Anexo 1

Cableado de datos: sobre el cableado se decide utilizar categoría 5e, por su menor costo. Sin embargo, se considera el cable 5e con cobertura especial para exteriores, para el caso del cableado hacia los Access Points fuera de las oficinas,

A continuación, se muestra un diagrama descriptivo de la distribución del cableado, el cual será tomado en cuenta para el presupuesto de los materiales de cableado (**Figura 1**).

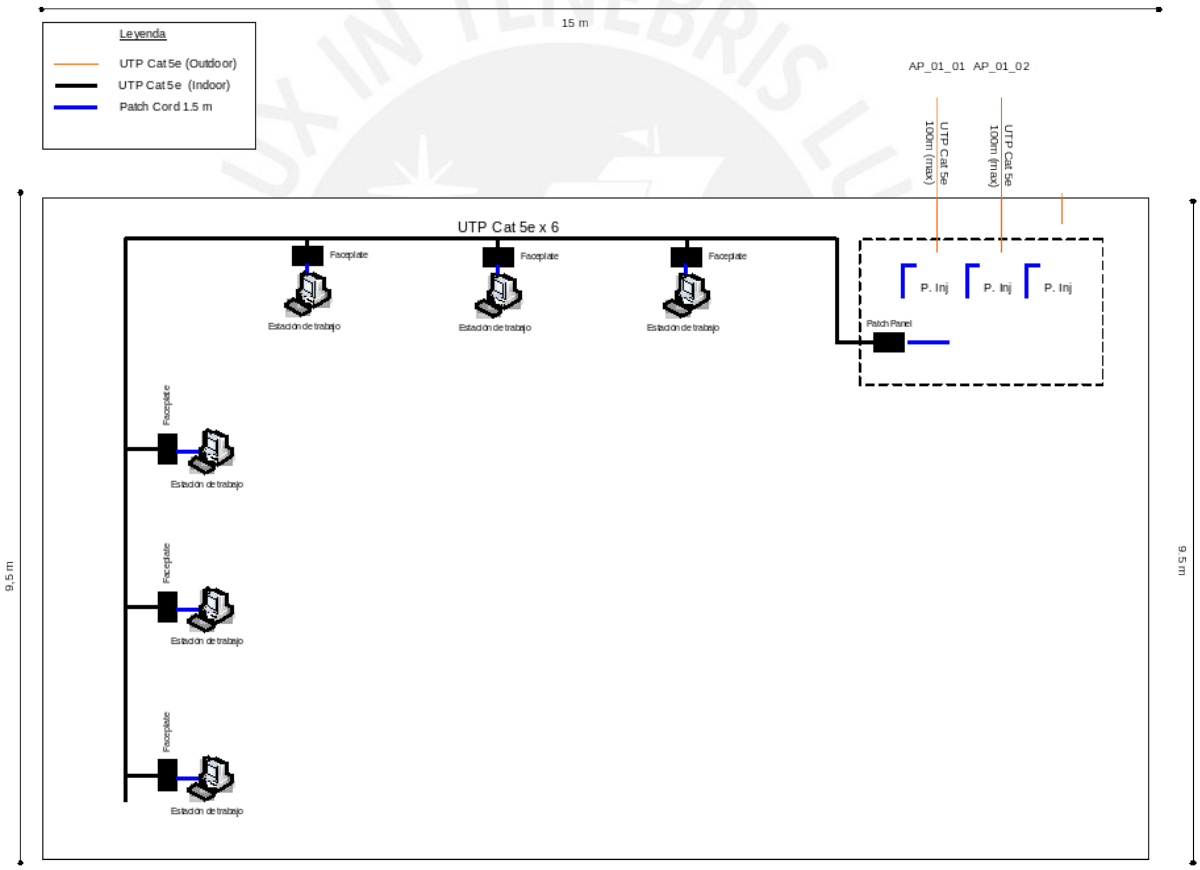


Figura 1: Distribución propuesta de cableado

Para el cableado externo se requieren 3 cables de 100 metros cada uno; para el cableado interno en la conexión hacia los faceplates, se requieren 4 cables de longitud 23.5m (15m+8.5m) y 4 cables de longitud de 15m. Es decir, 300m de cableado para exteriores y

154 m de cableado para interiores, se redondea a 160m de cableado para interiores. Además, se require de:

- 23.5 metros de canaleta para los cables (15 m + 8 .5m)
- Un patch panel de 24 puertos para el gabinete
- Un ordenador de 1 RU
- 2 jacks RJ45 por cada PC y 1 por cada Access Point
- 4 faceplates de 2 puertos cada 1uno
- 8 patch cords de 2 metros para las PCs
- 11 patch cords de 0.9 metros para la conexión desde el patch panel al switch

La siguiente tabla muestra los materiales listados, algunos con cantidades redondeadas:

Material	Cantidad
Patch cord 0.9m	16
Patch cord 2m	10
Cable UTP indoor (160m)	160
Cable UTP outdoor (300m)	300
Canaleta para cables (26m)	26
Patch panel 24 puertos	1
Conectores (jacks)	20
Faceplates dobles	5
Gabinete 9 RU	1
Ordenador 1 RU	1

Tabla 1: Materiales de cableado

Anexo 2

Cobertura inalámbrica

Se eligieron las antenas mostradas en la siguiente Tabla:

Fabricante	Modelo	Ganancia (dBi)	Banda de trabajo	Rango de Frecuencias (GHz)	Polarización	Ambiente	Precio (US$)
Cisco Systems	AIR-ANT2547V-N	5	B/G/N	2.4 - 2.83	Vertical	Externo	183.00
Cisco Systems	AIR-ANT2588P3M-N	8	B/G/N	2.4 - 2.5	Vertical	Externo	578.00

Tabla 1: Características de las antenas elegidas

Las figuras 1 y 2 muestran los patrones de radiación de las antenas elegidas. La primera es omnidireccional y la sergunda es direccional.

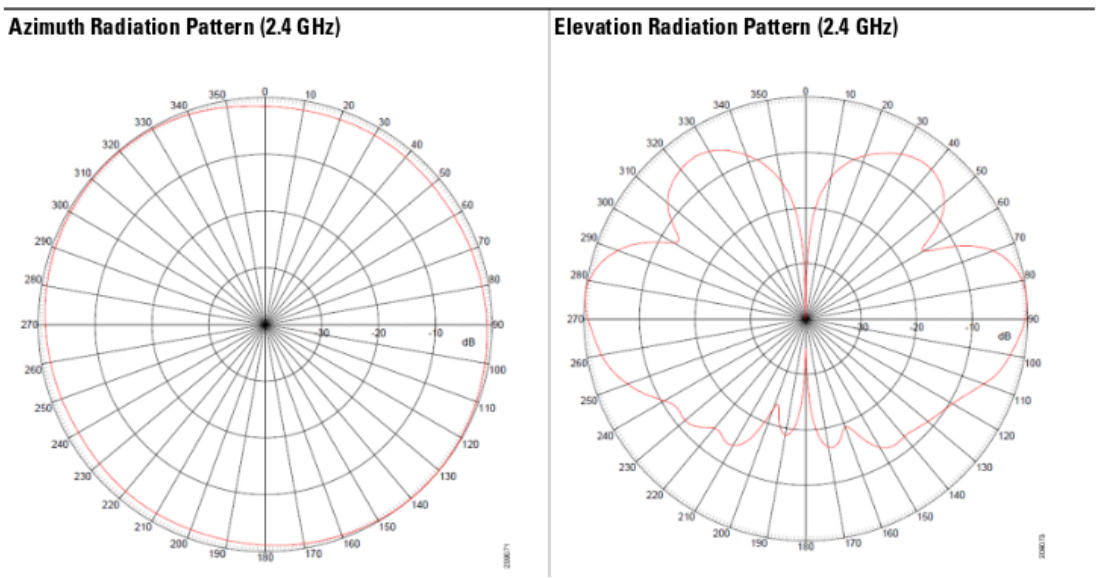


Figura 1: Patrón de radiación (ANT2547)

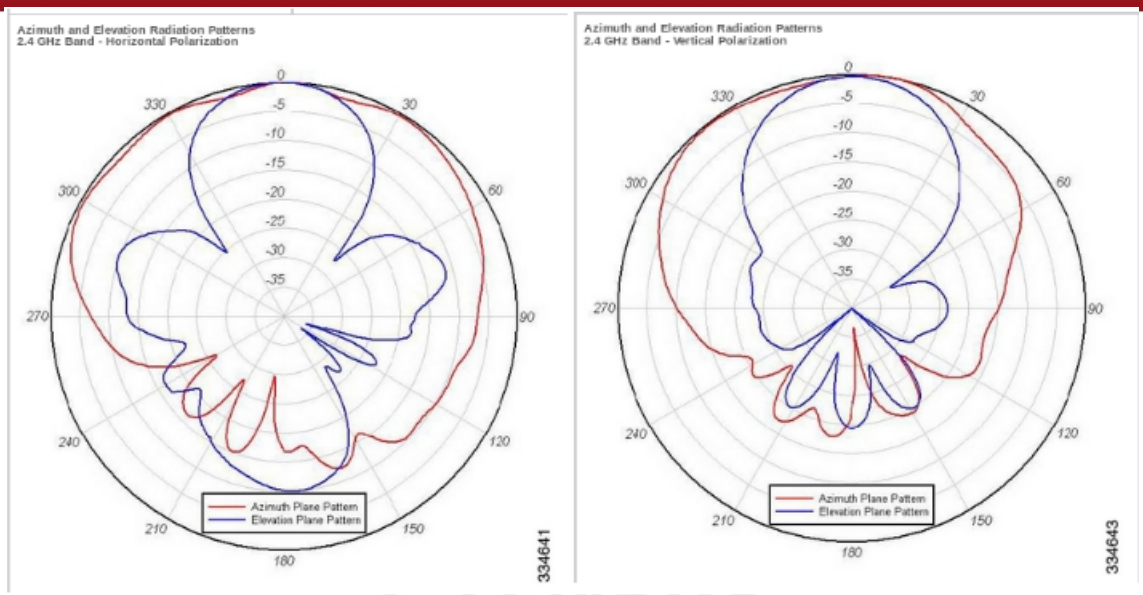


Figura 2: Patrón de radiación (ANT-2588)

Se realizó una simulación de cobertura usando el *Cisco Prime Planning Mode*.

La ubicación de los access points se requiere que sea tal, que dé cobertura al Centro Acuícola en el borde de las pozas con al menos 1 Mbps de velocidad de acceso, esa es la velocidad mínima a la que se negocia con el estándar 802.11b/g/n; esa velocidad cubre holgadamente lo requerido en el punto 3.9.

La **Figura 3** muestra la cobertura requerida para llegar a ese bitrate. Se hizo la simulación con las posiciones propuestas para los access points.

