6 **Right-click on the icon for your WiMAX Device and select Properties. A properties window displays with basic information about the WiMAX Device.**

Figure 121 Network Connections: My Network Places: Properties: Example

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21

The Status Screen

21.1 Overview

Use this screen to view a complete summary of your WiMAX Device connection status.

21.2 Status Screen

Click the STATUS icon in the navigation bar to go to this screen, where you can view the current status of the device, system resources, interfaces (LAN and WAN), and SIP accounts. You can also register and un-register SIP accounts as well as view detailed information from DHCP and statistics from WiMAX, VoIP, bandwidth management, and traffic.

Figure 122 Status

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The following tables describe the labels in this screen.

Table 113 Status

LABEL	DESCRIPTION
Refresh Interval	Select how often you want the WiMAX Device to update this screen.
Refresh Now	Click this to update this screen immediately.
Device Information	
System Name	This field displays the WiMAX Device system name. It is used for identification. You can change this in the ADVANCED > System Configuration > General screen's System Name field.
Firmware Version	This field displays the current version of the firmware inside the device. It also shows the date the firmware version was created. You can change the firmware version by uploading new firmware in ADVANCED > System Configuration > Firmware.
WAN Information	
IP Address	This field displays the current IP address of the WiMAX Device in the WAN.
IP Subnet Mask	This field displays the current subnet mask on the WAN.
DHCP	This field displays what DHCP services the WiMAX Device is using in the WAN. Choices are: Client - The WiMAX Device is a DHCP client in the WAN. Its IP address comes from a DHCP server on the WAN. None - The WiMAX Device is not using any DHCP services in the WAN. It has a static IP address.
LAN Information	
IP Address	This field displays the current IP address of the WiMAX Device in the LAN.
IP Subnet Mask	This field displays the current subnet mask in the LAN.
DHCP	This field displays what DHCP services the WiMAX Device is providing to the LAN. Choices are: Server - The WiMAX Device is a DHCP server in the LAN. It assigns IP addresses to other computers in the LAN. Relay - The WiMAX Device is routing DHCP requests to one or more DHCP servers. The DHCP server(s) may be on another network. None - The WiMAX Device is not providing any DHCP services to the LAN. You can change this in ADVANCED > LAN Configuration > DHCP Setup.
WiMAX Information	
Operator ID	Every WiMAX service provider has a unique Operator ID number, which is broadcast by each base station it owns. You can only connect to the Internet through base stations belonging to your service provider's network.
BSID	This field displays the identification number of the wireless base station to which the WiMAX Device is connected. Every base station transmits a unique BSID, which identifies it across the network.

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Table 113 Status (continued)

LABEL	DESCRIPTION
Cell ID	A base station's coverage area can be divided into multiple cells. This field shows the identification number of the cell in which the WiMAX Device is connected.
Frequency	This field displays the radio frequency of the WiMAX Device's wireless connection to a base station.
MAC address	This field displays the Media Access Control address of the WiMAX Device. Every network device has a unique MAC address which identifies it across the network.
WiMAX State	This field displays the status of the WiMAX Device's current connection. • INIT: the WiMAX Device is starting up. • DL_SYN: The WiMAX Device is unable to connect to a base station. • RANGING: the WiMAX Device and the base station are transmitting and receiving information about the distance between them. Ranging allows the WiMAX Device to use a lower transmission power level when communicating with a nearby base station, and a higher transmission power level when communicating with a distant base station. • CAP_NEGO: the WiMAX Device and the base station are exchanging information about their capabilities. • AUTH: the WiMAX Device and the base station are exchanging security information. • REGIST: the WiMAX Device is registering with a RADIUS server. • OPERATIONAL: the WiMAX Device has successfully registered with the base station. Traffic can now flow between the WiMAX Device and the base station. • IDLE: the WiMAX Device is in power saving mode, but can connect when a base station alerts it that there is traffic waiting.
Bandwidth	This field shows the size of the bandwidth step the WiMAX Device uses to connect to a base station in megahertz (MHz).
CINR mean	This field shows the average Carrier to Interference plus Noise Ratio of the current connection. This value is an indication of overall radio signal quality. A higher value indicates a higher signal quality, and a lower value indicates a lower signal quality.
CINR deviation	This field shows the amount of change in the CINR level. This value is an indication of radio signal stability. A lower number indicates a more stable signal, and a higher number indicates a less stable signal.
RSSI	This field shows the Received Signal Strength Indication. This value is a measurement of overall radio signal strength. A higher RSSI level indicates a stronger signal, and a lower RSSI level indicates a weaker signal. A strong signal does not necessarily indicate a good signal: a strong signal may have a low signal-to-noise ratio (SNR).
UL Data Rate	This field shows the number of data packets uploaded from the WiMAX Device to the base station each second.
DL Data Rate	This field shows the number of data packets downloaded to the WiMAX Device from the base station each second.
PER	This field shows the Packet Error Rate. The PER is the percentage of data packets transmitted across the network but not successfully received.

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Table 113 Status (continued)

LABEL	DESCRIPTION
Tx Power	This field shows the output transmission (Tx) level of the WiMAX Device.
System Status	
System Uptime	This field displays how long the WiMAX Device has been running since it last started up. The WiMAX Device starts up when you plug it in, when you restart it (ADVANCED > System Configuration > Restart), or when you reset it.
Current Date/ Time	This field displays the current date and time in the WiMAX Device. You can change this in SETUP > Time Setting.
CPU Usage	This field displays what percentage of the WiMAX Device's processing ability is currently being used. The higher the CPU usage, the more likely the WiMAX Device is to slow down. You can reduce this by disabling some services, such as DHCP, NAT, or content filtering.
Memory Usage	This field displays what percentage of the WiMAX Device's memory is currently used. The higher the memory usage, the more likely the WiMAX Device is to slow down. Some memory is required just to start the WiMAX Device and to run the web configurator. You can reduce the memory usage by disabling some services (see CPU Usage); by reducing the amount of memory allocated to NAT and firewall rules (you may have to reduce the number of NAT rules or firewall rules to do so); or by deleting rules in functions such as incoming call policies, speed dial entries, and static routes.
IVR Usage	This field displays what percentage of the WiMAX Device's IVR memory is currently used. IVR (Interactive Voice Response) refers to the customizable ring tone and on-hold music you set.
Interface Status	
Interface	This column displays each interface of the WiMAX Device.
Status	This field indicates whether or not the WiMAX Device is using the interface. For the WAN interface, this field displays Up when the WiMAX Device is connected to a WiMAX network, and Down when the WiMAX Device is not connected to a WiMAX network. For the LAN interface, this field displays Up when the WiMAX Device is using the interface and Down when the WiMAX Device is not using the interface.
Rate	For the LAN ports this displays the port speed and duplex setting. For the WAN interface, it displays the downstream and upstream transmission rate or N/A if the WiMAX Device is not connected to a base station. For the WLAN interface, it displays the transmission rate when WLAN is enabled or N/A when WLAN is disabled.
Summary	
Packet Statistics	Click this link to view port status and packet specific statistics.
WiMAX Site Information	Click this link to view details of the radio frequencies used by the WiMAX Device to connect to a base station.

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Table 113 Status (continued)

LABEL	DESCRIPTION
DHCP Table	Click this link to see details of computers to which the WiMAX Device has given an IP address.
VoIP Statistics	Click this link to view statistics about your VoIP usage.
WiMAX Profile	Click this link to view details of the current wireless security settings.
VoIP Status	
Account	This column displays each SIP account in the WiMAX Device.
Registration	This field displays the current registration status of the SIP account. You have to register SIP accounts with a SIP server to use VoIP. If the SIP account is already registered with the SIP server, Click Unregister to delete the SIP account's registration in the SIP server. This does not cancel your SIP account, but it deletes the mapping between your SIP identity and your IP address or domain name. The second field displays Registered. If the SIP account is not registered with the SIP server, Click Register to have the WiMAX Device attempt to register the SIP account with the SIP server. The second field displays the reason the account is not registered. Inactive - The SIP account is not active. You can activate it in VOICE > SIP > SIP Settings. Register Fail - The last time the WiMAX Device tried to register the SIP account with the SIP server, the attempt failed. The WiMAX Device automatically tries to register the SIP account when you turn on the WiMAX Device or when you activate it.
URI	This field displays the account number and service domain of the SIP account. You can change these in VOICE > SIP > SIP Settings.

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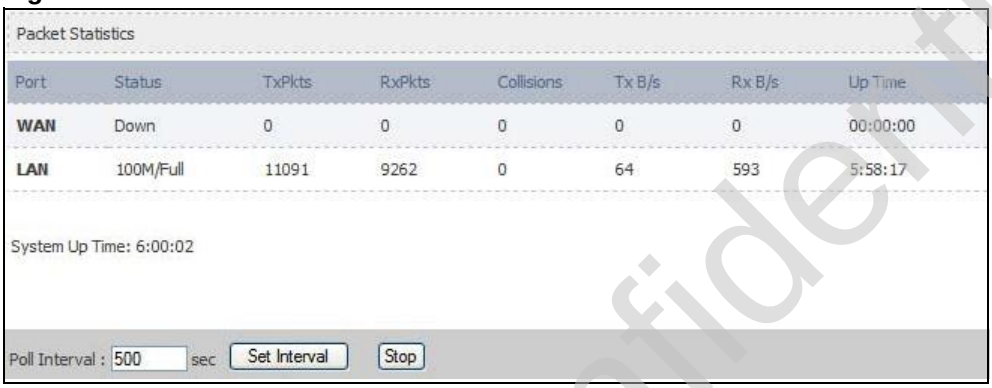
21.2.1 Packet Statistics

Click Status > Packet Statistics to open this screen. This read-only screen displays information about the data transmission through the WiMAX Device. To configure these settings, go to the corresponding area in the Advanced screens.

Figure 123 Packet Statistics



The following table describes the fields in this screen.

Table 114 Packet Statistics

LABEL	DESCRIPTION
Port	This column displays each interface of the WiMAX Device.
Status	This field indicates whether or not the WiMAX Device is using the interface. For the WAN interface, this field displays the port speed and duplex setting when the WiMAX Device is connected to a WiMAX network, and Down when the WiMAX Device is not connected to a WiMAX network. For the LAN interface, this field displays the port speed and duplex setting when the WiMAX Device is using the interface and Down when the WiMAX Device is not using the interface. For the WLAN interface, it displays the transmission rate when WLAN is enabled or Down when WLAN is disabled.
TxPkts	This field displays the number of packets transmitted on this interface.
RxPkts	This field displays the number of packets received on this interface.
Collisions	This field displays the number of collisions on this port.
Tx B/s	This field displays the number of bytes transmitted in the last second.
Rx B/s	This field displays the number of bytes received in the last second.
Up Time	This field displays the elapsed time this interface has been connected.
System up Time	This is the elapsed time the system has been on.
Poll Interval(s)	Type the time interval for the browser to refresh system statistics.
Set Interval	Click this button to apply the new poll interval you entered in the Poll Interval field above.
Stop	Click this button to halt the refreshing of the system statistics.

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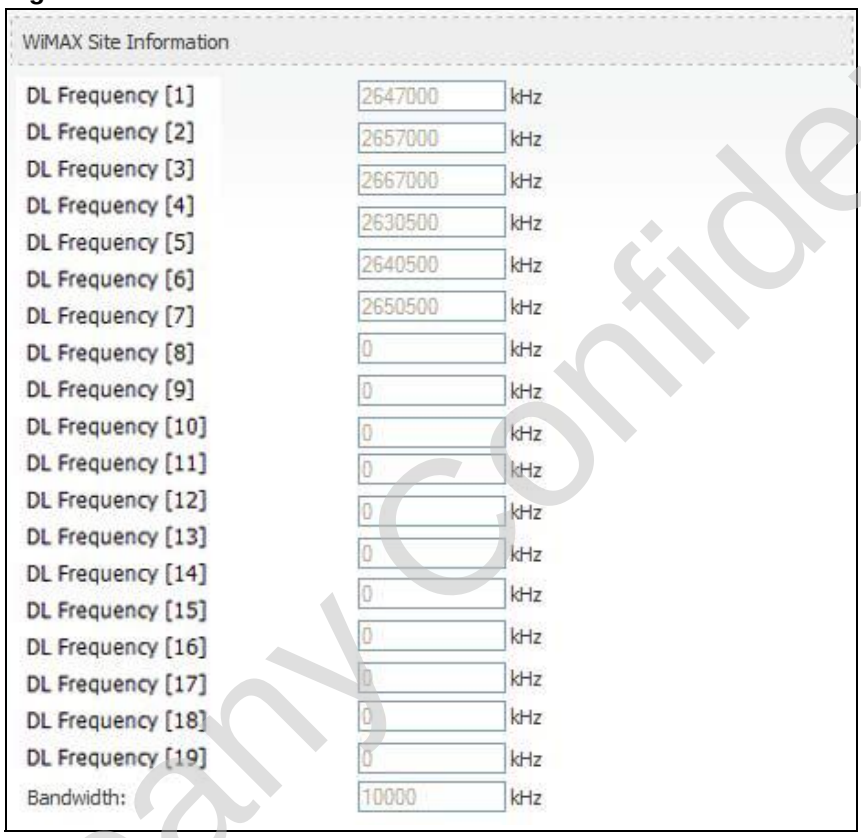
21.2.2 WiMAX Site Information

Click Status > WiMAX Site Information to open this screen. This read-only screen shows WiMAX frequency information for the WiMAX Device. These settings can be configured in the ADVANCED > WAN Configuration > WiMAX Configuration screen.

Figure 124 WiMAX Site Information



The following table describes the labels in this screen.

Table 115 WiMAX Site Information

LABEL	DESCRIPTION
DL Frequency [0] ~ [19]	These fields show the downlink frequency settings in kilohertz (kHz). These settings determine how the WiMAX Device searches for an available wireless connection.

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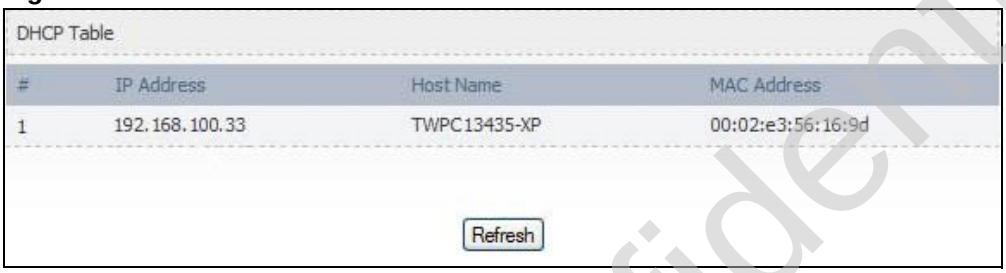
21.2.3 DHCP Table

Click Status > DHCP Table to open this screen. This read-only screen shows the IP addresses, Host Names and MAC addresses of the devices currently connected to the WiMAX Device. These settings can be configured in the ADVANCED > LAN Configuration > DHCP Setup screen.

Figure 125 DHCP Table



Each field is described in the following table.

Table 116 DHCP Table

LABEL	DESCRIPTION
#	The number of the item in this list.
IP Address	This field displays the IP address the WiMAX Device assigned to a computer in the network.
Host Name	This field displays the system name of the computer to which the WiMAX Device assigned the IP address.
MAC Address	This field displays the MAC address of the computer to which the WiMAX Device assigned the IP address.
Refresh	Click this button to update the table data.

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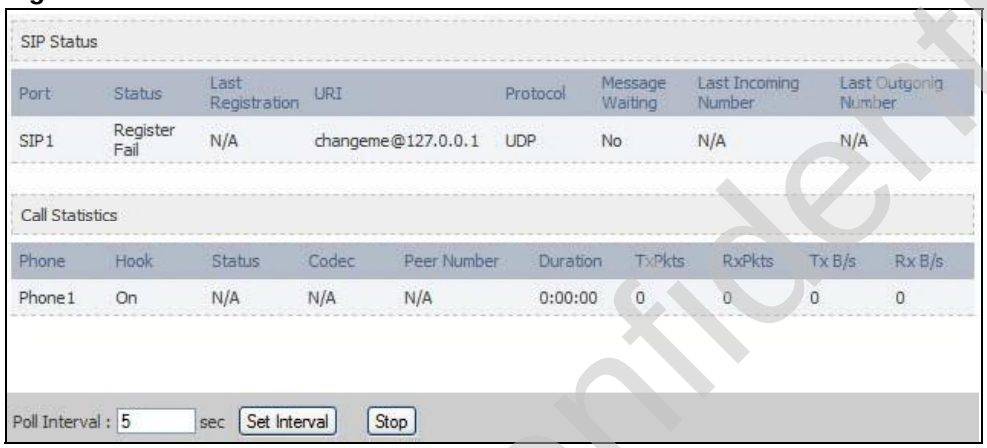
21.2.4 VoIP Statistics

Click Status > DHCP Table to open this screen. This read-only screen shows SIP registration information, status of calls and VoIP traffic statistics. These settings can be configured in the VOICE > Service Configuration > SIP Setting screen.

Figure 126 VoIP Statistics



Each field is described in the following table.

Table 117 VoIP Statistics

LABEL	DESCRIPTION
SIP Status	
Port	This column displays each SIP account in the WiMAX Device.
Status	This field displays the current registration status of the SIP account. You can change this in the Status screen. Registered - The SIP account is registered with a SIP server. Register Fail - The last time the WiMAX Device tried to register the SIP account with the SIP server, the attempt failed. The WiMAX Device automatically tries to register the SIP account when you turn on the WiMAX Device or when you activate it. Inactive - The SIP account is not active. You can activate it in VOICE > SIP > SIP Settings.
Last Registration	This field displays the last time you successfully registered the SIP account. It displays N/A if you never successfully registered this account.
URI	This field displays the account number and service domain of the SIP account. You can change these in VOICE > SIP > SIP Settings.
Protocol	This field displays the transport protocol the SIP account uses. SIP accounts always use UDP.
Message Waiting	This field indicates whether or not there are any messages waiting for the SIP account.
Last Incoming Number	This field displays the last number that called the SIP account. It displays N/A if no number has ever dialed the SIP account.

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Table 117 VoIP Statistics

LABEL	DESCRIPTION
Last Outgoing Number	This field displays the last number the SIP account called. It displays N/A if the SIP account has never dialed a number.
Call Statistics	
Phone	This field displays the WiMAX Device's phone port number.
Hook	This field indicates whether the phone is on the hook or off the hook. On - The phone is hanging up or already hung up. Off - The phone is dialing, calling, or connected.
Status	This field displays the current state of the phone call. N/A - There are no current VoIP calls, incoming calls or outgoing calls being made. DIAL - The callee's phone is ringing. RING - The phone is ringing for an incoming VoIP call. Process - There is a VoIP call in progress. DISC - The callee's line is busy, the callee hung up or your phone was left off the hook.
Codec	This field displays what voice codec is being used for a current VoIP call through a phone port.
Peer Number	This field displays the SIP number of the party that is currently engaged in a VoIP call through a phone port.
Duration	This field displays how long the current call has lasted.
Tx Pkts	This field displays the number of packets the WiMAX Device has transmitted in the current call.
Rx Pkts	This field displays the number of packets the WiMAX Device has received in the current call.
Tx B/s	This field displays how quickly the WiMAX Device has transmitted packets in the current call. The rate is the average number of bytes transmitted per second.
Rx B/s	This field displays how quickly the WiMAX Device has received packets in the current call. The rate is the average number of bytes transmitted per second.
Poll Interval(s)	Enter how often you want the WiMAX Device to update this screen, and click Set Interval.
Set Interval	Click this to make the WiMAX Device update the screen based on the amount of time you specified in Poll Interval.
Stop	Click this to make the WiMAX Device stop updating the screen.

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21.2.5 WiMAX Profile

Click Status > WiMAX Profile to open this screen. This read-only screen displays information about the security settings you are using. To configure these settings, go to the ADVANCED > WAN Configuration > Internet Connection screen.

Note: Not all WiMAX Device models have all the fields shown here.

Figure 127 WiMAX Profile

The following table describes the labels in this screen.

Table 118 The WiMAX Profile Screen

LABEL	DESCRIPTION
User	This is the username for your Internet access account.
Password	This is the password for your Internet access account. The password displays as a row of asterisks for security purposes.
Anonymous Identity	This is the anonymous identity provided by your Internet Service Provider. Anonymous identity (also known as outer identity) is used with EAP-TTLS encryption.
PKM	This field displays the Privacy Key Management version number. PKM provides security between the WiMAX Device and the base station. See the WiMAX security appendix for more information.
Authentication	This field displays the user authentication method. Authentication is the process of confirming the identity of a user (by means of a username and password, for example). EAP-TTLS allows an MS/SS and a base station to establish a secure link (or `tunnel′) with an AAA (Authentication, Authorization and Accounting) server in order to exchange authentication information. See the WiMAX security appendix for more details.

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Table 118 The WiMAX Profile Screen (continued)

LABEL	DESCRIPTION
TTLS Inner EAP	This field displays the type of secondary authentication method. Once a secure EAP-TTLS connection is established, the inner EAP is the protocol used to exchange security information between the mobile station, the base station and the AAA server to authenticate the mobile station. See the WiMAX security appendix for more details. The WiMAX Device supports the following inner authentication types: • CHAP (Challenge Handshake Authentication Protocol) • MSCHAP (Microsoft CHAP) • MSCHAPV2 (Microsoft CHAP version 2) • PAP (Password Authentication Protocol)
Auth Mode	This is the authentication mode. The WiMAX Device supports the following authentication modes: • User Only • Device Only with Cert • Certs and User Authentication
Certificate	This is the security certificate the WiMAX Device uses to authenticate the AAA server, if one is available.

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PART VI
Troubleshooting and Specifications

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22

Troubleshooting

This chapter offers some suggestions to solve problems you might encounter. The potential problems are divided into the following categories:

- Power, Hardware Connections, and LEDs
- WiMAX Device Access and Login
- Internet Access
- Phone Calls and VoIP
- Reset the WiMAX Device to Its Factory Defaults

22.1 Power, Hardware Connections, and LEDs

The WiMAX Device does not turn on. None of the LEDs turn on.

1. Make sure you are using the power adapter or cord included with the WiMAX Device.
2. Make sure the power adapter or cord is connected to the WiMAX Device and plugged in to an appropriate power source. Make sure the power source is turned on.
3. Disconnect and re-connect the power adapter or cord to the WiMAX Device.
4. If the problem continues, contact the vendor.

One of the LEDs does not behave as expected.

1. Make sure you understand the normal behavior of the LED. See Section 1.2.1 on page 34 for more information.

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2 Check the hardware connections. See the Quick Start Guide.

3 Inspect your cables for damage. Contact the vendor to replace any damaged cables.

4 Disconnect and re-connect the power adapter to the WiMAX Device.

5 If the problem continues, contact the vendor.

22.2 WiMAX Device Access and Login

I forgot the IP address for the WiMAX Device.

1 The default IP address is http://192.168.100.1.

2 If you changed the IP address and have forgotten it, you might get the IP address of the WiMAX Device by looking up the IP address of the default gateway for your computer. To do this in most Windows computers, click Start > Run, enter cmd, and then enter ipconfig. The IP address of the Default Gateway might be the IP address of the WiMAX Device (it depends on the network), so enter this IP address in your Internet browser.

3 If this does not work, you have to reset the WiMAX Device to its factory defaults. See Section 22.1 on page 267.

I forgot the password.

1 The default password is 1234.

2 If this does not work, you have to reset the WiMAX Device to its factory defaults. See Section 11.5 on page 142.

I cannot see or access the **Login** screen in the web configurator.

1 Make sure you are using the correct IP address.

- The default IP address is http://192.168.100.1.

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- If you changed the IP address (Section 5.2 on page 68), use the new IP address.
- If you changed the IP address and have forgotten it, see the troubleshooting suggestions for I forgot the IP address for the WiMAX Device.

2 Check the hardware connections, and make sure the LEDs are behaving as expected. See the Quick Start Guide and Section 1.2.1 on page 34.

3 Make sure your Internet browser does not block pop-up windows and has JavaScript and Java enabled. See Appendix D on page 327.

4 If there is a DHCP server on your network, make sure your computer is using a dynamic IP address. Your WiMAX Device is a DHCP server by default.

If there is no DHCP server on your network, make sure your computer's IP address is in the same subnet as the WiMAX Device. See Appendix E on page 337.

5 Reset the WiMAX Device to its factory defaults, and try to access the WiMAX Device with the default IP address. See Section 11.6 on page 143.

6 If the problem continues, contact the network administrator or vendor, or try one of the advanced suggestions.

Advanced Suggestions

- Try to access the WiMAX Device using another service, such as Telnet. If you can access the WiMAX Device, check the remote management settings and firewall rules to find out why the WiMAX Device does not respond to HTTP.
- If your computer is connected wirelessly, use a computer that is connected to a LAN/ETHERNET port.

I can see the **Login** screen, but I cannot log in to the WiMAX Device.

1 Make sure you have entered the user name and password correctly. The default user name is **admin**, and the default password is **1234**. These fields are case-sensitive, so make sure [Caps Lock] is not on.

2 You cannot log in to the web configurator while someone is using Telnet to access the WiMAX Device. Log out of the WiMAX Device in the other session, or ask the person who is logged in to log out.

3 Disconnect and re-connect the power adapter or cord to the WiMAX Device.

4 If this does not work, you have to reset the WiMAX Device to its factory defaults. See Section 11.5 on page 142.

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I cannot Telnet to the WiMAX Device.

See the troubleshooting suggestions for I cannot see or access the Login screen in the web configurator. Ignore the suggestions about your browser.

22.3 Internet Access

I cannot access the Internet.

