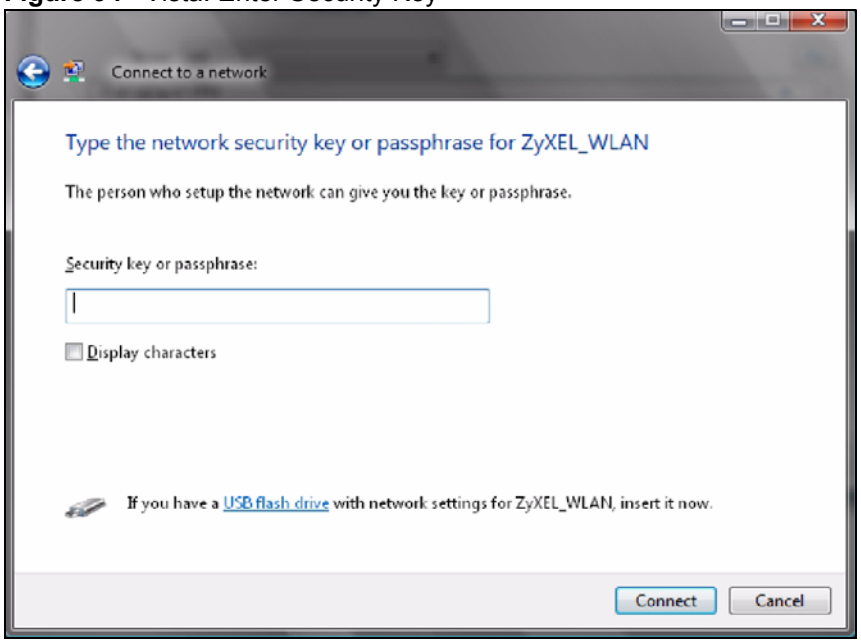


2 Double-click the network's name to join the network, or select a network and click **Connect**.

If the network to which you want to connect does not display, see the section on setting up a connection manually on page 120.

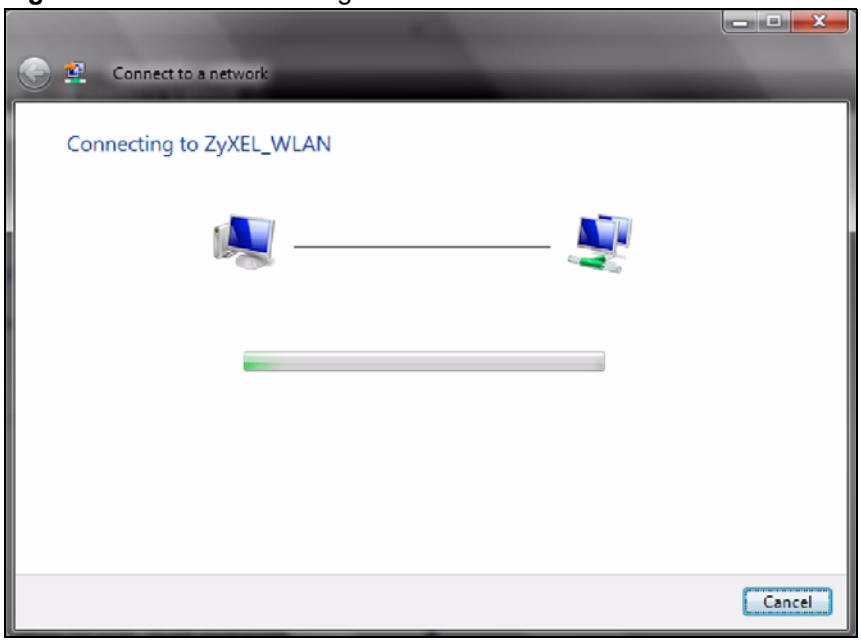
3 If security is enabled, you may be prompted to enter your security key.

Figure 94 Vista: Enter Security Key



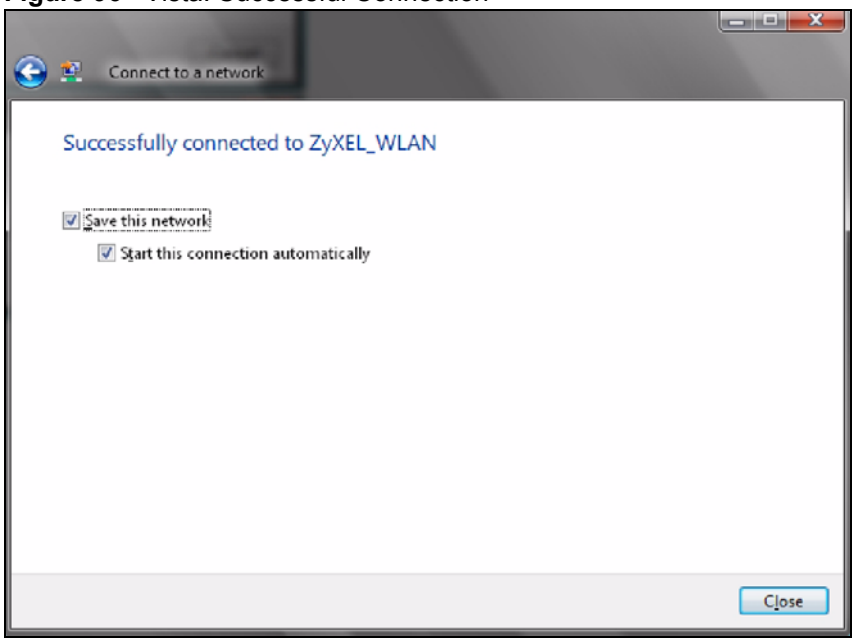
Your computer tries to connect to the wireless network.

Figure 95 Vista: Connecting



If your computer has connected to the wireless network successfully, the following screen displays.

Figure 96 Vista: Successful Connection



4 If you will use this network again, ensure that **Save this network** is selected. If you save the network, you do not have to configure its settings again.