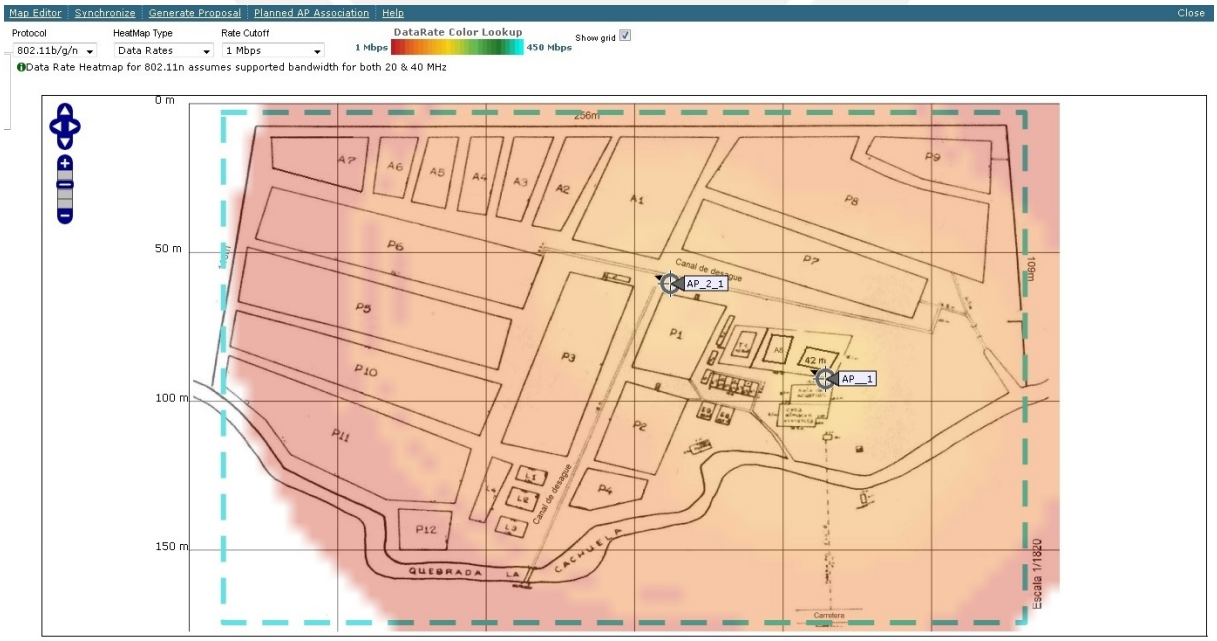


Figura 3: Simulación de cobertura a 1 Mbps

Antena 01: AIR-ANT2547V-N

Antena 02: AIR-ANT2588P3M-N

Se puede estimar la coordenada de los AP con la herramienta Google Earth, obteniéndose el siguiente gráfico (**Figura 4**):

Figura 4: Ubicación de antenas en centro acuícola

Las coordenadas de los Access Points se muestran en la siguiente tabla:

Access Point	Antena	Latitud	Longitud
AP_01_01	AIR-ANT2547V-N	- 12°33'36.64"	- 69°11'22.95"
AP_01_02	AIR-ANT2588P3M-N	- 12°33'34.86"	- 69°11'21.60"

Tabla 2: Ubicación de las antenas

Se utilizarán ambas antenas ya que la combinación de los patrones de radiación de ambas antenas es útil, para lograr una mayor cobertura. La antena AIR-ANT2547V-N tiene un patrón de radiación circular en el plano horizontal, mientras que la antena AIR-ANT2588P3M-N es direccionada. La antena AIR-ANT2547V-N va conectada directamente al Access Point y puede estar a la intemperie. La antena AIR-

ANT2588P3M-N es conectada al Access Point a través de cables coaxiales y puede estará a la intemperie, puede ser montada sobre un poste.

Se recomienda que los WAPs utilicen 3 canales que no tengan interferencia entre sí, que son el canal 1, canal 6 y canal 11. Para el caso de los 2 primeros se sugiere el canal 1 y 6, en caso de crecimiento y añadirse un WAPs, se sugiere el canal 11. Se muestran los canales en la **Figura 3**.

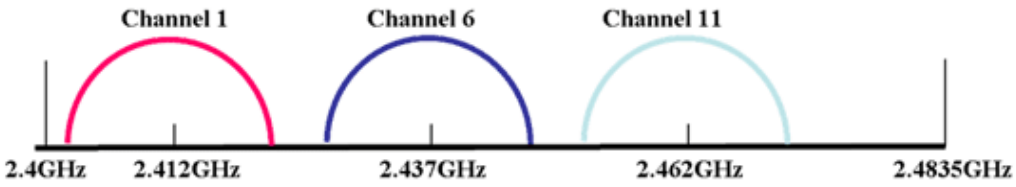


Figura 5: Canales 2.4GHz sin superposición

Anexo 3

Pozo a tierra: se seguirá lo establecido en la Norma Técnica Peruana (NTP 370.053, NTP 370.056). Según ello la barra debe ser de cobre y debe estar protegida contra la corrosión. Esta puede ser sólido, aislado, cableado, cubierto o desnudo, se elige el sólido pues es más fácil de encontrar en el mercado local. La varilla de cobre debe ser de un diámetro no menor a 12 mm y de longitud no menor a 2 m; debe introducirse a una profundidad mínima de 2.5 m. El pozo debe ser rellenado con el gel conductor destinado para estos fines. La resistencia del pozo debe ser no mayor a 5 Ω , pues es lo recomendado para equipos de cómputo. Estas condiciones deben ser cumplidas con el proveedor local con quien se trabaje. La Figura 1 es un diagrama referencial de la conexión a tierra:

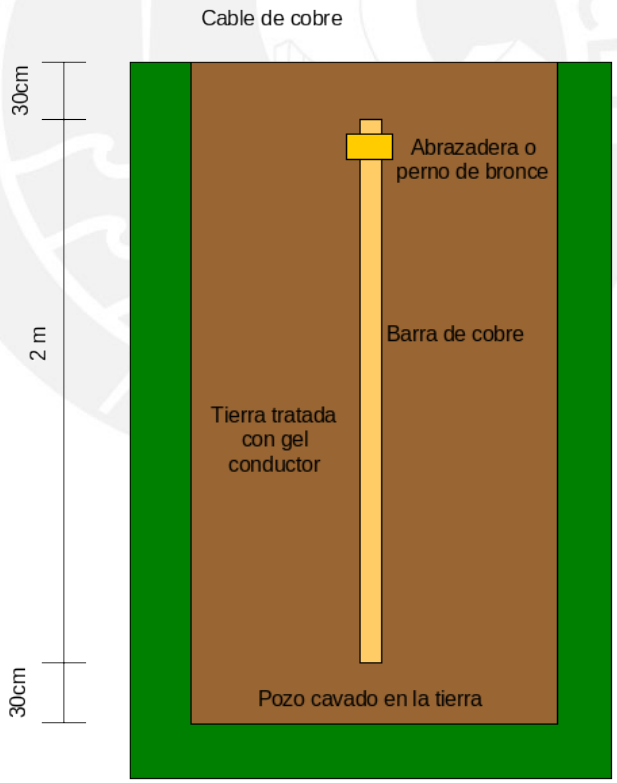


Figura 1: Esquema de pozo a tierra

Anexo 4

Pararrayos: como se indicó en la sección 3.5, se sugiere la instalación de un pararrayos para proteger de las tormentas eléctricas a los equipos de comunicaciones de La Cachuela. Las recomendaciones se han tomado de Imporcosa S.A., especialistas en soluciones de comunicaciones.

Para la instalación del pararrayos se requiere situar un mástil con puntas captadoras encima de la construcción que se desea proteger. Los elementos que lo conforman son el cabezal captador; el bajante conductor, que es un conductor desnudo de aproximadamente 50mm2, un contador de rayos utilizado para contabilizar cuantos rayos han caído y programar los mantenimientos; y la toma de tierra.

La siguiente figura (**Figura 1**) muestra un diagrama referencial de la instalación del pararrayos:

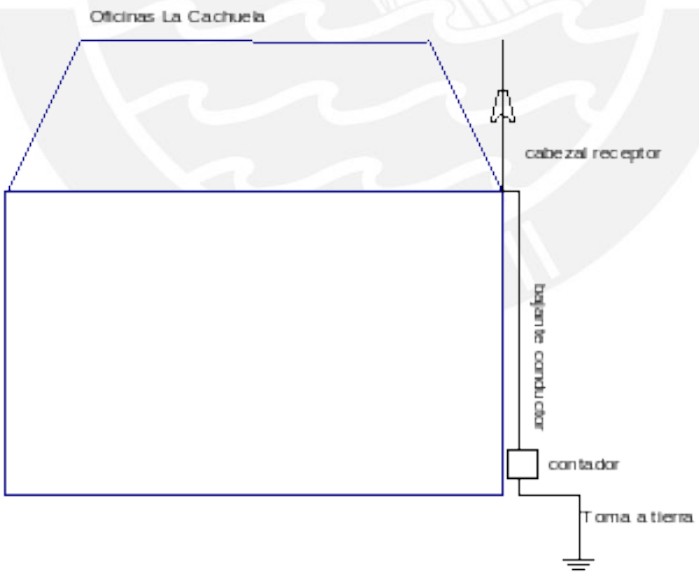


Figura 1: Esquema de instalación de pararrayos

Anexo 5

Resultados de la simulación

Las siguientes 3 figuran muestran pantallas de los resultados obtenidos:

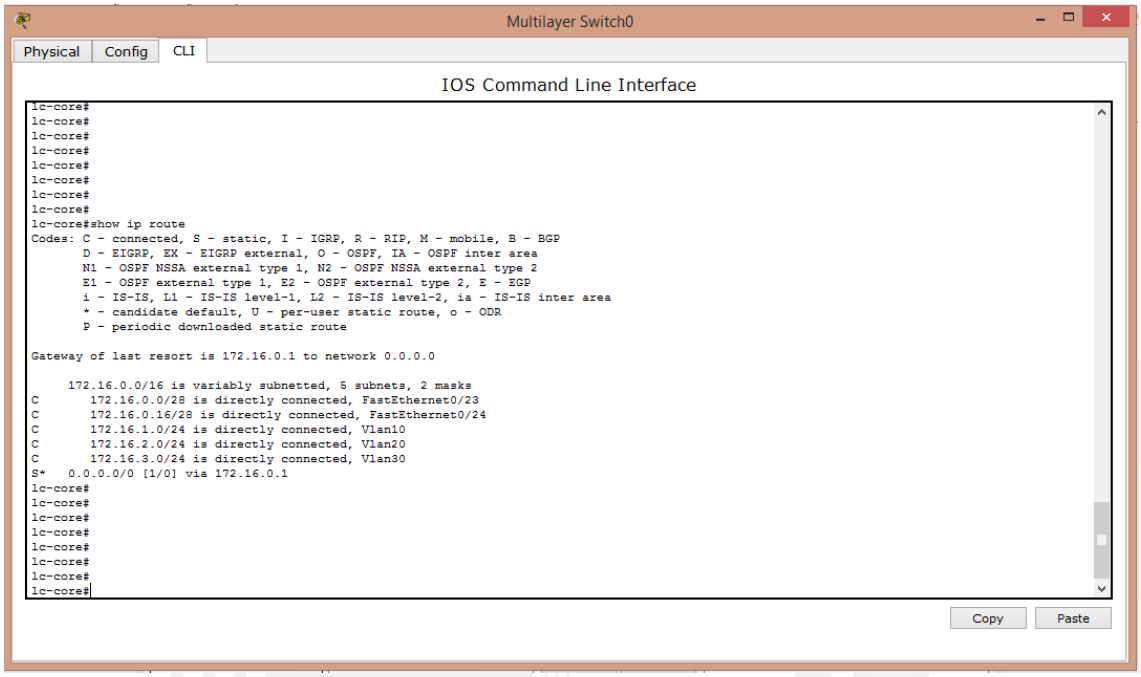


Figura 1: Tabla de rutas del switch core

La Figura 1 muestra las rutas del switch core. Cinco de ellas son interfaces directamente conectadas; tres de ellas son para usuario o servidores, y las otras dos para la interconexión con el firewall de Internet y el router hacia la interconexión WAN. Además, se observa la ruta por defecto hacia la dirección IP 172.16.0.1.

Dado que la conexión MPLS se muestra como referencial, no se tienen rutas que usen ese enlace agregadas en la configuración.