1. **Check the hardware connections, and make sure the LEDs are behaving as expected. See the Quick Start Guide and Section 1.2.1 on page 34.**
2. **Make sure you entered your ISP account information correctly in the wizard. These fields are case-sensitive, so make sure [Caps Lock] is not on.**
3. **Check your security settings. In the web configurator, go to the Status screen. Click the WiMAX Profile link in the Summary box and make sure that you are using the correct security settings for your Internet account.**
4. **Check your WiMAX settings. The WiMAX Device may have been set to search the wrong frequencies for a wireless connection. In the web configurator, go to the Status screen. Click the WiMAX Site Information link in the Summary box and ensure that the values are correct. If the values are incorrect, enter the correct frequency settings in the ADVANCED > WAN Configuration > WiMAX Configuration screen. If you are unsure of the correct values, contact your service provider.**
5. **If you are trying to access the Internet wirelessly, make sure the wireless settings in the wireless client are the same as the settings in the AP.**
6. **Disconnect all the cables from your WiMAX Device, and follow the directions in the Quick Start Guide again.**
7. **If the problem continues, contact your ISP.**

I cannot access the Internet any more. I had access to the Internet (with the WiMAX Device), but my Internet connection is not available any more.

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1 Check the hardware connections, and make sure the LEDs are behaving as expected. See the Quick Start Guide and Section 1.2.1 on page 34.

2 Disconnect and re-connect the power adapter to the WiMAX Device.

3 If the problem continues, contact your ISP.

The Internet connection is slow or intermittent.

1 The quality of the WiMAX Device's wireless connection to the base station may be poor. Poor signal reception may be improved by moving the WiMAX Device away from thick walls and other obstructions, or to a higher floor in your building.

2 There may be radio interference caused by nearby electrical devices such as microwave ovens and radio transmitters. Move the WiMAX Device away or switch the other devices off. Weather conditions may also affect signal quality.

3 As well as having an external antenna connector, the MAX-210HW2 is equipped with an internal directional antenna. If you know the location of the base station, orient the front of the WiMAX Device (the side with the LEDs) towards the base station. If you do not know the location of the base station, experiment by moving the WiMAX Device while observing the Strength Indicator LEDs for an increase in received signal strength. The MAX-200HW2 and MAX-230HW2 do not have internal antennas.

4 There might be a lot of traffic on the network. Look at the LEDs, and check Section 1.2.1 on page 34. If the WiMAX Device is sending or receiving a lot of information, try closing some programs that use the Internet, especially peer-to-peer applications.

5 Disconnect and re-connect the power adapter to the WiMAX Device.

6 If the problem continues, contact the network administrator or vendor, or try one of the advanced suggestions.

The Internet connection disconnects.

1 Check your WiMAX link and signal strength using the WiMAX Link and Strength Indicator LEDs on the device.

2 Contact your ISP if the problem persists.

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22.4 Phone Calls and VoIP

The telephone port won't work or the telephone lacks a dial tone.

1. **Check the telephone connections and telephone wire.**
2. **Make sure you have the VOICE > Service Configuration > SIP Settings screen properly configured (Chapter 12 on page 147).**

I can access the Internet, but cannot make VoIP calls.

1. **Make sure you have the VOICE > Service Configuration > SIP Settings screen properly configured (Chapter 12 on page 147).**
2. **The VoIP LED should come on. Make sure that your telephone is connected to the VoIP port (see the Quick Start Guide for information on connecting telephone cables to the these ports).**
3. **You can also check the VoIP status in the Status screen.**
4. **If the VoIP settings are correct, use speed dial to make peer-to-peer calls. If you cannot make a call using speed dial, there may be something wrong with the SIP server. Contact your VoIP service provider.**

Problems With Multiple SIP Accounts

You can set up two SIP accounts on your WiMAX Device. By default your WiMAX Device uses SIP account 1 for outgoing calls, and it uses SIP accounts 1 and 2 for incoming calls. With this setting, you always use SIP account 1 for your outgoing calls and you cannot distinguish which SIP account the calls are coming in through. If you want to control the use of different dialing plans for accounting purposes or other reasons, you need to configure your phone port in order to control which SIP account you are using when placing or receiving calls.

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22.5 Reset the WiMAX Device to Its Factory Defaults

If you reset the WiMAX Device, you lose all of the changes you have made. The WiMAX Device re-loads its default settings, and the password resets to 1234. You have to make all of your changes again.

You will lose all of your changes when you push the **Reset** button.

To reset the WiMAX Device,

1. **Make sure the Power LED is on and not blinking.**
2. **Press and hold the Reset button for five to ten seconds. Release the Reset button when the Power LED begins to blink. The default settings have been restored.**

   If the WiMAX Device restarts automatically, wait for the WiMAX Device to finish restarting, and log in to the web configurator. The password is "1234".

   If the WiMAX Device does not restart automatically, disconnect and reconnect the WiMAX Device's power. Then, follow the directions above again.

22.5.1 Pop-up Windows, JavaScripts and Java Permissions

Please see Appendix D on page 327.

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Product Specifications

This chapter gives details about your WiMAX Device's hardware and firmware features.

Table 119 IDU Hardware Specifications

FEATURE	DESCRIPTION
Device Name	MAX-306HW2-IDU
Dimension (W x D x H)	216 mm x 164 mm x 52 mm
Weight	450 g
Power	48V DC, 1.25A
Ethernet Ports	4 RJ-45 Ethernet ports
Phone Ports	2 RJ-11 phone ports
Power over Ethernet (PoE)	Provides Power over Ethernet via PoE port.
Wireless LAN Antenna	External dipole, 2dBi gain.
Wireless LAN Antenna Connector	1 R-SMA connector for external wireless LAN antenna
Operation Environmental	Temperature: 0°C ~ 45°C Humidity: 10% ~ 90% RH
Storage Environmental	Temperature: -25°C ~ 55°C Humidity: 10% ~ 95% RH
Certification	Safety CSA 60950-1-07 EMI & EMS CE certification & WiMAX Forum Wave II Compliance

Table 120 Indoor Wireless LAN Specification

FEATURE	DESCRIPTION
Standard	IEEE802.11b/g compliant
Transmit Output Power	802.11b: 17 ± 2dBm @11Mbps (Typical 18dBm) 802.11g: 14 ± 2dBm @54Mbps (Typical 15dBm)
Receiver Sensitivity	-70dBm @54M, -85dBm @11M

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Table 121 ODU Hardware Specifications

FEATURE	DESCRIPTION
Device Name	MAX-306 MAX-316
Dimension (W x D x H)	231 mm x 236 mm x 69.6 mm
Weight	4 kg including the mount kits
Data/Power Port	IDU end: RJ-45 Connector ODU end: RJ-45 Connector
WiMAX Antenna	MAX-306: CROSS- Polarization 12dBi (Built-in Antenna) MAX-316: CROSS- Polarization 14dBi (Built-in Antenna)
Physical Connector	1 Vent Connector
Operation Environmental	Temperature: -40°C ~ 60°C Humidity: 10% ~ 90% RH
Storage Environmental	Temperature: -40°C ~ 65°C Humidity: 10% ~ 95% RH
Certification	Safety EN60950-1 (CE-LVD & CB by TUV) EMI & EMS FCC certification & WiMAX Forum Wave II Compliance CE certification & WiMAX Forum Wave II Compliance Other Water Tightness: IP65 Wind Resistance Testing: Hurricane/Wind Speed 56.1-61.2(m/s)

Table 122 Outdoor Wireless LAN Specification

FEATURE	DESCRIPTION
Standard	IEEE 802.16e-2005
Modulation	QPSK, 16QAM, 64QAM (DL Only)
Duplex modeM	TDD
WiMAX Bandwidth	MAX-306: 2.5-2.7 GHz (5MHz/10MHz) MAX-316: 3.4-3.6 GHz (5MHz/7MHz/10MHz)
Channel Bandwidth / FFT size	5MHz / 512FFT, 7MHz / 1024 FFT and 10MHz / 1024FFT
Sensitivity	96dBm @ QPSK 1/2
Data Rate	Aggregate throughput up to 30 Mbps
Maximum Output Power at Antenna Port	26dBm

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PART VII
Appendices and Index

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A

WiMAX Security

Wireless security is vital to protect your wireless communications. Without it, information transmitted over the wireless network would be accessible to any networking device within range.

User Authentication and Data Encryption

The WiMAX (IEEE 802.16) standard employs user authentication and encryption to ensure secured communication at all times.

User authentication is the process of confirming a user's identity and level of authorization. Data encryption is the process of encoding information so that it cannot be read by anyone who does not know the code.

WiMAX uses PKMv2 (Privacy Key Management version 2) for authentication, and CCMP (Counter Mode with Cipher Block Chaining Message Authentication Protocol) for data encryption.

WiMAX supports EAP (Extensible Authentication Protocol, RFC 2486) which allows additional authentication methods to be deployed with no changes to the base station or the mobile or subscriber stations.

PKMv2

PKMv2 is a procedure that allows authentication of a mobile or subscriber station and negotiation of a public key to encrypt traffic between the MS/SS and the base station. PKMv2 uses standard EAP methods such as Transport Layer Security (EAP-TLS) or Tunneled TLS (EAP-TTLS) for secure communication.

In cryptography, a `key' is a piece of information, typically a string of random numbers and letters, that can be used to `lock' (encrypt) or `unlock' (decrypt) a message. Public key encryption uses key pairs, which consist of a public (freely available) key and a private (secret) key. The public key is used for encryption and the private key is used for decryption. You can decrypt a message only if you have the private key. Public key certificates (or `digital IDs') allow users to verify each other's identity.

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RADIUS

RADIUS is based on a client-server model that supports authentication, authorization and accounting. The base station is the client and the server is the RADIUS server. The RADIUS server handles the following tasks:

- **Authentication**

  Determines the identity of the users.
- **Authorization**

  Determines the network services available to authenticated users once they are connected to the network.
- **Accounting**

  Keeps track of the client's network activity.

RADIUS is a simple package exchange in which your base station acts as a message relay between the MS/SS and the network RADIUS server.

Types of RADIUS Messages

The following types of RADIUS messages are exchanged between the base station and the RADIUS server for user authentication:

- **Access-Request**

  Sent by an base station requesting authentication.
- **Access-Reject**

  Sent by a RADIUS server rejecting access.
- **Access-Accept**

  Sent by a RADIUS server allowing access.
- **Access-Challenge**

  Sent by a RADIUS server requesting more information in order to allow access. The base station sends a proper response from the user and then sends another Access-Request message.

The following types of RADIUS messages are exchanged between the base station and the RADIUS server for user accounting:

- **Accounting-Request**

  Sent by the base station requesting accounting.
- **Accounting-Response**

  Sent by the RADIUS server to indicate that it has started or stopped accounting.

In order to ensure network security, the access point and the RADIUS server use a shared secret key, which is a password they both know. The key is not sent over

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the network. In addition to the shared key, password information exchanged is also encrypted to protect the network from unauthorized access.

Diameter

Diameter (RFC 3588) is a type of AAA server that provides several improvements over RADIUS in efficiency, security, and support for roaming.

Security Association

The set of information about user authentication and data encryption between two computers is known as a security association (SA). In a WiMAX network, the process of security association has three stages.

- **Authorization request and reply**

  The MS/SS presents its public certificate to the base station. The base station verifies the certificate and sends an authentication key (AK) to the MS/SS.
- **Key request and reply**

  The MS/SS requests a transport encryption key (TEK) which the base station generates and encrypts using the authentication key.
- **Encrypted traffic**

  The MS/SS decrypts the TEK (using the authentication key). Both stations can now securely encrypt and decrypt the data flow.

CCMP

All traffic in a WiMAX network is encrypted using CCMP (Counter Mode with Cipher Block Chaining Message Authentication Protocol). CCMP is based on the 128-bit Advanced Encryption Standard (AES) algorithm.

'Counter mode' refers to the encryption of each block of plain text with an arbitrary number, known as the counter. This number changes each time a block of plain text is encrypted. Counter mode avoids the security weakness of repeated identical blocks of encrypted text that makes encrypted data vulnerable to pattern-spotting.

'Cipher Block Chaining Message Authentication' (also known as CBC-MAC) ensures message integrity by encrypting each block of plain text in such a way that its encryption is dependent on the block before it. This series of 'chained' blocks creates a message authentication code (MAC or CMAC) that ensures the encrypted data has not been tampered with.

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Authentication

The WiMAX Device supports EAP-TTLS authentication.

EAP-TTLS (Tunneled Transport Layer Service)

EAP-TTLS is an extension of the EAP-TLS authentication that uses certificates for only the server-side authentications to establish a secure connection (with EAP-TLS digital certifications are needed by both the server and the wireless clients for mutual authentication). Client authentication is then done by sending username and password through the secure connection, thus client identity is protected. For client authentication, EAP-TTLS supports EAP methods and legacy authentication methods such as PAP, CHAP, MS-CHAP and MS-CHAP v2.

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B

Setting Up Your Computer's IP Address

Note: Your specific ZyXEL device may not support all of the operating systems described in this appendix. See the product specifications for more information about which operating systems are supported.

This appendix shows you how to configure the IP settings on your computer in order for it to be able to communicate with the other devices on your network. Windows Vista/XP/2000, Mac OS 9/OS X, and all versions of UNIX/LINUX include the software components you need to use TCP/IP on your computer.

If you manually assign IP information instead of using a dynamic IP, make sure that your network's computers have IP addresses that place them in the same subnet.

In this appendix, you can set up an IP address for:

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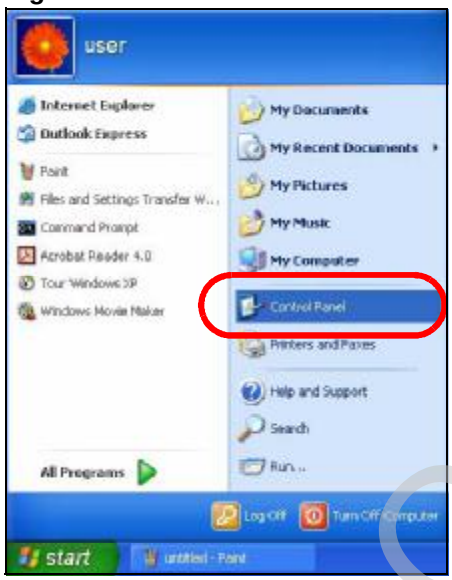
Windows XP/NT/2000

The following example uses the default Windows XP display theme but can also apply to Windows 2000 and Windows NT.

1 **Click Start > Control Panel.**

Figure 128 Windows XP: Start Menu



2 **In the Control Panel, click the Network Connections icon.**

Figure 129 Windows XP: Control Panel

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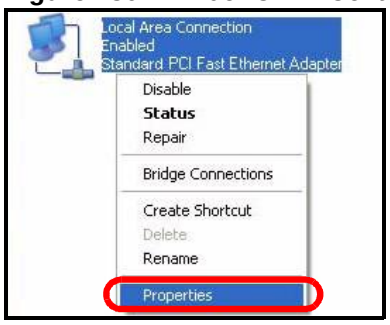
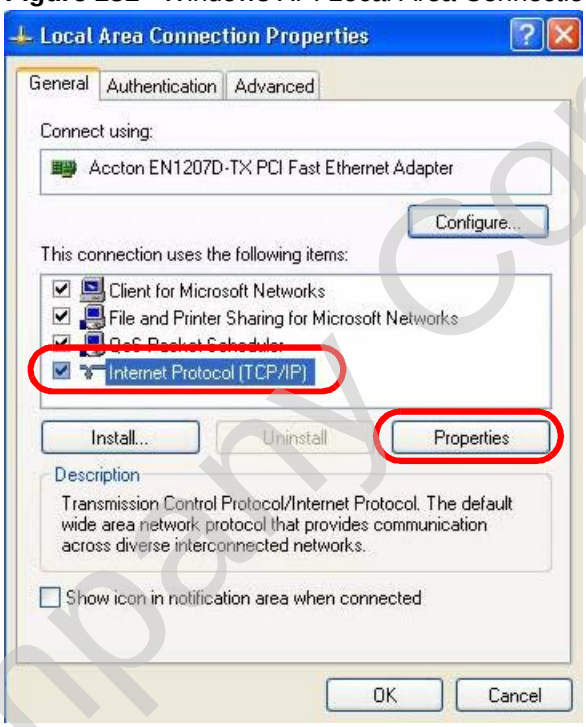
3 **Right-click Local Area Connection and then select Properties.**

Figure 130 Windows XP: Control Panel > Network Connections > Properties



4 **On the General tab, select Internet Protocol (TCP/IP) and then click Properties.**

Figure 131 Windows XP: Local Area Connection Properties



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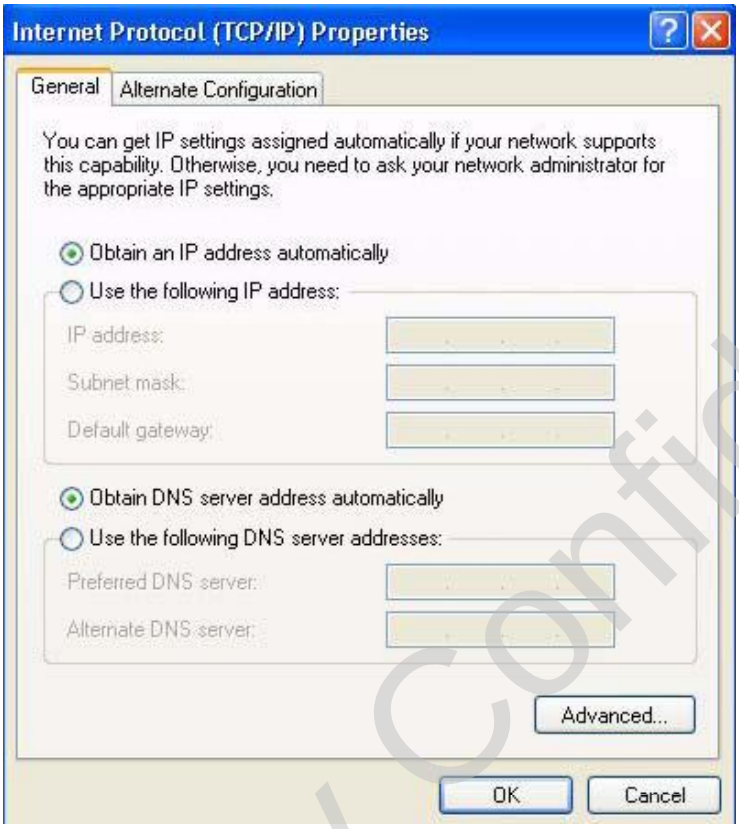
5 **The Internet Protocol TCP/IP Properties window opens.**

Figure 132 Windows XP: Internet Protocol (TCP/IP) Properties



6 **Select Obtain an IP address automatically if your network administrator or ISP assigns your IP address dynamically.**

Select Use the following IP Address and fill in the IP address, Subnet mask, and Default gateway fields if you have a static IP address that was assigned to you by your network administrator or ISP. You may also have to enter a Preferred DNS server and an Alternate DNS server, if that information was provided.

7 **Click OK to close the Internet Protocol (TCP/IP) Properties window.**

Click **OK** to close the **Local Area Connection Properties** window.**Verifying Settings**

1 **Click Start > All Programs > Accessories > Command Prompt.**

2 **In the Command Prompt window, type "ipconfig" and then press [ENTER].**

You can also go to Start > Control Panel > Network Connections, right-click a network connection, click Status and then click the Support tab to view your IP address and connection information.

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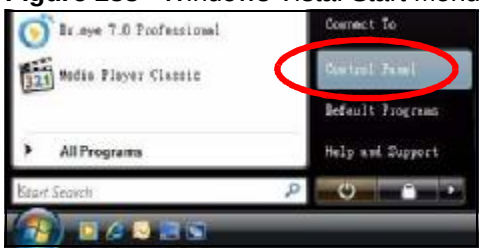
Windows Vista

This section shows screens from Windows Vista Professional.

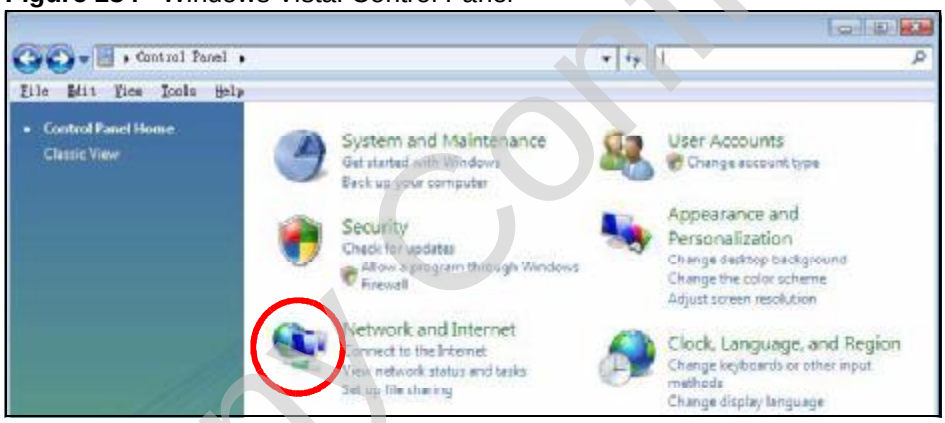
1 **Click Start > Control Panel.**

Figure 133 Windows Vista: Start Menu



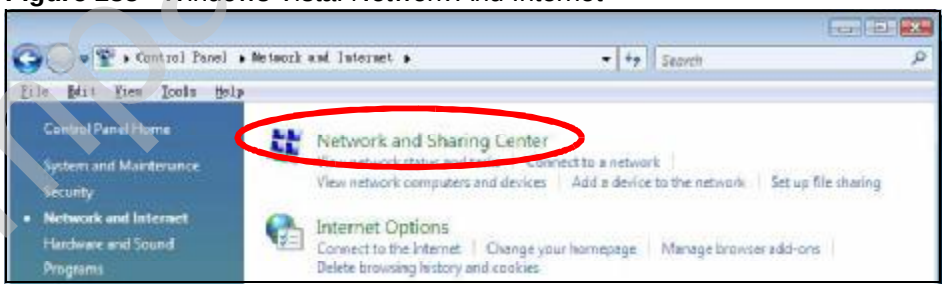
2 **In the Control Panel, click the Network and Internet icon.**

Figure 134 Windows Vista: Control Panel



3 **Click the Network and Sharing Center icon.**

Figure 135 Windows Vista: Network And Internet



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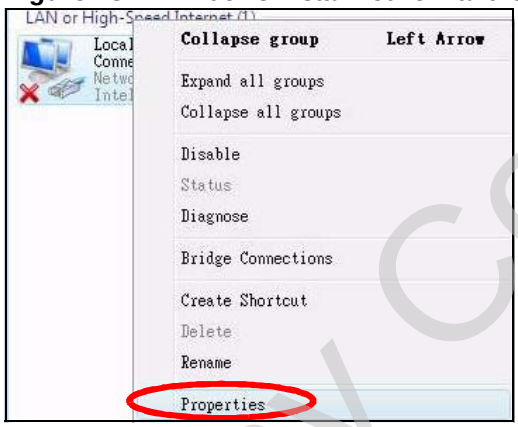
4 **Click Manage network connections.**

Figure 136 Windows Vista: Network and Sharing Center

5 **Right-click Local Area Connection and then select Properties.**

Figure 137 Windows Vista: Network and Sharing Center



Note: During this procedure, click **Continue** whenever Windows displays a screen saying that it needs your permission to continue.

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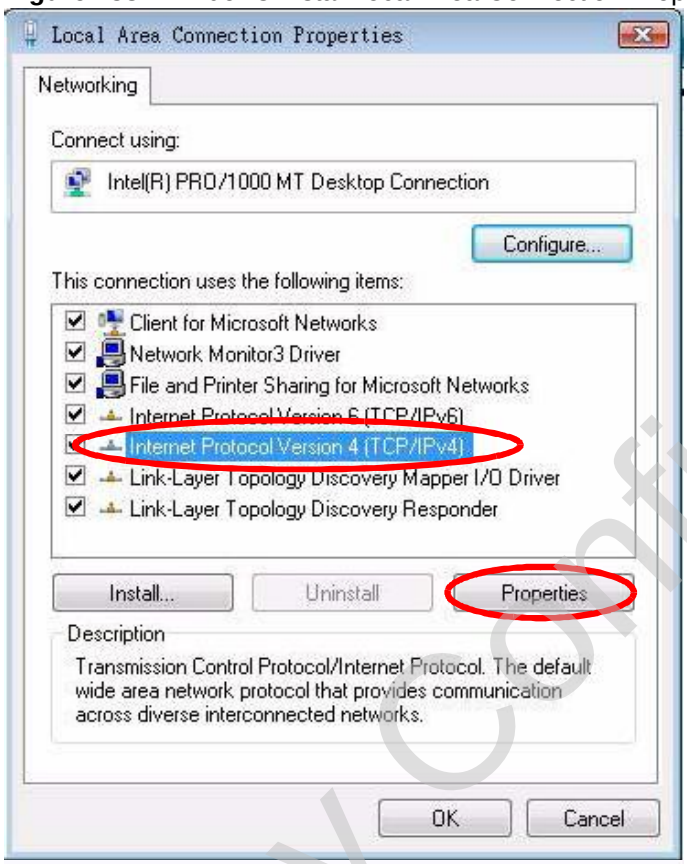
6 **Select Internet Protocol Version 4 (TCP/IPv4) and then select Properties.**

Figure 138 Windows Vista: Local Area Connection Properties



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7 **The Internet Protocol Version 4 (TCP/IPv4) Properties window opens.**

Figure 139 Windows Vista: Internet Protocol Version 4 (TCP/IPv4) Properties

8 **Select Obtain an IP address automatically if your network administrator or ISP assigns your IP address dynamically.**

Select Use the following IP Address and fill in the IP address, Subnet mask, and Default gateway fields if you have a static IP address that was assigned to you by your network administrator or ISP. You may also have to enter a Preferred DNS server and an Alternate DNS server, if that information was provided.Click Advanced.

