

Product Specifications

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

20.1 General ZyXEL Device Specifications

The following tables summarize the ZyXEL Device's hardware and firmware features.

Table 75 Hardware Specifications

SPECIFICATION	DESCRIPTION
Dimensions (W x D x H)	190 x 128 x 33 mm
Weight	3.6 Kg
Power	(devices that do not use an external power adaptor) AC: 100 - 240V 50/60Hz 1.5A maximum input internal universal power supply DC: 48 - 60V 1.5A max, 48 Watt consumption. There is no tolerance for the DC input voltage. This note is needed for DC powered devices, not AC.
Ethernet Ports	Auto-negotiating: 10 Mbps or 100 Mbps in either half-duplex or full-duplex mode. Auto-crossover: Use either crossover or straight-through Ethernet cables.
Line/Phone Ports	RJ-11 telephone wires.
LEDs	
Operating Environment	Temperature: 0° C ~ 50° C Humidity: 20% ~ 95% RH
Storage Environment	Temperature: -20° C ~ 60° C Humidity: 10% ~ 90% RH
Distance between the centers of the holes (for wall mounting) on the ZyXEL Device's back.	125 mm

Table 75 Hardware Specifications

SPECIFICATION	DESCRIPTION
Recommended type of screws for wall-mounting	M4 Tap Screw, see Figure 110 on page 206 .
Approvals	<p>Safety</p> <p>ANSI/UL Std No. 60950-1 CAN/CSA-C22.2 No 60950-1-03 EN 60950-1 1st Edition IEC 60950-1 1st Edition</p> <p>EMI</p> <p>FCC Part 15 Class B C-Tick EN55022 Class B (1998+A1:2000+A2: 2003) EN61000-3-2: 2000 EN61000-3-3: 1995+A1:2001</p> <p>EMS</p> <p>EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-8, EN61000-4-11, FCC Part 68, K.21 4KV by default.</p> <p>RF</p> <p>EN 301 489 -1/17 EN 300 328 FCC Part 15.207/209/247</p>

Table 76 Firmware Specifications

FEATURE	DESCRIPTION
Default IP Address	192.168.1.1
Default Subnet Mask	255.255.255.0 (24 bits)
Default Password	1234
DHCP Pool	192.168.1.33 to 192.168.1.64
Device Management	Use the web configurator to easily configure the rich range of features on the ZyXEL Device.
Wireless Functionality	Allow the IEEE 802.11b and/or IEEE 802.11g wireless clients to connect to the ZyXEL Device wirelessly. Enable wireless security (WEP, WPA(2), WPA(2)-PSK) and/or MAC filtering to protect your wireless network.
Firmware Upgrade	<p>Download new firmware (when available) from the ZyXEL web site and use the web configurator, an FTP or a TFTP tool to put it on the ZyXEL Device.</p> <p>Note: Only upload firmware for your specific model!</p>
Configuration Backup & Restoration	Make a copy of the ZyXEL Device's configuration. You can put it back on the ZyXEL Device later if you decide to revert back to an earlier configuration.
Network Address Translation (NAT)	Each computer on your network must have its own unique IP address. Use NAT to convert your public IP address(es) to multiple private IP addresses for the computers on your network.
Port Forwarding	If you have a server (mail or web server for example) on your network, you can use this feature to let people access it from the Internet.
DHCP (Dynamic Host Configuration Protocol)	Use this feature to have the ZyXEL Device assign IP addresses, an IP default gateway and DNS servers to computers on your network.

Table 76 Firmware Specifications

FEATURE	DESCRIPTION
Dynamic DNS Support	With Dynamic DNS (Domain Name System) support, you can use a fixed URL, www.zyxel.com for example, with a dynamic IP address. You must register for this service with a Dynamic DNS service provider.
IP Multicast	IP multicast is used to send traffic to a specific group of computers. The ZyXEL Device supports versions 1 and 2 of IGMP (Internet Group Management Protocol) used to join multicast groups (see RFC 2236).
IP Alias	IP alias allows you to subdivide a physical network into logical networks over the same Ethernet interface with the ZyXEL Device itself as the gateway for each subnet.
Time and Date	Get the current time and date from an external server when you turn on your ZyXEL Device. You can also set the time manually. These dates and times are then used in logs.
Logging and Tracing	Use packet tracing and logs for troubleshooting. You can send logs from the ZyXEL Device to an external syslog server.
PPPoE	PPPoE mimics a dial-up Internet access connection.
PPTP Encapsulation	Point-to-Point Tunneling Protocol (PPTP) enables secure transfer of data through a Virtual Private Network (VPN). The ZyXEL Device supports one PPTP connection at a time.
Universal Plug and Play (UPnP)	A UPnP-enabled device can dynamically join a network, obtain an IP address and convey its capabilities to other devices on the network.
RoadRunner Support	The ZyXEL Device supports Time Warner's RoadRunner Service in addition to standard cable modem services.
Firewall	You can configure firewall on the ZyXEL Device for secure Internet access. When the firewall is on, by default, all incoming traffic from the Internet to your network is blocked unless it is initiated from your network. This means that probes from the outside to your network are not allowed, but you can safely browse the Internet and download files for example.
Content Filter	The ZyXEL Device blocks or allows access to web sites that you specify and blocks access to web sites with URLs that contain keywords that you specify. You can define time periods and days during which content filtering is enabled. You can also include or exclude particular computers on your network from content filtering. You can also subscribe to category-based content filtering that allows your ZyXEL Device to check web sites against an external database.
Bandwidth Management	You can efficiently manage traffic on your network by reserving bandwidth and giving priority to certain types of traffic and/or to particular computers.
Remote Management	This allows you to decide whether a service (HTTP or FTP traffic for example) from a computer on a network (LAN or WAN for example) can access the ZyXEL Device.

The following list, which is not exhaustive, illustrates the standards supported in the ZyXEL Device.