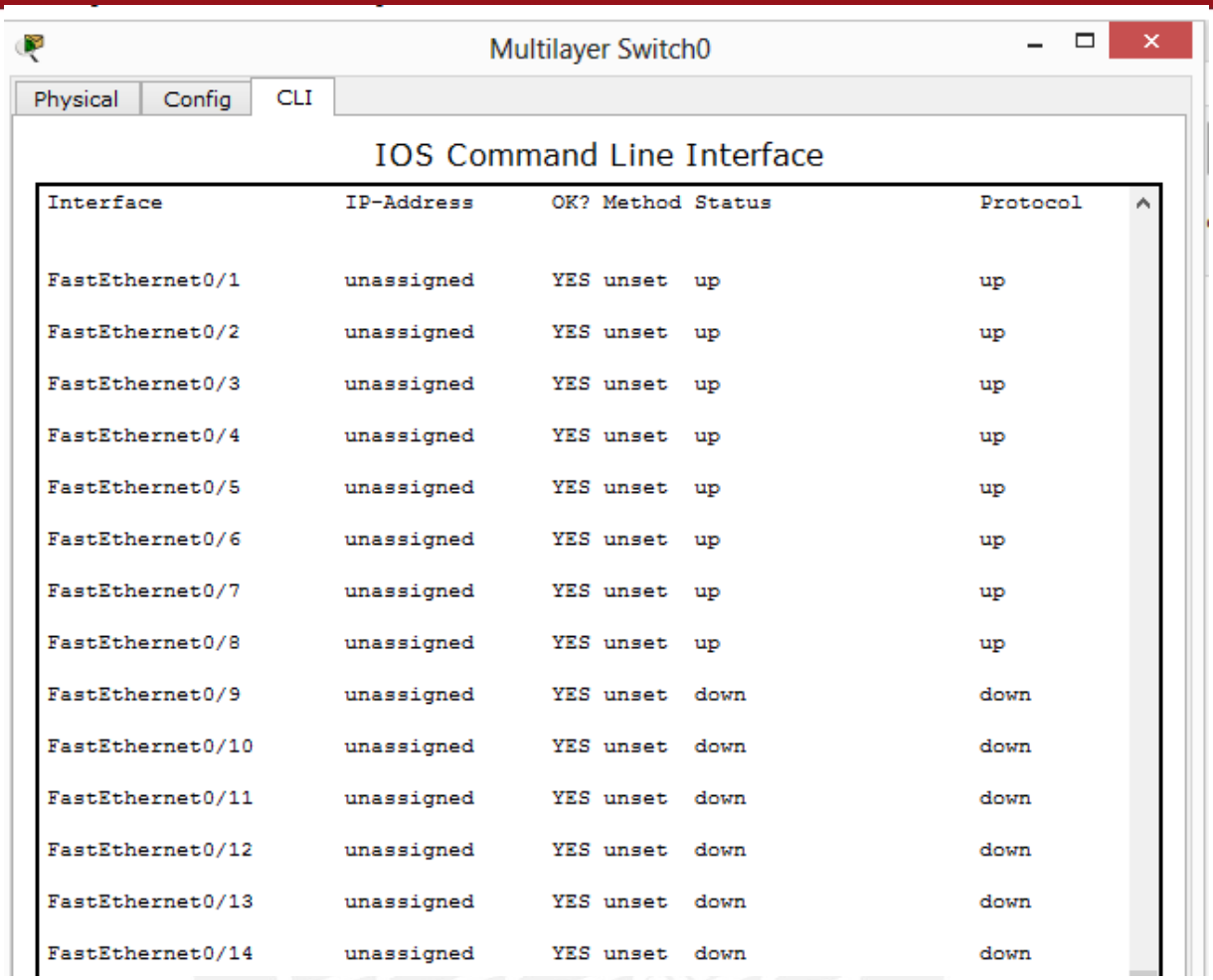


Figura 2: Interfases activas en el switch core (1)

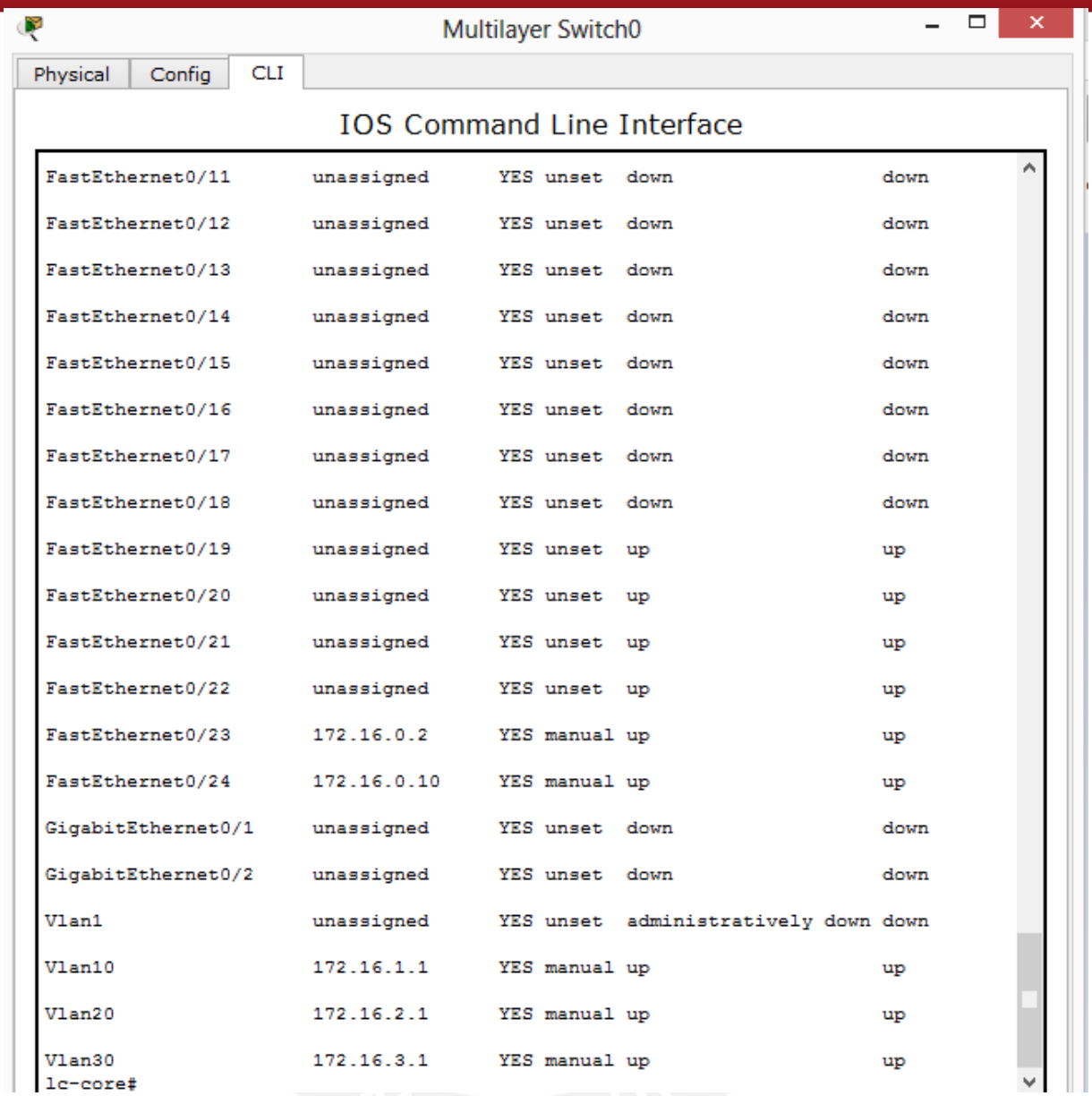


Figura 3: Interfases activas en el switch core (2)

En las Figuras 2 y 3, se observa que las 14 de las interfaces físicas se encuentran activas, usando la distribución propuesta en la Tabla 14. Además, existen 3 interfases lógicas activas (VLAN 10, VLAN 20 y VLAN 30).

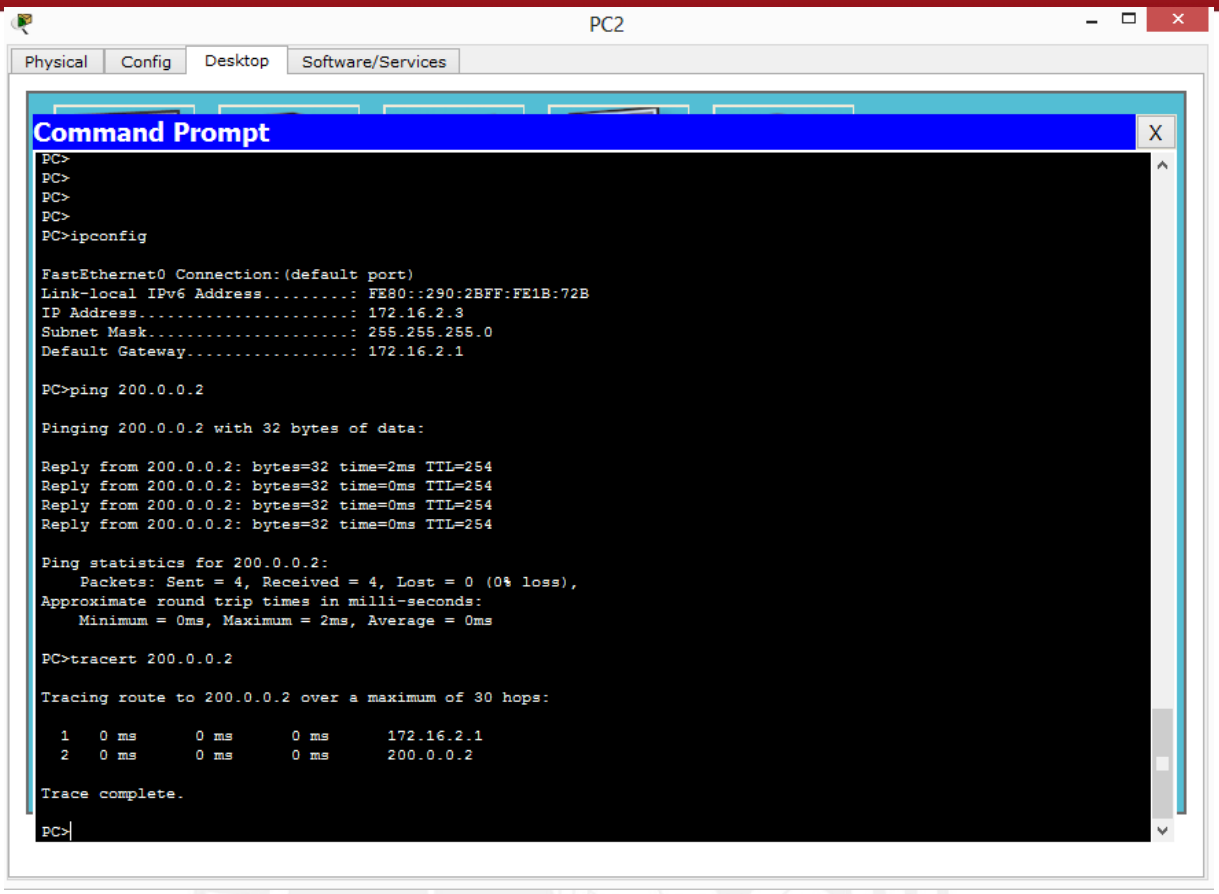


Figura 4: Tiempos de respuesta desde PC hacia firewall (router) de Internet

En la **Figura 4** se observa la dirección IP 172.16.2.3 recibida por DHCP en una de las PCs de los usuarios. El servidor DHCP es el switch core. La traza muestra que el primer salto es el switch core (capa 3) y el segundo el firewall de Internet (SRX100).

Se confirma que el enrutamiento propuesto permitiría que los elemento de la red se comuniquen entre si.

Anexo 6

Direccionamiento IP propuesto

La dirección IP púbica para navegar a Internet la brinda el proveedor, ya sea de forma manual o dinámica. A continuación, se muestra una tabla que resumen el direccionamiento IP interno y privado asignado; figura el número identificador de la VLAN y el rango de direcciones IP de los segmentos. Se propuso ese direccionamiento considerando que los servidores, usuarios de red inalámbrica y usuarios de red cableada tengan suficientes direcciones IP y un margen para poder seguir creciendo a futuro. Además, se buscó que estén aislados, de modo que un inconveniente en algún segmento no pueda extenderse a otro. Se crearon segmentos para la interconexión del switch core con el firewall y el switch core con el router del proveedor. El NAT hacia Internet lo realiza el firewall de Internet.

Descripción	Segmento de red	Rango de direcciones IP	VLAN ID	Direcciones IP disponibles
Servidores	172.16.1.0/24	172.16.1.1 – 172.16.1.254	10	254
Usuarios red cableada	172.16.2.0/24	172.16.2.1 – 172.16.2.254	20	254
Usuarios red Wireless	172.16.3.0/24	172.16.3.1 – 172.16.3.254	30	254
Interconexión con FW	172.16.0.0/28	172.16.0.1 – 172.16.0.14	5	14
Interconexión MPLS	172.16.0.16/28	172.16.0.17 – 172.16.0.30	6	14

Tabla 1: Direccionamiento IP y VLANs sugeridas

Anexo 7

Condiciones eléctricas

Se realizó una estimación de consumo máximo de energía del Centro Acuícola, con el fin de calcular que dispositivos de protección eléctrica y dimensión de cableado eléctrico requerían.