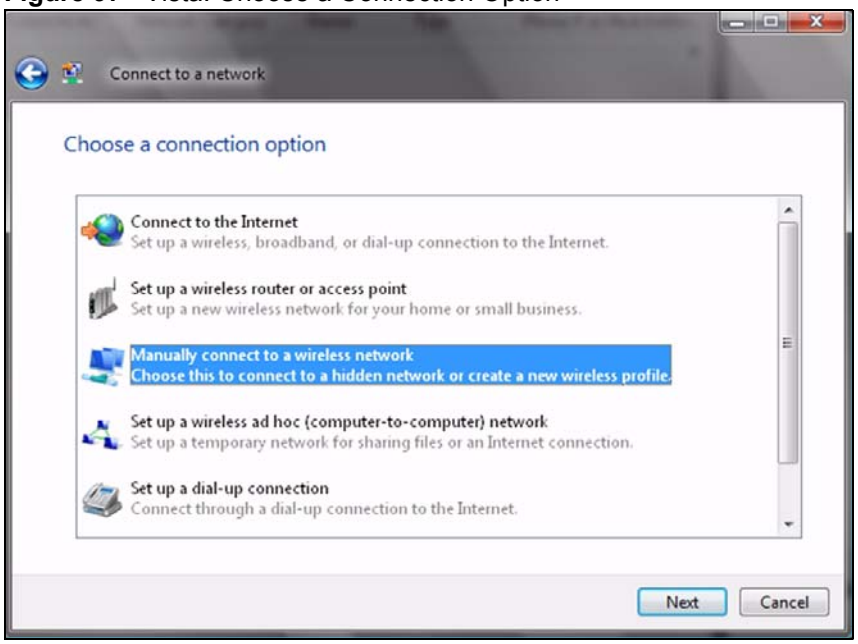
5 Select **Start this connection automatically** if you want Windows to always try to use this network when you start up your computer. If you do not select this (but select **Save this network**) you can connect manually each time by clicking **Start** > **Connect to** and selecting the network's name from the list.

Connecting to a Network Manually

If the wireless network to which you want to connect does not appear in the **Connect to** window (if your network's SSID is hidden, for example), take the following steps to configure your network connection manually

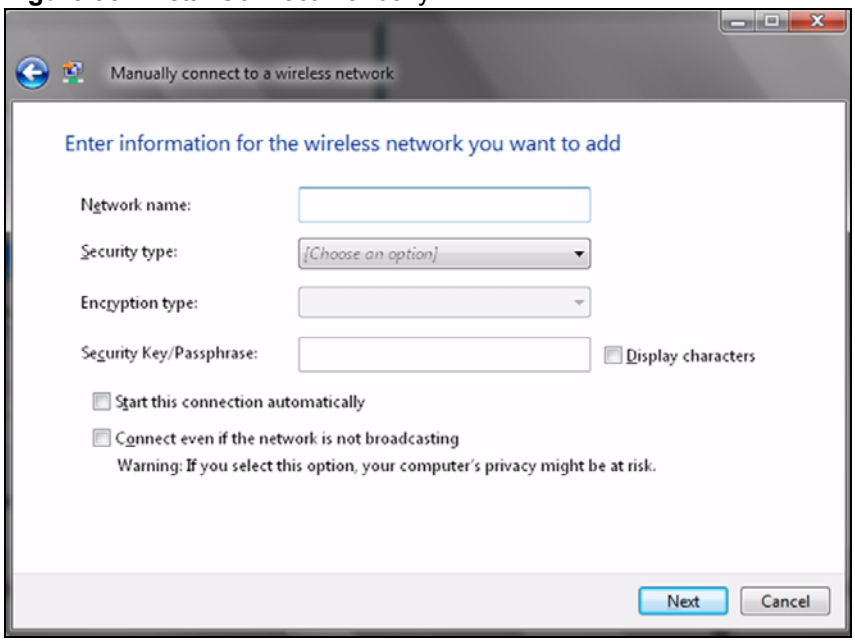
1 Click **Set up a connection or network** at the bottom of the **Connect to** screen. The following screen displays.

Figure 97 Vista: Choose a Connection Option



2 Click **Manually connect to a wireless network**. The following screen displays.

Figure 98 Vista: Connect Manually



The following table describes the labels in this screen.

Table 26 Vista: Connect Manually

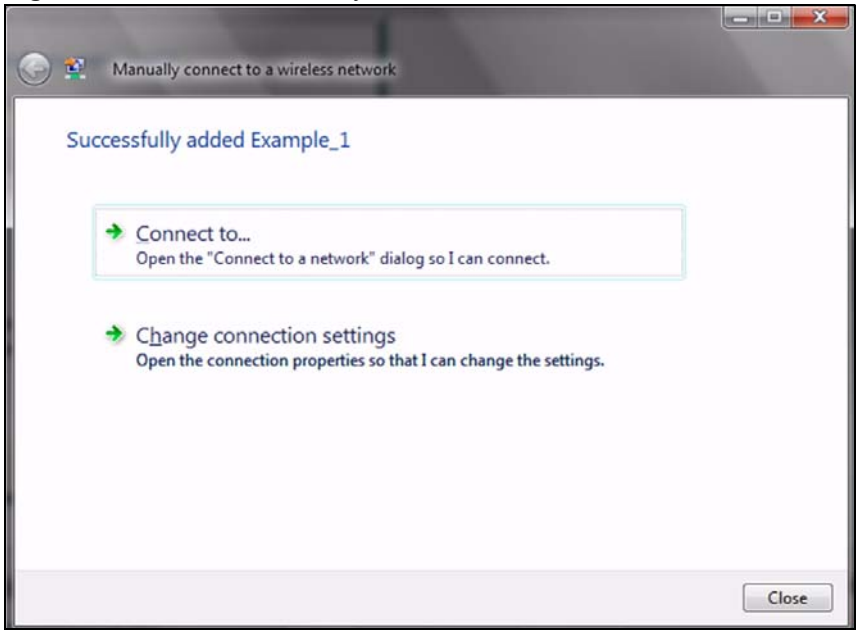
LABEL	DESCRIPTION
Network name	Enter your network's SSID (Service Set IDentifier).
Security type	Select the type of security used by the network to which you want to connect. The types of available security shown depend on your computer's wireless client. In this field, **WPA(2)-Personal** is the same as **WPA(2)-PSK**, and **WPA(2)-Enterprise** is the same as **WPA(2)**

Table 26 Vista: Connect Manually

LABEL	DESCRIPTION
Encryption type	Select the type of encryption used by the network. When you use **WEP** or **802.1x**, **WEP** displays. When you use a **WPA** mode (**WPA(2)-Personal** or **WPA(2)-Enterprise**) you can choose **AES** or **TKIP** (if supported by your computer's wireless client).
Security Key / Passphrase	If your network uses **WEP** or **WPA(2)-Personal** security, enter the key here.
Display Characters	Select this if you do not want the security key characters to be hidden.
Start this connection automatically	Select this box if you always want to try to connect to this network at startup. If you leave this box unchecked, you will need to connect manually each time.
Connect even if the network is not broadcasting	Select this box if you always want to try to connect to this network at startup, even if the network is not broadcasting its SSID. The warning in this field refers to the fact that if you do this, your computer sends out probe request packets, which contain the network's SSID and could be used by an attacker to access the network.
Next	Click this to save your settings and move on to the next page.
Cancel	Click this to stop setting up your network.