Table 77 Standards Supported

STANDARD	DESCRIPTION
RFC 867	Daytime Protocol
RFC 868	Time Protocol.
RFC 1058	RIP-1 (Routing Information Protocol)

Table 77 Standards Supported (continued)

STANDARD	DESCRIPTION
RFC 1112	IGMP v1
RFC 1157	SNMPv1: Simple Network Management Protocol version 1
RFC 1305	Network Time Protocol (NTP version 3)
RFC 1441	SNMPv2 Simple Network Management Protocol version 2
RFC 1483	Multiprotocol Encapsulation over ATM Adaptation Layer 5
RFC 1631	IP Network Address Translator (NAT)
RFC 1661	The Point-to-Point Protocol (PPP)
RFC 1723	RIP-2 (Routing Information Protocol)
RFC 1901	SNMPv2c Simple Network Management Protocol version 2c
RFC 2236	Internet Group Management Protocol, Version 2.
RFC 2364	PPP over AAL5 (PPP over ATM over ADSL)
RFC 2408	Internet Security Association and Key Management Protocol (ISAKMP)
RFC 2516	A Method for Transmitting PPP Over Ethernet (PPPoE)
RFC 2684	Multiprotocol Encapsulation over ATM Adaptation Layer 5.
RFC 2766	Network Address Translation - Protocol
IEEE 802.11	Also known by the brand Wi-Fi, denotes a set of Wireless LAN/WLAN standards developed by working group 11 of the IEEE LAN/MAN Standards Committee (IEEE 802).
IEEE 802.11b	Uses the 2.4 gigahertz (GHz) band
IEEE 802.11g	Uses the 2.4 gigahertz (GHz) band
IEEE 802.11g+	Turbo and Super G modes
IEEE 802.11d	Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges
IEEE 802.11x	Port Based Network Access Control.
IEEE 802.11e QoS	IEEE 802.11 e Wireless LAN for Quality of Service
ANSI T1.413, Issue 2	Asymmetric Digital Subscriber Line (ADSL) standard.
G dmt(G.992.1)	G.992.1 Asymmetrical Digital Subscriber Line (ADSL) Transceivers
ITU G.992.1 (G.DMT)	ITU standard for ADSL using discrete multitone modulation.
ITU G.992.2 (G. Lite)	ITU standard for ADSL using discrete multitone modulation.
ITU G.992.3 (G.dmt.bis)	ITU standard (also referred to as ADSL2) that extends the capability of basic ADSL in data rates.
ITU G.992.4 (G.lite.bis)	ITU standard (also referred to as ADSL2) that extends the capability of basic ADSL in data rates.
ITU G.992.5 (ADSL2+)	ITU standard (also referred to as ADSL2+) that extends the capability of basic ADSL by doubling the number of downstream bits.
ITU-T G.993.1 (VDSL)	ITU standard that defines VDSL.
ITU-T G.993.2 (VDSL2)	ITU standard that defines VDSL2.
Microsoft PPTP	MS PPTP (Microsoft's implementation of Point to Point Tunneling Protocol)
MBM v2	Media Bandwidth Management v2
RFC 2383	ST2+ over ATM Protocol Specification - UNI 3.1 Version

Table 77 Standards Supported (continued)

STANDARD	DESCRIPTION
TR-069	TR-069 DSL Forum Standard for CPE Wan Management.
1.363.5	Compliant AAL5 SAR (Segmentation And Re-assembly)

20.2 Wall-mounting Instructions

Complete the following steps to hang your ZyXEL Device on a wall.



See [Table 75 on page 201](#) for the size of screws to use and how far apart to place them.

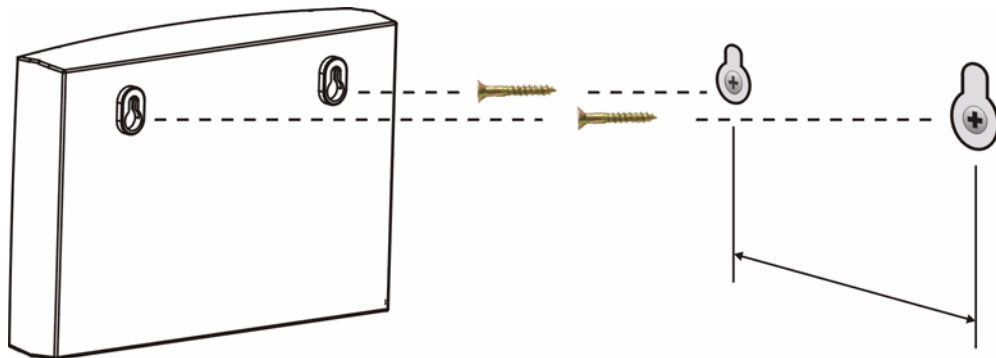
- 1 Select a position free of obstructions on a sturdy wall.
- 2 Drill two holes for the screws.



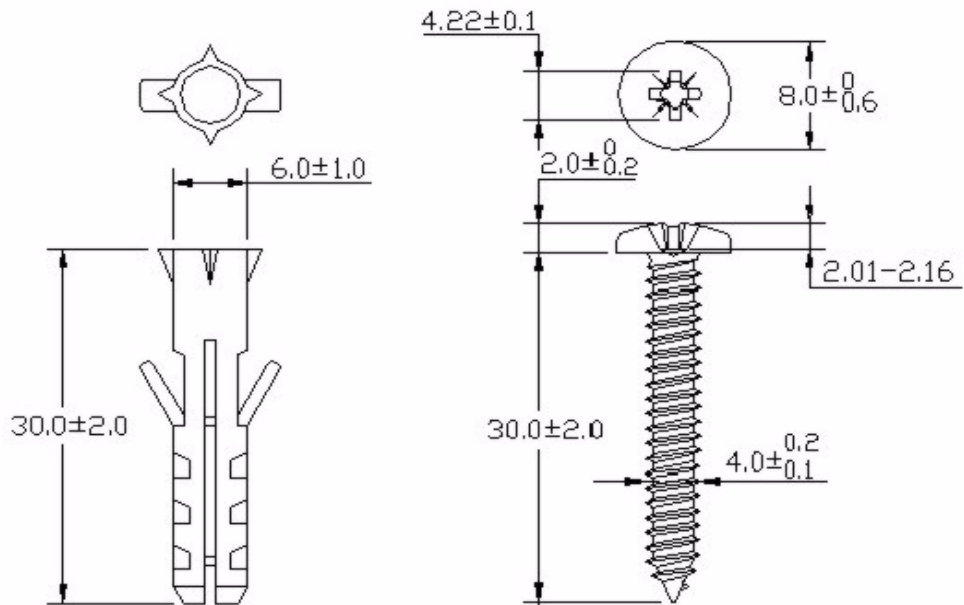
Be careful to avoid damaging pipes or cables located inside the wall when drilling holes for the screws.

- 3 Do not insert the screws all the way into the wall. Leave a small gap of about 0.5 cm between the heads of the screws and the wall.
- 4 Make sure the screws are snugly fastened to the wall. They need to hold the weight of the ZyXEL Device with the connection cables.
- 5 Align the holes on the back of the ZyXEL Device with the screws on the wall. Hang the ZyXEL Device on the screws.

Figure 109 Wall-mounting Example



The following are dimensions of an M4 tap screw and masonry plug used for wall mounting. All measurements are in millimeters (mm).