Grupo	Marca	Equipo	Modelo	Cantidad	Carga Eléctrica c/u (W)	Carga Eléctrica (W)
	Cisco	Switch	EX2200-24T-4G	1	50	50
	Cisco	Acces Point	Aironet 1602	2	13	26
	Router de Internet	Router	x	1	30	30
	PC	PC	PC	4	110	440
	Juniper	Firewall	SRX100	1	10	10
					Total Grupo 1	**556**
Grupo 1					**Total Grupo 1 + 20%**	**667.2**
	Hervidor			1	1800	1800
	Focos			4	80	320
	Horno microondas			1	1600	1600
	TV			1	80	80
	Radio			1	35	35
Grupo 2	Equipos adicionales			4	75	300
					Total Grupo 2	**4135**
					Total Grupo 2 + 20%	**4962**
					Total	**5629.2**

Tabla 1: Estimación de consumo de energía

Se consideró agrupar las cargas en dos grupos:

Grupo de cargas 1: alumbrado, tomacorrientes para radio, tv, horno microondas, etc

Grupo de cargas 2: tomacorrientes para PCs y equipos de comunicaciones

El consumo del Grupo 1, considerando un factor de protección de 20% es de 893W y el del Grupo 2, con el mismo factor de protección es de 4962W; el total es de 5855W. Se usan los valores mencionados para calcular la corriente consumida por cada grupo:

Grupo 1: 667W / 220V = 3.03 A

Grupo 2: 4962W / 220V = 22.55 A

Total: 5629W / 220V = 25.58 A

Para el total de la carga se recomienda un ITM de 30 Amperios; para el Grupo 1 de 10A y para el Grupo 2 de 25A, esto último por ser los valores comerciales presentes en el mercado.

Basados en la tabla 16, la corriente del Grupo 1 puede ser soportada por cable un cable de 1 mm2 de área transversal, la del Grupo 2 con uno de 6 mm2 de área transversal y la total con uno de 10 mm2. Es decir, se propone cable AWG 14 para el Grupo 1, cable AWG 8 para el Grupo 2 y AWG 7 para el ITM principal.

Cross sectional Area mm2	60°C	70°C	85 to 90°C	105°C	125°C	200°C	Minimum number of strands	
							Type A*	Type B*
0.75	6	10	12	16	20	25	16	
1	8	14	18	20	25	35	16	
1.5	12	18	21	25	30	40	19	26
2.5	17	25	30	35	40	45	19	41
4	22	35	40	45	50	55	19	65
6	29	45	50	60	70	75	19	105
10	40	65	70	90	100	120	19	168
16	54	90	100	130	150	170	37	266
25	71	120	140	170	185	200	49	420
35	87	160	185	210	225	240	127	665
50	105	210	230	270	300	325	127	1064
70	135	265	285	330	360	375	127	1323
95	165	310	330	390	410	430	259	1666
120	190	360	400	450	480	520	418	2107
150	220	380	430	475	520	560	418	2107

NOTE: Conductor current ratings may be interpolated for cross sectional areas between those shown in Table A1.

Tabla 2: Área transversal vs corriente nominal

El siguiente diagrama unifilar (**Figura 1**) muestra el diseño de protección eléctrica propuesto:

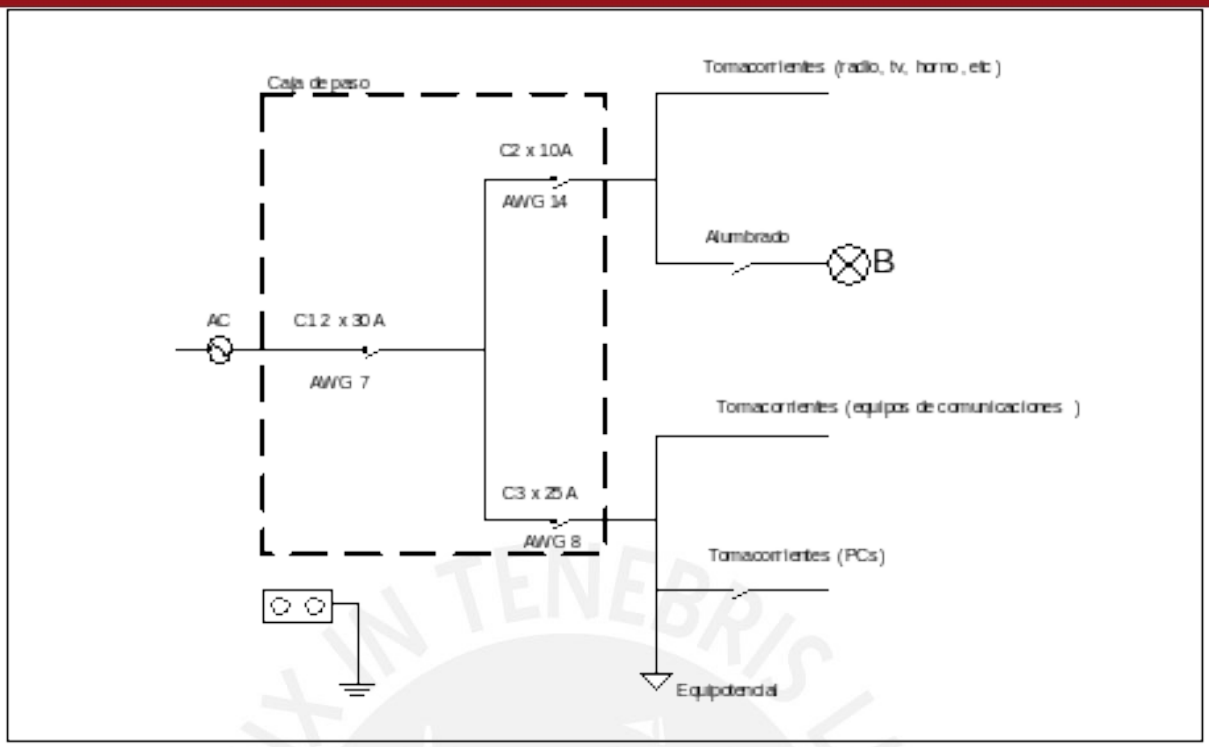


Figura 1: Diagrama unifilar

Sin embargo, ya que en el mismo tablero se encontrarán los 3 ITM, pueden usarse cables AWG 7 por la simplicidad de comprar una sola medida. En la siguiente tabla se estiman las longitudes:

Tramo	Cable	Longitud (m)
Medidor – caja de paso	AWG 7	10
ITM Principal – ITM G1	AGW 7	1
ITM Principal – ITM G2	AWG 7	1
Total	**AWG 7**	**12**

Tabla 3: Estimación de longitud de cableado eléctrico

Los cables eléctricos de las luminarias y tomacorrientes ya se encuentran instalados

En el gabinete se recomienda el uso de un enlace equipotencial donde estén conectados los equipos de comunicaciones. A su vez, el enlace equipotencial tiene conexión al pozo a tierra.

La **Figura 2** muestra en forma referencial, un enlace equipotencial:

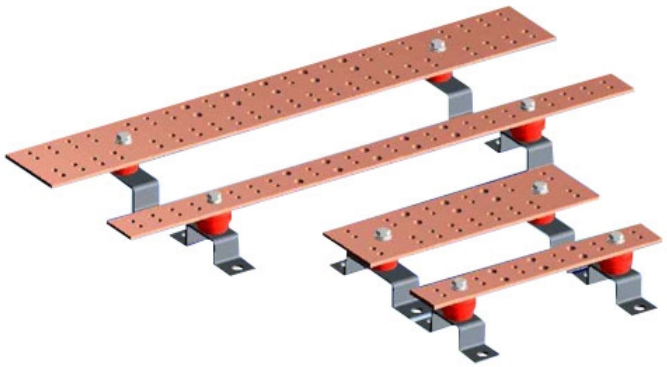


Figura 2: Enlace equipotencial

Anexo 8

Configuración de Access Points

```
Building configuration...

Current configuration : 1448 bytes
!
version 12.3
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname AP-Cachuela-01
!
logging buffered 1024000 informational
enable secret l4c4chu4la
!
clock timezone GMT -5
ip subnet-zero
no ip domain lookup
!
!
no aaa new-model
!
dot11 ssid W-CACHUELA01
   authentication open
   authentication key-management wpa
   infrastructure-ssid
   wpa-psk ascii 7 082D184D5D1A0D21410758 !  l4c4chV3l4
!
!
!
username userlc01 privilege 15 password 7 08311854130E5505002F
! p4zzw0rrD
bridge irb
!
!
interface Dot11Radio0
 no ip address
 no ip route-cache
 load-interval 30
 !
 encryption mode ciphers tkip
 !
 ssid lc
 !
 speed basic-1.0 basic-2.0 basic-5.5 6.0 9.0 basic-11.0 12.0 18.0
24.0 36.0 48.0 54.0
 channel 2462
 station-role root
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface FastEthernet0
 no ip address
 no ip route-cache
 bridge-group 1
 bridge-group 1 spanning-disabled
 hold-queue 80 in
!
```

```
interface BVI1
 ip address 172.16.3.251 255.255.255.0
 no ip route-cache
!
ip default-gateway 172.16.3.1
ip http server
no ip http secure-server
!
logging 172.16.1.5
snmp-server community l4c4chV3l5snMp RO
!
control-plane
!
bridge 1 route ip
!
!
!
line con 0
enable password 7 082D184D5D1A0D21410758
line vty 0 4
enable password 7 082D184D5D1A0D21410758
 login local
line vty 5 15
enable password 7 082D184D5D1A0D21410758
 login local
!
end
```

```
Building configuration...

Current configuration : 1448 bytes
!
version 12.3
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname AP-Cachuela-02
!
logging buffered 1024000 informational
enable secret l4c4chu4la
!
clock timezone GMT -5
ip subnet-zero
no ip domain lookup
!
!
no aaa new-model
!
dot11 ssid W-CACHUELA02
   authentication open
   authentication key-management wpa
   infrastructure-ssid
   wpa-psk ascii 7 082D184D5D1A0D21410758 !  l4c4chV3l4
!
!
!
username userlc01 privilege 15 password 7 08311854130E5505002F
! p4zzw0rrD
bridge irb
!
!
interface Dot11Radio0
 no ip address
 no ip route-cache
 load-interval 30
 !
 encryption mode ciphers tkip
 !
 ssid lc
 !
 speed basic-1.0 basic-2.0 basic-5.5 6.0 9.0 basic-11.0 12.0 18.0
24.0 36.0 48.0 54.0
 channel 2462
 station-role root
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface FastEthernet0
 no ip address
 no ip route-cache
 bridge-group 1
 bridge-group 1 spanning-disabled
 hold-queue 80 in
!
```

```
interface BVI1
 ip address 172.16.3.252 255.255.255.0
 no ip route-cache
!
ip default-gateway 172.16.3.1
ip http server
no ip http secure-server
!
logging 172.16.1.5
snmp-server community l4c4chV3l5snMp RO
!
control-plane
!
bridge 1 route ip
!
!
!
line con 0
enable password 7 082D184D5D1A0D21410758
line vty 0 4
enable password 7 082D184D5D1A0D21410758
 login local
line vty 5 15
enable password 7 082D184D5D1A0D21410758
 login local
!
end
```

White Paper

Antenna Patterns and Their Meaning

Much can be learned about how an antenna performs from its patterns. This paper describes many of the common antenna parameters that can be understood from the patterns.

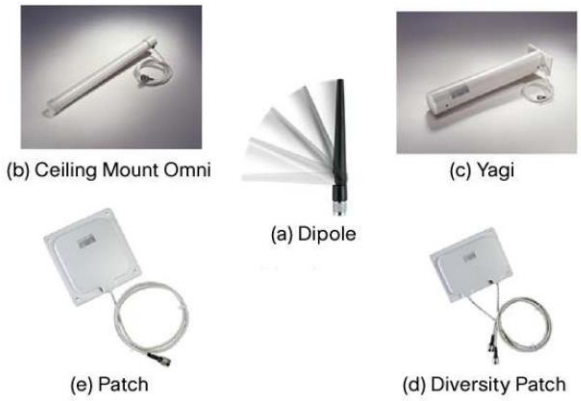
Introduction

A major component of a wireless LAN system is the antenna. There are several different types and they all have their place. However, there can be some confusion surrounding the language used to specify antennas as well as the basic function of each type of antenna. The purpose of this white paper is to dispel the confusion surrounding antennas and their function. This document is not meant to be an electromagnetic primer nor a deployment guide. Rather, it should be used as a dictionary of basic antennas and antenna terminology as well as a tutorial specifically covering antenna patterns and the parameters associated with those patterns. The focus is on many of the various antennas that might be encountered in a wireless LAN system.