3 When you have finished filling in the fields, click **Next**. the following screen displays.

Figure 99 Vista: Successfully Added Network



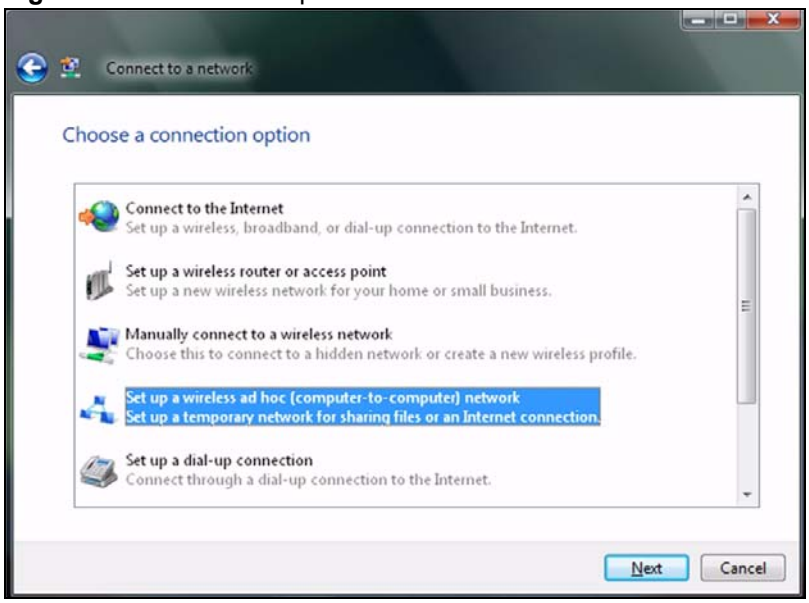
4 If you want to make any changes to the settings you just configured, click **Change connection settings**. Otherwise, click **Connect to...**. In the window that displays, double-click the new network's name to connect to the network.

Setting Up An Ad-Hoc Network

Take the following steps to set up a wireless connection between two computers in Windows Vista.

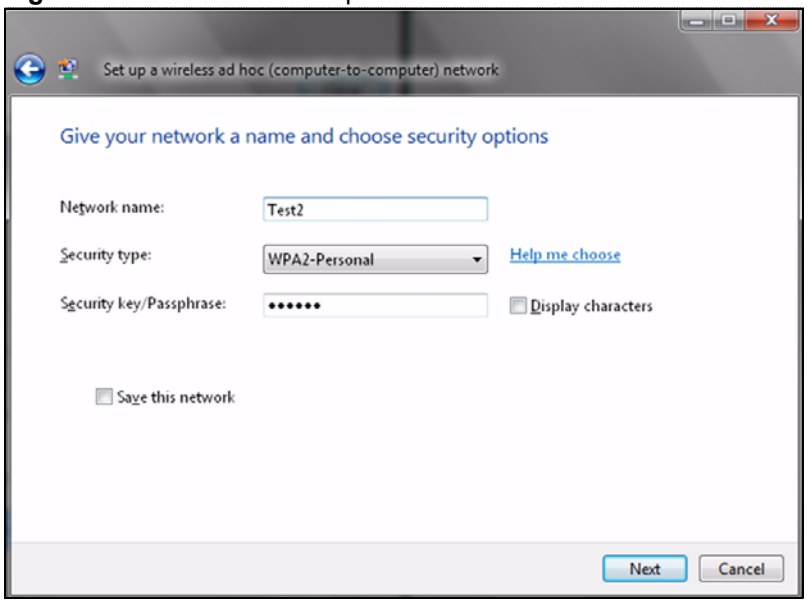
1 Click **Start** ( ) > **Connect To**. In the **Connect to** screen, click **Set up a connection or network**. The following screen displays.

Figure 100 Vista: Set Up An Ad-hoc Network



2 Select **Set up a wireless ad hoc (computer-to-computer) network** and click **Next**. The following screen displays.

Figure 101 Vista: Ad-hoc Options



3 Enter the **Network name** (SSID) you want to use for your network. Select a **Security type**. If you are not sure what kind of security you want to use, click the **Help me choose** link.

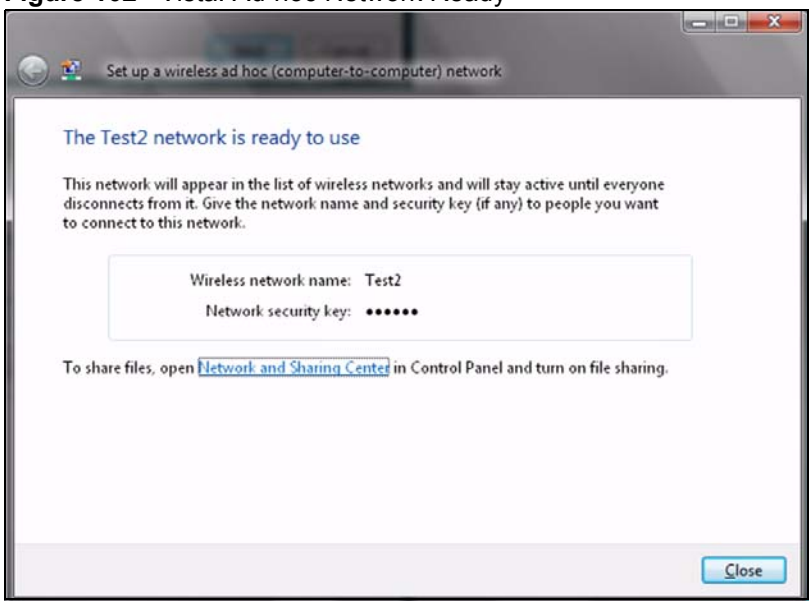
Make sure all the wireless clients on your ad-hoc network can support the type of security you select.

4 Enter the **Security key/Passphrase**. Everybody on the network must enter this key in their computer's wireless client in order to access the network. If you want to see the characters you entered, select the **Display characters** box. Otherwise, leave it empty (dots display instead of the characters).