Figure 110 Masonry Plug and M4 Tap Screw

20.3 Power Adaptor Specifications

Table 78 Power Adaptor Specifications

AC Power Adaptor Model	MU12-2050200-A1
Input Power	100~240 Volts AC / 50~60Hz/0.25A
Output Power	5 Volts DC / 2A
Power Consumption	10 W
Safety Standards	UL (UL 1950), CSA (CSA 22.2) CE mark, EN60950 (2001) T-Mark C-tick, QAS

PART VI

Appendices

- Pop-up Windows, JavaScripts and Java Permissions (209)
- Wireless LANs (217)
- Common Services (231)
- Legal Information (235)
- Customer Support (241)

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).



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

Internet Explorer Pop-up Blockers

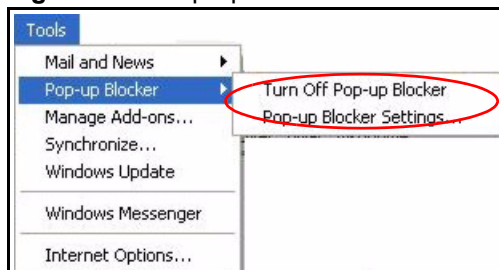
You may have to disable pop-up blocking to log into your device.

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 111 Pop-up Blocker

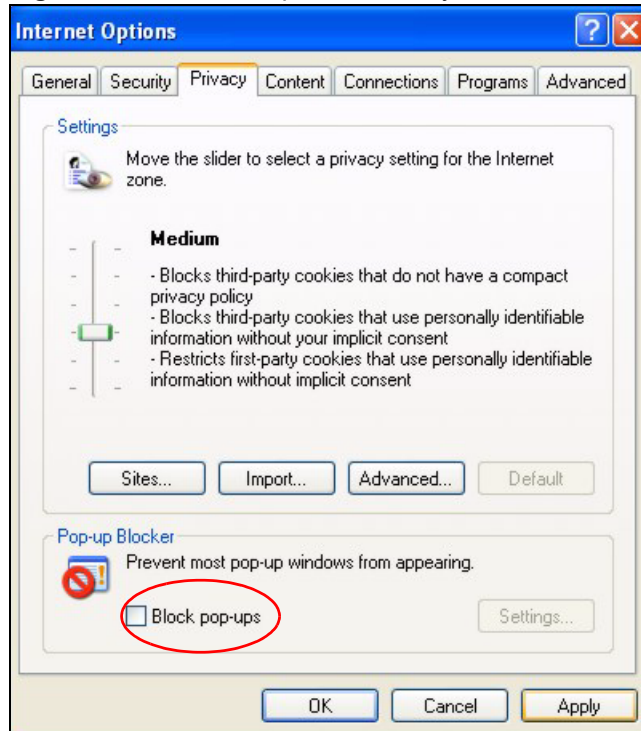


You can also check if pop-up blocking is disabled in the **Pop-up Blocker** section in the **Privacy** tab.

- 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 112 Internet Options: Privacy

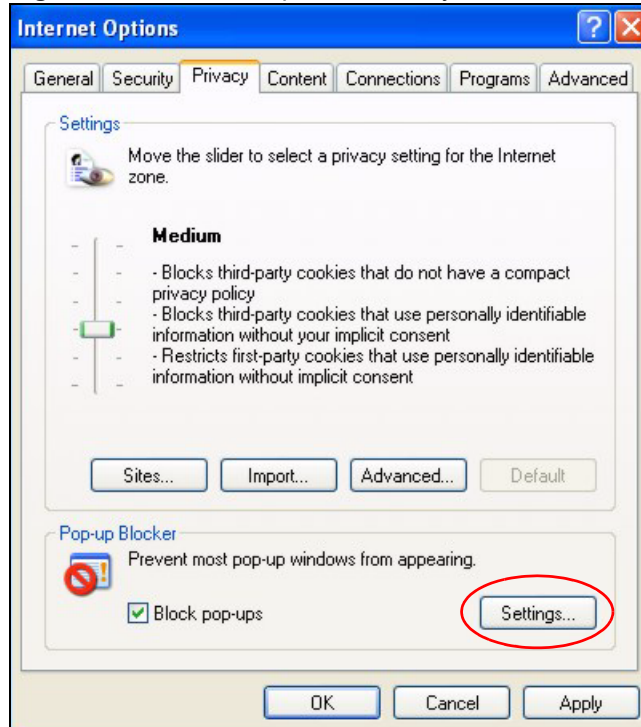


- 3 Click **Apply** to save this setting.

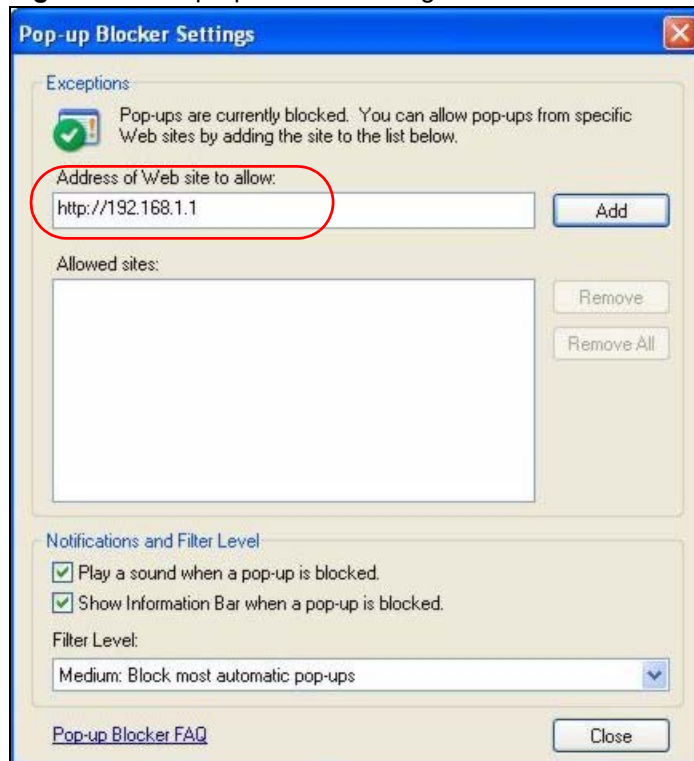
Enable Pop-up Blockers with Exceptions

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

Figure 113 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.
- 4 Click **Add** to move the IP address to the list of **Allowed sites**.