9 **Click OK to close the Internet Protocol (TCP/IP) Properties window.**

Click **OK** to close the **Local Area Connection Properties** window.**Verifying Settings**

1 **Click Start > All Programs > Accessories > Command Prompt.**

2 **In the Command Prompt window, type "ipconfig" and then press [ENTER].**

You can also go to Start > Control Panel > Network Connections, right-click a network connection, click Status and then click the Support tab to view your IP address and connection information.

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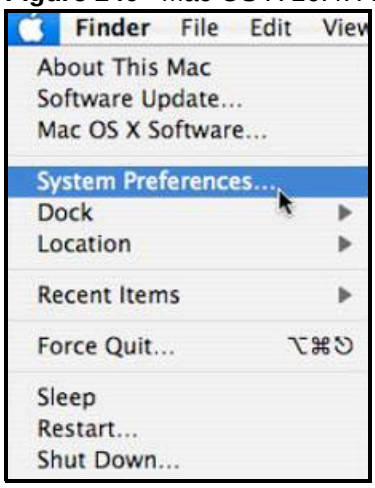
Mac OS X: 10.3 and 10.4

The screens in this section are from Mac OS X 10.4 but can also apply to 10.3.

1 **Click Apple > System Preferences.**

Figure 140 Mac OS X 10.4: Apple Menu



2 **In the System Preferences window, click the Network icon.**

Figure 141 Mac OS X 10.4: System Preferences

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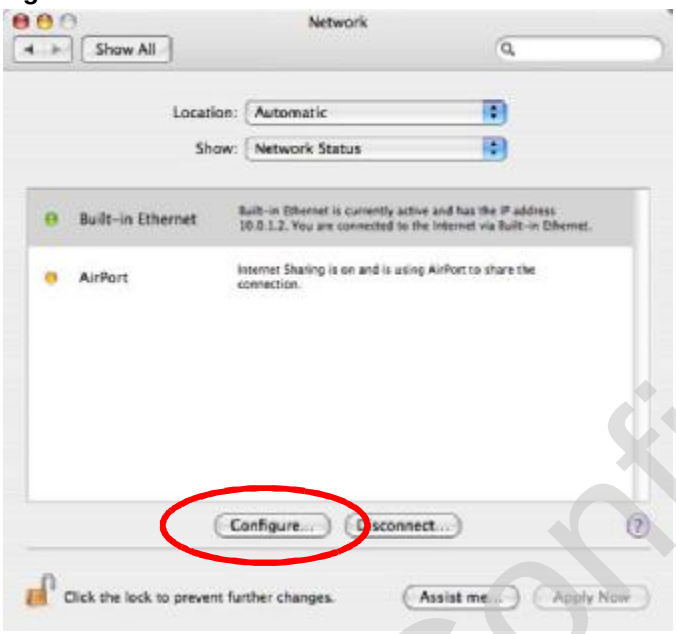
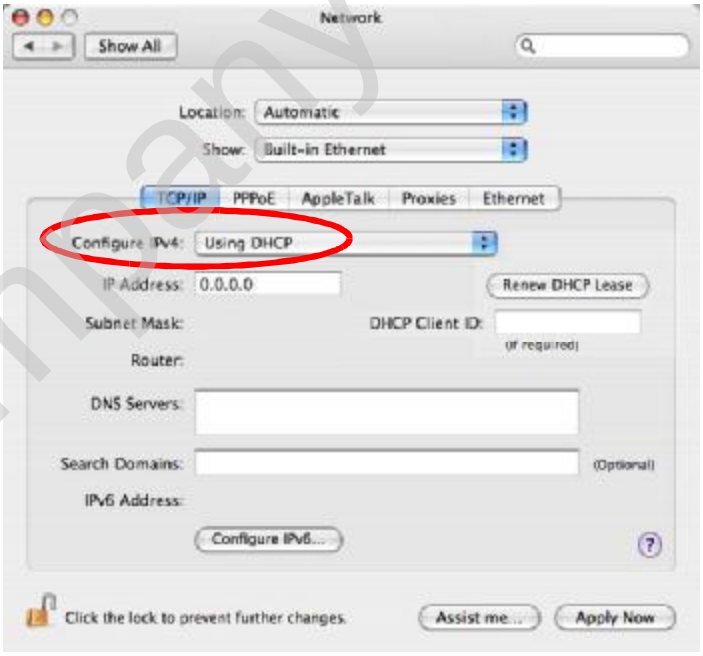
3 **When the Network preferences pane opens, select Built-in Ethernet from the network connection type list, and then click Configure.**

Figure 142 Mac OS X 10.4: Network Preferences



4 **For dynamically assigned settings, select Using DHCP from the Configure IPv4 list in the TCP / IP tab.**

Figure 143 Mac OS X 10.4: Network Preferences > TCP/IP Tab.



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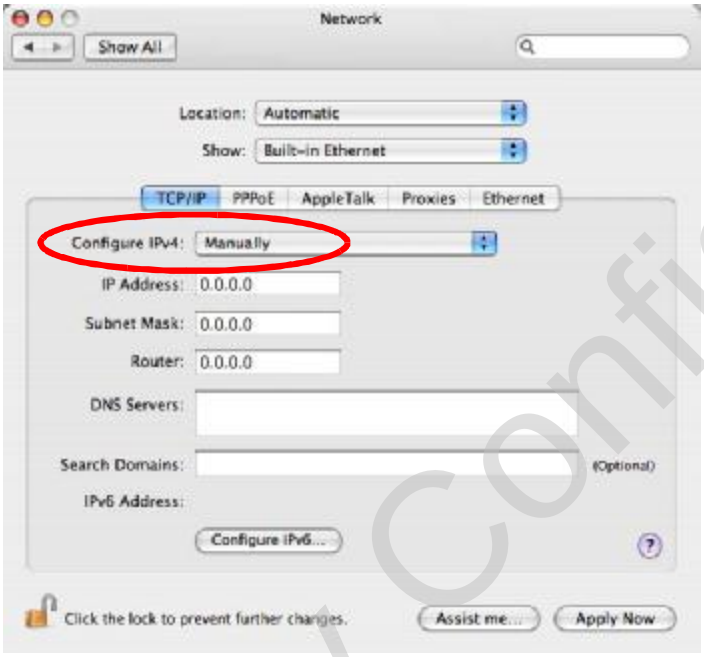
5 **For statically assigned settings, do the following:**

- **From the Configure IPv4 list, select Manually.**
- **In the IP Address field, type your IP address.**
- **In the Subnet Mask field, type your subnet mask.**
- **In the Router field, type the IP address of your device.**

Figure 144 Mac OS X 10.4: Network Preferences > Ethernet



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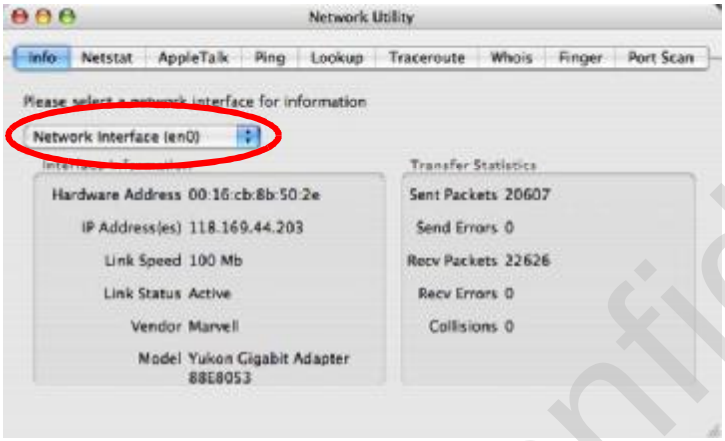
Click **Apply Now** and close the window.**Verifying Settings**

Check your TCP/IP properties by clicking Applications > Utilities > Network Utilities, and then selecting the appropriate Network Interface from the Info tab.

Figure 145 Mac OS X 10.4: Network Utility



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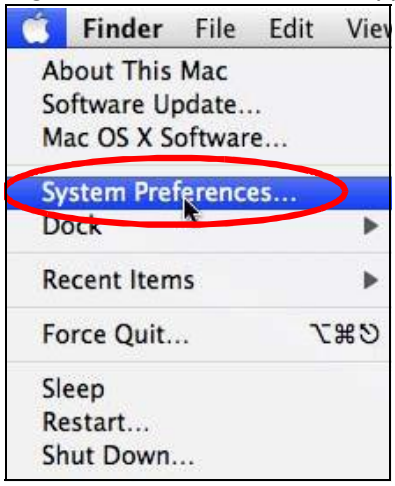
Mac OS X: 10.5

The screens in this section are from Mac OS X 10.5.

1 **Click Apple > System Preferences.**

Figure 146 Mac OS X 10.5: Apple Menu



2 **In System Preferences, click the Network icon.**

Figure 147 Mac OS X 10.5: Systems Preferences

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3 **When the Network preferences pane opens, select Ethernet from the list of available connection types.**

Figure 148 Mac OS X 10.5: Network Preferences > Ethernet

4 **From the Configure list, select Using DHCP for dynamically assigned settings.**

5 **For statically assigned settings, do the following:**

- **From the Configure list, select Manually.**
- **In the IP Address field, enter your IP address.**
- **In the Subnet Mask field, enter your subnet mask.**

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- **In the Router field, enter the IP address of your WiMAX Device.**

Figure 149 Mac OS X 10.5: Network Preferences > Ethernet

6 **Click Apply and close the window.**

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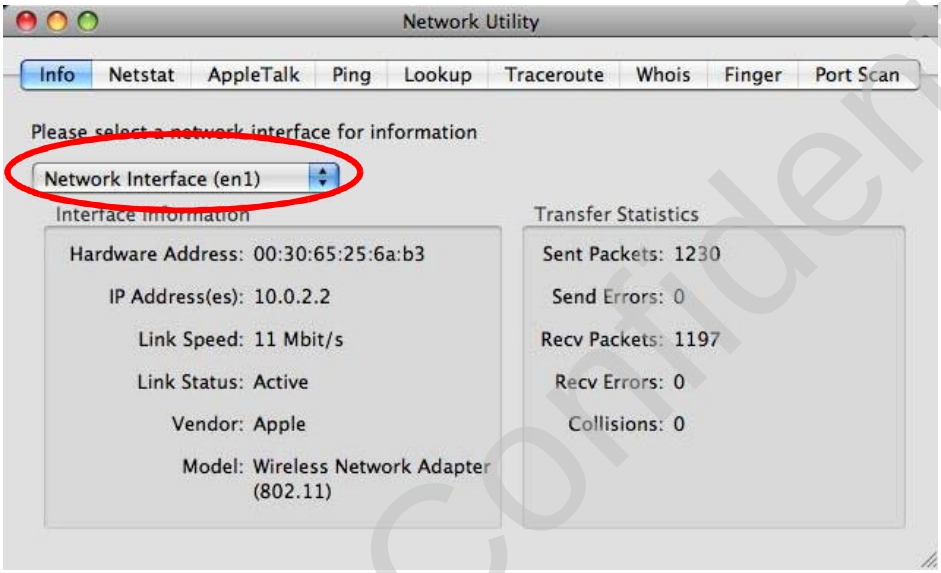
Verifying Settings

Check your TCP/IP properties by clicking Applications > Utilities > Network Utilities, and then selecting the appropriate Network interface from the Info tab.

Figure 150 Mac OS X 10.5: Network Utility



Linux: Ubuntu 8 (GNOME)

This section shows you how to configure your computer's TCP/IP settings in the GNU Object Model Environment (GNOME) using the Ubuntu 8 Linux distribution. The procedure, screens and file locations may vary depending on your specific distribution, release version, and individual configuration. The following screens use the default Ubuntu 8 installation.

Note: Make sure you are logged in as the root administrator.

Follow the steps below to configure your computer IP address in GNOME:

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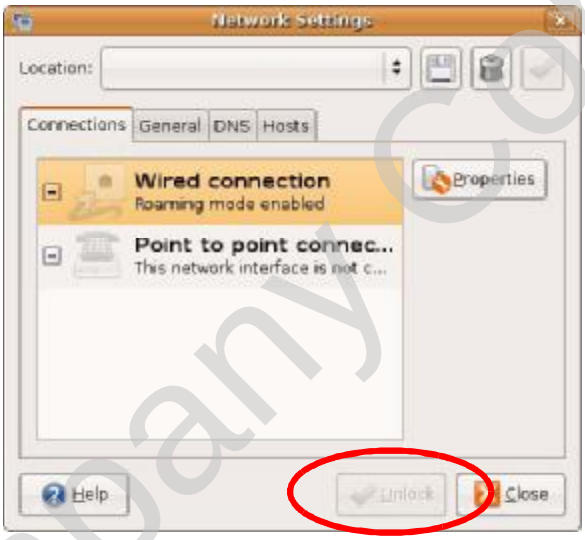
1 **Click System > Administration > Network.**

Figure 151 Ubuntu 8: System > Administration Menu

2 **When the Network Settings window opens, click Unlock to open the Authenticate window. (By default, the Unlock button is greyed out until clicked.) You cannot make changes to your configuration unless you first enter your admin password.**

Figure 152 Ubuntu 8: Network Settings > Connections



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3 **In the Authenticate window, enter your admin account name and password then click the Authenticate button.**

Figure 153 Ubuntu 8: Administrator Account Authentication

4 **In the Network Settings window, select the connection that you want to configure, then click Properties.**

Figure 154 Ubuntu 8: Network Settings > Connections

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5 **The Properties dialog box opens.**

Figure 155 Ubuntu 8: Network Settings > Properties

- **In the Configuration list, select Automatic Configuration (DHCP) if you have a dynamic IP address.**
- **In the Configuration list, select Static IP address if you have a static IP address. Fill in the IP address, Subnet mask, and Gateway address fields.**

6 **Click OK to save the changes and close the Properties dialog box and return to the Network Settings screen.**

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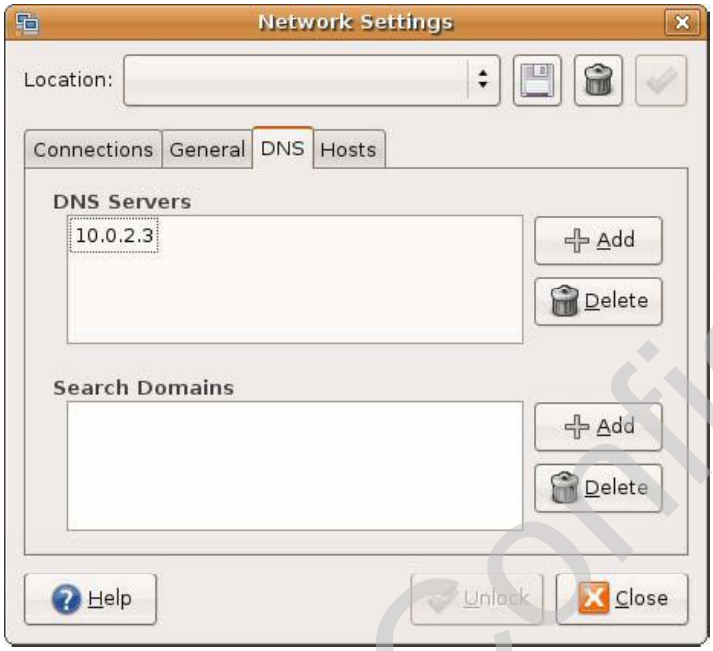
7 **If you know your DNS server IP address(es), click the DNS tab in the Network Settings window and then enter the DNS server information in the fields provided.**

Figure 156 Ubuntu 8: Network Settings > DNS



8 **Click the Close button to apply the changes.**

Verifying Settings

Check your TCP/IP properties by clicking System > Administration > Network Tools, and then selecting the appropriate Network device from the Devices

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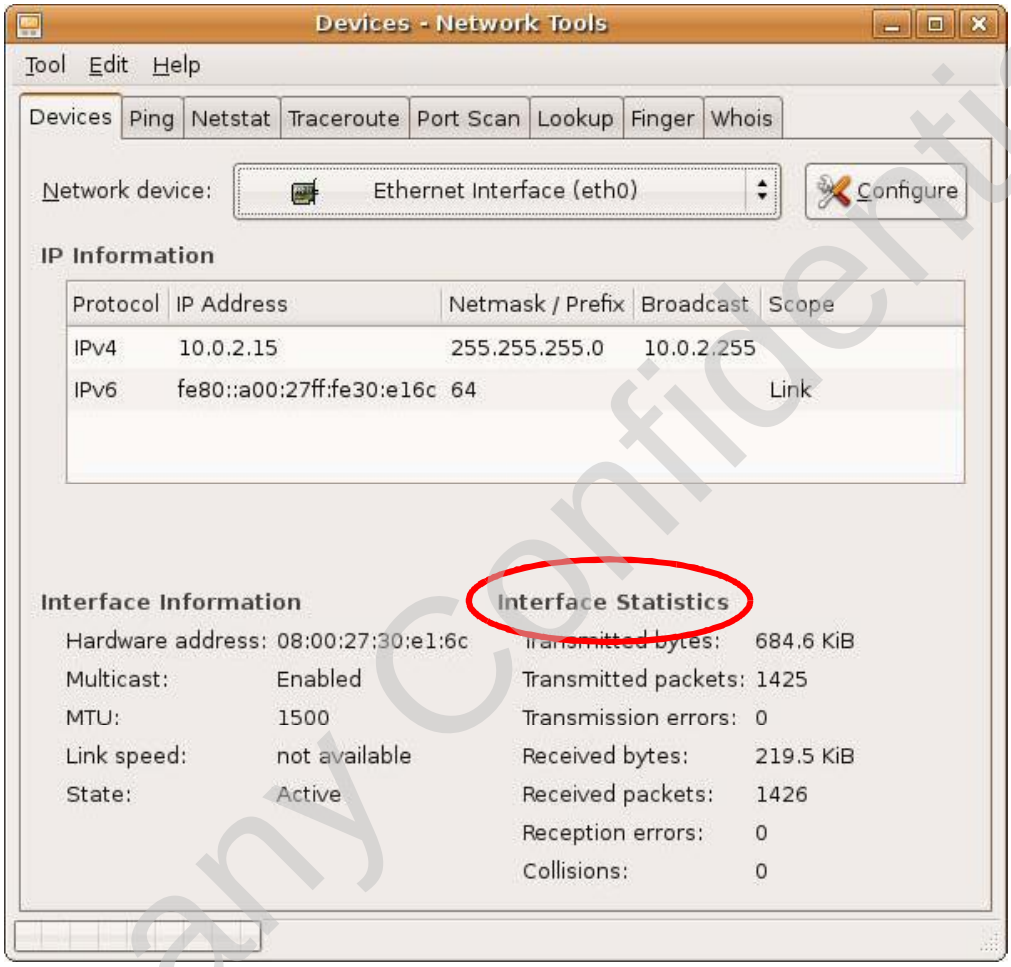
tab. The Interface Statistics column shows data if your connection is working properly.

Figure 157 Ubuntu 8: Network Tools



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Linux: openSUSE 10.3 (KDE)

This section shows you how to configure your computer's TCP/IP settings in the K Desktop Environment (KDE) using the openSUSE 10.3 Linux distribution. The procedure, screens and file locations may vary depending on your specific distribution, release version, and individual configuration. The following screens use the default openSUSE 10.3 installation.

Note: Make sure you are logged in as the root administrator.

Follow the steps below to configure your computer IP address in the KDE:

1 **Click K Menu > Computer > Administrator Settings (YaST).**

Figure 158 openSUSE 10.3: K Menu > Computer Menu

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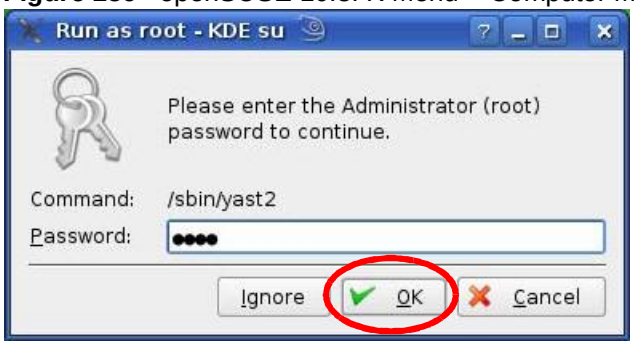
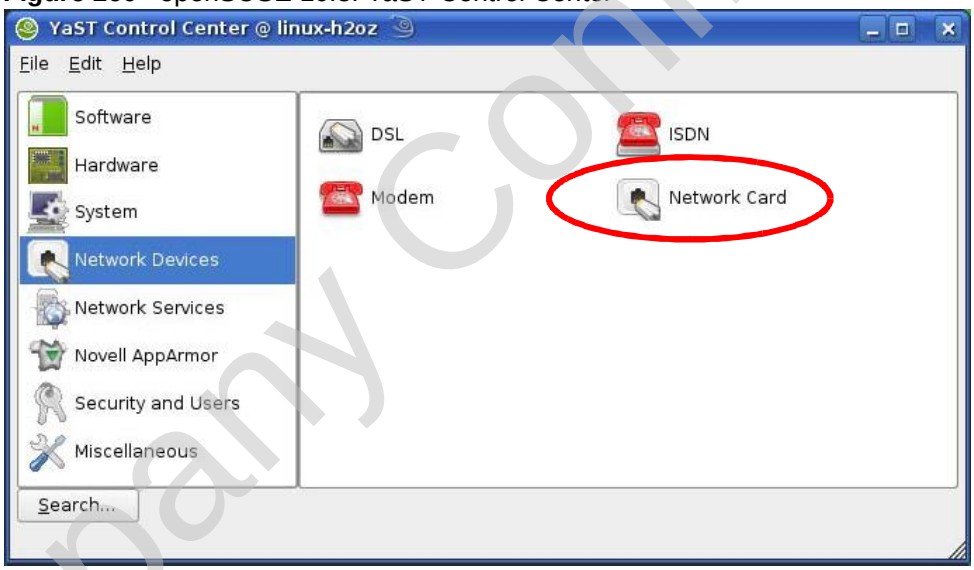
2 **When the Run as Root - KDE su dialog opens, enter the admin password and click OK.**

Figure 159 openSUSE 10.3: K Menu > Computer Menu



3 **When the YaST Control Center window opens, select Network Devices and then click the Network Card icon.**

Figure 160 openSUSE 10.3: YaST Control Center



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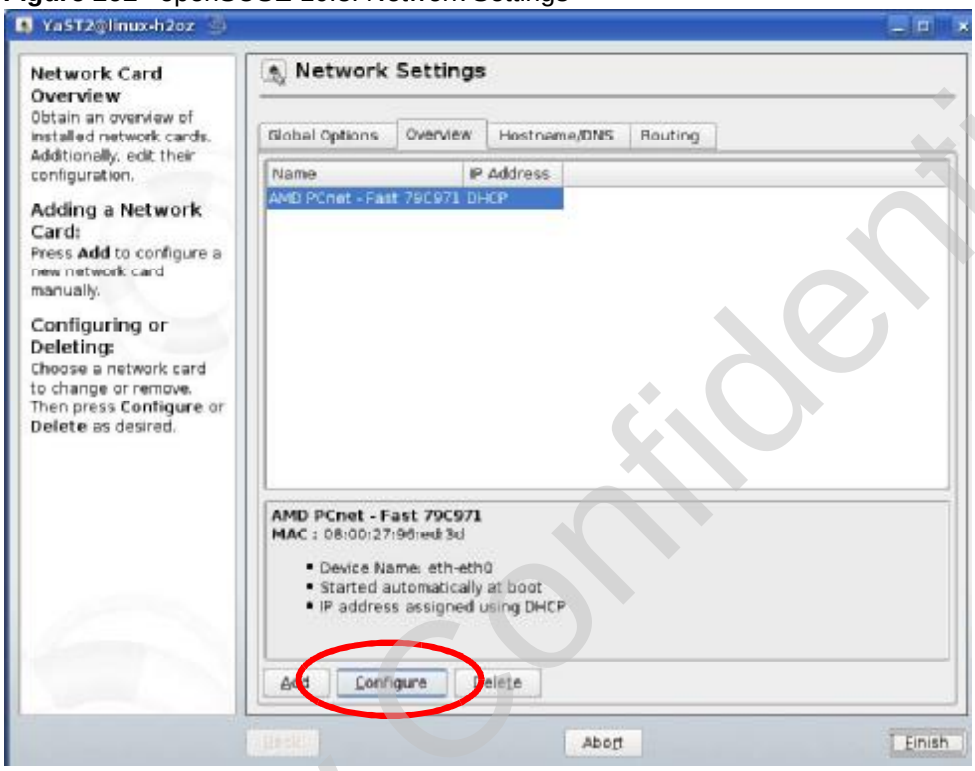
4 **When the Network Settings window opens, click the Overview tab, select the appropriate connection Name from the list, and then click the Configure button.**

Figure 161 openSUSE 10.3: Network Settings



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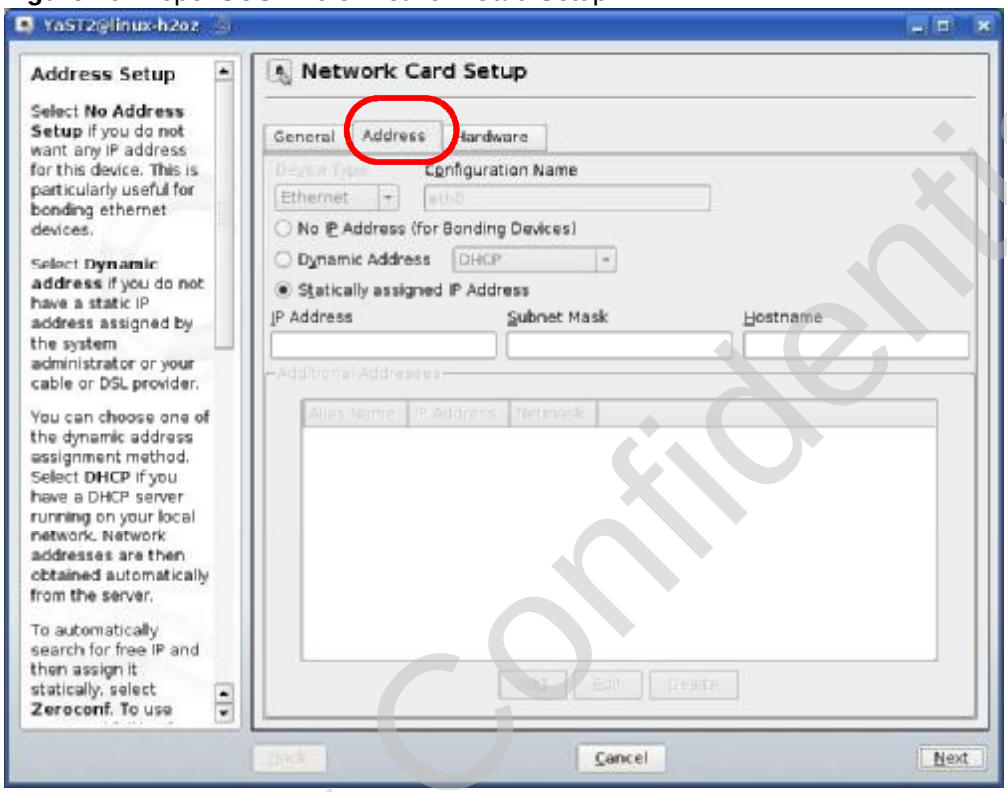
5 **When the Network Card Setup window opens, click the Address tab**

Figure 162 openSUSE 10.3: Network Card Setup



6 **Select Dynamic Address (DHCP) if you have a dynamic IP address.**

Select Statically assigned IP Address if you have a static IP address. Fill in the IP address, Subnet mask, and Hostname fields.