5 If you will use this ad-hoc network again, select the **Save this network** box. If you do this, the next time you click **Start** > **Connect to**, you can select the network from the list.

6 Click **Next**. The following screen displays.

Figure 102 Vista: Ad-hoc Network Ready



7 If you want to share files with other computers on the ad-hoc network, or let other computers use your Internet connection, click the **Network and Sharing Center** link. Otherwise, click **Close**.

Windows XP

Be sure you have the Windows XP service pack 2 installed on your computer. Otherwise, you should at least have the Windows XP service pack 1 already on your computer and download the support patch for WPA from the Microsoft web site.

Windows XP SP2 screen shots are shown unless otherwise specified. Click the help icon ( ) in most screens, move the cursor to the item that you want the information about and click to view the help.

Activating Wireless Zero Configuration

1 Click **Start**, **Control Panel** and double-click **Network Connections**.

2 Double-click on the icon for wireless network connection.

3 The status window displays as shown below. Click **Properties**.

Figure 103 Windows XP SP1: Wireless Network Connection Status

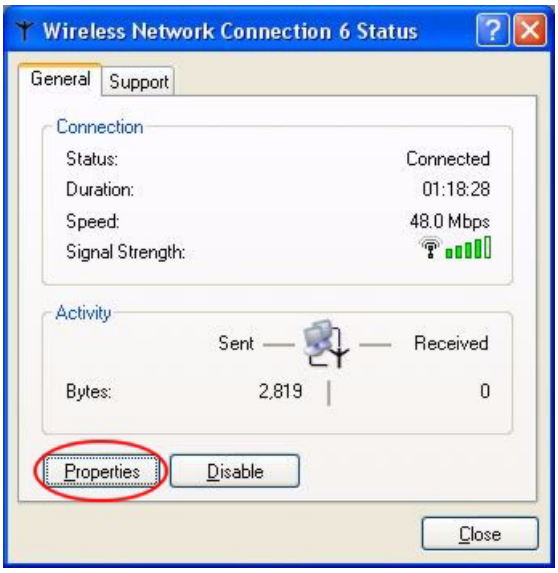
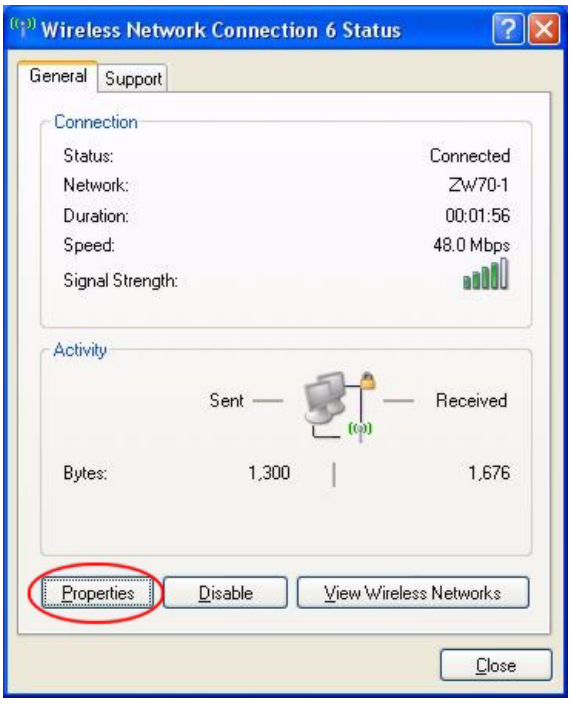


Figure 104 Windows XP SP2: Wireless Network Connection Status



4 The **Wireless Network Connection Properties** screen displays. Click the **Wireless Networks** tab.

Make sure the **Use Windows to configure my wireless network settings** check box is selected.

Figure 105 Windows XP SP1: Wireless Network Connection Properties

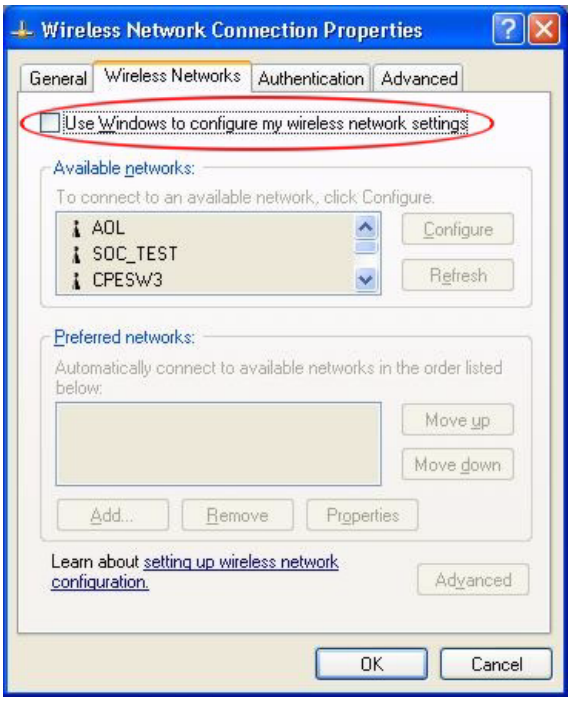
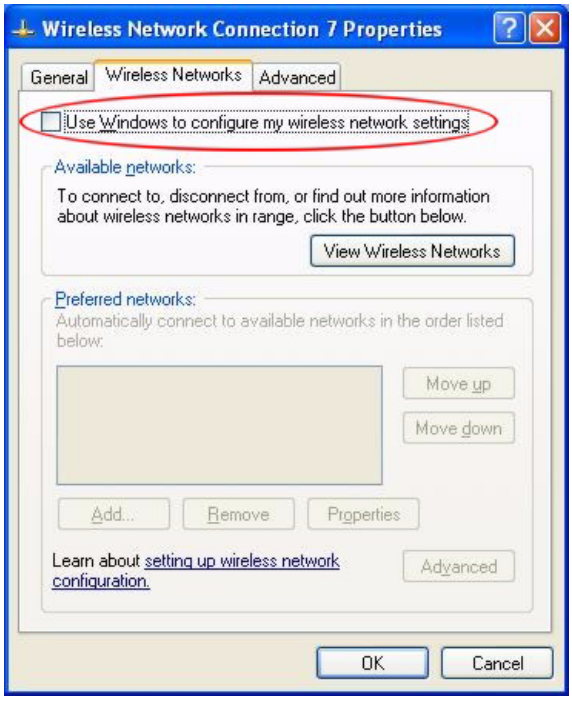
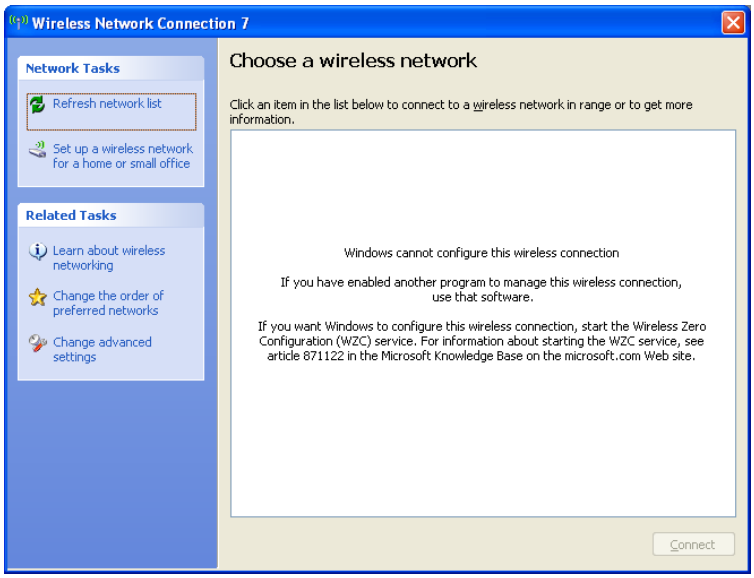