Figure 114 Pop-up Blocker Settings

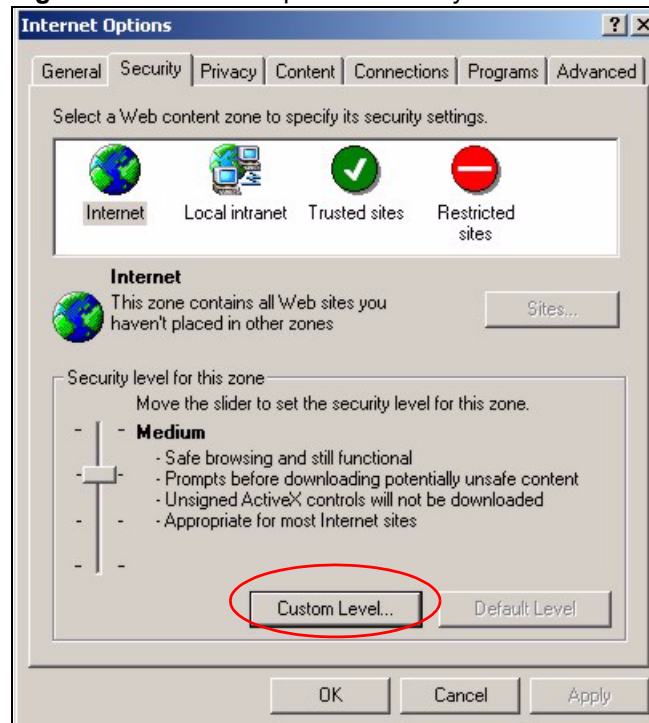
- 5 Click **Close** to return to the **Privacy** screen.
- 6 Click **Apply** to save this setting.

JavaScripts

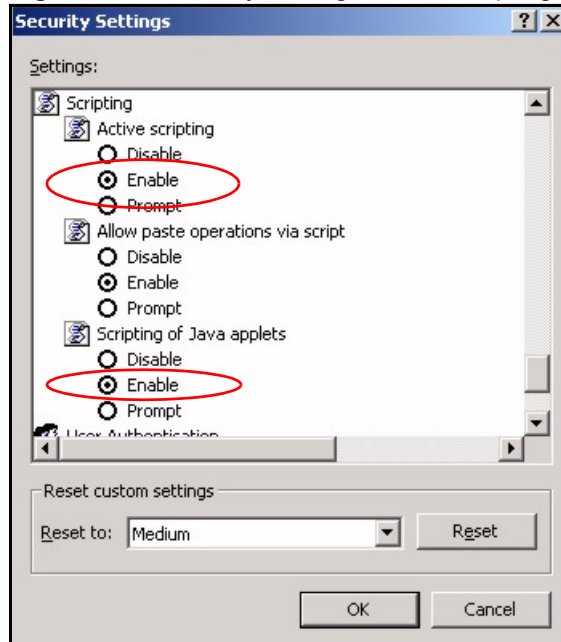
If pages of the web configurator do not display properly in Internet Explorer, check that JavaScripts are allowed.

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

Figure 115 Internet Options: Security

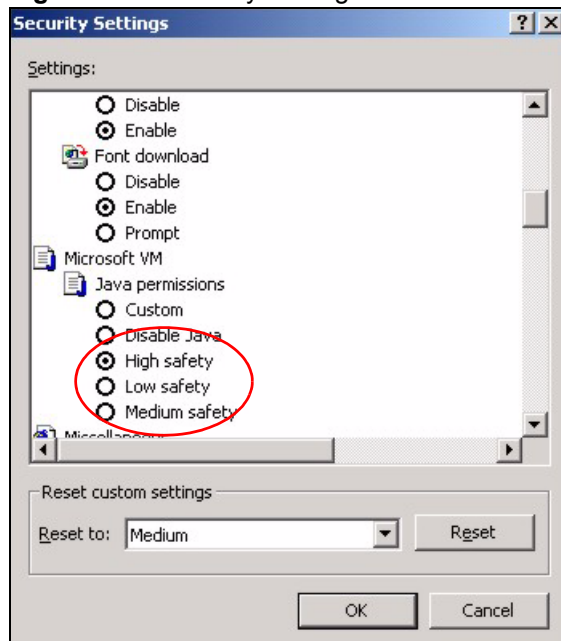


- 2 Click the **Custom Level...** button.
- 3 Scroll down to **Scripting**.
- 4 Under **Active scripting** make sure that **Enable** is selected (the default).
- 5 Under **Scripting of Java applets** make sure that **Enable** is selected (the default).
- 6 Click **OK** to close the window.

Figure 116 Security Settings - Java Scripting

Java Permissions

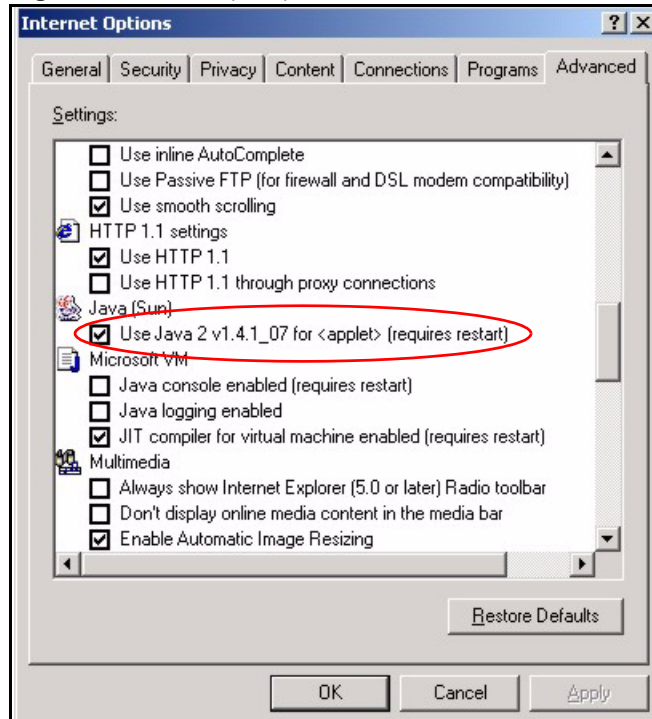
- 1 From Internet Explorer, click **Tools, Internet Options** and then the **Security** tab.
- 2 Click the **Custom Level...** button.
- 3 Scroll down to **Microsoft VM**.
- 4 Under **Java permissions** make sure that a safety level is selected.
- 5 Click **OK** to close the window.

Figure 117 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.
- 3 Click **OK** to close the window.