7 **Click Next to save the changes and close the Network Card Setup window.**

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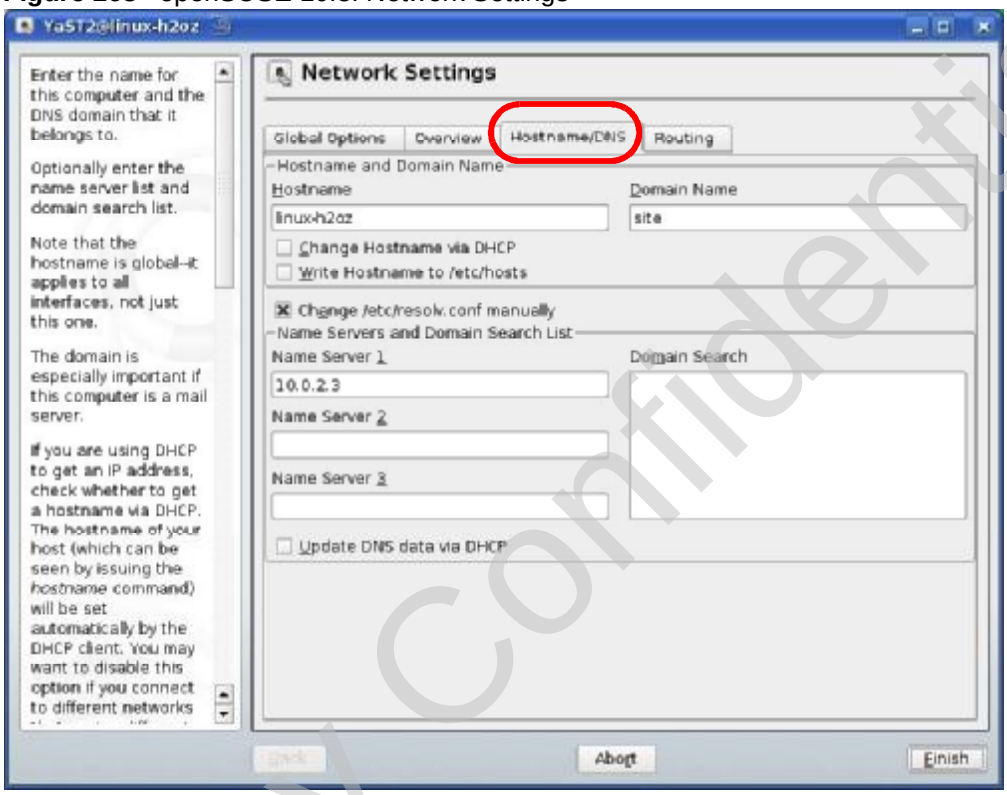
8 **If you know your DNS server IP address(es), click the Hostname / DNS tab in Network Settings and then enter the DNS server information in the fields provided.**

Figure 163 openSUSE 10.3: Network Settings



9 **Click Finish to save your settings and close the window.**

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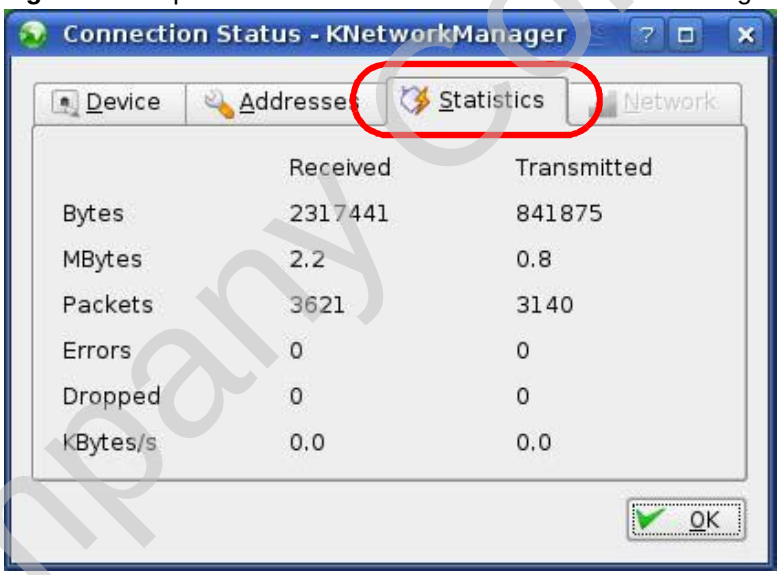
Verifying Settings

Click the KNetwork Manager icon on the Task bar to check your TCP/IP properties. From the Options sub-menu, select Show Connection Information.

Figure 164 openSUSE 10.3: KNetwork Manager

When the Connection Status - KNetwork Manager window opens, click the Statistics tab to see if your connection is working properly.

Figure 165 openSUSE: Connection Status - KNetwork Manager



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C

Wireless LANs

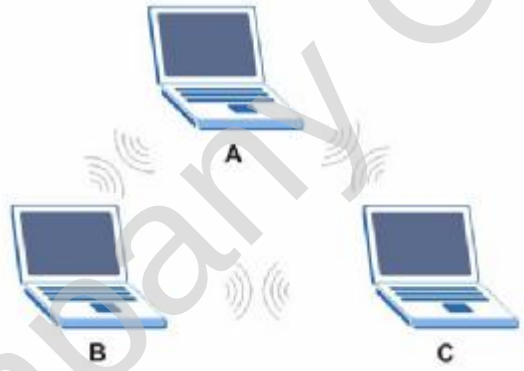
Wireless LAN Topologies

This section discusses ad-hoc and infrastructure wireless LAN topologies.

Ad-hoc Wireless LAN Configuration

The simplest WLAN configuration is an independent (Ad-hoc) WLAN that connects a set of computers with wireless adapters (A, B, C). Any time two or more wireless adapters are within range of each other, they can set up an independent network, which is commonly referred to as an ad-hoc network or Independent Basic Service Set (IBSS). The following diagram shows an example of notebook computers using wireless adapters to form an ad-hoc wireless LAN.

Figure 166 Peer-to-Peer Communication in an Ad-hoc Network



BSS

A Basic Service Set (BSS) exists when all communications between wireless clients or between a wireless client and a wired network client go through one access point (AP).

Intra-BSS traffic is traffic between wireless clients in the BSS. When Intra-BSS is enabled, wireless client A and B can access the wired network and communicate

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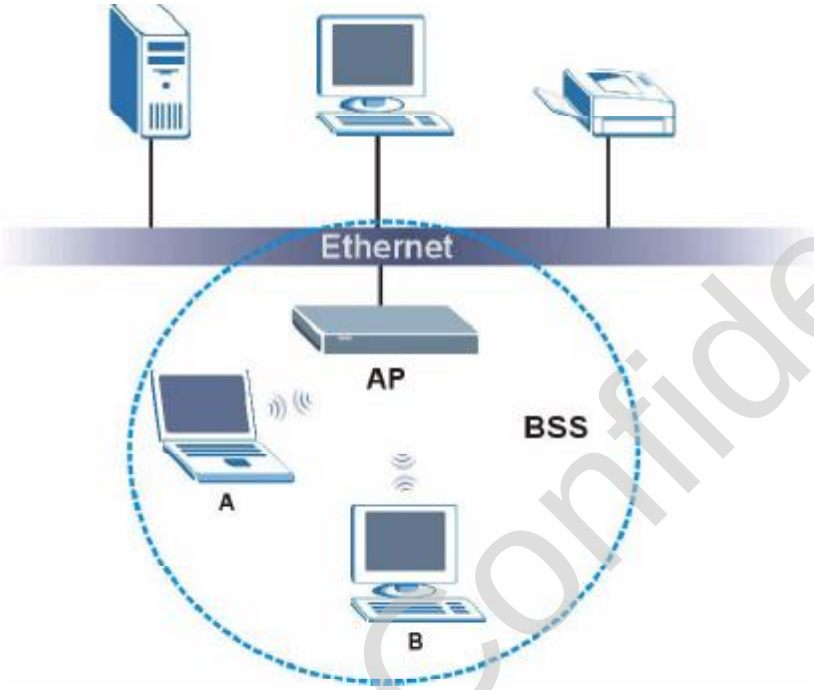
with each other. When Intra-BSS is disabled, wireless client A and B can still access the wired network but cannot communicate with each other.

Figure 167 Basic Service Set



ESS

An Extended Service Set (ESS) consists of a series of overlapping BSSs, each containing an access point, with each access point connected together by a wired network. This wired connection between APs is called a Distribution System (DS).

This type of wireless LAN topology is called an Infrastructure WLAN. The Access Points not only provide communication with the wired network but also mediate wireless network traffic in the immediate neighborhood.

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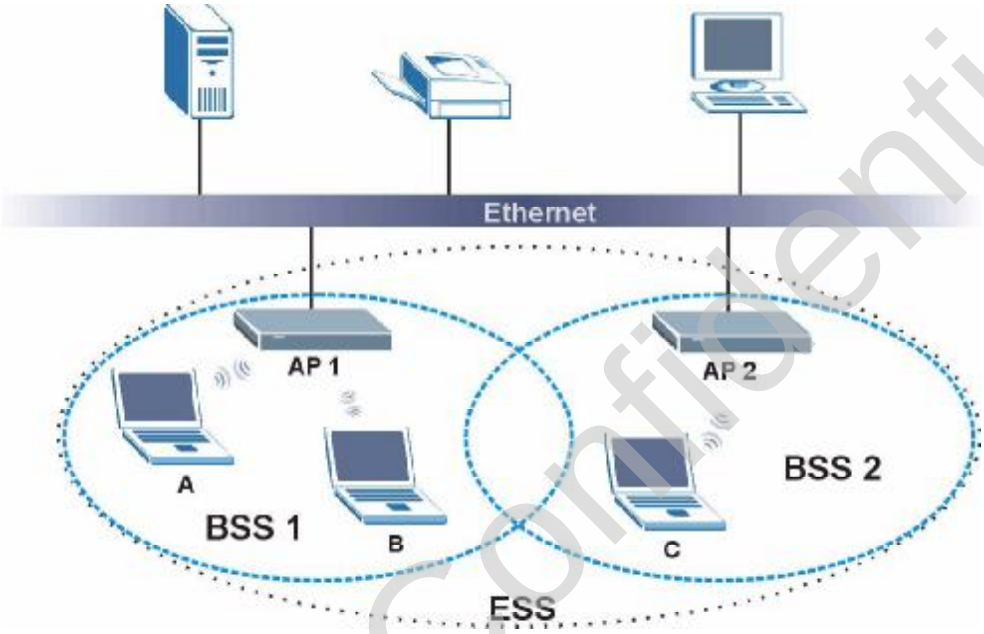
An ESSID (ESS IDentification) uniquely identifies each ESS. All access points and their associated wireless clients within the same ESS must have the same ESSID in order to communicate.

Figure 168 Infrastructure WLAN



Channel

A channel is the radio frequency(ies) used by wireless devices to transmit and receive data. Channels available depend on your geographical area. You may have a choice of channels (for your region) so you should use a channel different from an adjacent AP (access point) to reduce interference. Interference occurs when radio signals from different access points overlap causing interference and degrading performance.

Adjacent channels partially overlap however. To avoid interference due to overlap, your AP should be on a channel at least five channels away from a channel that an adjacent AP is using. For example, if your region has 11 channels and an adjacent AP is using channel 1, then you need to select a channel between 6 or 11.

RTS/CTS

A hidden node occurs when two stations are within range of the same access point, but are not within range of each other. The following figure illustrates a hidden node. Both stations (STA) are within range of the access point (AP) or

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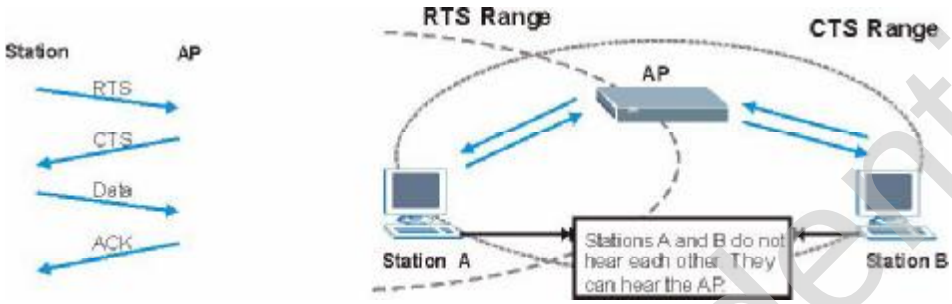
wireless gateway, but out-of-range of each other, so they cannot "hear" each other, that is they do not know if the channel is currently being used. Therefore, they are considered hidden from each other.

Figure 169 RTS/CTS



When station A sends data to the AP, it might not know that the station B is already using the channel. If these two stations send data at the same time, collisions may occur when both sets of data arrive at the AP at the same time, resulting in a loss of messages for both stations.

RTS/CTS is designed to prevent collisions due to hidden nodes. An RTS/CTS defines the biggest size data frame you can send before an RTS (Request To Send)/CTS (Clear to Send) handshake is invoked.

When a data frame exceeds the RTS/CTS value you set (between 0 to 2432 bytes), the station that wants to transmit this frame must first send an RTS (Request To Send) message to the AP for permission to send it. The AP then responds with a CTS (Clear to Send) message to all other stations within its range to notify them to defer their transmission. It also reserves and confirms with the requesting station the time frame for the requested transmission.

Stations can send frames smaller than the specified RTS/CTS directly to the AP without the RTS (Request To Send)/CTS (Clear to Send) handshake.

You should only configure RTS/CTS if the possibility of hidden nodes exists on your network and the "cost" of resending large frames is more than the extra network overhead involved in the RTS (Request To Send)/CTS (Clear to Send) handshake.

If the RTS/CTS value is greater than the Fragmentation Threshold value (see next), then the RTS (Request To Send)/CTS (Clear to Send) handshake will never occur as data frames will be fragmented before they reach RTS/CTS size.

Note: Enabling the RTS Threshold causes redundant network overhead that could negatively affect the throughput performance instead of providing a remedy.

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Fragmentation Threshold

A Fragmentation Threshold is the maximum data fragment size (between 256 and 2432 bytes) that can be sent in the wireless network before the AP will fragment the packet into smaller data frames.

A large Fragmentation Threshold is recommended for networks not prone to interference while you should set a smaller threshold for busy networks or networks that are prone to interference.

If the Fragmentation Threshold value is smaller than the RTS/CTS value (see previously) you set then the RTS (Request To Send)/CTS (Clear to Send) handshake will never occur as data frames will be fragmented before they reach RTS/CTS size.

Preamble Type

Preamble is used to signal that data is coming to the receiver. Short and long refer to the length of the synchronization field in a packet.

Short preamble increases performance as less time sending preamble means more time for sending data. All IEEE 802.11 compliant wireless adapters support long preamble, but not all support short preamble.

Use long preamble if you are unsure what preamble mode other wireless devices on the network support, and to provide more reliable communications in busy wireless networks.

Use short preamble if you are sure all wireless devices on the network support it, and to provide more efficient communications.

Use the dynamic setting to automatically use short preamble when all wireless devices on the network support it, otherwise the WiMAX Device uses long preamble.

Note: The wireless devices MUST use the same preamble mode in order to communicate.

IEEE 802.11g Wireless LAN

IEEE 802.11g is fully compatible with the IEEE 802.11b standard. This means an IEEE 802.11b adapter can interface directly with an IEEE 802.11g access point (and vice versa) at 11 Mbps or lower depending on range. IEEE 802.11g has

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several intermediate rate steps between the maximum and minimum data rates. The IEEE 802.11g data rate and modulation are as follows:

Table 123 IEEE 802.11g

DATA RATE (MBPS)	MODULATION
1	DBPSK (Differential Binary Phase Shift Keyed)
2	DQPSK (Differential Quadrature Phase Shift Keying)
5.5 / 11	CCK (Complementary Code Keying)
6/9/12/18/24/36/48/54	OFDM (Orthogonal Frequency Division Multiplexing)

Wireless Security Overview

Wireless security is vital to your network to protect wireless communication between wireless clients, access points and the wired network.

Wireless security methods available on the WiMAX Device are data encryption, wireless client authentication, restricting access by device MAC address and hiding the WiMAX Device identity.

The following figure shows the relative effectiveness of these wireless security methods available on your WiMAX Device.

Table 124 Wireless Security Levels

SECURITY LEVEL	SECURITY TYPE
Least Secure	Unique SSID (Default)
	Unique SSID with Hide SSID Enabled
	MAC Address Filtering
	WEP Encryption
	IEEE802.1x EAP with RADIUS Server Authentication
	Wi-Fi Protected Access (WPA)
Most Secure	WPA2

Note: You must enable the same wireless security settings on the WiMAX Device and on all wireless clients that you want to associate with it.

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IEEE 802.1x

In June 2001, the IEEE 802.1x standard was designed to extend the features of IEEE 802.11 to support extended authentication as well as providing additional accounting and control features. It is supported by Windows XP and a number of network devices. Some advantages of IEEE 802.1x are:

- **User based identification that allows for roaming.**
- **Support for RADIUS (Remote Authentication Dial In User Service, RFC 2138, 2139) for centralized user profile and accounting management on a network RADIUS server.**
- **Support for EAP (Extensible Authentication Protocol, RFC 2486) that allows additional authentication methods to be deployed with no changes to the access point or the wireless clients.**

RADIUS

RADIUS is based on a client-server model that supports authentication, authorization and accounting. The access point is the client and the server is the RADIUS server. The RADIUS server handles the following tasks:

- **Authentication**

  Determines the identity of the users.
- **Authorization**

  Determines the network services available to authenticated users once they are connected to the network.
- **Accounting**

  Keeps track of the client's network activity.

RADIUS is a simple package exchange in which your AP acts as a message relay between the wireless client and the network RADIUS server.

Types of RADIUS Messages

The following types of RADIUS messages are exchanged between the access point and the RADIUS server for user authentication:

- **Access-Request**

  Sent by an access point requesting authentication.
- **Access-Reject**

  Sent by a RADIUS server rejecting access.
- **Access-Accept**

  Sent by a RADIUS server allowing access.

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- **Access-Challenge**

  Sent by a RADIUS server requesting more information in order to allow access. The access point sends a proper response from the user and then sends another Access-Request message.

The following types of RADIUS messages are exchanged between the access point and the RADIUS server for user accounting:

- **Accounting-Request**

  Sent by the access point requesting accounting.
- **Accounting-Response**

  Sent by the RADIUS server to indicate that it has started or stopped accounting.

In order to ensure network security, the access point and the RADIUS server use a shared secret key, which is a password, they both know. The key is not sent over the network. In addition to the shared key, password information exchanged is also encrypted to protect the network from unauthorized access.

Types of EAP Authentication

This section discusses some popular authentication types: EAP-MD5, EAP-TLS, EAP-TTLS, PEAP and LEAP. Your wireless LAN device may not support all authentication types.

EAP (Extensible Authentication Protocol) is an authentication protocol that runs on top of the IEEE 802.1x transport mechanism in order to support multiple types of user authentication. By using EAP to interact with an EAP-compatible RADIUS server, an access point helps a wireless station and a RADIUS server perform authentication.

The type of authentication you use depends on the RADIUS server and an intermediary AP(s) that supports IEEE 802.1x. .

For EAP-TLS authentication type, you must first have a wired connection to the network and obtain the certificate(s) from a certificate authority (CA). A certificate (also called digital IDs) can be used to authenticate users and a CA issues certificates and guarantees the identity of each certificate owner.

EAP-MD5 (Message-Digest Algorithm 5)

MD5 authentication is the simplest one-way authentication method. The authentication server sends a challenge to the wireless client. The wireless client 'proves' that it knows the password by encrypting the password with the challenge and sends back the information. Password is not sent in plain text.

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However, MD5 authentication has some weaknesses. Since the authentication server needs to get the plaintext passwords, the passwords must be stored. Thus someone other than the authentication server may access the password file. In addition, it is possible to impersonate an authentication server as MD5 authentication method does not perform mutual authentication. Finally, MD5 authentication method does not support data encryption with dynamic session key. You must configure WEP encryption keys for data encryption.

EAP-TLS (Transport Layer Security)

With EAP-TLS, digital certifications are needed by both the server and the wireless clients for mutual authentication. The server presents a certificate to the client. After validating the identity of the server, the client sends a different certificate to the server. The exchange of certificates is done in the open before a secured tunnel is created. This makes user identity vulnerable to passive attacks. A digital certificate is an electronic ID card that authenticates the sender's identity. However, to implement EAP-TLS, you need a Certificate Authority (CA) to handle certificates, which imposes a management overhead.

EAP-TTLS (Tunneled Transport Layer Service)

EAP-TTLS is an extension of the EAP-TLS authentication that uses certificates for only the server-side authentications to establish a secure connection. Client authentication is then done by sending username and password through the secure connection, thus client identity is protected. For client authentication, EAP-TTLS supports EAP methods and legacy authentication methods such as PAP, CHAP, MS-CHAP and MS-CHAP v2.

PEAP (Protected EAP)

Like EAP-TTLS, server-side certificate authentication is used to establish a secure connection, then use simple username and password methods through the secured connection to authenticate the clients, thus hiding client identity. However, PEAP only supports EAP methods, such as EAP-MD5, EAP-MSCHAPv2 and EAP-GTC (EAP-Generic Token Card), for client authentication. EAP-GTC is implemented only by Cisco.

LEAP

LEAP (Lightweight Extensible Authentication Protocol) is a Cisco implementation of IEEE 802.1x.

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Dynamic WEP Key Exchange

The AP maps a unique key that is generated with the RADIUS server. This key expires when the wireless connection times out, disconnects or reauthentication times out. A new WEP key is generated each time reauthentication is performed.

If this feature is enabled, it is not necessary to configure a default encryption key in the wireless security configuration screen. You may still configure and store keys, but they will not be used while dynamic WEP is enabled.

Note: EAP-MD5 cannot be used with Dynamic WEP Key Exchange

For added security, certificate-based authentications (EAP-TLS, EAP-TTLS and PEAP) use dynamic keys for data encryption. They are often deployed in corporate environments, but for public deployment, a simple user name and password pair is more practical. The following table is a comparison of the features of authentication types.

Table 125 Comparison of EAP Authentication Types

	EAP-MD5	EAP-TLS	EAP-TTLS	PEAP	LEAP
Mutual Authentication	No	Yes	Yes	Yes	Yes
Certificate – Client	No	Yes	Optional	Optional	No
Certificate – Server	No	Yes	Yes	Yes	No
Dynamic Key Exchange	No	Yes	Yes	Yes	Yes
Credential Integrity	None	Strong	Strong	Strong	Moderate
Deployment Difficulty	Easy	Hard	Moderate	Moderate	Moderate
Client Identity Protection	No	No	Yes	Yes	No

WPA and WPA2

Wi-Fi Protected Access (WPA) is a subset of the IEEE 802.11i standard. WPA2 (IEEE 802.11i) is a wireless security standard that defines stronger encryption, authentication and key management than WPA.

Key differences between WPA or WPA2 and WEP are improved data encryption and user authentication.

If both an AP and the wireless clients support WPA2 and you have an external RADIUS server, use WPA2 for stronger data encryption. If you don't have an external RADIUS server, you should use WPA2-PSK (WPA2-Pre-Shared Key) that only requires a single (identical) password entered into each access point, wireless gateway and wireless client. As long as the passwords match, a wireless client will be granted access to a WLAN.