Figure 106 Windows XP SP2: Wireless Network Connection Properties



If you see the following screen, refer to article 871122 on the Microsoft web site for information on starting WZC.

Figure 107 Windows XP SP2: WZC Not Available



Connecting to a Wireless Network

1 Double-click the network icon for wireless connections in the system tray to open the Wireless Network Connection Status screen.

Figure 108 Windows XP SP2: System Tray Icon

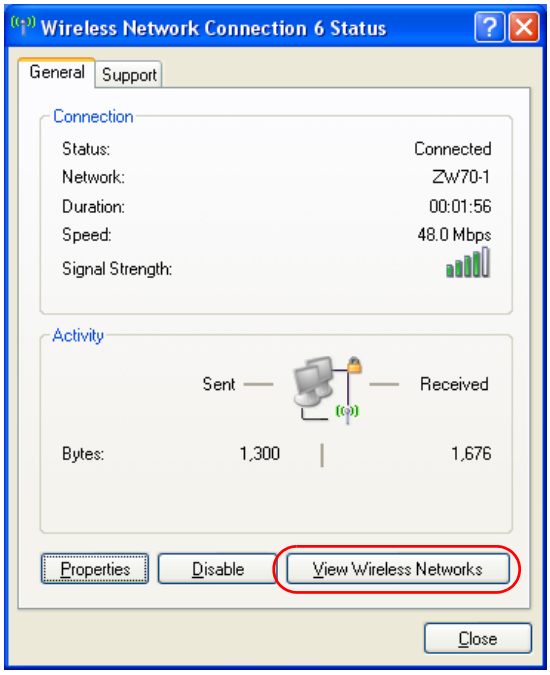
The type of the wireless network icon in Windows XP SP2 indicates the status of the NWD210N. Refer to the following table for details.

Table 27 Windows XP SP2: System Tray Icon

ICON	DESCRIPTION
	The NWD210N is connected to a wireless network.
	The NWD210N is in the process of connecting to a wireless network.
	The connection to a wireless network is limited because the network did not assign a network address to the computer.
	The NWD210N is not connected to a wireless network.

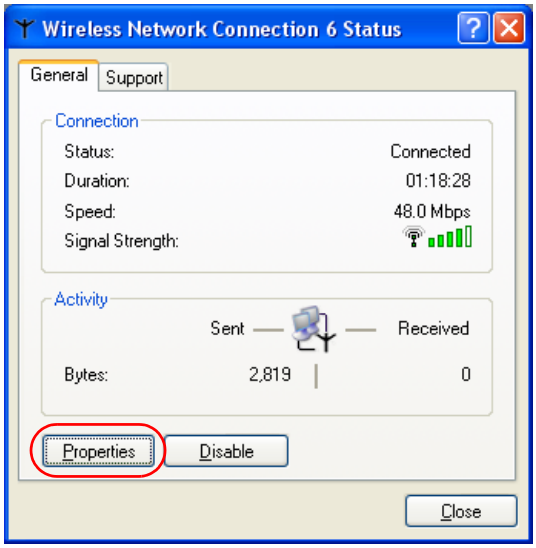
2 Windows XP SP2: In the **Wireless Network Connection Status** screen, click **View Wireless Networks** to open the **Wireless Network Connection** screen.

Figure 109 Windows XP SP2: Wireless Network Connection Status



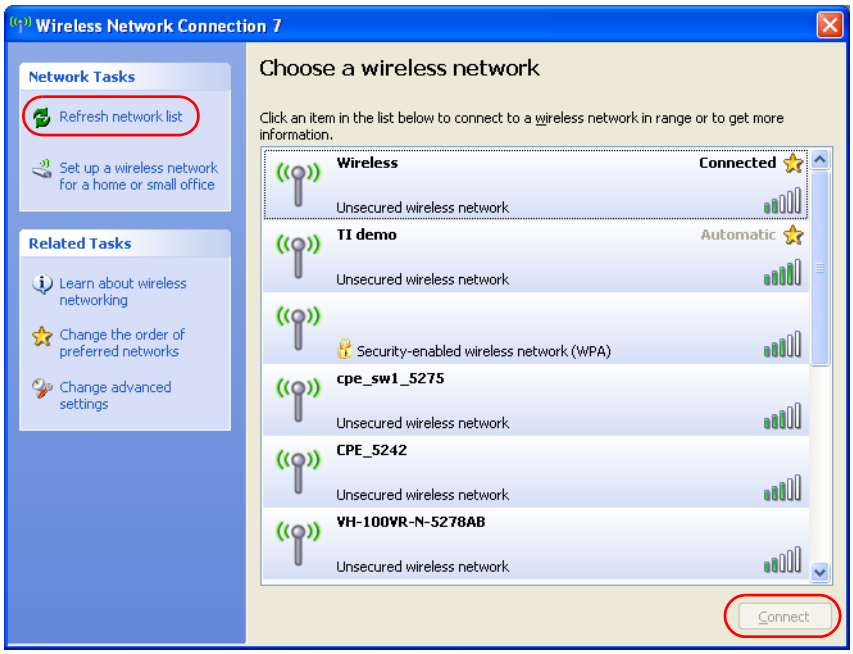
Windows XP SP1: In the **Wireless Network Connection Status** screen, click **Properties** and the **Wireless Networks** tab to open the **Wireless Network Connection Properties** screen.