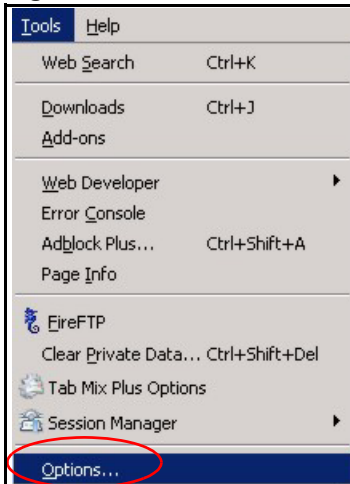
Figure 118 Java (Sun)



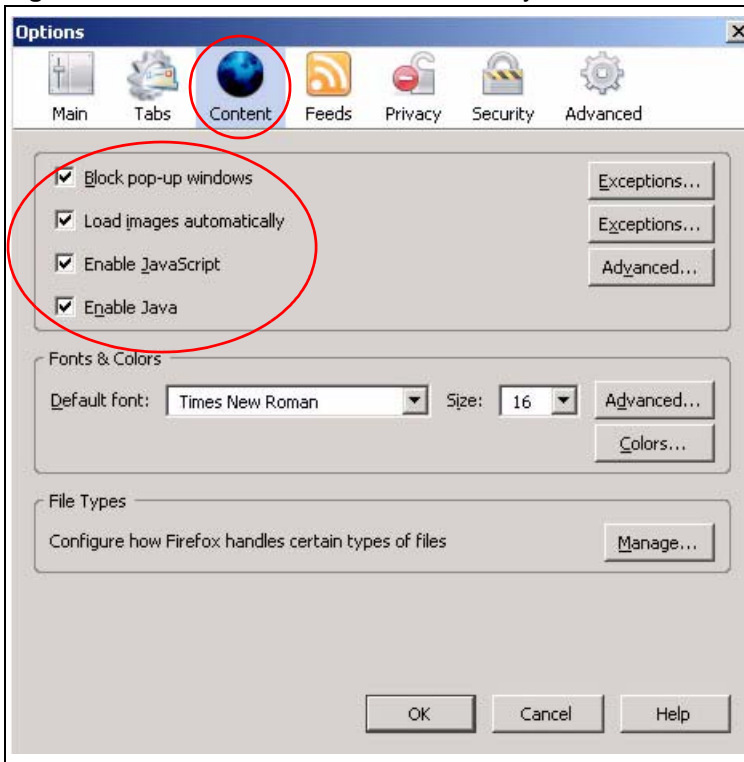
Mozilla Firefox

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 119 Mozilla Firefox: Tools > Options

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

Figure 120 Mozilla Firefox Content Security

Wireless LANs

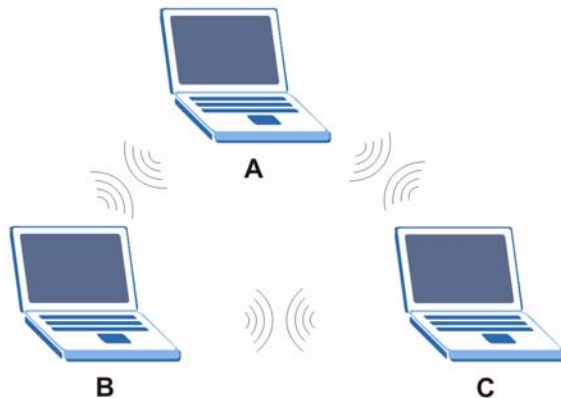
Wireless LAN Topologies

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.

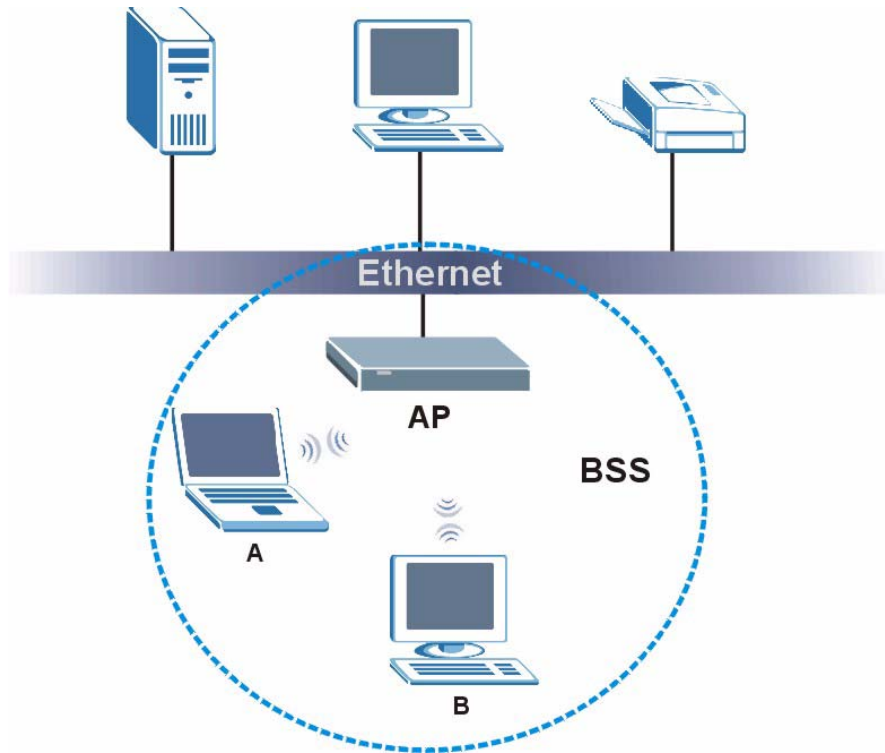
Figure 121 Peer-to-Peer Communication in an Ad-hoc Network



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 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.

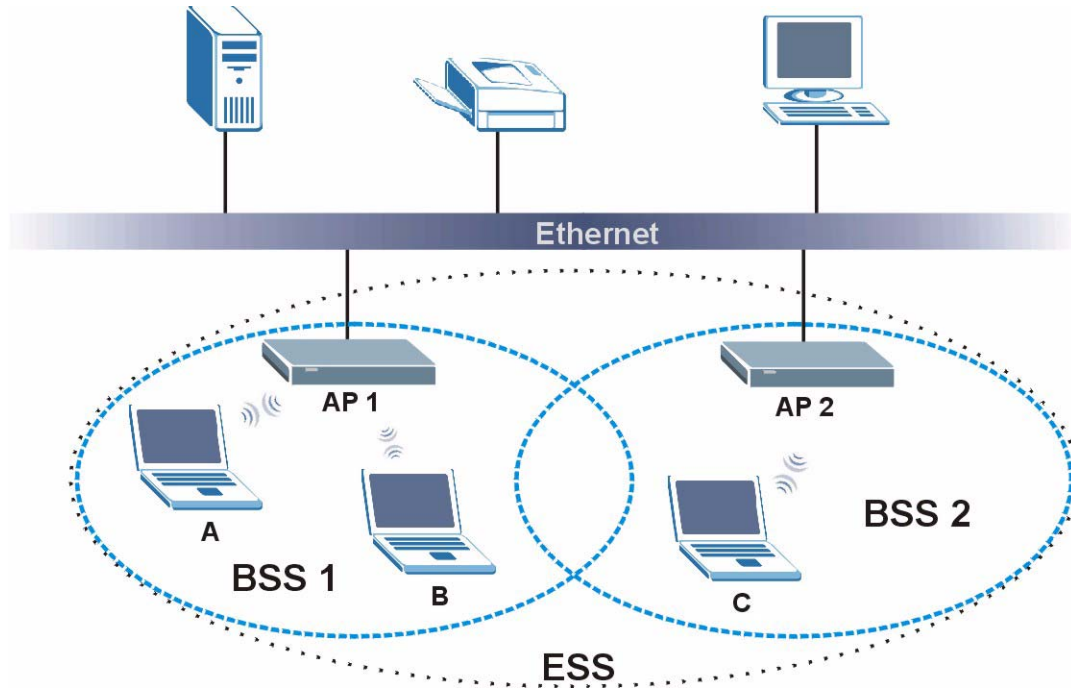
Figure 122 Basic Service Set

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.