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If the AP or the wireless clients do not support WPA2, just use WPA or WPA-PSK depending on whether you have an external RADIUS server or not.

Select WEP only when the AP and/or wireless clients do not support WPA or WPA2. WEP is less secure than WPA or WPA2.

Encryption

WPA improves data encryption by using Temporal Key Integrity Protocol (TKIP), Message Integrity Check (MIC) and IEEE 802.1x. WPA2 also uses TKIP when required for compatibility reasons, but offers stronger encryption than TKIP with Advanced Encryption Standard (AES) in the Counter mode with Cipher block chaining Message authentication code Protocol (CCMP).

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

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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.

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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 170 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.**

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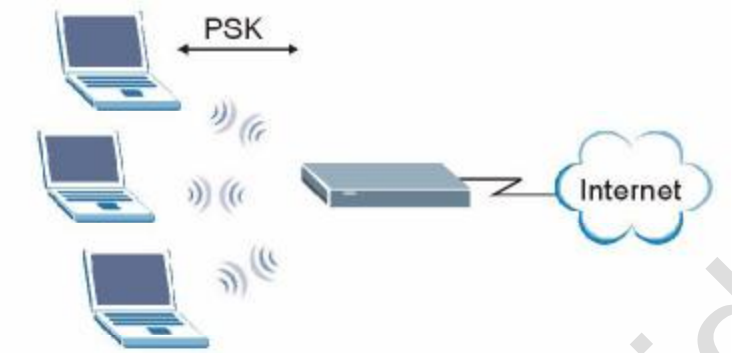
4 **The AP and wireless clients use the TKIP or AES encryption process, the PMK and information exchanged in a handshake to create temporal encryption keys. They use these keys to encrypt data exchanged between them.**

Figure 171 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 126 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

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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.

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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.

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Pop-up Windows, JavaScripts and Java Permissions

In order to use the web configurator you need to allow:

- **Web browser pop-up windows from your device.**
- **JavaScripts (enabled by default).**
- **Java permissions (enabled by default).**

Note: Internet Explorer 6 screens are used here. Screens for other Internet Explorer versions may vary.

Internet Explorer Pop-up Blockers

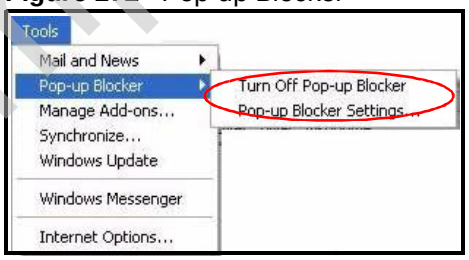
You may have to disable pop-up blocking to log into your device.

Either disable pop-up blocking (enabled by default in Windows XP SP (Service Pack) 2) or allow pop-up blocking and create an exception for your device's IP address.

Disable Pop-up Blockers

1 **In Internet Explorer, select Tools, Pop-up Blocker and then select Turn Off Pop-up Blocker.**

Figure 172 Pop-up Blocker



You can also check if pop-up blocking is disabled in the Pop-up Blocker section in the Privacy tab.

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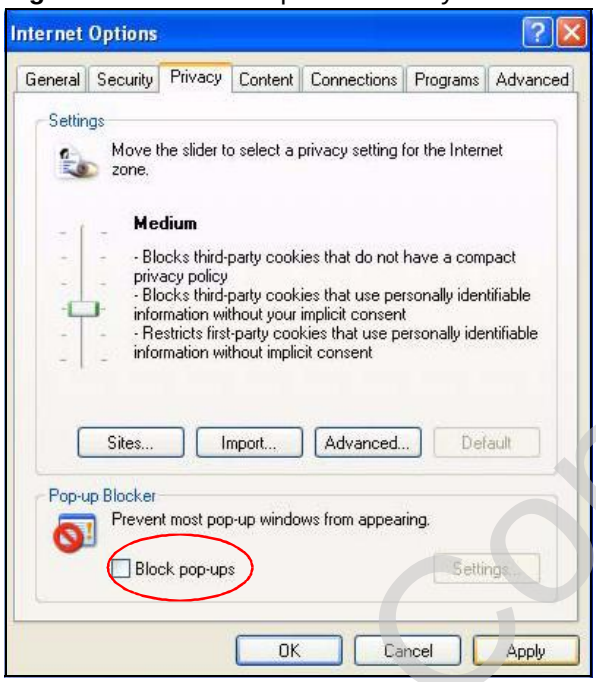
1 **In Internet Explorer, select Tools, Internet Options, Privacy.**

2 **Clear the Block pop-ups check box in the Pop-up Blocker section of the screen. This disables any web pop-up blockers you may have enabled.**

Figure 173 Internet Options: Privacy



3 **Click Apply to save this setting.**

Enable Pop-up Blockers with Exceptions

Alternatively, if you only want to allow pop-up windows from your device, see the following steps.

1 **In Internet Explorer, select Tools, Internet Options and then the Privacy tab.**

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2 **Select Settings...to open the Pop-up Blocker Settings screen.**

Figure 174 Internet Options: Privacy

3 **Type the IP address of your device (the web page that you do not want to have blocked) with the prefix "http://". For example, http://192.168.167.1.**

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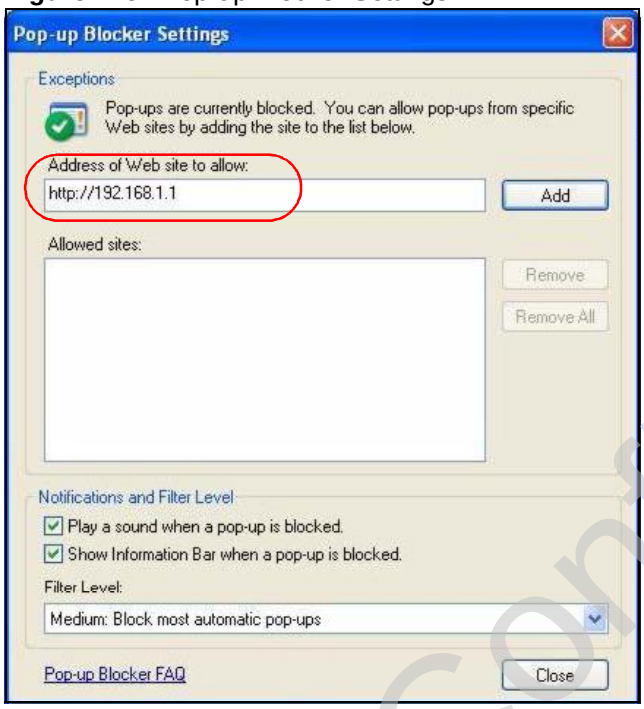
4 **Click Add to move the IP address to the list of Allowed sites.**

Figure 175 Pop-up Blocker Settings



5 **Click Close to return to the Privacy screen.**

6 **Click Apply to save this setting.**

JavaScripts

If pages of the web configurator do not display properly in Internet Explorer, check that JavaScripts are allowed.

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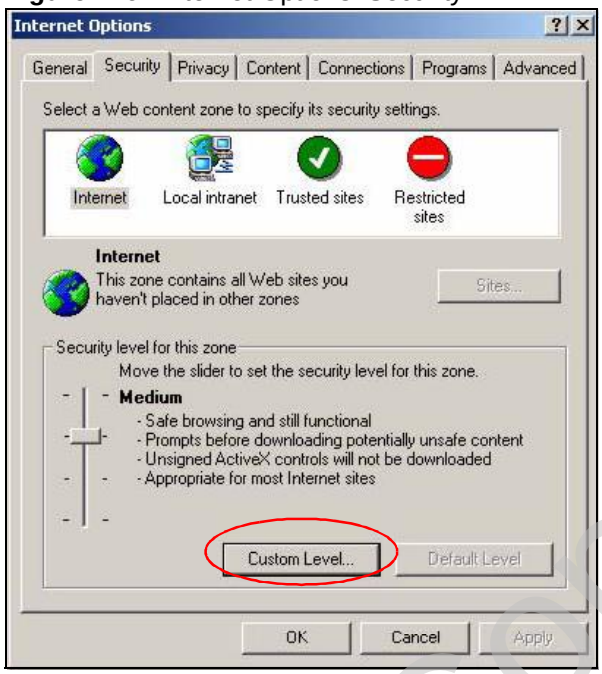
1 **In Internet Explorer, click Tools, Internet Options and then the Security tab.**

Figure 176 Internet Options: Security



2 **Click the Custom Level... button.**

3 **Scroll down to Scripting.**

4 **Under Active scripting make sure that Enable is selected (the default).**

5 **Under Scripting of Java applets make sure that Enable is selected (the default).**

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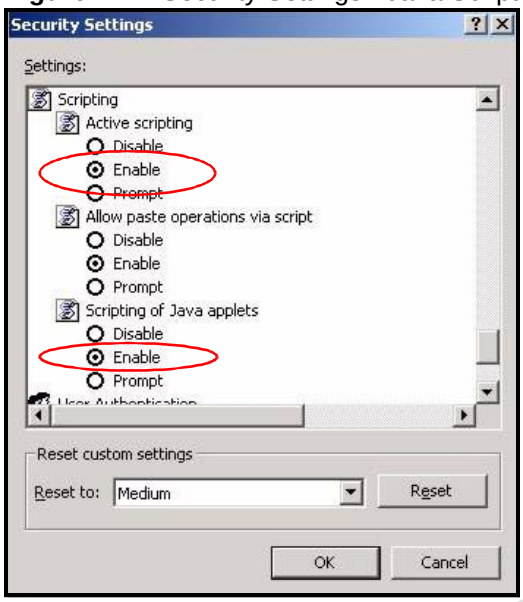
6 **Click OK to close the window.**

Figure 177 Security Settings - Java Scripting



Java Permissions

1 **From Internet Explorer, click Tools, Internet Options and then the Security tab.**

2 **Click the Custom Level... button.**

3 **Scroll down to Microsoft VM.**

4 **Under Java permissions make sure that a safety level is selected.**

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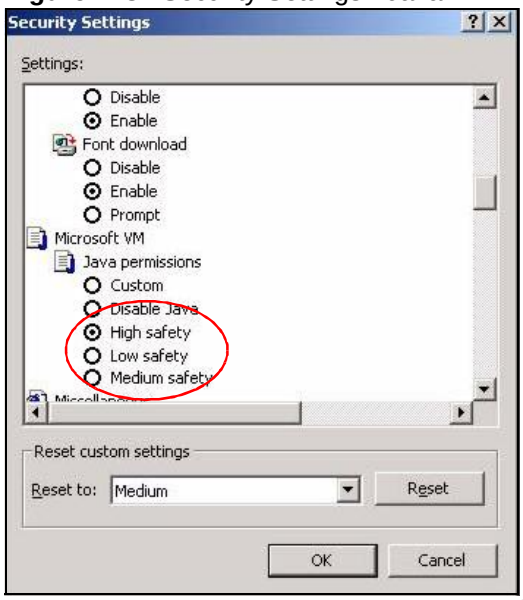
5 **Click OK to close the window.**

Figure 178 Security Settings - Java



JAVA (Sun)

1 **From Internet Explorer, click Tools, Internet Options and then the Advanced tab.**

2 **Make sure that Use Java 2 for <applet> under Java (Sun) is selected.**

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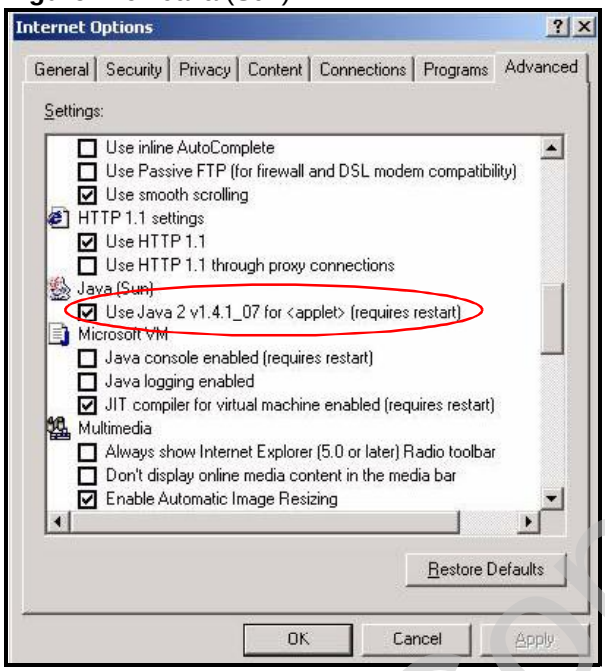
3 **Click OK to close the window.**

Figure 179 Java (Sun)

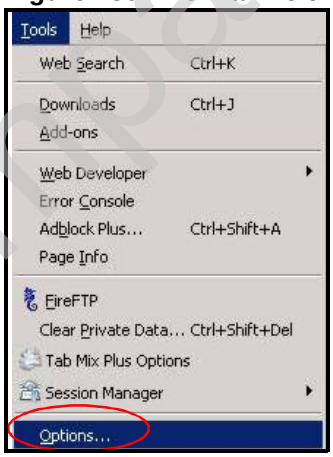


Mozilla Firefox

Mozilla Firefox 2.0 screens are used here. Screens for other versions may vary.

You can enable Java, Javascripts and pop-ups in one screen. Click Tools, then click Options in the screen that appears.

Figure 180 Mozilla Firefox: TOOLS > Options



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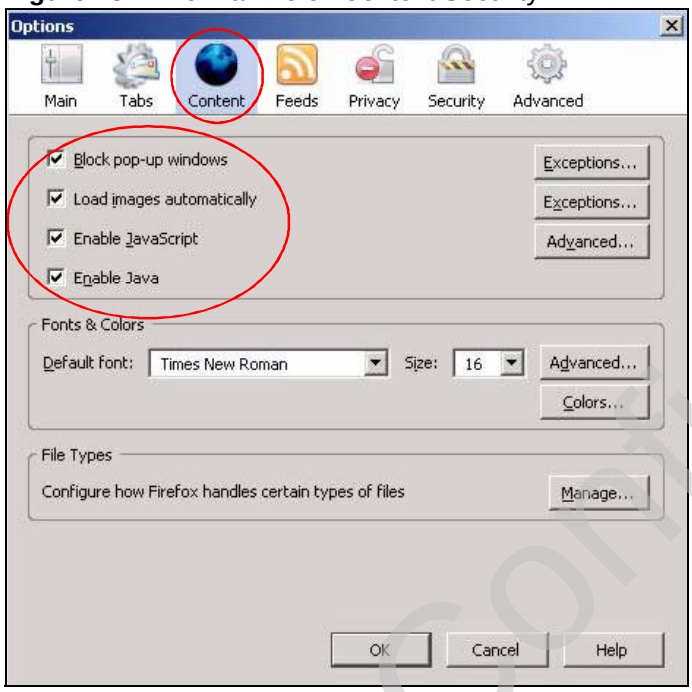
Click Content.to show the screen below. Select the check boxes as shown in the following screen.

Figure 181 Mozilla Firefox Content Security



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IP Addresses and Subnetting

This appendix introduces IP addresses and subnet masks.

IP addresses identify individual devices on a network. Every networking device (including computers, servers, routers, printers, etc.) needs an IP address to communicate across the network. These networking devices are also known as hosts.

Subnet masks determine the maximum number of possible hosts on a network. You can also use subnet masks to divide one network into multiple sub-networks.

Introduction to IP Addresses

One part of the IP address is the network number, and the other part is the host ID. In the same way that houses on a street share a common street name, the hosts on a network share a common network number. Similarly, as each house has its own house number, each host on the network has its own unique identifying number - the host ID. Routers use the network number to send packets to the correct network, while the host ID determines to which host on the network the packets are delivered.

Structure

An IP address is made up of four parts, written in dotted decimal notation (for example, 192.168.100.1). Each of these four parts is known as an octet. An octet is an eight-digit binary number (for example 11000000, which is 192 in decimal notation).

Therefore, each octet has a possible range of 00000000 to 11111111 in binary, or 0 to 255 in decimal.

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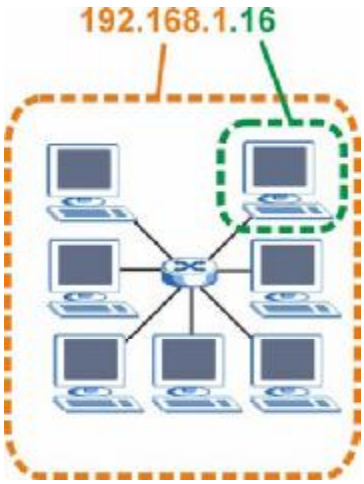
The following figure shows an example IP address in which the first three octets (192.168.1) are the network number, and the fourth octet (16) is the host ID.

Figure 182 Network Number and Host ID



How much of the IP address is the network number and how much is the host ID varies according to the subnet mask.

Subnet Masks

A subnet mask is used to determine which bits are part of the network number, and which bits are part of the host ID (using a logical AND operation). The term "subnet" is short for "sub-network".

A subnet mask has 32 bits. If a bit in the subnet mask is a "1" then the corresponding bit in the IP address is part of the network number. If a bit in the subnet mask is "0" then the corresponding bit in the IP address is part of the host ID.

The following example shows a subnet mask identifying the network number (in bold text) and host ID of an IP address (192.168.1.2 in decimal).

Table 127 IP Address Network Number and Host ID Example

	1ST OCTET: (192)	2ND OCTET: (168)	3RD OCTET: (1)	4TH OCTET (2)
IP Address (Binary)	11000000	10101000	00000001	00000010
Subnet Mask (Binary)	11111111	11111111	11111111	00000000
Network Number	11000000	10101000	00000001	
Host ID				00000010

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By convention, subnet masks always consist of a continuous sequence of ones beginning from the leftmost bit of the mask, followed by a continuous sequence of zeros, for a total number of 32 bits.

Subnet masks can be referred to by the size of the network number part (the bits with a "1" value). For example, an "8-bit mask" means that the first 8 bits of the mask are ones and the remaining 24 bits are zeroes.

Subnet masks are expressed in dotted decimal notation just like IP addresses. The following examples show the binary and decimal notation for 8-bit, 16-bit, 24-bit and 29-bit subnet masks.

Table 128 Subnet Masks

	BINARY				DECIMAL
	1ST OCTET	2ND OCTET	3RD OCTET	4TH OCTET	
8-bit mask	11111111	00000000	00000000	00000000	255.0.0.0
16-bit mask	11111111	11111111	00000000	00000000	255.255.0.0
24-bit mask	11111111	11111111	11111111	00000000	255.255.255.0
29-bit mask	11111111	11111111	11111111	11111000	255.255.255.248

Network Size

The size of the network number determines the maximum number of possible hosts you can have on your network. The larger the number of network number bits, the smaller the number of remaining host ID bits.

An IP address with host IDs of all zeros is the IP address of the network (192.168.1.0 with a 24-bit subnet mask, for example). An IP address with host IDs of all ones is the broadcast address for that network (192.168.1.255 with a 24-bit subnet mask, for example).

As these two IP addresses cannot be used for individual hosts, calculate the maximum number of possible hosts in a network as follows:

Table 129 Maximum Host Numbers

SUBNET MASK		HOST ID SIZE		MAXIMUM NUMBER OF HOSTS
8 bits	255.0.0.0	24 bits	$2^{24} - 2$	16777214
16 bits	255.255.0.0	16 bits	$2^{16} - 2$	65534
24 bits	255.255.255.0	8 bits	$2^{8} - 2$	254
29 bits	255.255.255.248	3 bits	$2^{3} - 2$	6

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Notation

Since the mask is always a continuous number of ones beginning from the left, followed by a continuous number of zeros for the remainder of the 32 bit mask, you can simply specify the number of ones instead of writing the value of each octet. This is usually specified by writing a "/" followed by the number of bits in the mask after the address.

For example, 192.1.1.0 /25 is equivalent to saying 192.1.1.0 with subnet mask 255.255.255.128.

The following table shows some possible subnet masks using both notations.

Table 130 Alternative Subnet Mask Notation

SUBNET MASK	ALTERNATIVE NOTATION	LAST OCTET (BINARY)	LAST OCTET (DECIMAL)
255.255.255.0	/24	0000 0000	0
255.255.255.128	/25	1000 0000	128
255.255.255.192	/26	1100 0000	192
255.255.255.224	/27	1110 0000	224
255.255.255.240	/28	1111 0000	240
255.255.255.248	/29	1111 1000	248
255.255.255.252	/30	1111 1100	252

Subnetting

You can use subnetting to divide one network into multiple sub-networks. In the following example a network administrator creates two sub-networks to isolate a group of servers from the rest of the company network for security reasons.

In this example, the company network address is 192.168.1.0. The first three octets of the address (192.168.1) are the network number, and the remaining octet is the host ID, allowing a maximum of $2^8 - 2$ or 254 possible hosts.

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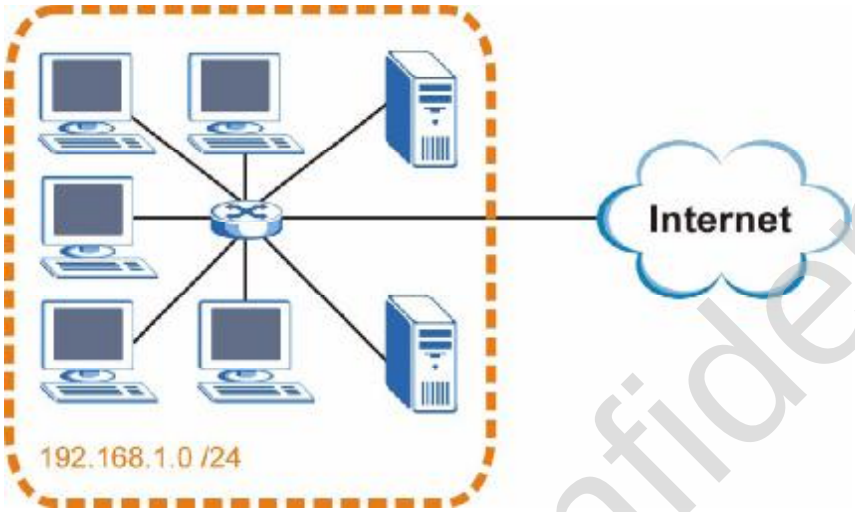
The following figure shows the company network before subnetting.

Figure 183 Subnetting Example: Before Subnetting



You can "borrow" one of the host ID bits to divide the network 192.168.1.0 into two separate sub-networks. The subnet mask is now 25 bits (255.255.255.128 or /25).

The "borrowed" host ID bit can have a value of either 0 or 1, allowing two subnets; 192.168.1.0 /25 and 192.168.100.128 /25.

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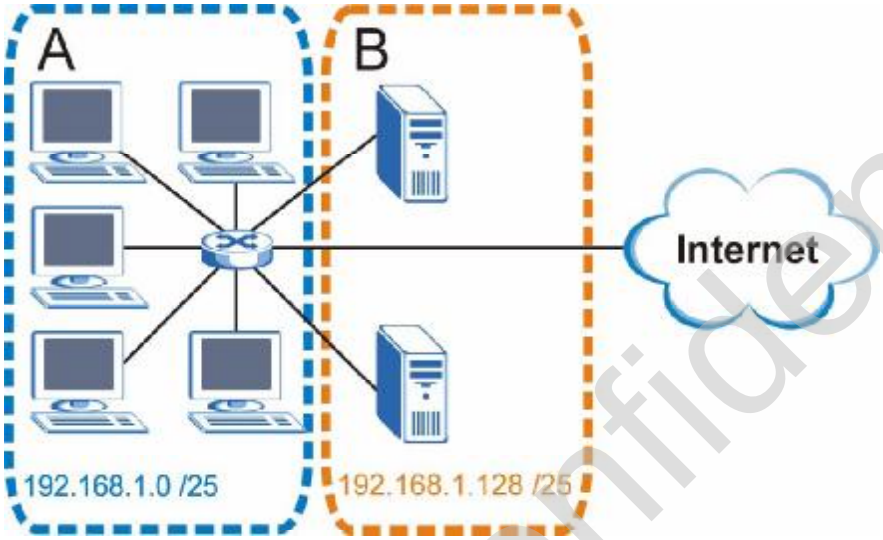
The following figure shows the company network after subnetting. There are now two sub-networks, A and B.

Figure 184 Subnetting Example: After Subnetting



In a 25-bit subnet the host ID has 7 bits, so each sub-network has a maximum of $2^7 - 2$ or 126 possible hosts (a host ID of all zeroes is the subnet's address itself, all ones is the subnet's broadcast address).

192.168.1.0 with mask 255.255.255.128 is subnet A itself, and 192.168.100.127 with mask 255.255.255.128 is its broadcast address. Therefore, the lowest IP address that can be assigned to an actual host for subnet A is 192.168.100.1 and the highest is 192.168.100.126.

Similarly, the host ID range for subnet B is 192.168.100.129 to 192.168.1.254.

Example: Four Subnets

The previous example illustrated using a 25-bit subnet mask to divide a 24-bit address into two subnets. Similarly, to divide a 24-bit address into four subnets, you need to "borrow" two host ID bits to give four possible combinations (00, 01, 10 and 11). The subnet mask is 26 bits (11111111.11111111.11111111.11000000) or 255.255.255.192.

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Each subnet contains 6 host ID bits, giving 2^6 - 2 or 62 hosts for each subnet (a host ID of all zeroes is the subnet itself, all ones is the subnet's broadcast address).