Figure 110 Windows XP SP1: Wireless Network Connection Status



3 Windows XP SP2: Click **Refresh network list** to reload and search for available wireless devices within transmission range. Select a wireless network in the list and click **Connect** to join the selected wireless network.

Figure 111 Windows XP SP2: Wireless Network Connection



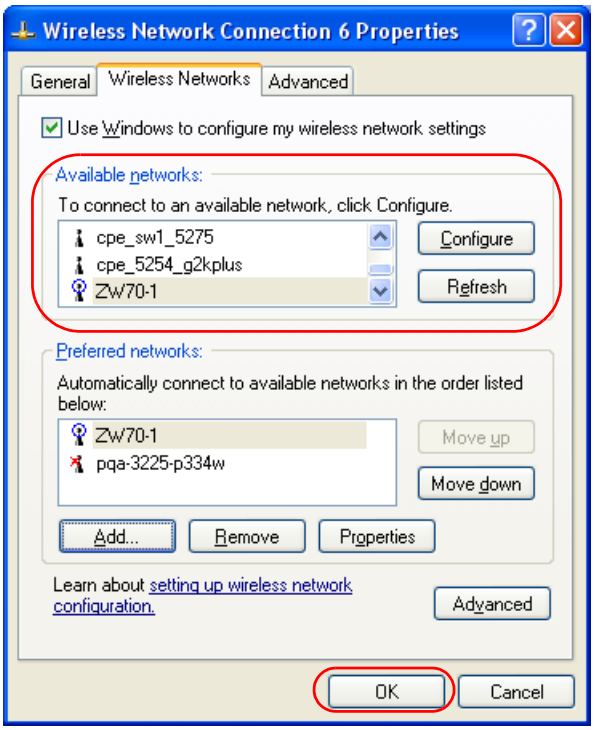
The following table describes the icons in the wireless network list.

Table 28 Windows XP SP2: Wireless Network Connection

ICON	DESCRIPTION
	This denotes that wireless security is activated for the wireless network.
	This denotes that this wireless network is your preferred network. Ordering your preferred networks is important because the NWD210N tries to associate to the preferred network first in the order that you specify. Refer to the section on ordering the preferred networks for detailed information.
	This denotes the signal strength of the wireless network. Move your cursor to the icon to see details on the signal strength.

Windows XP SP1: Click **Refresh** to reload and search for available wireless devices within transmission range. Select a wireless network in the **Available networks** list, click **Configure** and set the related fields to the same security settings as the associated AP to add the selected network into the **Preferred** networks table. Click **OK** to join the selected wireless network. Refer to the section on security settings (discussed later) for more information.

Figure 112 Windows XP SP1: Wireless Network Connection Properties



4 4.Windows XP SP2: If the wireless security is activated for the selected wireless network, the **Wireless Network Connection** screen displays. You must set the related fields in the **Wireless Network Connection** screen to the same security settings as the associated AP and click **Connect**. Refer to the section about security settings for more information. Otherwise click **Cancel** and connect to another wireless network without data encryption. If there is no security activated for the selected wireless network, a warning screen appears. Click **Connect Anyway** if wireless security is not your concern.

Figure 113 Windows XP SP2: Wireless Network Connection: WEP or WPA-PSK

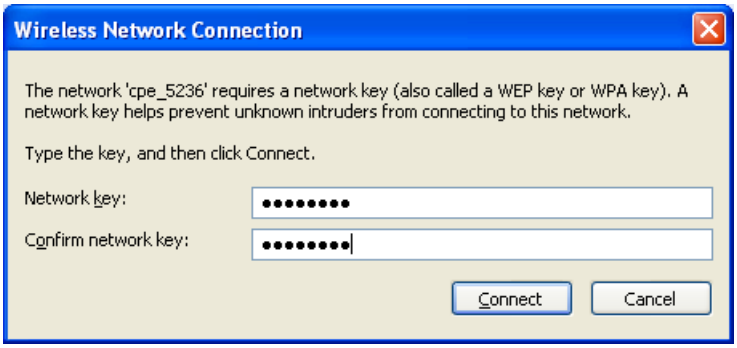


Figure 114 Windows XP SP2: Wireless Network Connection: No Security

5 Verify that you have successfully connected to the selected network and check the connection status in the wireless network list or the connection icon in the **Preferred networks** or **Available networks** list.

The following table describes the connection icons.

Table 29 Windows XP: Wireless Networks

ICON	DESCRIPTION
	This denotes the wireless network is an available wireless network.
	This denotes the NWD210N is associated to the wireless network.
	This denotes the wireless network is not available.

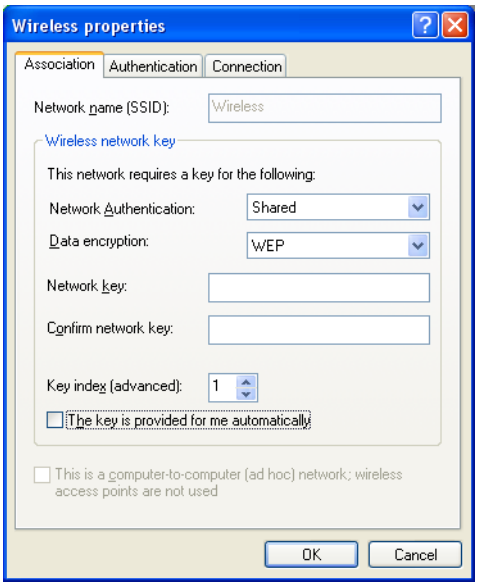
Security Settings

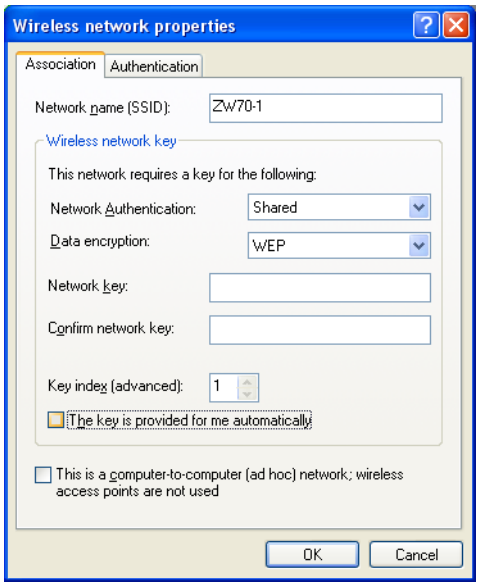
When you configure the NWD210N to connect to a secure network but the security settings are not yet enabled on the NWD210N, you will see different screens according to the authentication and encryption methods used by the selected network.