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 123 Infrastructure WLAN

Channel

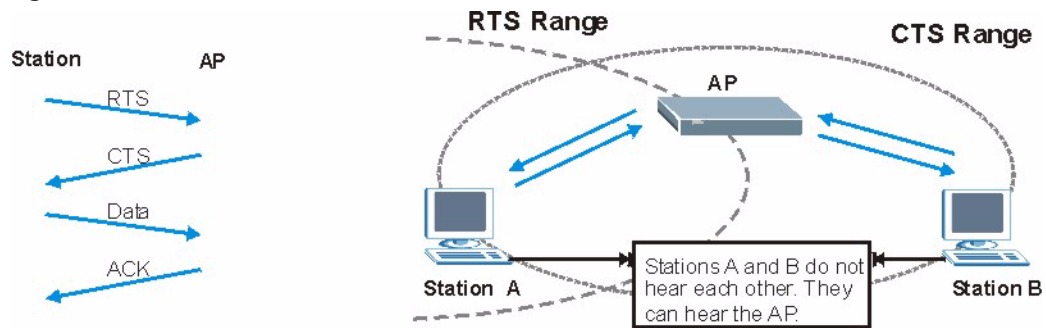
A channel is the radio frequency(ies) used by wireless devices to transmit and receive data. Channels available depend on your geographical area. You may have a choice of channels (for your region) so you should use a channel different from an adjacent AP (access point) to reduce interference. Interference 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 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 124 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.



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

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 ZyXEL Device uses long preamble.



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

Table 79 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 ZyXEL Device are data encryption, wireless client authentication, restricting access by device MAC address and hiding the ZyXEL Device identity.

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

Table 80 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



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

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.
- 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.

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.

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.



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 81 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.

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

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

TKIP uses 128-bit keys that are dynamically generated and distributed by the authentication server. AES (Advanced Encryption Standard) is a block cipher that uses a 256-bit mathematical algorithm called Rijndael. They both include a per-packet key mixing function, a Message Integrity Check (MIC) named Michael, an extended initialization vector (IV) with sequencing rules, and a re-keying mechanism.

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

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

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

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

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

User Authentication

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

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

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

Wireless Client WPA Supplicants

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

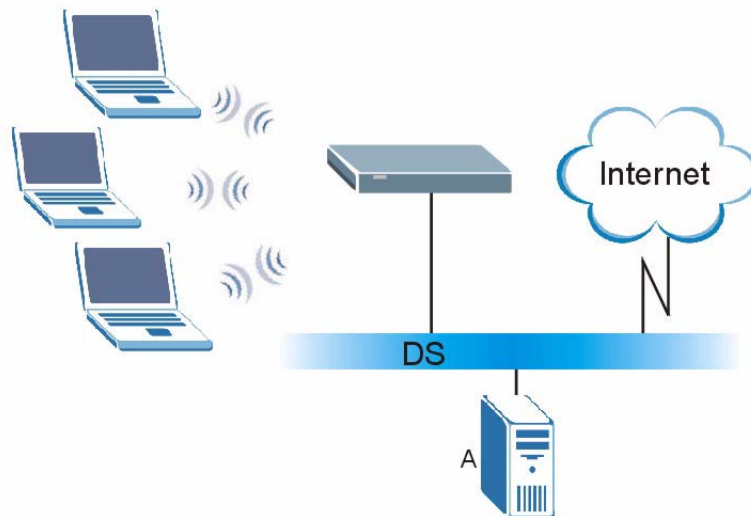
The Windows XP patch is a free download that adds WPA capability to Windows XP's built-in "Zero Configuration" wireless client. However, you must run Windows XP to use it.

WPA(2) with RADIUS Application Example

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

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

Figure 125 WPA(2) with RADIUS Application Example



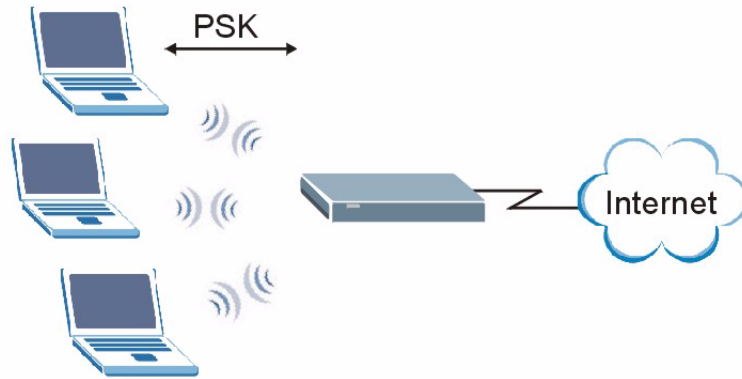
WPA(2)-PSK Application Example

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

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

- 3 The AP and wireless clients generate a common PMK (Pairwise Master Key). The key itself is not sent over the network, but is derived from the PSK and the SSID.
- 4 The AP and wireless clients use the TKIP or AES encryption process, the PMK and information exchanged in a handshake to create temporal encryption keys. They use these keys to encrypt data exchanged between them.

Figure 126 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 82 Wireless Security Relational Matrix

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

Antenna Overview

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

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

Antenna Characteristics

Frequency

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

Radiation Pattern

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

Antenna Gain

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

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

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

Types of Antennas for WLAN

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

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

Positioning Antennas

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

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

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

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 83 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.
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.

Table 83 Commonly Used Services (continued)

NAME	PROTOCOL	PORT(S)	DESCRIPTION
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).
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.

Table 83 Commonly Used Services (continued)

NAME	PROTOCOL	PORT(S)	DESCRIPTION
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.
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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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 equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.
- IEEE 802.11b or 802.11g operation of this product in the U.S.A. is firmware-limited to channels 1 through 11.
- End-users and installers must be provide with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

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

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.