We begin with a glossary of basic definitions and then progress through a discussion of some common antenna types and their properties. Along the way, the antenna patterns are shown and explained, including the 3-D radiation pattern from the antennas. Typical performance from each antenna type is described as well. Of course, there are plenty of exceptions to the "typical" antenna, as many antenna types can be designed to enhance one or more parameters. But it is often helpful to see a few examples and have some of these parameters highlighted.

In a WLAN system, commonly used antennas are dipoles, omnidirectional antennas, patches and Yagis. These antennas are shown in Figure 1. Although these antenna packages might vary somewhat from one manufacturer to another, these are typical packages for these types of antennas. The function of each of these antenna types is explained in some detail in this paper.

Figure 1. Various Antennas Commonly Found in WLAN Systems



Historical Note: The antenna type that we commonly refer to as a Yagi was first developed in the late 1920's by two professors, Shintaro Uda and Hidetsugu Yagi at Tohoku University in Japan. While the antenna was mainly developed by Uda, Professor Yagi popularized the antenna design in the US and elsewhere through various conference presentations. Yagi's name has been associated with this antenna type since that time.

Basic Definitions

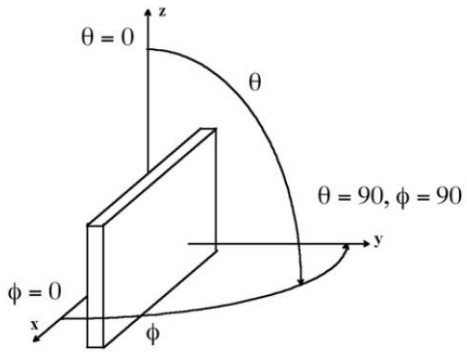
We often define antennas and antenna terminology in terms of a transmitting antenna, but all the definitions apply to receiving antennas as well. In fact, an antenna's properties are the same in either operating mode. So, whether it is stated or not, all the definitions and descriptions describe antennas that are either part of a transmitter or a receiver.

Antenna. An *antenna* is a transducer between a guided wave and a radiated wave, or vice versa. The structure that "guides" the energy to the antenna is most evident as a coaxial cable attached to the antenna. The radiated energy is characterized by the antenna's radiation pattern.

Antenna pattern. The radiation pattern or *antenna pattern* is the graphical representation of the radiation properties of the antenna as a function of space. That is, the antenna's pattern describes how the antenna radiates energy out into space (or how it receives energy). It is important to state that an antenna radiates energy in all directions, at least to some extent, so the antenna pattern is actually three-dimensional. It is common, however, to describe this 3D pattern with two planar patterns, called the *principal plane patterns*. These principal plane patterns can be obtained by making two slices through the 3D pattern through the maximum value of the pattern or by direct measurement. It is these principal plane patterns that are commonly referred to as the antenna patterns.

Characterizing an antenna's radiation properties with two principal plane patterns works quite well for antennas that have well-behaved patterns – that is, not much information is lost when only two planes are shown. Figure 2 shows a possible coordinate system used for making such antenna measurements.

Figure 2. Antenna Measurement Coordinate System

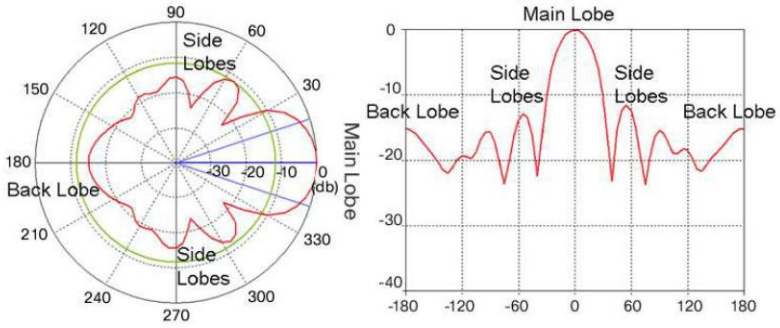


In discussions of principal plane patterns or even antenna patterns, you will frequently encounter the terms *azimuth plane pattern* and *elevation plane pattern*. The term *azimuth* is commonly found in reference to "the horizon" or "the horizontal" whereas the term *elevation* commonly refers to "the vertical". When used to describe antenna patterns, these terms assume that the antenna is mounted (or measured) in the orientation in which it will be used. In Figure 2, the x-y plane (θ = 90 deg) is the azimuth plane. The azimuth plane pattern is measured when the measurement is made traversing the entire x-y plane around the antenna under test. The elevation plane is then a plane orthogonal to the x-y plane, say the y-z plane (φ = 90 deg). The elevation plane pattern is made traversing the entire y-z plane around the antenna under test.

The antenna patterns (azimuth and elevation plane patterns) are frequently shown as plots in polar coordinates. This gives the viewer the ability to easily visualize how the antenna radiates in all directions as if the antenna was "aimed" or mounted already. Occasionally, it may be helpful to plot the antenna patterns in Cartesian (rectangular) coordinates, especially when there are several side lobes in the patterns and where the levels of these side lobes are important.

Lobes. Any given antenna pattern has portions of the pattern that are called *lobes*. A "lobe" can be a main lobe, a side lobe or a back lobe and these descriptions refer to that portion of the pattern in which the lobe appears. In general, a *lobe* is any part of the pattern that is surrounded by regions of relatively weaker radiation. So a lobe is any part of the pattern that "sticks out" and the names of the various types of lobes are somewhat self-explanatory. Figure 3 provides a view of a radiation pattern with the lobes labeled in each type of plot.

Figure 3. Radiation Patterns in Polar and Cartesian Coordinates Showing Various Types of Lobes



(a) Pattern in Polar Coordinates

(b) Pattern in Cartesian Coordinates

Isotropic radiator. An *isotropic radiator* is a hypothetical lossless antenna that radiates its energy equally in all directions. This imaginary antenna would have a spherical radiation pattern and the principal plane cuts would both be circles (indeed, any plane cut would be a circle).

Gain. The *gain* of an antenna (in any given direction) is defined as the ratio of the power gain in a given direction to the power gain of a reference antenna in the same direction. It is standard practice to use an isotropic radiator as the reference antenna in this definition. Note that an isotropic radiator would be lossless and that it would radiate its energy equally in all directions. That means that the gain of an isotropic radiator is G = 1 (or 0 dB). It is customary to use the unit dBi (decibels relative to an isotropic radiator) for gain with respect to an isotropic radiator. Gain expressed in dBi is computed using the following formula:

GdBi = 10*Log (GNumeric/GIsotropic) = 10*Log (GNumeric)

Occasionally, a theoretical dipole is used as the reference, so the unit dBd (decibels relative to a dipole) will be used to describe the gain with respect to a dipole. This unit tends to be used when referring to the gain of omnidirectional antennas of higher gain. In the case of these higher gain omnidirectional antennas, their gain in dBd would be an expression of their gain above 2.2 dBi. So if an antenna has a gain of 3 dBd it also has a gain of 5.2 dBi.

Note that when a single number is stated for the gain of an antenna, it is assumed that this is the maximum gain (the gain in the direction of the maximum radiation).

It is important to state that an antenna with gain doesn't create radiated power. The antenna simply directs the way the radiated power is distributed relative to radiating the power equally in all directions and the gain is just a characterization of the way the power is radiated.

3-dB beamwidth. The *3-dB beamwidth (or half-power beamwidth)* of an antenna is typically defined for each of the principal planes. The 3-dB beamwidth in each plane is defined as the angle between the points in the main lobe that are down from the maximum gain by 3 dB. This is illustrated in Figure 3. The 3-dB beamwidth in the plot in this figure is shown as the angle between the two blue lines in the polar plot. In this example, the 3-dB beamwidth in this plane is about 37 degrees. Antennas with wide beamwidths typically have low gain and antennas with narrow beamwidths tend to have higher gain. Remember that gain is a measure of how much of the power is radiated in a given direction. So an antenna that directs most of its energy into a narrow beam (at least in one plane) will have a higher gain.

Front-to-back ratio. The *front-to-back ratio (F/B)* is used as a figure of merit that attempts to describe the level of radiation from the back of a directional antenna. Basically, the front-to-back ratio is the ratio of the peak gain in the forward direction to the gain 180-degrees behind the peak. Of course on a dB scale, the front-to-back ratio is just the difference between the peak gain in the forward direction and the gain 180-degrees behind the peak.

Polarization. The *polarization or polarization state* of an antenna is a somewhat difficult and involved concept. An antenna will generate an electromagnetic wave that varies in time as it travels through space. If a wave traveling "outward" varies "up and down" in time with the electric field always in one plane, that wave (or antenna) is said to be *linearly polarized* (vertically polarized since the variation is up and down rather than side to side). If that wave rotates or "spins" in time as it travels through space, the wave (or antenna) is said to be *elliptically polarized*. As a special case, if that wave spins out in a circular path, the wave (or antenna) is *circularly polarized*. This implies that certain antennas are sensitive to particular types of electromagnetic waves. The practical implication of this concept is that antennas with the same polarization provide the best transmission/reception path.

Consider antennas that generate and are sensitive to linearly polarized waves. If a linearly polarized antenna launches a linearly polarized electromagnetic wave traveling "up and down" or vertically, the best possible receiver of that electromagnetic wave will be another antenna that is similarly linearly polarized (vertically polarized). Linear polarization also includes the possibility of the electromagnetic waves traveling "right to left" (horizontally) as well. Often antennas can simply be physically rotated to make them horizontally or vertically polarized, although this may not always be the best choice.

Circularly polarized antennas can radiate electromagnetic waves that spin clockwise or counter-clockwise depending on the structure. So a similarly polarized antenna should be used to receive these signals. This spin direction is typically characterized by left circular polarization (LCP) or right circular polarization (RCP).

Note that the polarization of an antenna doesn't always imply anything about the size or shape of the antenna. A dipole is usually called vertically polarized because of the way a dipole is typically used, that is, because it is mounted vertically, but the antenna is linearly polarized. Likewise, antennas that are circular in their construction do not have to be circularly polarized. Many circular patches are linearly polarized and many rectangular patches are circularly polarized. These examples are simple demonstrations of the fact that the polarization state of an antenna is not related to its shape.

VSWR. The *voltage standing wave ratio (VSWR)* is defined as the ratio of the maximum voltage to the minimum voltage in a standing wave pattern. A standing wave is developed when power is reflected from a load. So the VSWR is a measure of how much power is delivered to a device as opposed to the amount of power that is reflected from the device. If the source and load impedance are the same, the VSWR is 1:1; there is no reflected power. So the VSWR is also a measure of how closely the source and load impedance are matched. For most antennas in WLAN, it is a measure of how close the antenna is to a perfect 50 Ohms.

VSWR bandwidth. The *VSWR bandwidth* is defined as the frequency range over which an antenna has a specified VSWR. Often, the 2:1 VSWR bandwidth is specified, but 1.5:1 is also common.

Directional antenna. A *directional antenna* is one that radiates its energy more effectively in one (or some) direction than others. Typically, these antennas have one main lobe and several minor lobes. Examples of directional antennas are patches and dishes.

Omnidirectional antenna. An *omnidirectional antenna* is an antenna that has a non-directional pattern (circular pattern) in a given plane with a directional pattern in any orthogonal plane. Examples of omnidirectional antennas are dipoles and collinear antennas.

Common Antennas and Their Patterns

In this section, some common antennas are described along with details about typical patterns that can be expected from these common antennas. Described here are a dipole, a collinear array, a single patch antenna, a patch array, a Yagi and even a sector antenna. The patterns from each antenna are shown and explained in detail, including a 3D radiation pattern. The emphasis is on describing the patterns and the parameters that are derived from these patterns.

It is important to mention that it doesn't really matter in which direction the patterns are shown. The orientation of a particular pattern is often a matter of personal preference. For example, some people like directional antenna patterns to always point up while others like them to point to the right or left because that's the way the antenna will often be deployed. The important thing is to have some basic knowledge of what these antennas are meant to do, so that you can understand the pattern parameters. Then the pattern's direction is of little importance.

The patterns shown here represent output from simulated antennas. The omnidirectional patterns have been rotated so that the elevation plane patterns appear to radiate out toward the horizon, as is typical of an omnidirectional antenna deployment. The patches and the Yagi patterns remain as simulated, that is, they appear in the same coordinate system in which they were simulated, not deployed.