Table 131 Subnet 1

IP/SUBNET MASK	NETWORK NUMBER	LAST OCTET BIT VALUE
IP Address (Decimal)	192.168.1.	0
IP Address (Binary)	11000000.10101000.00000001.	00000000
Subnet Mask (Binary)	11111111.11111111.11111111.	11000000
Subnet Address: 192.168.1.0	Lowest Host ID: 192.168.100.1	
Broadcast Address: 192.168.1.63	Highest Host ID: 192.168.1.62	

Table 132 Subnet 2

IP/SUBNET MASK	NETWORK NUMBER	LAST OCTET BIT VALUE
IP Address	192.168.1.	64
IP Address (Binary)	11000000.10101000.00000001.	01000000
Subnet Mask (Binary)	11111111.11111111.11111111.	11000000
Subnet Address: 192.168.1.64	Lowest Host ID: 192.168.1.65	
Broadcast Address: 192.168.100.127	Highest Host ID: 192.168.100.126	

Table 133 Subnet 3

IP/SUBNET MASK	NETWORK NUMBER	LAST OCTET BIT VALUE
IP Address	192.168.1.	128
IP Address (Binary)	11000000.10101000.00000001.	10000000
Subnet Mask (Binary)	11111111.11111111.11111111.	11000000
Subnet Address: 192.168.100.128	Lowest Host ID: 192.168.100.129	
Broadcast Address: 192.168.100.191	Highest Host ID: 192.168.100.190	

Table 134 Subnet 4

IP/SUBNET MASK	NETWORK NUMBER	LAST OCTET BIT VALUE
IP Address	192.168.1.	192
IP Address (Binary)	11000000.10101000.00000001.	11000000
Subnet Mask (Binary)	11111111.11111111.11111111.	11000000

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Table 134 Subnet 4 (continued)

IP/SUBNET MASK	NETWORK NUMBER	LAST OCTET BIT VALUE
Subnet Address: 192.168.100.192	Lowest Host ID: 192.168.100.193	
Broadcast Address: 192.168.1.255	Highest Host ID: 192.168.1.254	

Example: Eight Subnets

Similarly, use a 27-bit mask to create eight subnets (000, 001, 010, 011, 100, 101, 110 and 111).

The following table shows IP address last octet values for each subnet.

Table 135 Eight Subnets

SUBNET	SUBNET ADDRESS	FIRST ADDRESS	LAST ADDRESS	BROADCAST ADDRESS
1	0	1	30	31
2	32	33	62	63
3	64	65	94	95
4	96	97	126	127
5	128	129	158	159
6	160	161	190	191
7	192	193	222	223
8	224	225	254	255

Subnet Planning

The following table is a summary for subnet planning on a network with a 24-bit network number.

Table 136 24-bit Network Number Subnet Planning

NO. "BORROWED" HOST BITS	SUBNET MASK	NO. SUBNETS	NO. HOSTS PER SUBNET
1	255.255.255.128 (/25)	2	126
2	255.255.255.192 (/26)	4	62
3	255.255.255.224 (/27)	8	30
4	255.255.255.240 (/28)	16	14
5	255.255.255.248 (/29)	32	6
6	255.255.255.252 (/30)	64	2
7	255.255.255.254 (/31)	128	1

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The following table is a summary for subnet planning on a network with a 16-bit network number.

Table 137 16-bit Network Number Subnet Planning

NO. "BORROWED" HOST BITS	SUBNET MASK	NO. SUBNETS	NO. HOSTS PER SUBNET
1	255.255.128.0 (/17)	2	32766
2	255.255.192.0 (/18)	4	16382
3	255.255.224.0 (/19)	8	8190
4	255.255.240.0 (/20)	16	4094
5	255.255.248.0 (/21)	32	2046
6	255.255.252.0 (/22)	64	1022
7	255.255.254.0 (/23)	128	510
8	255.255.255.0 (/24)	256	254
9	255.255.255.128 (/25)	512	126
10	255.255.255.192 (/26)	1024	62
11	255.255.255.224 (/27)	2048	30
12	255.255.255.240 (/28)	4096	14
13	255.255.255.248 (/29)	8192	6
14	255.255.255.252 (/30)	16384	2
15	255.255.255.254 (/31)	32768	1

Configuring IP Addresses

Where you obtain your network number depends on your particular situation. If the ISP or your network administrator assigns you a block of registered IP addresses, follow their instructions in selecting the IP addresses and the subnet mask.

If the ISP did not explicitly give you an IP network number, then most likely you have a single user account and the ISP will assign you a dynamic IP address when the connection is established. If this is the case, it is recommended that you select a network number from 192.168.0.0 to 192.168.255.0. The Internet Assigned Number Authority (IANA) reserved this block of addresses specifically for private use; please do not use any other number unless you are told otherwise. You must also enable Network Address Translation (NAT) on the WiMAX Device.

Once you have decided on the network number, pick an IP address for your WiMAX Device that is easy to remember (for instance, 192.168.100.1) but make sure that no other device on your network is using that IP address.

The subnet mask specifies the network number portion of an IP address. Your WiMAX Device will compute the subnet mask automatically based on the IP

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address that you entered. You don't need to change the subnet mask computed by the WiMAX Device unless you are instructed to do otherwise.

Private IP Addresses

Every machine on the Internet must have a unique address. If your networks are isolated from the Internet (running only between two branch offices, for example) you can assign any IP addresses to the hosts without problems. However, the Internet Assigned Numbers Authority (IANA) has reserved the following three blocks of IP addresses specifically for private networks:

- 10.0.0.0 — 10.255.255.255
- 172.16.0.0 — 172.31.255.255
- 192.168.0.0 — 192.168.255.255

You can obtain your IP address from the IANA, from an ISP, or it can be assigned from a private network. If you belong to a small organization and your Internet access is through an ISP, the ISP can provide you with the Internet addresses for your local networks. On the other hand, if you are part of a much larger organization, you should consult your network administrator for the appropriate IP addresses.

Regardless of your particular situation, do not create an arbitrary IP address; always follow the guidelines above. For more information on address assignment, please refer to RFC 1597, Address Allocation for Private Internets and RFC 1466, Guidelines for Management of IP Address Space.

IP Address Conflicts

Each device on a network must have a unique IP address. Devices with duplicate IP addresses on the same network will not be able to access the Internet or other resources. The devices may also be unreachable through the network.

Conflicting Computer IP Addresses Example

More than one device can not use the same IP address. In the following example computer A has a static (or fixed) IP address that is the same as the IP address that a DHCP server assigns to computer B which is a DHCP client. Neither can access the Internet. This problem can be solved by assigning a different static IP

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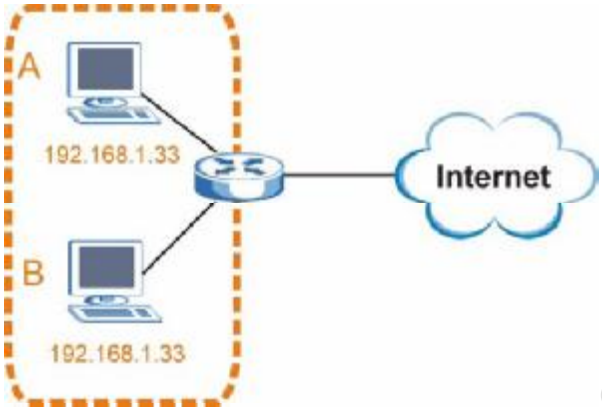
address to computer A or setting computer A to obtain an IP address automatically.

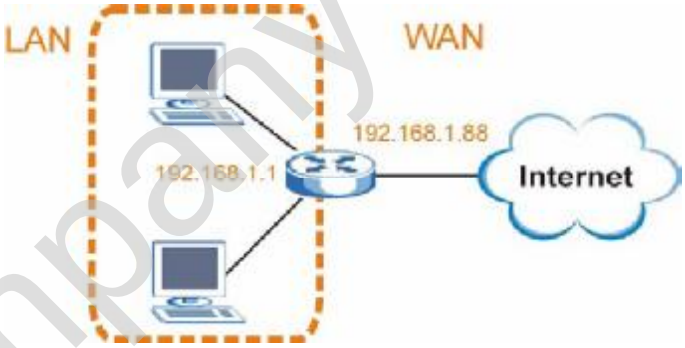
Figure 185 Conflicting Computer IP Addresses Example



Conflicting Router IP Addresses Example

Since a router connects different networks, it must have interfaces using different network numbers. For example, if a router is set between a LAN and the Internet (WAN), the router's LAN and WAN addresses must be on different subnets. In the following example, the LAN and WAN are on the same subnet. The LAN computers cannot access the Internet because the router cannot route between networks.

Figure 186 Conflicting Computer IP Addresses Example



Conflicting Computer and Router IP Addresses Example

More than one device can not use the same IP address. In the following example, the computer and the router's LAN port both use 192.168.100.1 as the IP address.

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The computer cannot access the Internet. This problem can be solved by assigning a different IP address to the computer or the router's LAN port.

Figure 187 Conflicting Computer and Router IP Addresses Example

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Importing Certificates

This appendix shows you how to import public key certificates into your web browser.

Public key certificates are used by web browsers to ensure that a secure web site is legitimate. When a certificate authority such as VeriSign, Comodo, or Network Solutions, to name a few, receives a certificate request from a website operator, they confirm that the web domain and contact information in the request match those on public record with a domain name registrar. If they match, then the certificate is issued to the website operator, who then places it on the site to be issued to all visiting web browsers to let them know that the site is legitimate.

Many ZyXEL products, such as the NSA-2401, issue their own public key certificates. These can be used by web browsers on a LAN or WAN to verify that they are in fact connecting to the legitimate device and not one masquerading as it. However, because the certificates were not issued by one of the several organizations officially recognized by the most common web browsers, you will need to import the ZyXEL-created certificate into your web browser and flag that certificate as a trusted authority.

Note: You can see if you are browsing on a secure website if the URL in your web browser's address bar begins with `https://` or there is a sealed padlock icon () somewhere in the main browser window (not all browsers show the padlock in the same location.)

In this appendix, you can import a public key certificate for:

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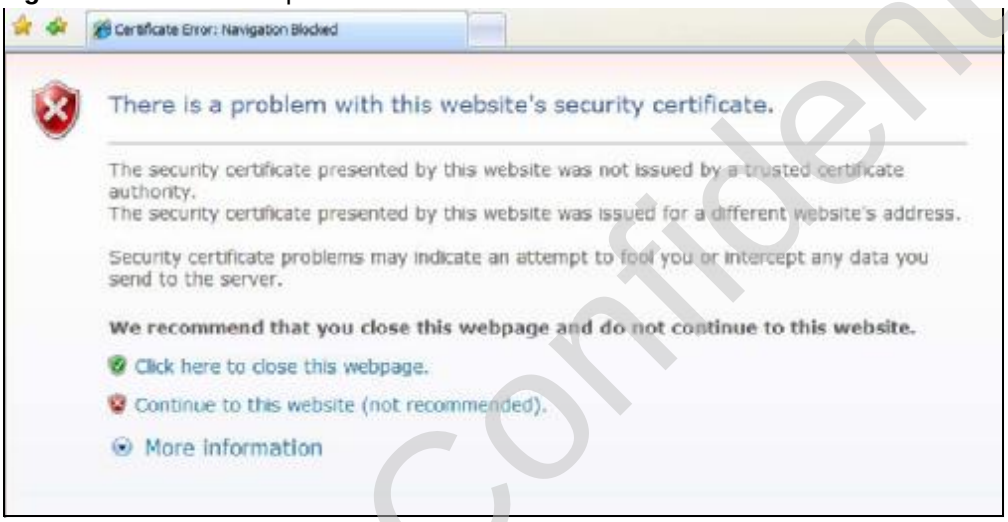
Internet Explorer

The following example uses Microsoft Internet Explorer 7 on Windows XP Professional; however, they can also apply to Internet Explorer on Windows Vista.

1 **If your device's web configurator is set to use SSL certification, then the first time you browse to it you are presented with a certification error.**

Figure 188 Internet Explorer 7: Certification Error



2 **Click Continue to this website (not recommended).**

Figure 189 Internet Explorer 7: Certification Error

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3 **In the Address Bar, click Certificate Error > View certificates.**

Figure 190 Internet Explorer 7: Certificate Error

4 **In the Certificate dialog box, click Install Certificate.**

Figure 191 Internet Explorer 7: Certificate

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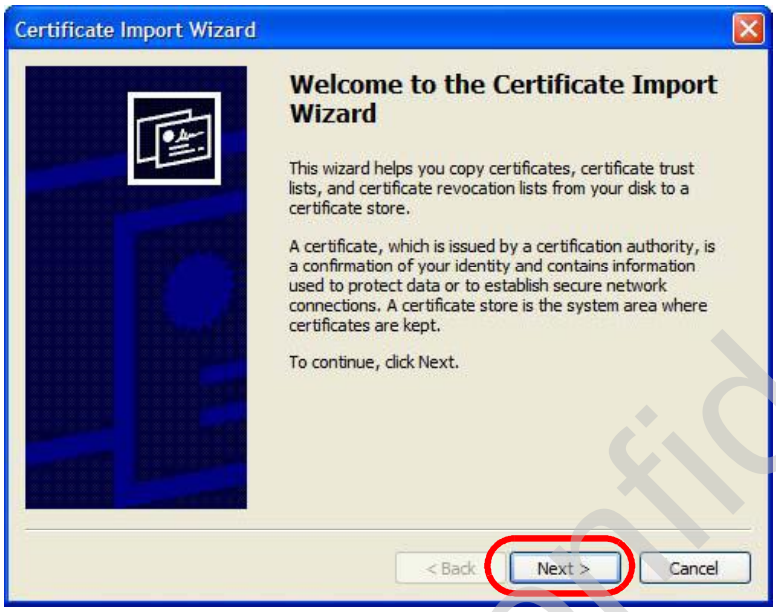
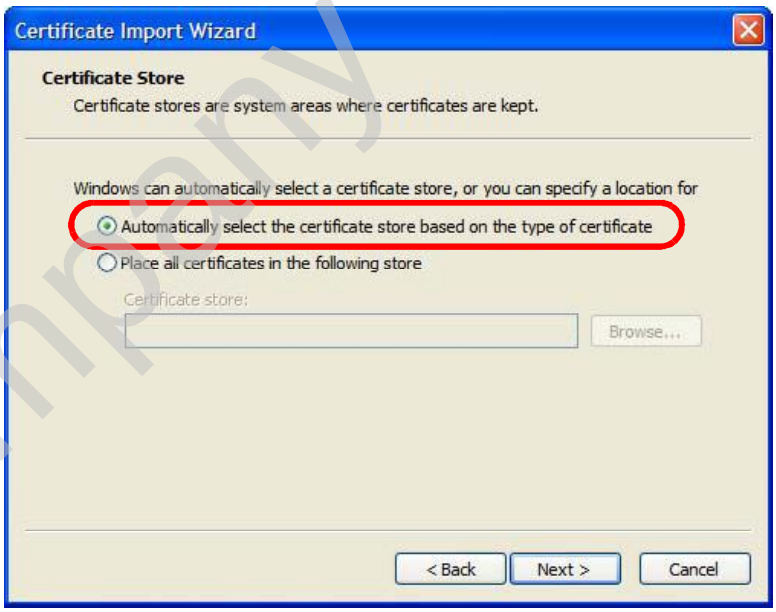
5 **In the Certificate Import Wizard, click Next.**

Figure 192 Internet Explorer 7: Certificate Import Wizard



6 **If you want Internet Explorer to Automatically select certificate store based on the type of certificate, click Next again and then go to step 9.**

Figure 193 Internet Explorer 7: Certificate Import Wizard



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7 **Otherwise, select Place all certificates in the following store and then click Browse.**

Figure 194 Internet Explorer 7: Certificate Import Wizard

8 **In the Select Certificate Store dialog box, choose a location in which to save the certificate and then click OK.**

Figure 195 Internet Explorer 7: Select Certificate Store

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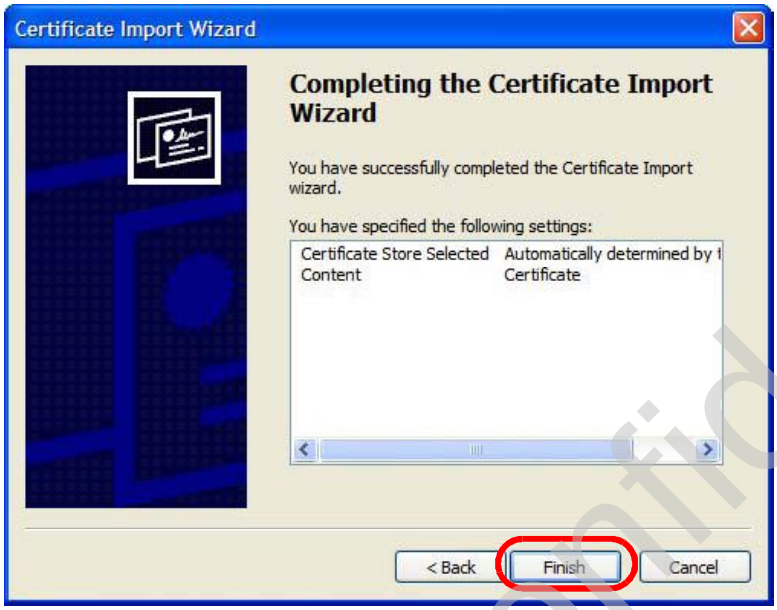
9 **In the Completing the Certificate Import Wizard screen, click Finish.**

Figure 196 Internet Explorer 7: Certificate Import Wizard



10 **If you are presented with another Security Warning, click Yes.**

Figure 197 Internet Explorer 7: Security Warning

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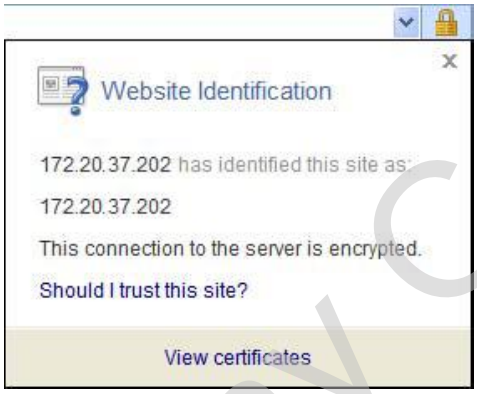
11 **Finally, click OK when presented with the successful certificate installation message.**

Figure 198 Internet Explorer 7: Certificate Import Wizard

12 **The next time you start Internet Explorer and go to a ZyXEL web configurator page, a sealed padlock icon appears in the address bar. Click it to view the page's Website Identification information.**

Figure 199 Internet Explorer 7: Website Identification



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Installing a Stand-Alone Certificate File in Internet Explorer

Rather than browsing to a ZyXEL web configurator and installing a public key certificate when prompted, you can install a stand-alone certificate file if one has been issued to you.

1 **Double-click the public key certificate file.**

Figure 200 Internet Explorer 7: Public Key Certificate File

2 **In the security warning dialog box, click Open.**

Figure 201 Internet Explorer 7: Open File - Security Warning

3 **Refer to steps 4-12 in the Internet Explorer procedure beginning on page 350 to complete the installation process.**

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Removing a Certificate in Internet Explorer

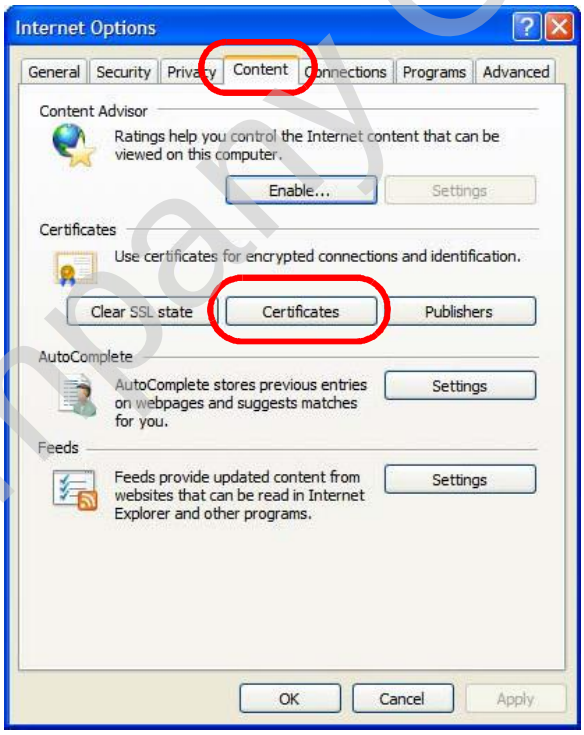
This section shows you how to remove a public key certificate in Internet Explorer 7.

1 **Open Internet Explorer and click TOOLS > Internet Options.**

Figure 202 Internet Explorer 7: Tools Menu

2 **In the Internet Options dialog box, click Content > Certificates.**

Figure 203 Internet Explorer 7: Internet Options



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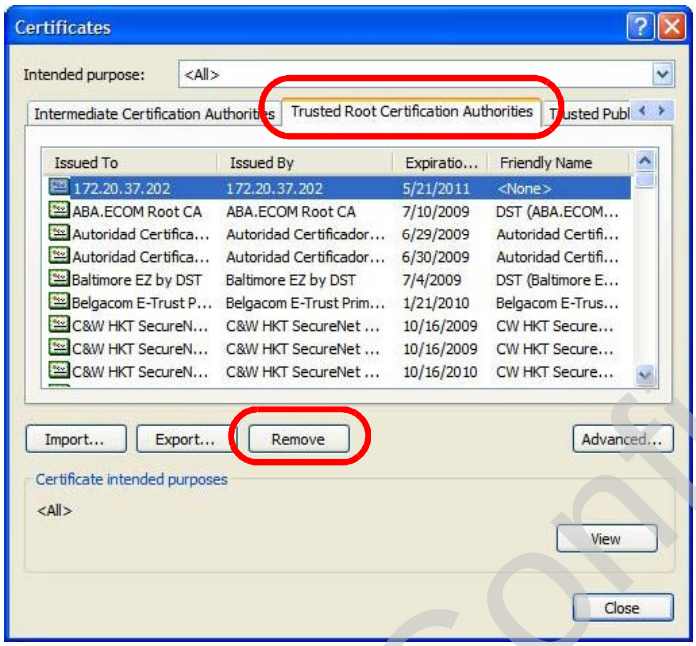
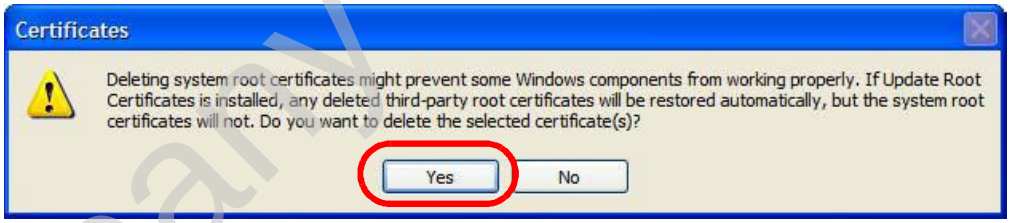
3 **In the Certificates dialog box, click the Trusted Root Certificates Authorities tab, select the certificate that you want to delete, and then click Remove.**

Figure 204 Internet Explorer 7: Certificates



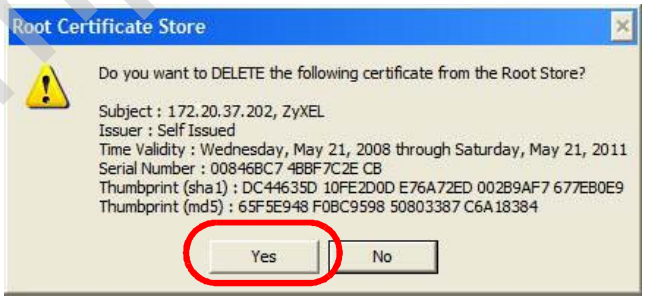
4 **In the Certificates confirmation, click Yes.**

Figure 205 Internet Explorer 7: Certificates



5 **In the Root Certificate Store dialog box, click Yes.**

Figure 206 Internet Explorer 7: Root Certificate Store



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6 **The next time you go to the web site that issued the public key certificate you just removed, a certification error appears.**

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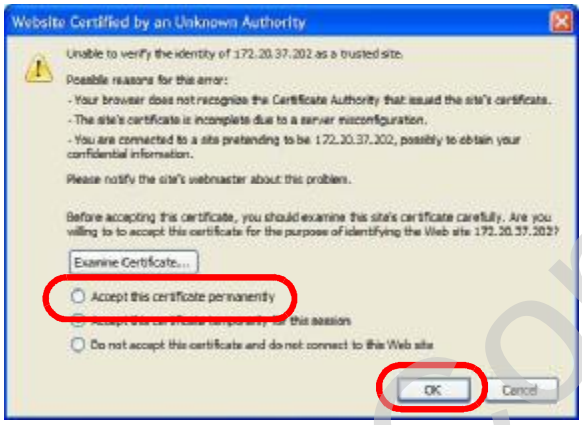
Firefox

The following example uses Mozilla Firefox 2 on Windows XP Professional; however, the screens can also apply to Firefox 2 on all platforms.

1 **If your device's web configurator is set to use SSL certification, then the first time you browse to it you are presented with a certification error.**

2 **Select Accept this certificate permanently and click OK.**

Figure 207 Firefox 2: Website Certified by an Unknown Authority



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3 **The certificate is stored and you can now connect securely to the web configurator. A sealed padlock appears in the address bar, which you can click to open the Page Info > Security window to view the web page's security information.**

Figure 208 Firefox 2: Page Info

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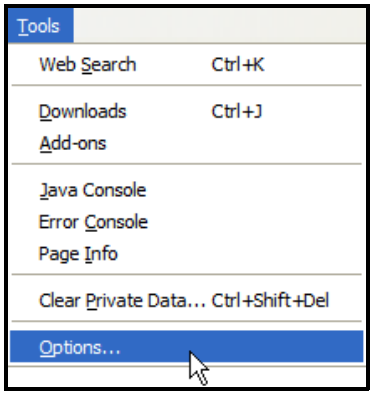
Installing a Stand-Alone Certificate File in Firefox

Rather than browsing to a ZyXEL web configurator and installing a public key certificate when prompted, you can install a stand-alone certificate file if one has been issued to you.