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Index

A

Access point **65**
See also AP.
Address Assignment **56**
Address mapping **99**
Address Resolution Protocol (ARP) **60**
Advanced Encryption Standard
See AES.
AES **226**
antenna
directional **229**
gain **229**
omni-directional **229**
Any IP **59**
How it works **60**
note **60**
Any IP Setup **62**
Any IP table **185**
AP **65**
See also access point.
AP (access point) **219**
Application-level Firewalls **108**
ATM Adaptation Layer 5 (AAL5) **81**
Attack Alert **136**
Attack Types **112**

B

Backup Type **91**
Bandwidth Borrowing **170**
bandwidth budget **165**
bandwidth capacity **165**
Bandwidth Class **165**
bandwidth class **165**
Bandwidth Filter **165**
bandwidth filter **165**
Bandwidth Management **165**
Bandwidth Management Statistics **176**
Bandwidth Manager Class Configuration **173**
Bandwidth Manager Class Setup **172**
Bandwidth Manager Monitor **177**
Bandwidth Manager Summary **171**

Basic Service Set, See BSS **217**
Blocking Time **136**
Borrow bandwidth from parent class **174**
Brute-force Attack, **111**
BSS **217**
BW Budget **174**

C

CA **224**
CBR (Continuous Bit Rate) **88**
Certificate Authority
See CA.
certifications **236, 237**
notices **236, 238**
viewing **237, 239**
change password at login **34**
channel **65, 219**
interference **219**
Class Name **174**
command interface **29, 30**
Configuration **56, 185**
contact information **241**
Content Filtering **139**
Categories **139**
Schedule **141**
Trusted computers **141**
URL keyword blocking **140**
Content filtering **139**
copyright **235**
CTS (Clear to Send) **220**
Custom Ports
Creating/Editing **128**
customer support **241**
Customized Services **128**
Customized services **128**

D

default LAN IP address **33**
Denial of Service **108, 109, 135, 136**
Destination Address **121**

- device model number [189](#)
- DHCP [56, 57, 103, 185](#)
- DHCP server [185](#)
- DHCP table [185](#)
- diagnostic [187](#)
- dimensions [201](#)
- disclaimer [235](#)
- Domain Name [56, 97](#)
- Domain Name System [56](#)
- DoS [109](#)
 - Basics [109](#)
 - Types [110](#)
- DoS attacks, types of [110](#)
- DSL line, reinitialize [188](#)
- Dynamic DNS [103](#)
- dynamic WEP key exchange [225](#)
- DYNDNS Wildcard [103](#)

E

- EAP Authentication [223](#)
- ECHO [97](#)
- E-mail
 - Log Example [162](#)
- embedded help [35](#)
- Encapsulated Routing Link Protocol (ENET ENCAP) [81](#)
- Encapsulation [81](#)
 - ENET ENCAP [81](#)
 - PPP over Ethernet [81](#)
 - PPPoA [81](#)
 - RFC 1483 [82](#)
- encryption [67, 226](#)
 - and local (user) database [67](#)
 - key [68](#)
 - WPA compatible [68](#)
- ESS [218](#)
- ESSID [199](#)
- Extended Service Set, See ESS [218](#)

F

- Fairness-based Scheduler [168](#)
- FCC interference statement [236, 237](#)
- file transfer using FTP
 - command example [191](#)
- filename convention, configuration
 - configuration

- file names [191](#)
- Finger [97](#)
- Firewall
 - Access Methods [119](#)
 - Address Type [127](#)
 - Alerts [122](#)
 - Anti-Probing [134](#)
 - Creating/Editing Rules [125](#)
 - Custom Ports [128](#)
 - Enabling [122](#)
 - Firewall Vs Filters [117](#)
 - Guidelines For Enhancing Security [116](#)
 - Introduction [108](#)
 - LAN to WAN Rules [121](#)
 - Policies [119](#)
 - Rule Checklist [120](#)
 - Rule Logic [120](#)
 - Rule Security Ramifications [120](#)
 - Services [133](#)
 - Types [107](#)
 - When To Use [118](#)
- firmware [189](#)
 - upgrade [189](#)
 - upload [189](#)
 - upload error [190](#)

- fragmentation threshold [220](#)
- FTP [30, 96, 97, 143, 190](#)
 - file transfer procedure [191](#)
 - restrictions over WAN [192](#)
- FTP Restrictions [143](#)

H

- Half-Open Sessions [135](#)
- hidden node [219](#)
- hide SSID [66](#)
- Host [37](#)
- HTTP [97, 108, 109, 110](#)
- HTTP (Hypertext Transfer Protocol) [189](#)
- humidity [201](#)

I

- IANA [57, 58](#)
- IANA (Internet Assigned Number Authority) [128](#)
- IBSS [217](#)
- ICMP echo [111](#)
- IEEE 802.11g [221](#)
- IGMP [58, 59](#)
- Independent Basic Service Set

See IBSS [217](#)
 initialization vector (IV) [226](#)
 Install UPnP [149](#)
 Windows Me [149](#)
 Windows XP [150](#)
 Internet access [41](#)
 Internet access wizard setup [41](#), [49](#)
 Internet Assigned Numbers Authority See IANA [57](#)
 Internet Control Message Protocol (ICMP) [111](#), [134](#)
 IP Address [57](#), [97](#), [185](#)
 IP Address Assignment [82](#)
 ENET ENCAP [83](#)
 PPPoA or PPPoE [82](#)
 RFC 1483 [82](#)
 IP Pool Setup [56](#)
 IP protocol type [133](#)
 IP Spoofing [110](#), [113](#)

K

Key Fields For Configuring Rules [121](#)

L

LAN Setup [55](#), [81](#)
 LAN TCP/IP [57](#)
 LAN to WAN Rules [121](#)
 LAND [110](#), [111](#)
 LEDs [30](#)
 local (user) database [66](#)
 and encryption [67](#)
 Local Network
 Rule Summary [124](#)
 Logs [159](#)

M

MAC (Media Access Control) [185](#)
 MAC (Media Access Control) address. [77](#)
 MAC address [66](#)
 MAC address filter [66](#)
 MAC Address Filter Action [78](#)
 MAC Address Filtering [77](#)
 maintenance [181](#)
 management idle timeout period [34](#)

managing the device
 good habits [30](#)
 using FTP. See FTP.
 using Telnet. See command interface.
 using the command interface. See command interface.
 using the web configurator. See web configurator.
 Maximize Bandwidth Usage [168](#)
 Maximum Burst Size (MBS) [84](#), [88](#)
 Max-incomplete High [135](#)
 Max-incomplete Low [135](#)
 Message Integrity Check (MIC) [226](#)
 Metric [83](#)
 Multicast [58](#)
 Multiplexing [82](#)
 multiplexing [82](#)
 LLC-based [82](#)
 VC-based [82](#)
 Multiprotocol Encapsulation [82](#)

N

Nailed-Up Connection [83](#)
 NAT [57](#), [96](#), [97](#)
 Address mapping rule [101](#)
 Application [94](#)
 Definitions [93](#)
 How it works [94](#)
 Mapping Types [95](#)
 What it does [94](#)
 What NAT does [94](#)
 NAT (Network Address Translation) [93](#)
 NAT mode [98](#)
 NAT Traversal [147](#)
 navigating the web configurator [34](#)
 NetBIOS commands [112](#)
 Network Management [97](#)
 NNTP [97](#)