Omnidirectional Antennas

Omnidirectional antennas are commonly referred to as "omnis." In addition, an omni often refers to an omnidirectional antenna but specifically not a dipole. Often, an omni refers to an omnidirectional antenna that has more gain than a dipole. However, a dipole is an omnidirectional antenna as we will see in the next section. The dipole is just a special case.

Dipole Antennas

A dipole antenna most commonly refers to a half-wavelength (λ/2) dipole. The physical antenna (not the package that it is in) is constructed of conductive elements whose combined length is about half of a wavelength at its intended frequency of operation. This is a simple antenna that radiates its energy out toward the horizon (perpendicular to the antenna). The patterns shown in Figure 4 are those resulting from a perfect dipole formed with two thin wires oriented vertically along the z-axis.

The resulting 3D pattern looks kind of like a donut or a bagel with the antenna sitting in the hole and radiating energy outward. The strongest energy is radiated outward, perpendicular to the antenna in the x-y plane.

The azimuth plane pattern is formed by slicing through the 3D pattern in the horizontal plane, the x-y plane in this case, just as you would slice through a bagel. Notice that the azimuth plane pattern is non-directional, that is, the antenna radiates its energy equally in all directions in the azimuth plane. So the azimuth plane pattern is a circle, passing through the peak gain at all angles, shown in Figure 4c.

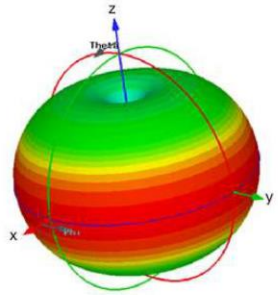
Notice that the patterns in any orthogonal plane (any plane, actually) are directional in nature and so this antenna meets the definition of an omnidirectional antenna. The elevation plane pattern is formed by slicing the 3D pattern through an orthogonal plane (either the x-z plane or the y-z plane). From the elevation plane pattern we see that the dipole antenna has an elevation plane beamwidth of 78-degrees as indicated on the pattern in Figure 4d by the two blue lines. These lines are drawn where the gain is down from the peak by 3-dB. The elevation plane beamwidth is the total angular width between the two 3-dB points on the curve.

The gain of the half-wave dipole is approximately 2.2 dBi. The value of 2.2 dBi is achieved at the horizon in the elevation plane and everywhere in the azimuth plane. Note that the azimuth plane pattern is a circle passing through the gain value of 2.2 dBi at all angles. These values are the 3-dB beamwidth and gain of a theoretical half-wave dipole. Dipole antennas are often quoted this way although many of the dipoles on the market don't quite achieve these theoretical numbers.

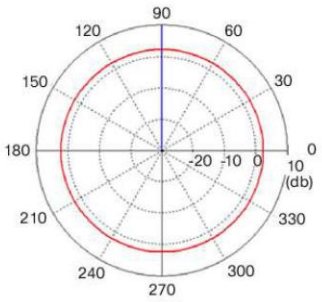
Given these antenna patterns, you can see that a dipole antenna should be mounted so that it is vertically oriented with respect to the floor or ground. This results in the maximum amount of energy radiating out into the intended coverage area. The null in the middle of the pattern will point up and down. Indoors, this typically isn't a concern because of the close proximity of the ceiling and all the multipath present in the indoor environment.

Figure 4. Dipole Antenna with 3D Radiation Pattern, Azimuth Plane Pattern and Elevation Plane Pattern

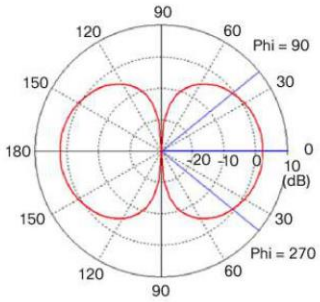
(a) Dipole Antenna Model



(b) Dipole 3D Radiation Pattern



(c) Dipole Azimuth Plane Pattern



(d) Dipole Elevation Plane Pattern

Collinear Omni Antennas

In order to create an omnidirectional antenna with higher gain, multiple omnidirectional structures (either wires or elements on a circuit board) can be arranged in a vertical, linear fashion to retain the same omnidirectional pattern in the azimuth plane but a more focused elevation plane beam which then has higher gain. This is frequently referred to as a *collinear array*. Note that the higher gain doesn't imply that the antenna creates more power. It means that the same amount of power is radiated in a more focused way.

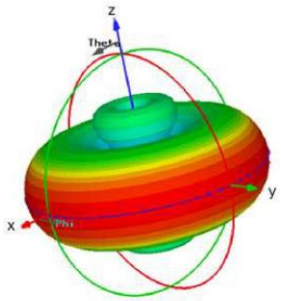
A typical omni pattern is shown in Figure 5. The antenna shown in the figure was formed from an array of three dipoles, oriented along the z-axis. Notice now that the 3D pattern shown in Figure 5a looks like a flatter "bagel" with a little "bowl" stuck to the top and bottom. The bagel forms the omnidirectional azimuth plane shown in Figure 5b and the main lobes in the elevation plane, just like the dipole. The little "bowls" on the top and bottom form the sidelobes present in the elevation plane in Figure 5c.

Again, the azimuth plane pattern is formed by slicing the 3D pattern through the horizontal plane (the x-y plane). As expected, the pattern is circular and it passes through the peak gain at all angles. Note that the pattern in the orthogonal planes is directional, so this antenna meets the basic definition of an omnidirectional antenna.

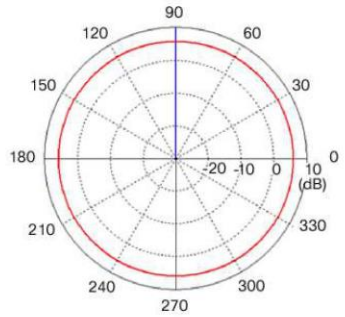
The resulting gain is about 5.8 dBi with an elevation plane beamwidth of about 38 degrees, as indicated again by the blue lines in the elevation plane shown in the Figure 5c. This beamwidth is significantly narrower than the dipole. It is easy to see how the energy radiated from this antenna is more focused, resulting in higher gain (with respect to the dipole).

As is typical of higher gain omnidirectional antennas, the elevation plane shows obvious side lobes. The side lobes in the principal plane patterns are formed by slicing through the "bowls" that sit above and below the main lobes in the 3D pattern. These lobes are about 14 dB down from the peak of the main lobes. Note that the azimuth plane pattern is still the same well-behaved, circular pattern as in the dipole, but the elevation plane pattern is much narrower, indicating that the power is radiated in a more directed way, thus producing a higher gain.

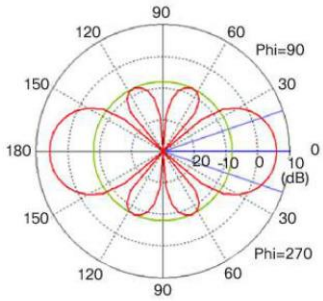
Figure 5. 3D Radiation Pattern from 5.8 dBi Omnidirectional Antenna, Azimuth Plane Pattern and Elevation Plane Pattern



(a) 5.8 dBi Omni 3D Pattern



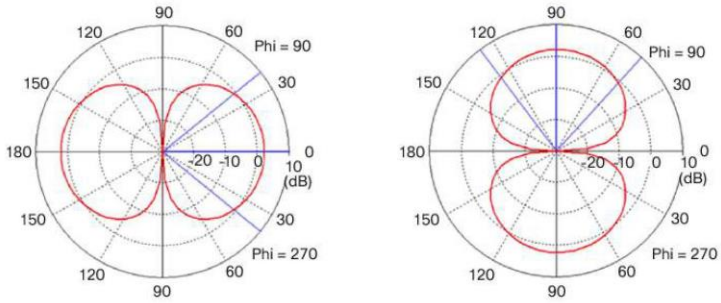
(b) 5.8 dBi Omni Azimuth Plane Pattern



(c) 5.8 dBi Omni Elevation Plane Pattern

As shown in Figures 4 and 5, the goal of a dipole or any omni is to radiate energy equally in all directions in a plane. For dipoles and collinear arrays, the omnidirectional plane is intended to be the azimuth plane (the plane of the floor or the ground). For this reason, it doesn't matter how the patterns are presented. It is understood that the elevation plane pattern is always orthogonal to the azimuth plane pattern. The orientation of the actual plot is largely dependent on the orientation of the antenna in the measurement system and that's all there is to it. So, whether the elevation plane looks like Figure 6a or Figure 6b, you can be certain that when your dipole or omni is oriented vertically, the antenna will radiate out toward the horizon in an omnidirectional fashion.

Figure 6. Elevation Plane Demonstration



Directional Antennas

Directional antennas are used for coverage as well as point-to-point links. They can be patch antennas, dishes, horns or a whole host of other varieties. They all accomplish the same goal: radiating their energy out in a particular direction.

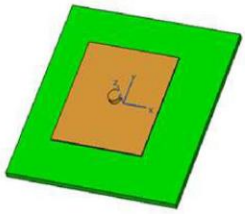
Patch Antennas

A patch antenna, in its simplest form, is just a single rectangular (or circular) conductive plate that is spaced above a ground plane. Patch antennas are attractive due to their low profile and ease of fabrication.

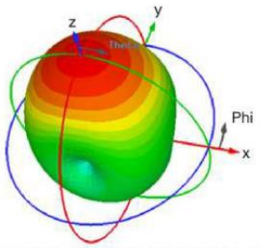
The radiation pattern of a single patch is characterized by a single main lobe of moderate beamwidth. Frequently, the beamwidths in the azimuth and elevation planes are similar, resulting in a fairly circular beam, although this is by no means universal. The beamwidths can be manipulated to produce an antenna with higher or lower gain, depending on the requirements. An antenna built with a single patch will have a maximum gain of about 9 dBi or a bit less.

The patch antenna in Figure 7 shows how simple these antennas can be. This is a simple rectangular patch built over a rectangular ground plane. The radiation patterns exhibit typical patch antenna characteristics. There is a single main lobe with a fairly wide beamwidth with shallow nulls pointing up and down from the antenna. Other than that, there aren't many features to the pattern. The one shown in Figure 7 is designed to have higher gain rather than symmetrical plane patterns. The gain is about 8.8 dBi with an azimuth plane beamwidth of 70 degrees and an elevation plane beamwidth of 57 degrees. These are not uncommon beamwidths for single patch antennas.

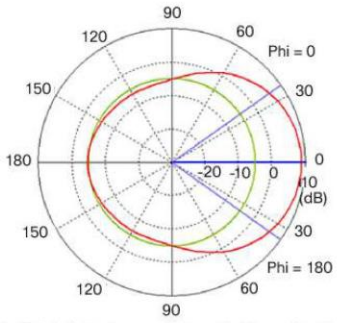
Figure 7. Single Patch Antenna with 3D Radiation Pattern, Azimuth Plane Pattern and Elevation Plane Pattern



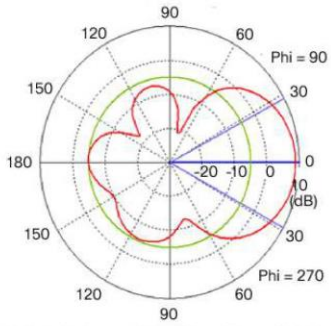
(a) Patch Antenna Model



(b) Patch Antenna 3D Radiation Pattern



(c) Patch Antenna Azimuth Plane Pattern



(d) Patch Antenna Elevation Plane Pattern

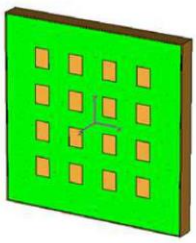
The azimuth and elevation plane patterns are derived by simply slicing through the 3D radiation pattern. In this case, the azimuth plane pattern is obtained by slicing through the x-z plane, and the elevation plane pattern is formed by slicing through the y-z plane. Note that there is one main lobe that is radiated out from the front of the antenna. There are three back lobes in the elevation plane (in this case), the strongest of which happens to be 180 degrees behind the peak of the main lobe, establishing the front-to-back ratio at about 14 dB. That is, the gain of the antenna 180 degrees behind the peak is 14 dB lower than the peak gain.

Again, it doesn't matter if these patterns are shown pointing up, down, to the left or to the right. That is usually an artifact of the measurement system. A patch antenna radiates its energy out from the front of the antenna. That will establish the true direction of the patterns.