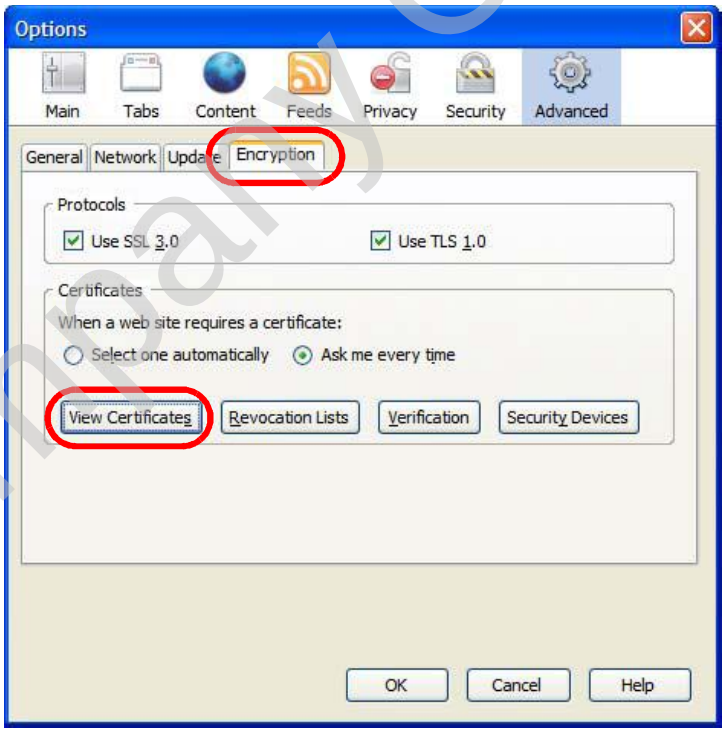
1 **Open Firefox and click TOOLS > Options.**

Figure 209 Firefox 2: Tools Menu



2 **In the Options dialog box, click ADVANCED > Encryption > View Certificates.**

Figure 210 Firefox 2: Options



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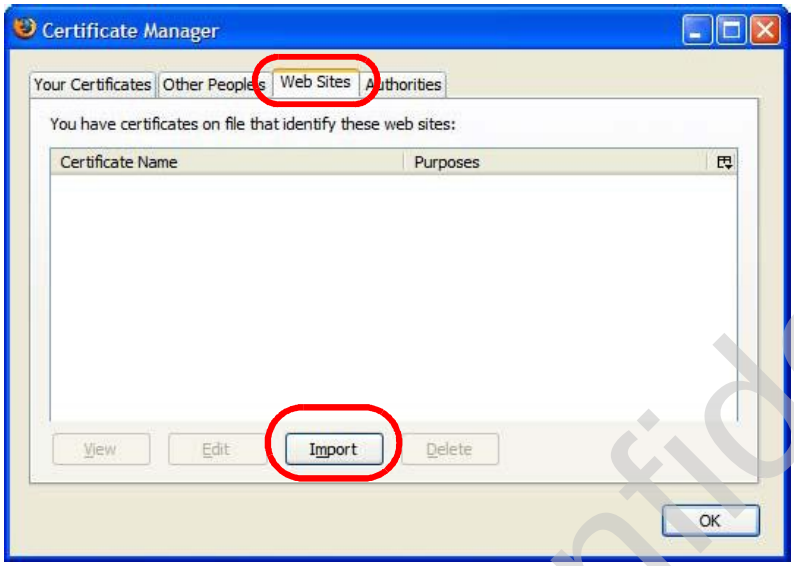
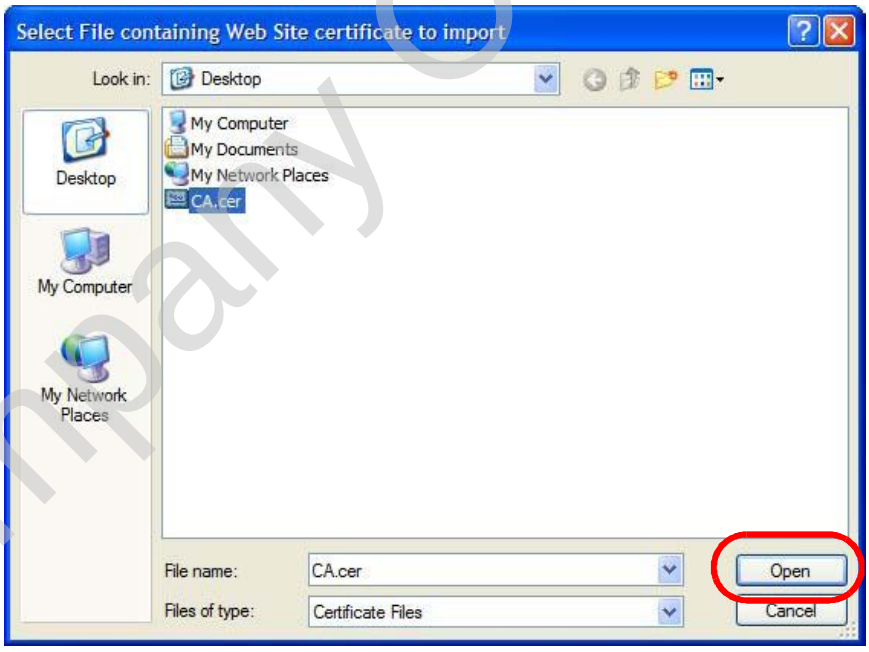
3 **In the Certificate Manager dialog box, click Web Sites > Import.**

Figure 211 Firefox 2: Certificate Manager



4 **Use the Select File dialog box to locate the certificate and then click Open.**

Figure 212 Firefox 2: Select File



5 **The next time you visit the web site, click the padlock in the address bar to open the Page Info > Security window to see the web page's security information.**

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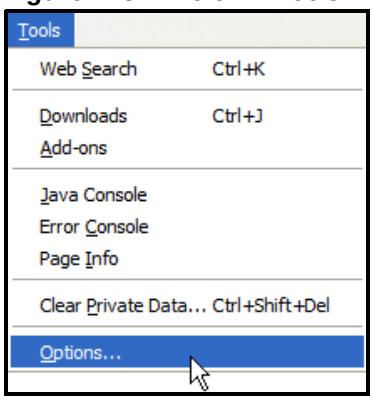
Removing a Certificate in Firefox

This section shows you how to remove a public key certificate in Firefox 2.

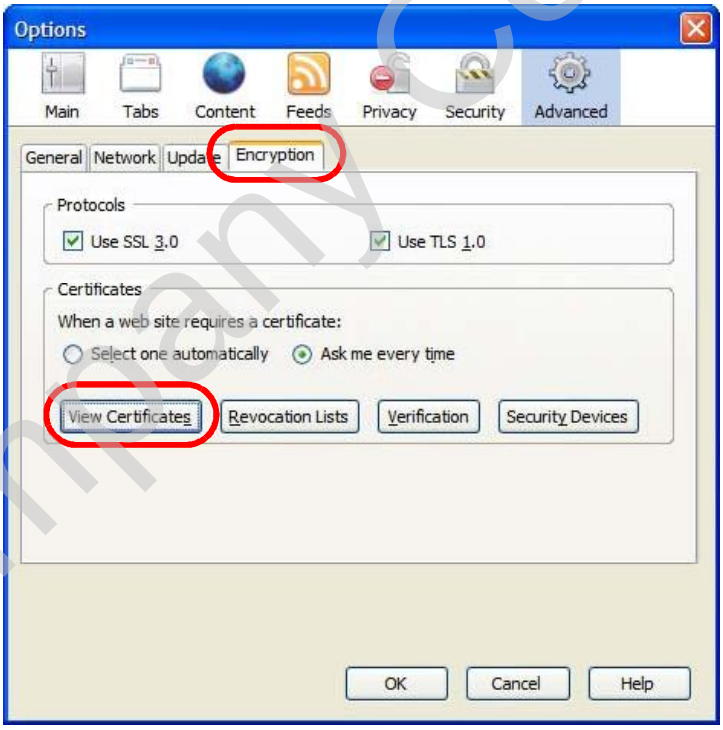
1 **Open Firefox and click TOOLS > Options.**

Figure 213 Firefox 2: Tools Menu



2 **In the Options dialog box, click ADVANCED > Encryption > View Certificates.**

Figure 214 Firefox 2: Options



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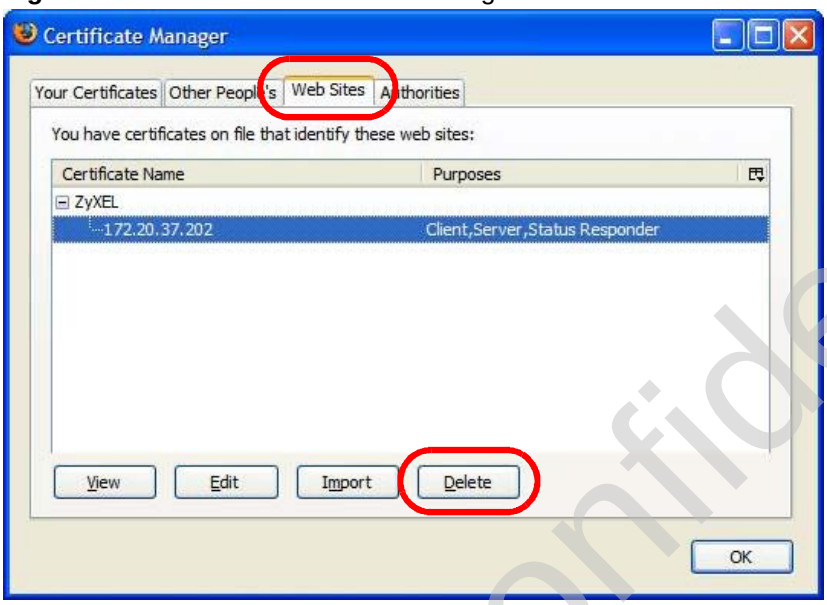
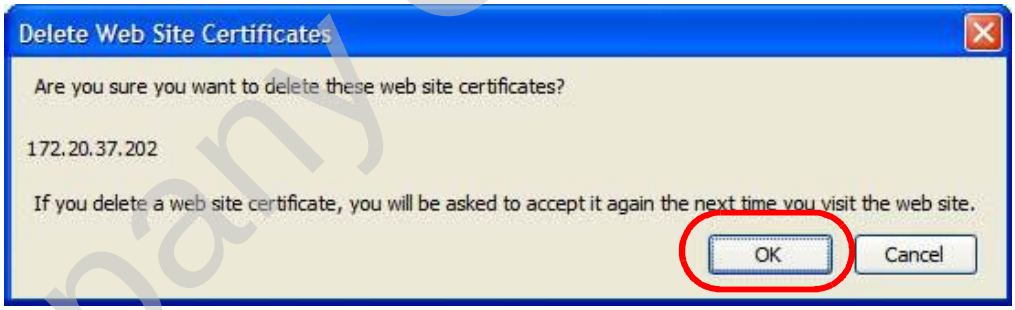
3 **In the Certificate Manager dialog box, select the Web Sites tab, select the certificate that you want to remove, and then click Delete.**

Figure 215 Firefox 2: Certificate Manager



4 **In the Delete Web Site Certificates dialog box, click OK.**

Figure 216 Firefox 2: Delete Web Site Certificates



5 **The next time you go to the web site that issued the public key certificate you just removed, a certification error appears.**

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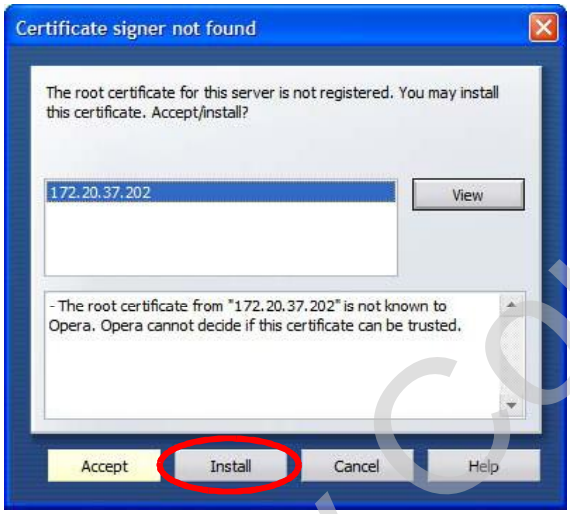
Opera

The following example uses Opera 9 on Windows XP Professional; however, the screens can apply to Opera 9 on all platforms.

1 **If your device's web configurator is set to use SSL certification, then the first time you browse to it you are presented with a certification error.**

2 **Click Install to accept the certificate.**

Figure 217 Opera 9: Certificate signer not found



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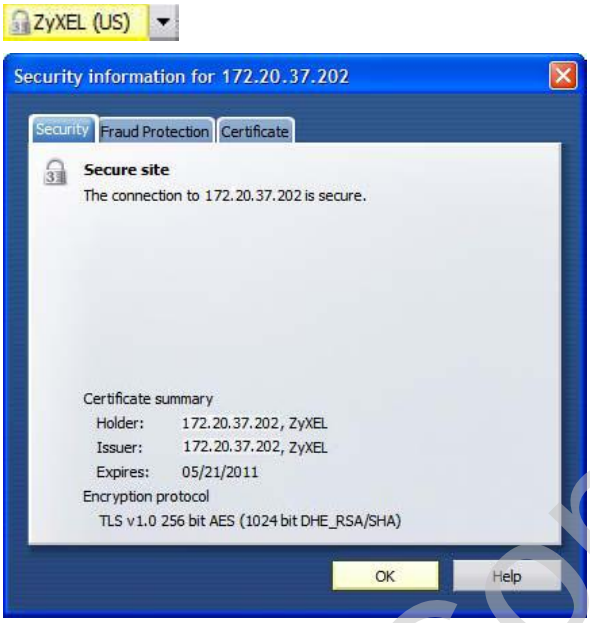
3 **The next time you visit the web site, click the padlock in the address bar to open the Security information window to view the web page's security details.**

Figure 218 Opera 9: Security information



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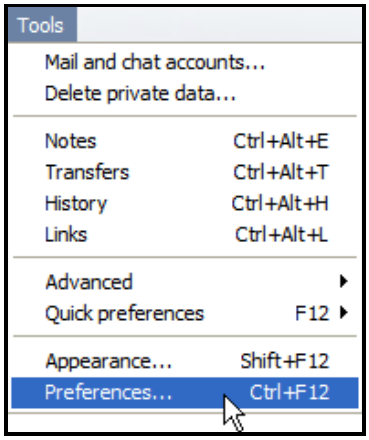
Installing a Stand-Alone Certificate File in Opera

Rather than browsing to a ZyXEL web configurator and installing a public key certificate when prompted, you can install a stand-alone certificate file if one has been issued to you.

1 **Open Opera and click TOOLS > Preferences.**

Figure 219 Opera 9: Tools Menu



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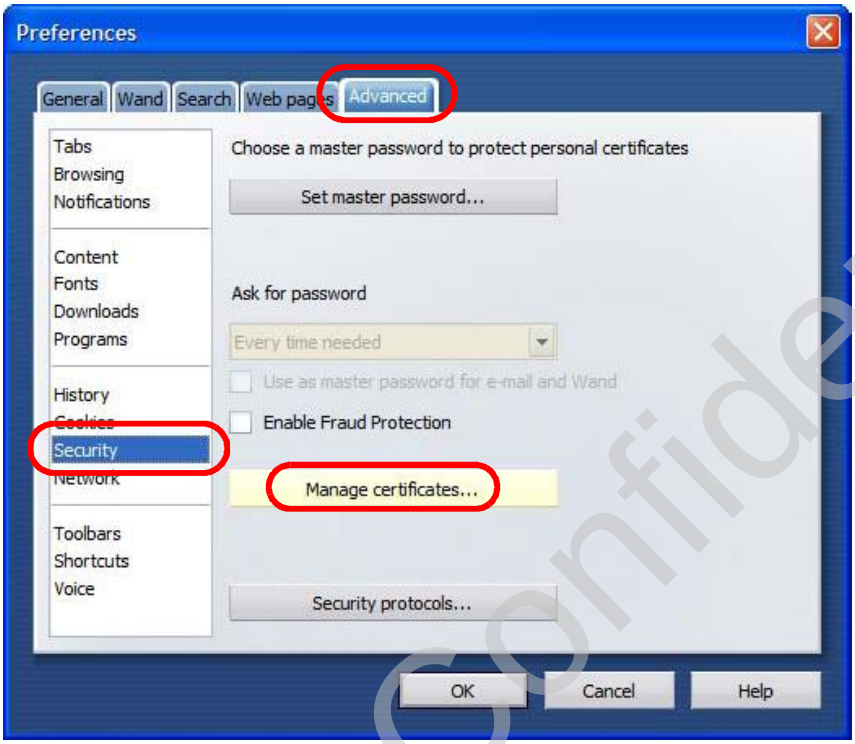
2 **In Preferences, click ADVANCED > Security > Manage certificates.**

Figure 220 Opera 9: Preferences



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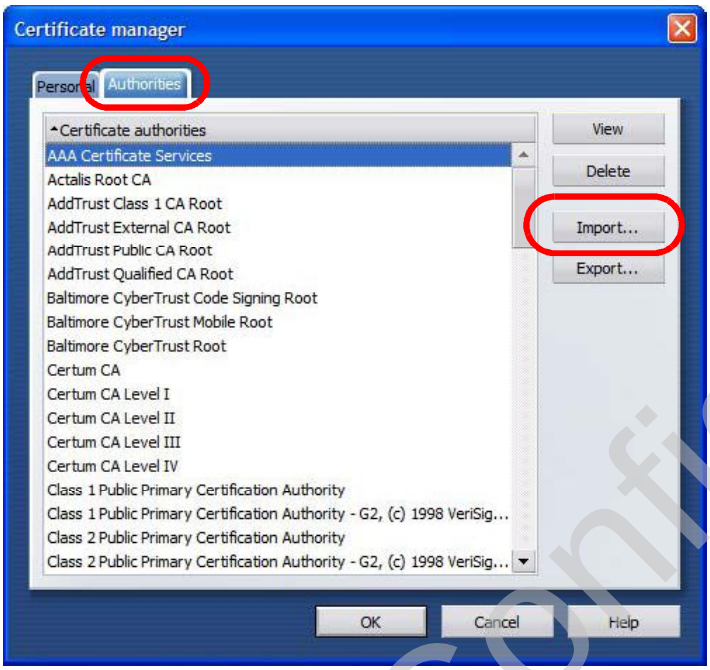
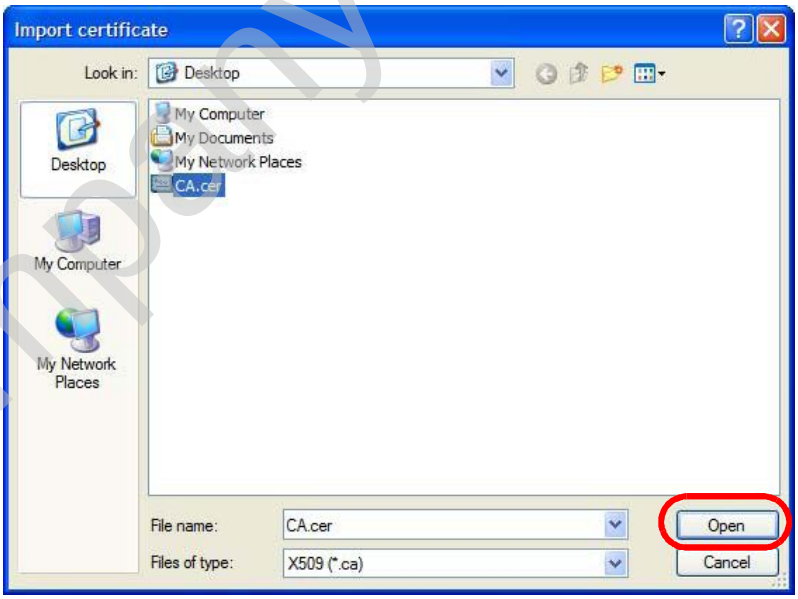
3 **In the Certificates Manager, click Authorities > Import.**

Figure 221 Opera 9: Certificate manager



4 **Use the Import certificate dialog box to locate the certificate and then click Open.**

Figure 222 Opera 9: Import certificate



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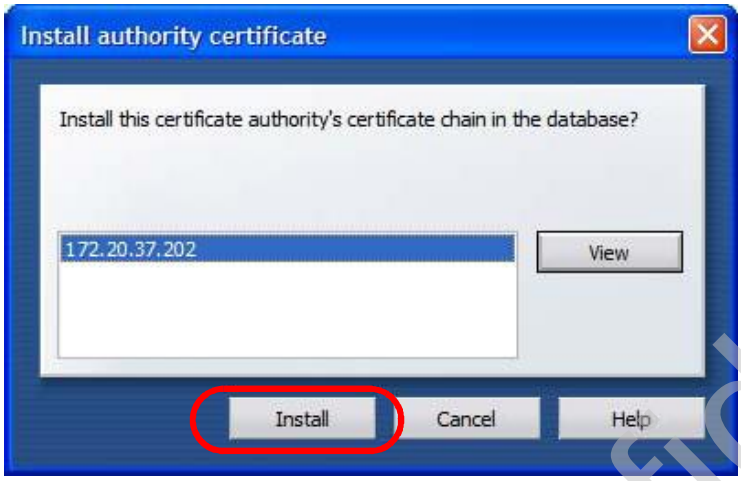
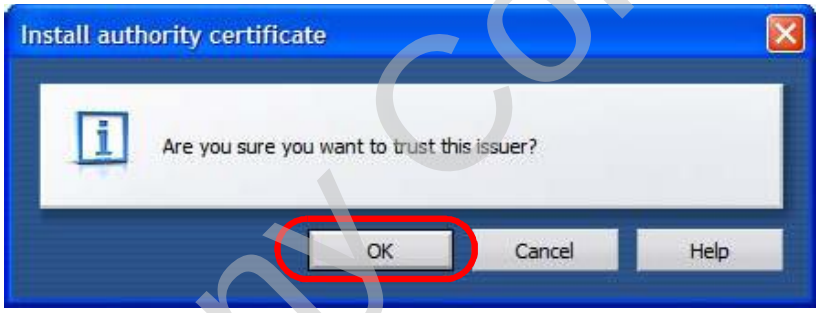
5 **In the Install authority certificate dialog box, click Install.**

Figure 223 Opera 9: Install authority certificate



6 **Next, click OK.**

Figure 224 Opera 9: Install authority certificate



7 **The next time you visit the web site, click the padlock in the address bar to open the Security information window to view the web page's security details.**

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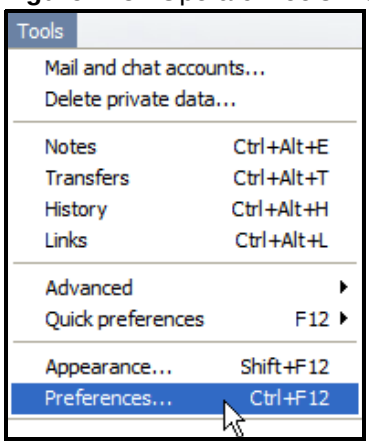
Removing a Certificate in Opera

This section shows you how to remove a public key certificate in Opera 9.