O

One-Minute High [135](#)

P

Packet Filtering [117](#)

- Packet filtering
 - When to use [117](#)
- Packet Filtering Firewalls [107](#)
- Pairwise Master Key (PMK) [226](#), [228](#)
- Peak Cell Rate (PCR) [84](#), [88](#)
- Ping of Death [110](#)
- Point to Point Protocol over ATM Adaptation Layer 5 (AAL5) [81](#)
- Point-to-Point Tunneling Protocol [97](#)
- POP3 [97](#), [109](#), [110](#)
- Port Numbers [97](#)
- power adaptor specifications [206](#)
- power specification [201](#)
- PPP session over Ethernet (PPP over Ethernet, RFC 2516) [81](#)
- PPPoE [84](#)
 - Benefits [84](#)
- PPPoE (Point-to-Point Protocol over Ethernet) [84](#)
- PPTP [97](#)
- preamble mode [221](#)
- Priority [174](#)
- Priority-based Scheduler [168](#)
- product registration [239](#)
- Proportional Bandwidth Allocation [166](#)
- PSK [226](#)
- PVC (Permanent Virtual Circuit) [81](#)

R

- RADIUS [222](#)
 - message types [223](#)
 - messages [223](#)
 - shared secret key [223](#)
- RADIUS server [66](#)
- real-time application [165](#)
- registration
 - product [239](#)
- reinitialize the ADSL line [188](#)
- related documentation [3](#)
- Remote Management and NAT [144](#)
- Remote Management Limitations [143](#)
- Reset button, the [34](#)
- resetting the Device [34](#)
- RFC 1483 [82](#)
- RFC 1631 [93](#)
- RIPSee Routing Information Protocol [58](#)
- Roaming [79](#)
- Root Class [172](#)
- Routing Information Protocol [58](#)

- Direction [58](#)
- Version [58](#)
- RTS (Request To Send) [220](#)
 - threshold [219](#), [220](#)
- RTS (Request To Send) threshold [71](#)
- Rule Summary [123](#)
- Rules [121](#)
 - Checklist [120](#)
 - Key Fields [121](#)
 - LAN to WAN [121](#)
 - Logic [120](#)
 - Predefined Services [133](#)
 - Summary [123](#)

S

- safety warnings [6](#)
- Saving the State [113](#)
- Scheduler [167](#)
- screws [205](#)
- Security In General [116](#)
- Security Ramifications [120](#)
- Server [95](#), [96](#)
- Service [121](#)
- Service Set IDentification [70](#)
- Service Set IDentity. See SSID.
- Service Type [129](#)
- Services [97](#)
- SMTP [97](#)
- Smurf [111](#), [112](#)
- SNMP [97](#)
- Source Address [121](#), [127](#)
- specifications [206](#)
 - power adaptor [206](#)
- SSID [65](#), [70](#)
 - hide [66](#)
- Stateful Inspection [107](#), [108](#), [113](#), [114](#)
 - Process [114](#)
- SUA [96](#), [97](#)
- SUA (Single User Account) [96](#)
- SUA server [96](#), [98](#)
 - Default server set [97](#)
- SUA vs NAT [96](#)
- SUA/NAT Server Set [99](#)
- Sub-class Layers [172](#)
- Subnet Mask [57](#), [127](#)
- Sustain Cell Rate (SCR) [88](#)
- Sustained Cell Rate (SCR) [84](#)
- SYN Flood [110](#), [111](#)
- SYN-ACK [111](#)

syntax conventions [4](#)
System Timeout [144](#)

T

TCP Maximum Incomplete [136](#)
TCP Security [115](#)
TCP/IP [109](#), [110](#), [144](#)
Teardrop [110](#)
Telnet [144](#)
Telnet Configuration [144](#)
temperature [201](#)
Temporal Key Integrity Protocol (TKIP) [226](#)
TFTP Restrictions [143](#)
Three-Way Handshake [110](#)
Threshold Values [135](#)
Traceroute [112](#)
trademarks [235](#)
Traffic Redirect [90](#)
Traffic redirect [90](#), [92](#)
Traffic shaping [84](#)

U

UBR (Unspecified Bit Rate) [88](#)
UDP/ICMP Security [115](#)
Universal Plug and Play [147](#)
 Application [147](#)
 Security issues [147](#)
Universal Plug and Play Forum [148](#)
UPnP [147](#)
Upper Layer Protocols [115](#), [116](#)
user authentication [66](#)
 local (user) database [66](#)
 RADIUS server [66](#)
 weaknesses [67](#)
User Name [104](#)

V

VBR (Variable Bit Rate) [88](#)
Virtual Channel Identifier (VCI) [82](#)
virtual circuit (VC) [82](#)
Virtual Path Identifier (VPI) [82](#)
Voice-over-IP (VoIP) [165](#)

VPI & VCI [82](#)

W

WAN (Wide Area Network) [81](#)
WAN backup [90](#)
WAN to LAN Rules [121](#)
warranty [239](#)
 note [239](#)
Web Configurator [33](#), [34](#), [35](#), [108](#), [116](#), [121](#)
web configurator [29](#)
web configurator screen summary [35](#)
WEP encryption [72](#)
Wi-Fi Protected Access [225](#)
wireless channel [199](#)
wireless client [65](#)
wireless client WPA supplicants [227](#)
Wireless LAN
 Configuring [70](#)
wireless LAN [199](#)
Wireless network
 basic guidelines [65](#)
 channel [65](#)
 encryption [67](#)
 example [65](#)
 MAC address filter [66](#)
 overview [65](#)
 security [66](#)
 SSID [65](#)
Wireless security [66](#)
 overview [66](#)
 type [66](#)
wireless security [199](#), [221](#)
WLAN
 interference [219](#)
 security parameters [228](#)
WPA [225](#)
 key caching [226](#)
 pre-authentication [226](#)
 user authentication [226](#)
 vs WPA-PSK [226](#)
 wireless client supplicant [227](#)
 with RADIUS application example [227](#)
WPA compatible [68](#)
WPA2 [225](#)
 user authentication [226](#)
 vs WPA2-PSK [226](#)
 wireless client supplicant [227](#)
 with RADIUS application example [227](#)
WPA2-Pre-Shared Key [225](#)
WPA2-PSK [225](#), [226](#)
 application example [227](#)

WPA-PSK [225](#), [226](#)
application example [227](#)

Z

Zero configuration Internet access [85](#)
ZyNOS (ZyXEL Network Operating System) [191](#)
ZyXEL Firewall
Introduction [108](#)