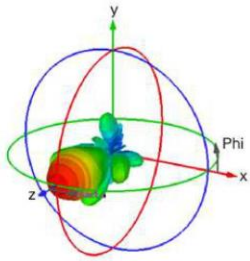
Patch Array Antennas

A patch array antenna is, in general, some arrangement of multiple patch antennas that are all driven by the same source. Frequently, this arrangement consists of patches arranged in orderly rows and columns (a rectangular array) as shown in Figure 8. The reason for these types of arrangements is higher gain. Higher gain commonly implies a narrower beamwidth and that is, indeed, the case with patch arrays. The array shown here has a gain of about 18 dBi with an azimuth and elevation plane beamwidth of about 20 degrees. Notice that the back lobes are very small and that the front-to-back ratio is about 30 dB. The first sidelobes are down from the peak about 14 dB.

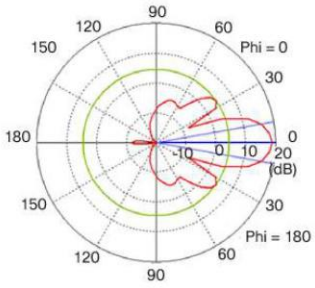
Figure 8. A 4x4 Patch Array Antenna with 3D Radiation Pattern, Azimuth Plane Pattern and Elevation Plane Pattern



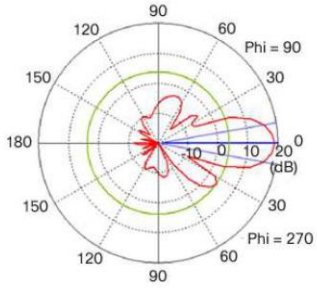
(a) 4x4 Patch Array Antenna



(b) 4x4 Patch Array 3D Radiation Pattern



(c) 4x4 Patch Array Azimuth Plane Pattern



(d) 4x4 Patch Array Elevation Plane Pattern

Antenna patterns are frequently shown normalized to the peak gain. The peak gain (in dBi) is simply subtracted from the gain at all the points on the curve and the pattern is plotted with the new values. These patterns are expressed in dB with 0 dB corresponding to the peak gain. A normalized pattern is especially useful when the sidelobe levels and the depth of the nulls are of interest since it's easier to read their respective levels. The patterns of the patch array shown here have enough lobes and features that a look at their normalized patterns in rectangular coordinates might be interesting. Figure 9 shows the azimuth plane in both polar and Cartesian (rectangular) coordinates. Figure 10 shows the elevation plane in both coordinate systems.

The side lobe levels are easily readable from the rectangular plots. In the azimuth plane, the side lobes are down about 14 dB from the peak. The first side lobe levels are more than 14 dB down in the elevation plane. Note that the back lobe is 30 dB down from the peak. That means the front-to-back ratio is 30 dB. Of course, if the patterns are given in normalized form, the peak gain must be given to determine absolute levels of any of the pattern parameters. The side lobes are labeled in all the plots. Notice that the lower side lobes are to the left of the main beam in the Cartesian plots. These plots show the main beam at 0 degrees, so below the main beam would imply negative angle and above the main beam would imply positive angle.

Figure 9. Azimuth Plane Patterns of the 4 x 4 Patch Array in Polar and Rectangular Coordinates

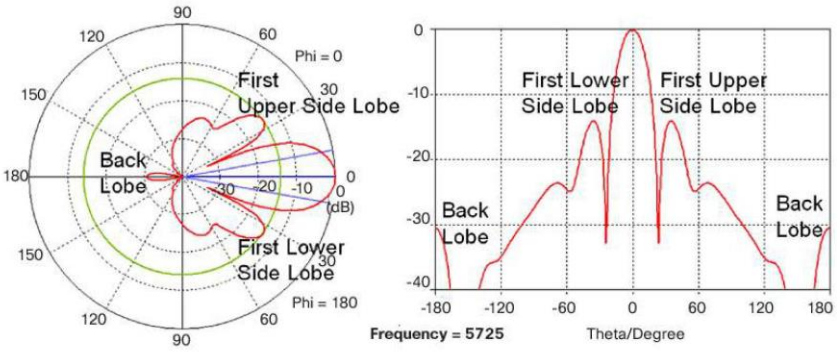
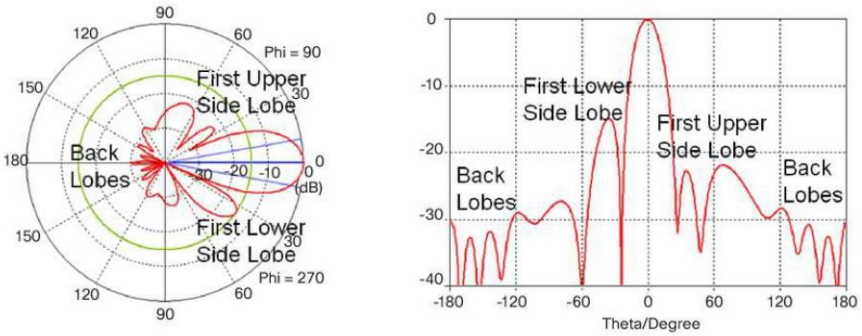


Figure 10. Elevation Plane Patterns of the 4 x 4 Patch Array in Polar and Rectangular Coordinates

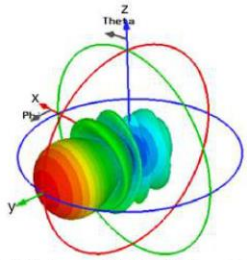


Yagi Antennas

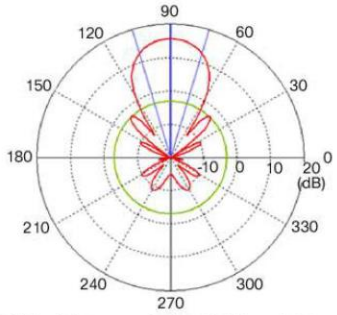
A Yagi antenna is formed by driving a simple antenna, typically a dipole or dipole-like antenna, and shaping the beam using a well-chosen series of non-driven elements whose length and spacing are tightly controlled. The Yagi shown here in Figure 11 is built with one reflector (the bar behind the driven antenna) and 14 directors (the bars in front of the driven antenna). This configuration yields a gain of about 15 dBi with azimuth and elevation plane beamwidths that are basically the same, around 36 degrees. That is a common feature of Yagi antennas. Many times these antennas are designed so that they can be rotated for either horizontal or vertical polarization, so having the same 3-dB beamwidth in each plane is a nice feature in those instances.

Figure 11. Yagi Antenna Model with 3D Radiation Pattern, Azimuth Plane Patten, and Elevation Plane Pattern

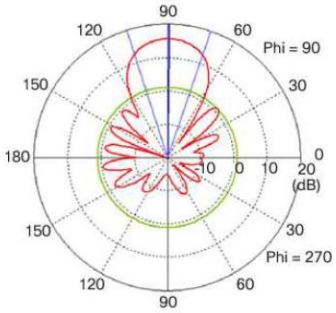
(a) Yagi Antenna Model



(b) Yagi Antenna 3D Radiation Pattern



(c) Yagi Antenna Azimuth Plane Pattern



(d) Yagi Antenna Elevation Plane Pattern

Again, the Yagi antenna is a directional antenna that radiates its energy out in one main direction. Very often, these antennas are enclosed in a tube, with the result that the user may not see all the antenna elements. Their directional nature seems to be somewhat intuitive due to their common, tubular form factor. It is easy to visualize aiming these antennas much like a rifle.

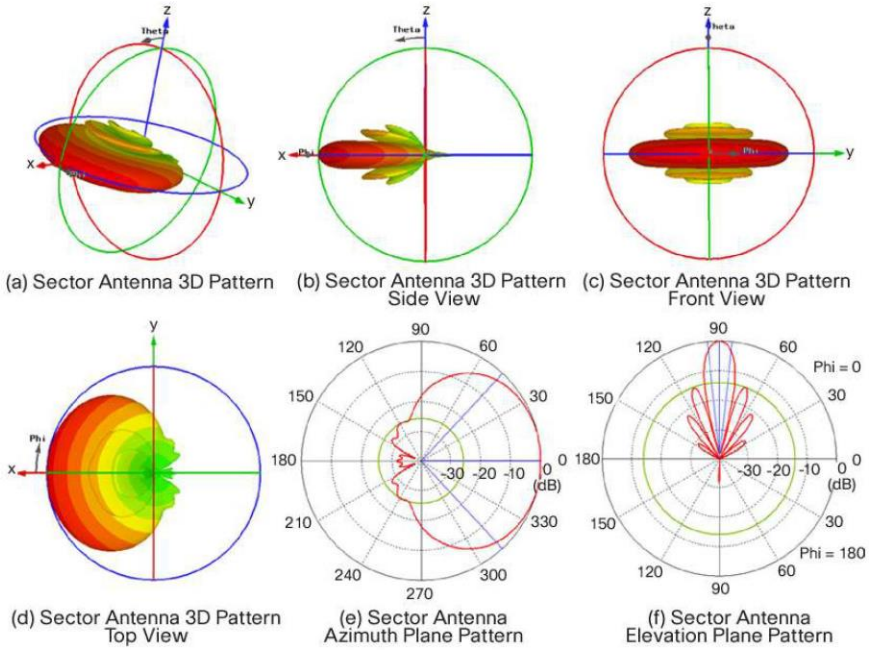
Sector Antennas

A sector antenna or "sector panel" is a somewhat specialized antenna frequently encountered in outdoor systems where wide coverage areas are desired. Very often they are built from an array of dipoles placed in front of a shaped reflector. The size and shape of the reflector determines the performance of these antennas to a large extent. Many of these antennas have reflector shapes that are somewhat flat with some ridges or other features along the edges. A sector antenna is almost always categorized by its azimuth plane 3-dB beamwidth. Commonly available are 60-, 90-, and 120-degree sectors. Sectors are frequently deployed higher up in the air and may have side lobe and front-to-back ratio requirements associated with them. The presence of other antennas and the height of the deployment can weigh heavily on the actual antenna selection.

Figure 12 shows the patterns from a sector antenna, including a few images of the 3D pattern. Notice that the pattern is wide in the azimuth plane, but very narrow in the elevation plane. This is typical of sectors and that is how they achieve their high gains, by compressing the elevation plane. This sector was formed with a vertical array of ten dipoles strategically placed in front of a shaped reflector.

This is an 18 dBi, 90-degree sector. It is a 90-degree sector because the azimuth plane 3-dB beam is 90-degrees as shown in Figure 9e. In this case the elevation plane beamwidth is about 12 degrees and the first side lobes (elevation plane, Figure 9f) are down about 14 dB. Note that the principal plane patterns aren't oriented in any particular manner. Remember that they don't really have to be oriented in any particular way when you know what the antenna is supposed to do. It is assumed that the azimuth plane is parallel to the ground and the elevation plane is perpendicular to the ground.

Figure 12. Various 3D Radiation Patterns from a 90 degree Sector Antenna, Azimuth Plane Pattern and Elevation Plane Pattern



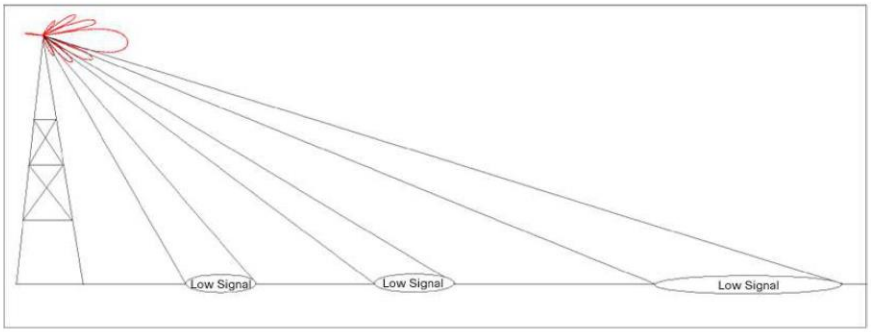
(a) Sector Antenna 3D Pattern (b) Sector Antenna 3D Pattern Side View (c) Sector Antenna 3D Pattern Front View

(d) Sector Antenna 3D Pattern Top View (e) Sector Antenna Azimuth Plane Pattern (f) Sector Antenna Elevation Plane Pattern

One of the problems encountered when deploying sectors, or omnidirectional antennas for that matter, is that there can be several nulls in the elevation plane. When the gain is higher, the number of nulls (and side lobes) generally goes up as well. When the antennas are used in offices or in low hanging outdoor deployments, this is seldom a problem. Signal strengths are generally high enough everywhere to guarantee service to all users with careful planning. But when the antennas are mounted high in the air on towers, these nulls can affect the performance of the system.