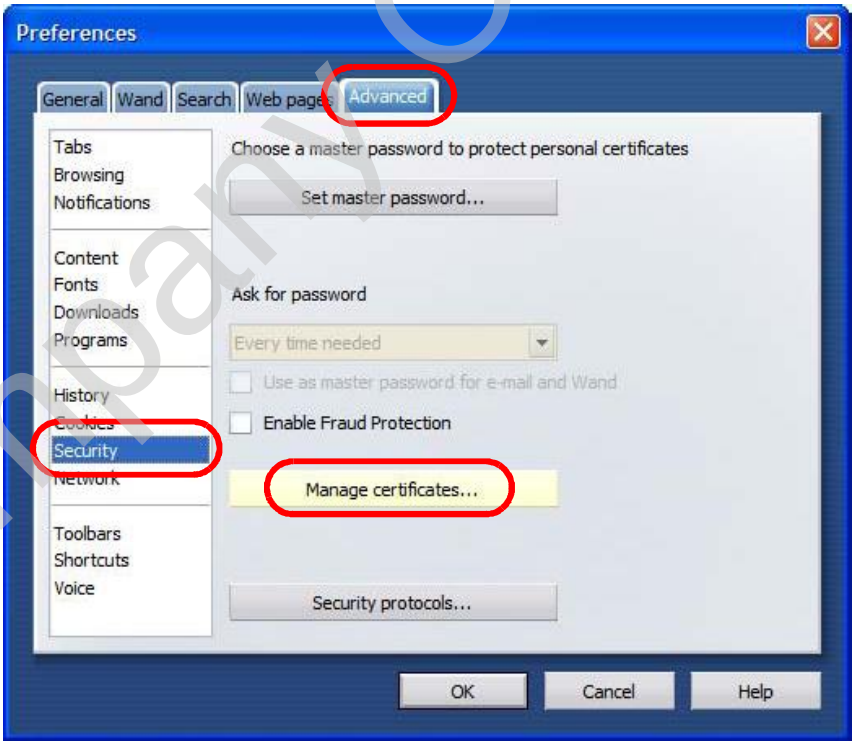
1 **Open Opera and click TOOLS > Preferences.**

Figure 225 Opera 9: Tools Menu



2 **In Preferences, ADVANCED > Security > Manage certificates.**

Figure 226 Opera 9: Preferences



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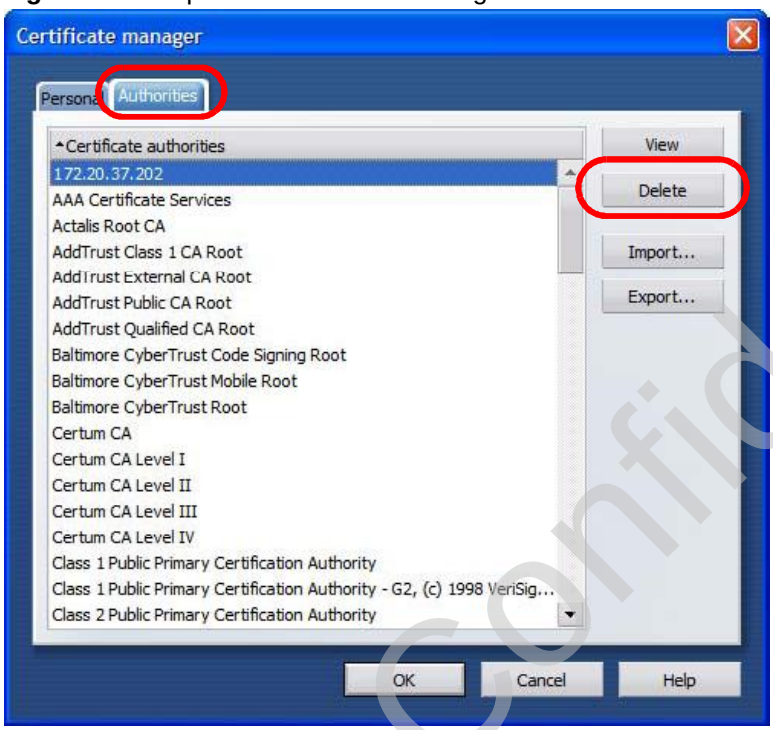
3 **In the Certificates manager, select the Authorities tab, select the certificate that you want to remove, and then click Delete.**

Figure 227 Opera 9: Certificate manager



4 **The next time you go to the web site that issued the public key certificate you just removed, a certification error appears.**

Note: There is no confirmation when you delete a certificate authority, so be absolutely certain that you want to go through with it before clicking the button.

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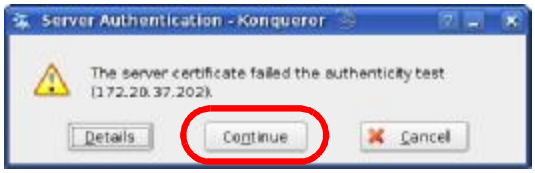
Konqueror

The following example uses Konqueror 3.5 on openSUSE 10.3, however the screens apply to Konqueror 3.5 on all Linux KDE distributions.

1 **If your device's web configurator is set to use SSL certification, then the first time you browse to it you are presented with a certification error.**

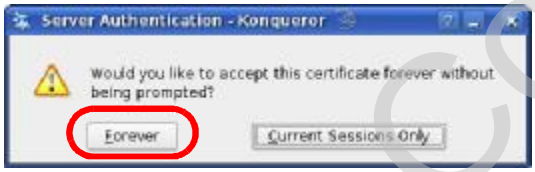
2 **Click Continue.**

Figure 228 Konqueror 3.5: Server Authentication



3 **Click Forever when prompted to accept the certificate.**

Figure 229 Konqueror 3.5: Server Authentication



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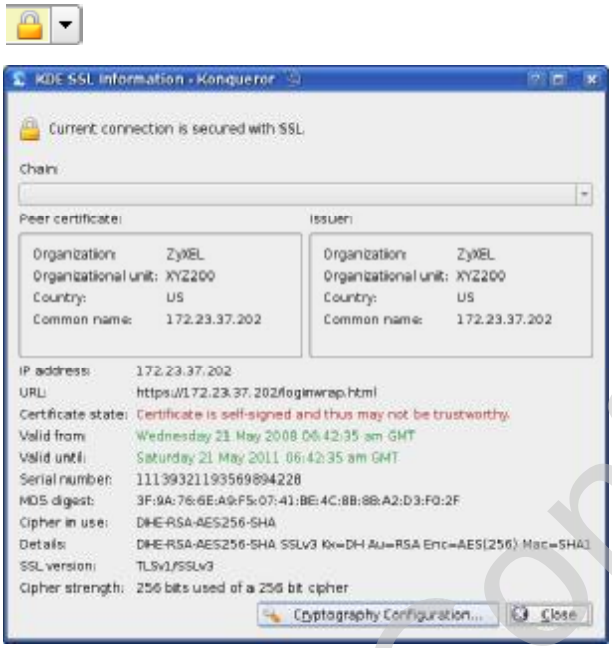
4 **Click the padlock in the address bar to open the KDE SSL Information window and view the web page's security details.**

Figure 230 Konqueror 3.5: KDE SSL Information



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Installing a Stand-Alone Certificate File in Konqueror

Rather than browsing to a ZyXEL web configurator and installing a public key certificate when prompted, you can install a stand-alone certificate file if one has been issued to you.

1 **Double-click the public key certificate file.**

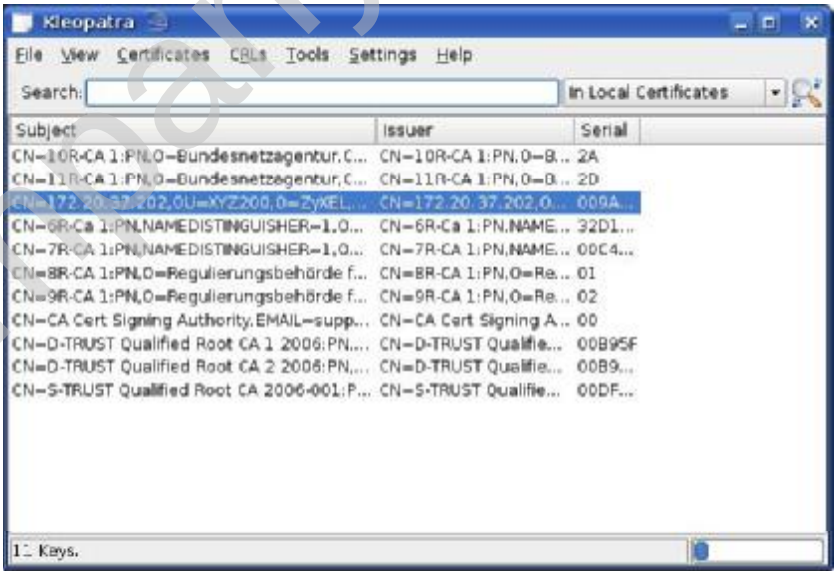
Figure 231 Konqueror 3.5: Public Key Certificate File

2 **In the Certificate Import Result - Kleopatra dialog box, click OK.**

Figure 232 Konqueror 3.5: Certificate Import Result

The public key certificate appears in the KDE certificate manager, Kleopatra.

Figure 233 Konqueror 3.5: Kleopatra



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3 **The next time you visit the web site, click the padlock in the address bar to open the KDE SSL Information window to view the web page's security details.**

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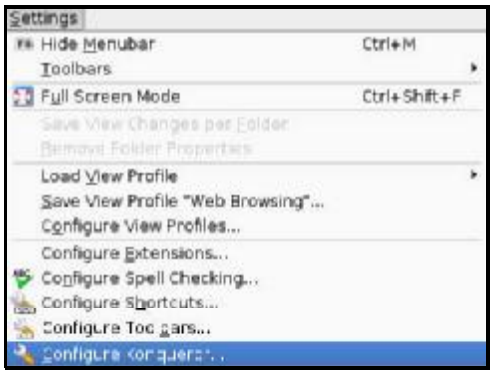
Removing a Certificate in Konqueror

This section shows you how to remove a public key certificate in Konqueror 3.5.

1 **Open Konqueror and click Settings > Configure Konqueror.**

Figure 234 Konqueror 3.5: Settings Menu



2 **In the Configure dialog box, select Crypto.**

3 **On the Peer SSL Certificates tab, select the certificate you want to delete and then click Remove.**

Figure 235 Konqueror 3.5: Configure

4 **The next time you go to the web site that issued the public key certificate you just removed, a certification error appears.**

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Note: There is no confirmation when you remove a certificate authority, so be absolutely certain you want to go through with it before clicking the button.

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G

SIP Passthrough

Enabling/Disabling the SIP ALG

You can turn off the WiMAX Device SIP ALG to avoid retranslating the IP address of an existing SIP device that is using STUN. If you want to use STUN with a SIP client device (a SIP phone or IP phone for example) behind the WiMAX Device, use the `ip alg disable ALG_SIP` command to turn off the SIP ALG.

Signaling Session Timeout

Most SIP clients have an "expire" mechanism indicating the lifetime of signaling sessions. The SIP UA sends registration packets to the SIP server periodically and keeps the session alive in the WiMAX Device.

If the SIP client does not have this mechanism and makes no call during the WiMAX Device SIP timeout default (60 minutes), the WiMAX Device SIP ALG drops any incoming calls after the timeout period. You can use the `ip alg siptimeout` command to change the timeout value.

Audio Session Timeout

If no voice packets go through the SIP ALG before the timeout period default (5 minutes) expires, the SIP ALG does not drop the call but blocks all voice traffic and deletes the audio session. You cannot hear anything and you will need to make a new call to continue your conversation.

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H

Common Services

The following table lists some commonly-used services and their associated protocols and port numbers. For a comprehensive list of port numbers, ICMP type/code numbers and services, visit the IANA (Internet Assigned Number Authority) web site.

- **Name:** This is a short, descriptive name for the service. You can use this one or create a different one, if you like.
- **Protocol:** This is the type of IP protocol used by the service. If this is TCP/UDP, then the service uses the same port number with TCP and UDP. If this is USER-DEFINED, the Port(s) is the IP protocol number, not the port number.
- **Port(s):** This value depends on the Protocol. Please refer to RFC 1700 for further information about port numbers.
  - If the Protocol is TCP, UDP, or TCP/UDP, this is the IP port number.
  - If the Protocol is USER, this is the IP protocol number.
- **Description:** This is a brief explanation of the applications that use this service or the situations in which this service is used.

Table 138 Commonly Used Services

NAME	PROTOCOL	PORT(S)	DESCRIPTION
AH (IPSEC_TUNNEL)	User-Defined	51	The IPSEC AH (Authentication Header) tunneling protocol uses this service.
AIM/New-ICQ	TCP	5190	AOL's Internet Messenger service. It is also used as a listening port by ICQ.
AUTH	TCP	113	Authentication protocol used by some servers.
BGP	TCP	179	Border Gateway Protocol.
BOOTP_CLIENT	UDP	68	DHCP Client.
BOOTP_SERVER	UDP	67	DHCP Server.
CU-SEEME	TCP UDP	7648 24032	A popular videoconferencing solution from White Pines Software.
DNS	TCP/UDP	53	Domain Name Server, a service that matches web names (for example www.zyxel.com) to IP numbers.

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Table 138 Commonly Used Services (continued)

NAME	PROTOCOL	PORT(S)	DESCRIPTION
ESP (IPSEC_TUNNEL)	User-Defined	50	The IPSEC ESP (Encapsulation Security Protocol) tunneling protocol uses this service.
FINGER	TCP	79	Finger is a UNIX or Internet related command that can be used to find out if a user is logged on.
FTP	TCP TCP	20 21	File Transfer Program, a program to enable fast transfer of files, including large files that may not be possible by e-mail.
H.323	TCP	1720	NetMeeting uses this protocol.
HTTP	TCP	80	Hyper Text Transfer Protocol - a client/server protocol for the world wide web.
HTTPS	TCP	443	HTTPS is a secured http session often used in e-commerce.
ICMP	User-Defined	1	Internet Control Message Protocol is often used for diagnostic or routing purposes.
ICQ	UDP	4000	This is a popular Internet chat program.
IGMP (MULTICAST)	User-Defined	2	Internet Group Management Protocol is used when sending packets to a specific group of hosts.
IKE	UDP	500	The Internet Key Exchange algorithm is used for key distribution and management.
IRC	TCP/UDP	6667	This is another popular Internet chat program.
MSN Messenger	TCP	1863	Microsoft Networks' messenger service uses this protocol.
NEW-ICQ	TCP	5190	An Internet chat program.
NEWS	TCP	144	A protocol for news groups.
NFS	UDP	2049	Network File System - NFS is a client/ server distributed file service that provides transparent file sharing for network environments.
NNTP	TCP	119	Network News Transport Protocol is the delivery mechanism for the USENET newsgroup service.
PING	User-Defined	1	Packet INternet Groper is a protocol that sends out ICMP echo requests to test whether or not a remote host is reachable.
POP3	TCP	110	Post Office Protocol version 3 lets a client computer get e-mail from a POP3 server through a temporary connection (TCP/IP or other).

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Table 138 Commonly Used Services (continued)

NAME	PROTOCOL	PORT(S)	DESCRIPTION
PPTP	TCP	1723	Point-to-Point Tunneling Protocol enables secure transfer of data over public networks. This is the control channel.
PPTP_TUNNEL (GRE)	User-Defined	47	PPTP (Point-to-Point Tunneling Protocol) enables secure transfer of data over public networks. This is the data channel.
RCMD	TCP	512	Remote Command Service.
REAL_AUDIO	TCP	7070	A streaming audio service that enables real time sound over the web.
REXEC	TCP	514	Remote Execution Daemon.
RLOGIN	TCP	513	Remote Login.
RTELNET	TCP	107	Remote Telnet.
RTSP	TCP/UDP	554	The Real Time Streaming (media control) Protocol (RTSP) is a remote control for multimedia on the Internet.
SFTP	TCP	115	Simple File Transfer Protocol.
SMTP	TCP	25	Simple Mail Transfer Protocol is the message-exchange standard for the Internet. SMTP enables you to move messages from one e-mail server to another.
SNMP	TCP/UDP	161	Simple Network Management Program.
SNMP-TRAPS	TCP/UDP	162	Traps for use with the SNMP (RFC:1215).
SQL-NET	TCP	1521	Structured Query Language is an interface to access data on many different types of database systems, including mainframes, midrange systems, UNIX systems and network servers.
SSH	TCP/UDP	22	Secure Shell Remote Login Program.
STRM WORKS	UDP	1558	Stream Works Protocol.
SYSLOG	UDP	514	Syslog allows you to send system logs to a UNIX server.
TACACS	UDP	49	Login Host Protocol used for (Terminal Access Controller Access Control System).
TELNET	TCP	23	Telnet is the login and terminal emulation protocol common on the Internet and in UNIX environments. It operates over TCP/IP networks. Its primary function is to allow users to log into remote host systems.

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Table 138 Commonly Used Services (continued)

NAME	PROTOCOL	PORT(S)	DESCRIPTION
TFTP	UDP	69	Trivial File Transfer Protocol is an Internet file transfer protocol similar to FTP, but uses the UDP (User Datagram Protocol) rather than TCP (Transmission Control Protocol).
VDOLIVE	TCP	7000	Another videoconferencing solution.

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Certifications

Federal Communications Commission (FCC) Interference Statement

The device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

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

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.**

FCC Radiation Exposure Statement

- **This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.**
- **To comply with FCC RF exposure compliance requirements, a separation distance of at least 23 cm must be maintained between the antenna of this device and all persons.**

注意 !

依據 低功率電波輻射性電機管理辦法

第十二條 經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

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第十四條　低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。
前項合法通信，指依電信規定作業之無線電信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

本機限在不干擾合法電臺與不受被干擾保障條件下於室內使用。
減少電磁波影響，請妥適使用。

Notices

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

This Class B digital apparatus complies with Canadian ICES-003.

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

Viewing Certifications

1. **Go to http://www.zyxel.com.**
2. **Select your product on the ZyXEL home page to go to that product's page.**
3. **Select the certification you wish to view from this page.**

ZyXEL Limited Warranty

ZyXEL warrants to the original end user (purchaser) that this product is free from any defects in materials or workmanship for a period of up to two years from the date of purchase. During the warranty period, and upon proof of purchase, should the product have indications of failure due to faulty workmanship and/or materials, ZyXEL will, at its discretion, repair or replace the defective products or components without charge for either parts or labor, and to whatever extent it shall deem necessary to restore the product or components to proper operating condition. Any replacement will consist of a new or re-manufactured functionally equivalent product of equal or higher value, and will be solely at the discretion of ZyXEL. This warranty shall not apply if the product has been modified, misused, tampered with, damaged by an act of God, or subjected to abnormal working conditions.

Note

Repair or replacement, as provided under this warranty, is the exclusive remedy of the purchaser. This warranty is in lieu of all other warranties, express or

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Customer Support

In the event of problems that cannot be solved by using this manual, you should contact your vendor. If you cannot contact your vendor, then contact a ZyXEL office for the region in which you bought the device. Regional offices are listed below (see also http://www.zyxel.com/web/contact_us.php). Please have the following information ready when you contact an office.

Required Information

- Product model and serial number.
- Warranty Information.
- Date that you received your device.
- Brief description of the problem and the steps you took to solve it.

"+" is the (prefix) number you dial to make an international telephone call.

Corporate Headquarters (Worldwide)

- Support E-mail: support@zyxel.com.tw
- Sales E-mail: sales@zyxel.com.tw
- Telephone: +886-3-578-3942
- Fax: +886-3-578-2439
- Web: www.zyxel.com
- Regular Mail: ZyXEL Communications Corp., 6 Innovation Road II, Science Park, Hsinchu 300, Taiwan

China - ZyXEL Communications (Beijing) Corp.

- Support E-mail: cso.zycn@zyxel.cn
- Sales E-mail: sales@zyxel.cn
- Telephone: +86-010-82800646
- Fax: +86-010-82800587
- Address: 902, Unit B, Horizon Building, No.6, Zhichun Str, Haidian District, Beijing
- Web: http://www.zyxel.cn

Company Confidential

China - ZyXEL Communications (Shanghai) Corp.

- **Support E-mail: cso.zycn@zyxel.cn**
- **Sales E-mail: sales@zyxel.cn**
- **Telephone: +86-021-61199055**
- **Fax: +86-021-52069033**
- **Address: 1005F, ShengGao International Tower, No.137 XianXia Rd., Shanghai**
- **Web: http://www.zyxel.cn**

Costa Rica

- **Support E-mail: soporte@zyxel.co.cr**
- **Sales E-mail: sales@zyxel.co.cr**
- **Telephone: +506-2017878**
- **Fax: +506-2015098**
- **Web: www.zyxel.co.cr**
- **Regular Mail: ZyXEL Costa Rica, Plaza Roble Escazú, Etapa El Patio, Tercer Piso, San José, Costa Rica**

Czech Republic

- **E-mail: info@cz.zyxel.com**
- **Telephone: +420-241-091-350**
- **Fax: +420-241-091-359**
- **Web: www.zyxel.cz**
- **Regular Mail: ZyXEL Communications, Czech s.r.o., Modranská 621, 143 01 Praha 4 - Modrany, Ceská Republika**

Denmark

- **Support E-mail: support@zyxel.dk**
- **Sales E-mail: sales@zyxel.dk**
- **Telephone: +45-39-55-07-00**
- **Fax: +45-39-55-07-07**
- **Web: www.zyxel.dk**
- **Regular Mail: ZyXEL Communications A/S, Columbusvej, 2860 Soeborg, Denmark**

Finland

- **Support E-mail: support@zyxel.fi**
- **Sales E-mail: sales@zyxel.fi**
- **Telephone: +358-9-4780-8411**

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- **Fax: +358-9-4780-8448**
- **Web: www.zyxel.fi**
- **Regular Mail: ZyXEL Communications Oy, Malminkaari 10, 00700 Helsinki, Finland**

France

- **E-mail: info@zyxel.fr**
- **Telephone: +33-4-72-52-97-97**
- **Fax: +33-4-72-52-19-20**
- **Web: www.zyxel.fr**
- **Regular Mail: ZyXEL France, 1 rue des Vergers, Bat. 1 / C, 69760 Limonest, France**

Germany

- **Support E-mail: support@zyxel.de**
- **Sales E-mail: sales@zyxel.de**
- **Telephone: +49-2405-6909-69**
- **Fax: +49-2405-6909-99**
- **Web: www.zyxel.de**
- **Regular Mail: ZyXEL Deutschland GmbH., Adenauerstr. 20/A2 D-52146, Wuerselen, Germany**

Hungary

- **Support E-mail: support@zyxel.hu**
- **Sales E-mail: info@zyxel.hu**
- **Telephone: +36-1-3361649**
- **Fax: +36-1-3259100**
- **Web: www.zyxel.hu**
- **Regular Mail: ZyXEL Hungary, 48, Zoldlomb Str., H-1025, Budapest, Hungary**

India

- **Support E-mail: support@zyxel.in**
- **Sales E-mail: sales@zyxel.in**
- **Telephone: +91-11-30888144 to +91-11-30888153**
- **Fax: +91-11-30888149, +91-11-26810715**
- **Web: http://www.zyxel.in**
- **Regular Mail: India - ZyXEL Technology India Pvt Ltd., II-Floor, F2/9 Okhla Phase -1, New Delhi 110020, India**

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Japan

- **Support E-mail: support@zyxel.co.jp**
- **Sales E-mail: zyp@zyxel.co.jp**
- **Telephone: +81-3-6847-3700**
- **Fax: +81-3-6847-3705**
- **Web: www.zyxel.co.jp**
- **Regular Mail: ZyXEL Japan, 3F, Office T&U, 1-10-10 Higashi-Gotanda, Shinagawa-ku, Tokyo 141-0022, Japan**

Kazakhstan

- **Support: http://zyxel.kz/support**
- **Sales E-mail: sales@zyxel.kz**
- **Telephone: +7-3272-590-698**
- **Fax: +7-3272-590-689**
- **Web: www.zyxel.kz**
- **Regular Mail: ZyXEL Kazakhstan, 43 Dostyk Ave., Office 414, Dostyk Business Centre, 050010 Almaty, Republic of Kazakhstan**

Malaysia

- **Support E-mail: support@zyxel.com.my**
- **Sales E-mail: sales@zyxel.com.my**
- **Telephone: +603-8076-9933**
- **Fax: +603-8076-9833**
- **Web: http://www.zyxel.com.my**
- **Regular Mail: ZyXEL Malaysia Sdn Bhd., 1-02 & 1-03, Jalan Kenari 17F, Bandar Puchong Jaya, 47100 Puchong, Selangor Darul Ehsan, Malaysia**

North America

- **Support E-mail: support@zyxel.com**
- **Support Telephone: +1-800-978-7222**
- **Sales E-mail: sales@zyxel.com**
- **Sales Telephone: +1-714-632-0882**
- **Fax: +1-714-632-0858**
- **Web: www.zyxel.com**
- **Regular Mail: ZyXEL Communications Inc., 1130 N. Miller St., Anaheim, CA 92806-2001, U.S.A.**

Norway

- **Support E-mail: support@zyxel.no**

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- **Fax: +47-22-80-61-81**
- **Web: www.zyxel.no**
- **Regular Mail: ZyXEL Communications A/S, Nils Hansens vei 13, 0667 Oslo, Norway**

Poland

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- **Regular Mail: ZyXEL Communications, ul. Okrzei 1A, 03-715 Warszawa, Poland**

Russia

- **Support: http://zyxel.ru/support**
- **Sales E-mail: sales@zyxel.ru**
- **Telephone: +7-095-542-89-29**
- **Fax: +7-095-542-89-25**
- **Web: www.zyxel.ru**
- **Regular Mail: ZyXEL Russia, Ostrovityanova 37a Str., Moscow 117279, Russia**

Singapore

- **Support E-mail: support@zyxel.com.sg**
- **Sales E-mail: sales@zyxel.com.sg**
- **Telephone: +65-6899-6678**
- **Fax: +65-6899-8887**
- **Web: http://www.zyxel.com.sg**
- **Regular Mail: ZyXEL Singapore Pte Ltd., No. 2 International Business Park, The Strategy #03-28, Singapore 609930**

Spain

- **Support E-mail: support@zyxel.es**
- **Sales E-mail: sales@zyxel.es**
- **Telephone: +34-902-195-420**
- **Fax: +34-913-005-345**
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Sweden

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- **Web: www.zyxel.se**
- **Regular Mail: ZyXEL Communications A/S, Sjöporten 4, 41764 Göteborg, Sweden**

Taiwan

- **Support E-mail: support@zyxel.com.tw**
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- **Telephone: +886-2-27399889**
- **Fax: +886-2-27353220**
- **Web: http://www.zyxel.com.tw**
- **Address: Room B, 21F., No.333, Sec. 2, Dunhua S. Rd., Da-an District, Taipei**

Thailand

- **Support E-mail: support@zyxel.co.th**
- **Sales E-mail: sales@zyxel.co.th**
- **Telephone: +662-831-5315**
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- **Web: http://www.zyxel.co.th**
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Turkey

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Ukraine

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- **Sales E-mail: sales@ua.zyxel.com**
- **Telephone: +380-44-247-69-78**

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- **Regular Mail: ZyXEL Ukraine, 13, Pimonenko Str., Kiev 04050, Ukraine**

United Kingdom

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- **Sales E-mail: sales@zyxel.co.uk**
- **Telephone: +44-1344-303044, 0845 122 0301 (UK only)**
- **Fax: +44-1344-303034**
- **Web: www.zyxel.co.uk**
- **Regular Mail: ZyXEL Communications UK Ltd., 11 The Courtyard, Eastern Road, Bracknell, Berkshire RG12 2XB, United Kingdom (UK)**

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