Association

Select a network in the Preferred networks list and click Properties to view or configure security.

Figure 115 Windows XP: Wireless (network) properties: Association





The following table describes the labels in this screen.

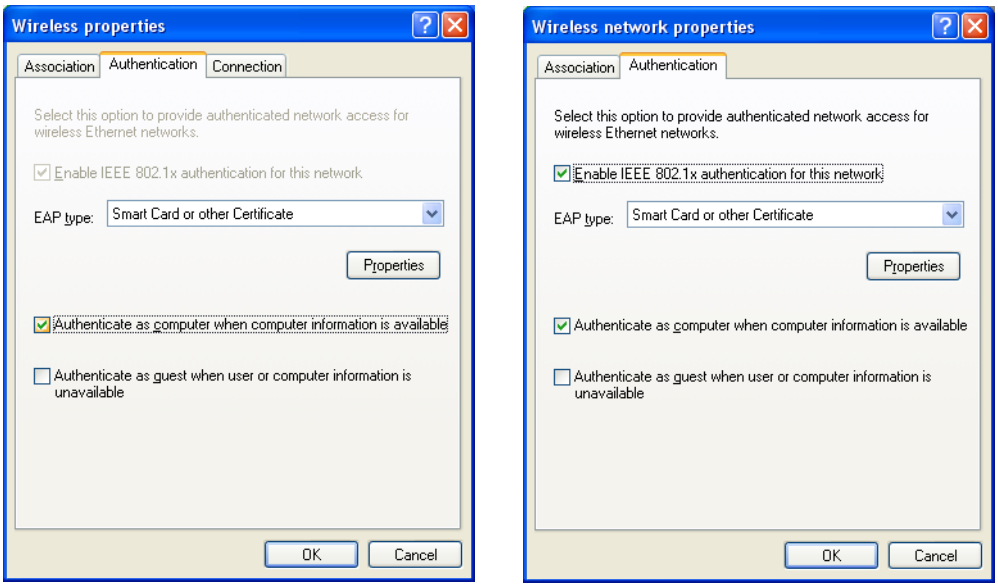
Table 30 Windows XP: Wireless (network) properties: Association

LABEL	DESCRIPTION
Network name (SSID)	This field displays the SSID (Service Set IDentifier) of each wireless network.
Network Authentication	This field automatically shows the authentication method (**Share**, **Open**, **WPA** or **WPA-PSK**) used by the selected network.
Data Encryption	This field automatically shows the encryption type (**TKIP**, **WEP** or **Disable**) used by the selected network.
Network Key	Enter the pre-shared key or WEP key. The values for the keys must be set up exactly the same on all wireless devices in the same wireless LAN.
Confirm network key	Enter the key again for confirmation.
Key index (advanced)	Select a default WEP key to use for data encryption. This field is available only when the network use **WEP** encryption method and the **The key is provided for me automatically** check box is not selected.
The key is provided for me automatically	If this check box is selected, the wireless AP assigns the NWD210N a key.
This is a computer-to-computer (ad hoc) network; wireless access points are not used	If this check box is selected, you are connecting to another computer directly.
OK	Click **OK** to save your changes.
Cancel	Click **Cancel** to leave this screen without saving any changes you may have made.

Authentication

Click the **Authentication** tab in the **Wireless (network) properties** screen to display the screen shown next. The fields on this screen are grayed out when the network is in Ad-Hoc mode or data encryption is disabled.

Figure 116 Windows XP: Wireless (network) properties: Authentication



The following table describes the labels in this screen.

Table 31 Windows XP: Wireless (network) properties: Authentication

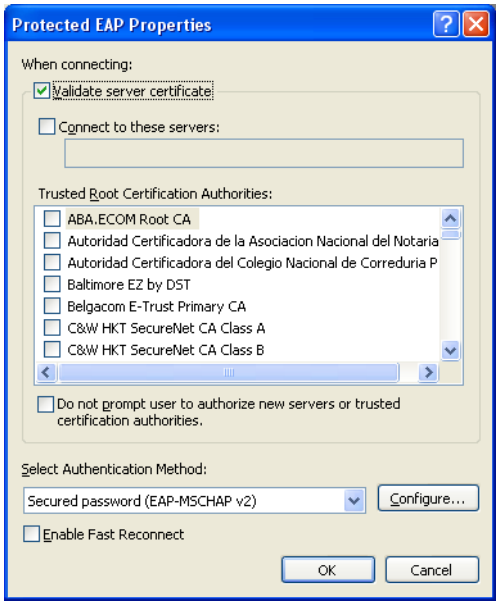
LABEL	DESCRIPTION
Enable IEEE 802.1x authentication for this network	This field displays whether the IEEE 802.1x authentication is active. If the network authentication is set to **Open** in the previous screen, you can choose to disable or enable this feature.
EAP Type	Select the type of EAP authentication. Options are **Protected EAP (PEAP)** and **Smart Card or other Certificate**.
Properties	Click this button to open the properties screen and configure certificates. The screen varies depending on what you select in the **EAP type** field.
Authenticate as computer when computer information is available	Select this check box to have the computer send its information to the network for authentication when a user is not logged on.
Authenticate as guest when user or computer information is unavailable	Select this check box to have the computer access to the network as a guest when a user is not logged on or computer information is not available.
OK	Click **OK** to save your changes.
Cancel	Click **Cancel** to leave this screen without saving any changes you may have made.

Authentication Properties

Select an EAP authentication type in the **Wireless (network) properties: Authentication** screen and click the **Properties** button to display the following screen.

Protected EAP Properties

Figure 117 Windows XP: Protected EAP Properties



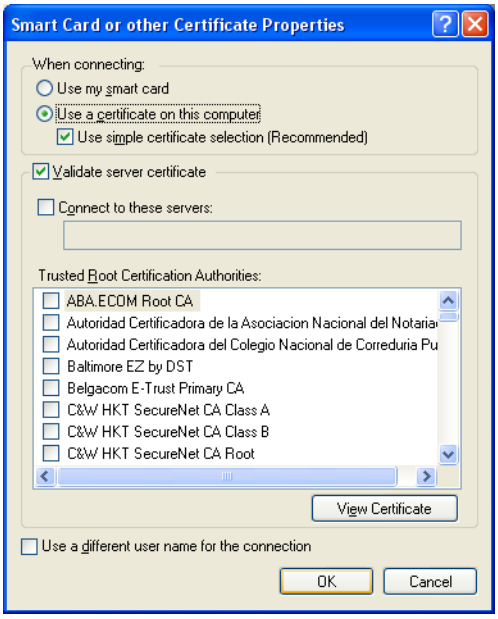
The following table describes the labels in this screen.

Table 32 Windows XP: Protected EAP Properties

LABEL	DESCRIPTION
Validate server certificate	Select the check box to verify the certificate of the authentication server.
Connect to these servers	Select the check box and specify a domain in the field below to have your computer connect to a server which resides only within this domain.
Trusted Root Certification Authorities:	Select a trusted certification authority from the list below. Note: You must first have a wired connection to a network and obtain the certificate(s) from a certificate authority (CA). Consult your network administrator for more information.
Do not prompt user to authorize new server or trusted certification authorities.	Select this check box to verify a new authentication server or trusted CA without prompting. This field is available only if you installed the Windows XP server pack 2.
Select Authentication Method:	Select an authentication method from the drop-down list box and click **Configure** to do settings.
Enable Fast Reconnect	Select the check box to automatically reconnect to the network (without re-authentication) if the wireless connection goes down.
OK	Click **OK** to save your changes.
Cancel	Click **Cancel** to leave this screen without saving any changes you may have made.

Smart Card or other Certificate Properties

Figure 118 Windows XP: Smart Card or other Certificate Properties



The following table describes the labels in this screen.

Table 33 Windows XP: Smart Card or other Certificate Properties

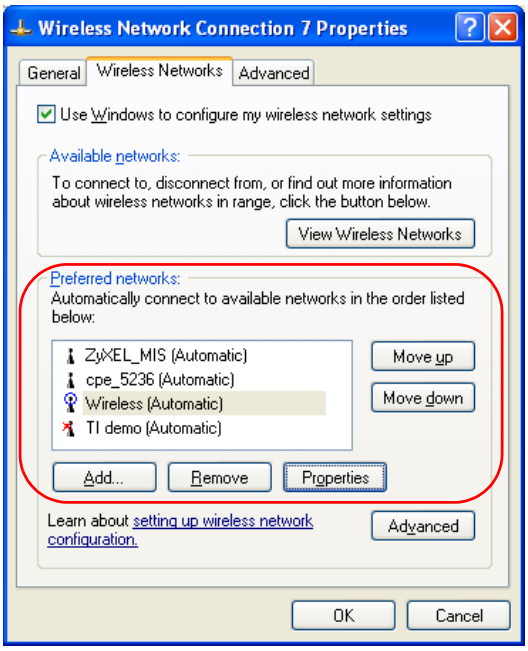
LABEL	DESCRIPTION
Use my smart card	Select this check box to use the smart card for authentication.
Use a certificate on this computer	Select this check box to use a certificate on your computer for authentication.
Validate server certificate	Select the check box to check the certificate of the authentication server.
Connect to these servers	Select the check box and specify a domain in the field below to have your computer connect to a server which resides only within this domain.
Trusted Root Certification Authorities:	Select a trusted certification authority from the list below. Note: You must first have a wired connection to a network and obtain the certificate(s) from a certificate authority (CA). Consult your network administrator for more information.
View Certificate	Click this button if you want to verify the selected certificate.
Use a different user name for the connection:	Select the check box to use a different user name when the user name in the smart card or certificate is not the same as the user name in the domain that you are logged on to.
OK	Click **OK** to save your changes.
Cancel	Click **Cancel** to leave this screen without saving any changes you may have made.

Ordering the Preferred Networks

Follow the steps below to manage your preferred networks.

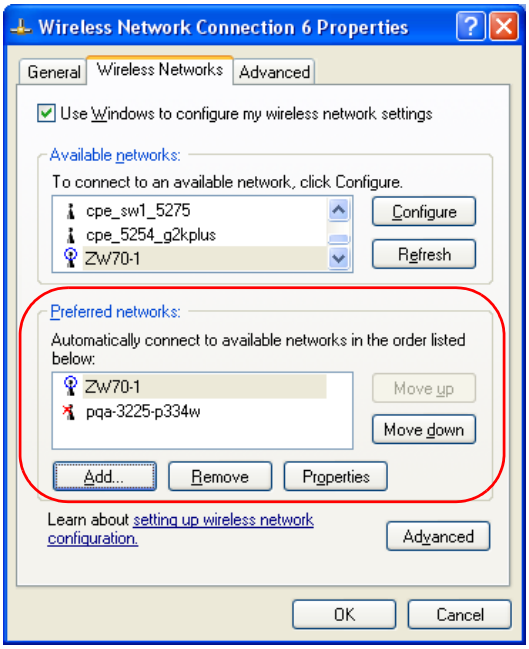
1 Windows XP SP2: Click **Change the order of preferred networks** in the **Wireless Network Connection** screen (see Figure 111 on page 129). The screen displays as shown.

Figure 119 Windows XP SP2: Wireless Networks: Preferred Networks



Windows XP SP1: In the **Wireless Network Connection Status** screen, click **Properties** and the **Wireless Networks** tab to open the screen as shown.

Figure 120 Windows XP SP1: Wireless Networks: Preferred Networks



2 Whenever the NWD210N tries to connect to a new network, the new network is added in the **Preferred networks** table automatically. Select a network and click **Move up** or

Move down to change it's order, click **Remove** to delete it or click **Properties** to view the security, authentication or connection information of the selected network. Click **Add** to add a preferred network into the list manually.

D

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This device 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 device generates, 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 device does cause harmful interference to radio/television reception, which can be determined by turning the device off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

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- This equipment has been SAR-evaluated for use in laptops (notebooks) with side slot configuration.
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- IEEE 802.11b or 802.11g operation of this product in the U.S.A. is firmware-limited to channels 1 through 11.

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Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device has been designed for the WLAN 2.4 GHz network throughout the EC region and Switzerland, with restrictions in France.

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Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

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- Warranty Information.
- Date that you received your device.
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Index

A

B

C

D

E

F

G

H

I

L

M

N

O

P

Q

R

S

T

U

V

W

Z