Figure 13 illustrates the problem. Assume that the sector antenna is mechanically tilted down by 5 degrees. This effectively tilts the elevation plane pattern down 5 degrees as shown. This puts certain regions under the antenna in areas below the nulls in the pattern resulting in areas of low signal strength.

Figure 13. Coverage Gaps from Elevation Plane Nulls

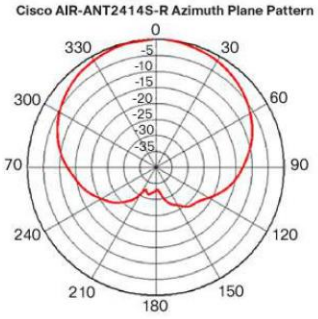


System users "in the nulls" might have a problem depending on how much signal actually gets transmitted to the ground. The further out from the antenna, the worse the problem gets not only because the signal strength gets lower as the distance from the antenna increases, but also because the size of the low-signal area gets bigger. Notice too that many users are getting their coverage from the side lobes rather than from the main beam. This can be an important consideration.

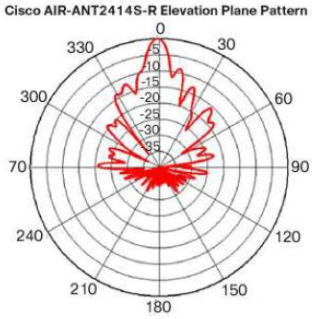
Some sectors are specifically designed to combat this problem with "null fill." When the nulls are filled in, the distribution of energy to the various antenna elements in the array is changed so that more energy is radiated "below" the antenna. As a result, the peak gain of the main lobe is generally reduced. In order to preserve the peak gain, more elements must be added and the antenna gets physically larger. An example of a sector with "null fill" is shown below in Figure 14. This is actually the Cisco® AIR-ANT2414S-R. The AIR-ANT2414S-R is a 14 dBi, 90-degree sector antenna. Many of the 90-degree sector antennas on the market for 2.4 GHz are shorter, but do not have the "null fill" property. This antenna was designed to keep the gain relatively high while filling in the nulls "under the antenna," particularly the deep first null and second null that affect the coverage far away from the antenna.

Figure 14. A Cisco 90-degree Sector Antenna with Azimuth and Elevation Plane Patterns

(a) Cisco AIR-ANT2414S-R, 14 dBi Sector Antenna



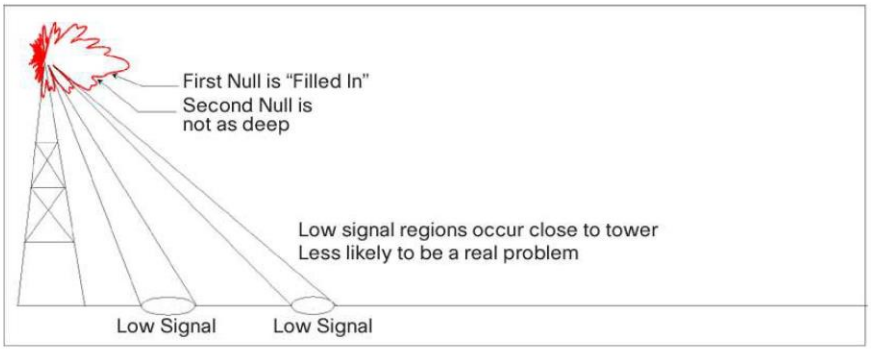
(b) Cisco AIR-ANT2414S-R Azimuth Plane Pattern



(c) Cisco AIR-ANT2414S-R Elevation Plane Pattern

Notice that the first two nulls in the elevation plane "under the antenna" are not as deep or seem to be gone altogether. This allows for increased signal levels to users who might otherwise be without coverage as illustrated in Figure 15. The figure shows that if the antenna is tilted down 5 degrees as in the previously illustrated case, there is no null pointed far away from the antenna. The nulls that still exist point to areas close to the tower, where total lack of coverage is less likely due to the shorter ranges involved.

Figure 15. Illustration of Reduced Coverage Gaps from a Sector Antenna with "Null Fill"



Summary

This paper covered basic antenna definitions and explained terms frequently encountered in examining antenna patterns. Gain and beamwidth definitions were made and pattern parameters such as front-to-back ratio and side lobe levels were discussed. Along the way, the basic function of several common antennas was covered. Omnidirectional antennas like dipoles and collinear arrays were shown to radiate their power out in all directions in a plane, away from the vertical axis of the antenna. Increasing the gain reduces the elevation plane beamwidth and typically increases the number of side lobes. In general, directional antennas, like patches and Yagis, radiate their power out from the front of the antenna. In these cases, both the azimuth plane and elevation plane patterns become important. Increasing the gain will tend to reduce both the azimuth and elevation plane beamwidths unless specific design measures are taken. This is apparent in the design of sector antennas where the azimuth plane beamwidth is typically large compared to the elevation plane beamwidth.

Knowing how these antennas behave prevents confusion when examining the antenna patterns and helps eliminate concerns about "which way the antenna points" when looking at the patterns. The function of the antenna establishes the orientation of the azimuth and elevation plane patterns. The user can then orient or "aim" the pattern in any direction and still understand how the antenna will perform.

Finally, an illustration of some of the effects of nulls and side lobes was shown in the discussion of sector antennas. Two sector antennas were shown mounted high on a tower. One of the sectors made no attempt to control the elevation plane nulls and the other was designed to fill in the worst of the nulls. The regions of low signal level resulting from elevation plane nulls were shown and discussed. It is apparent from this simple discussion that antennas have to be carefully deployed to get the best performance from the system. Knowing the basic definitions and functionality of these common antenna types will provide the basis for good deployment decisions.

References

The following books are excellent references for definitions and basic theory. They also contain a wealth of antenna theory that may be somewhat challenging.

John D. Kraus and Ronald J. Marhefka, *Antennas for all Applications*, McGraw-Hill, 2002

Constantine Balanis, *Antenna Theory*, John Wiley & Sons, 1997

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JUNIPER NETWORKS

DATASHEET

SRX SERIES SERVICES GATEWAYS FOR THE BRANCH

SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650

Product Overview

SRX Series Services Gateways for the branch are next-generation security gateways that provide essential capabilities that connect, secure, and manage workforce locations sized from handfuls to hundreds of users. By consolidating fast, highly available switching, routing, security, and next generation firewall capabilities in a single device, enterprises can protect their resources as well as economically deliver new services, safe connectivity, and a satisfying end-user experience. All SRX Series Services Gateways, including products scaled for Enterprise branch, Enterprise edge, and Data Center applications, are powered by Junos OS—the proven operating system that provides unmatched consistency, better performance with services, and superior infrastructure protection at a lower total cost of ownership.

Product Description

The Juniper Networks® SRX Series Services Gateways for the branch combine next generation firewall and unified threat management (UTM) services with routing and switching in a single, high-performance, cost-effective network device.

- SRX Series for the branch runs Juniper Networks Junos® operating system, the proven OS that is used by core Internet routers in all of the top 100 service providers around the world. The rigorously tested carrier-class routing features of IPv4/IPv6, OSPF, BGP, and multicast have been proven in over 15 years of worldwide deployments.
- SRX Series for the branch provides perimeter security, content security, application visibility, tracking and policy enforcement, user role-based control, threat intelligence through integration with Juniper Networks Spotlight Secure*, and network-wide threat visibility and control. Using zones and policies, network administrators can configure and deploy branch SRX Series gateways quickly and securely. Policy-based VPNs support more complex security architectures that require dynamic addressing and split tunneling. The SRX Series also includes wizards for firewall, IPsec VPN, Network Address Translation (NAT), and initial setup to simplify configurations out of the box.
- For content security, SRX Series for the branch offers a complete suite of next generation firewall, unified threat management (UTM) and threat intelligence services consisting of: intrusion prevention system (IPS), application security (AppSecure), user role-based firewall controls, on-box and cloud-based antivirus, antispam, and enhanced Web filtering to protect your network from the latest content-borne threats. Integrated threat intelligence via Spotlight Secure offers adaptive threat protection against command and control (C&C) related botnets and policy enforcement based on GeoIP and attacker fingerprinting technology (the latter for Web application protection)—all of which are based on Juniper provided feeds. Customers may also leverage their own custom and third-party feeds for protection from advanced malware and other threats. The branch SRX Series integrates with other Juniper security products to deliver enterprise-wide unified access control (UAC) and adaptive threat management.
- SRX Series for the branch are secure routers that bring high performance and proven deployment capabilities to enterprises that need to build a worldwide network of thousands of sites. The wide variety of options allow configuration of performance, functionality, and price scaled to support from a handful to thousands of users. Ethernet, serial, T1/E1, DS3/E3, xDSL, Wi-Fi, and 3G/4G LTE wireless are all available options for WAN or Internet connectivity to securely link your sites. Multiple form factors allow you to make cost-effective choices for mission-critical deployments. Managing the network is easy using the proven Junos OS command-line interface (CLI), scripting capabilities, a simple-to-use Web-based GUI, or Juniper Networks Junos® Space Security Director for centralized management.

*Available on SRX550 and higher devices

Architecture and Key Components

Key Hardware Features of the Branch SRX Series Products

Product	Description
SRX100 Services Gateway	• Eight 10/100 Ethernet LAN ports and 1 USB port (support for 3G USB) • Full UTM[1]; antivirus[1], antispam[1], enhanced Web filtering[1], and content filtering • Intrusion prevention system[1], AppSecure[1] • 2 GB DRAM, 2 GB flash default
SRX110 Services Gateway	• VDSL/ADSL2+ and Ethernet WAN interfaces • Eight 10/100 Ethernet LAN ports and two USB port (support for 3G USB) • Full UTM[1]; antivirus[1], antispam[1], enhanced Web filtering[1], intrusion prevention system[1], AppSecure[1] • Unified Access Control (UAC) and content filtering • 2 GB DRAM, 2 GB CF default
SRX210 Services Gateway	• Two 10/100/1000 Ethernet and 6 10/100 Ethernet LAN ports, 1 Mini-PIM slot, and 2 USB ports (support for 3G USB) • Factory option of 4 dynamic Power over Ethernet (PoE) ports 802.3af • Support for T1/E1, serial, ADSL/2/2+, VDSL, G.SHDSL, and Ethernet small form-factor pluggable transceiver (SFP) • Content Security Accelerator hardware for faster performance of IPS and ExpressAV (with high memory version) • Full UTM[1]; antivirus1, antispam[1], enhanced Web filtering[1], and content filtering • Intrusion prevention system[1], User role-based firewall, and AppSecure[1] • 2 GB DRAM, 2 GB flash default
SRX220 Services Gateway	• Eight 10/100/1000 Ethernet LAN ports, 2 Mini-PIM slots • Factory option of 8 PoE ports; PoE+ 802.3at, backwards compatible with 802.3af • Support for T1/E1, serial, ADSL2/2+, VDSL, G.SHDSL, and Ethernet SFP • Content Security Accelerator hardware for faster performance of IPS and ExpressAV • Full UTM[1]; antivirus[1], antispam[1], enhanced Web filtering[1], and content filtering • Intrusion prevention system[1], User role-based firewall and AppSecure[1] • 2 GB DRAM, 2 GB CF default
SRX240 Services Gateway	• 16 10/100/1000 Ethernet LAN ports, 4 Mini-PIM slots • Factory option of 16 PoE ports; PoE+ 802.3at, backwards compatible with 802.3af • Support for T1/E1, serial, ADSL2/2+, VDSL, G.SHDSL, and Ethernet SFP • Content Security Accelerator hardware for faster performance of IPS and ExpressAV • Full UTM[1]; antivirus1, antispam[1], enhanced Web filtering[1], and content filtering • Intrusion prevention system[1], AppSecure[1]
SRX550 Services Gateway	• Ten fixed Ethernet ports (6 10/100/1000 Copper, 4 SFP), 2 Mini-PIM slots, 6 GPIM slots or multiple GPIM and XPIM combinations • Support for T1/E1, serial, ADSL2/2+, VDSL, G.SHDSL, DS3/E3, Gigabit Ethernet ports; supports up to 52 Ethernet ports including SFP; 40 switch ports with optional PoE including 802.3at, PoE+, backwards compatible with 802.3af (or 50 non-PoE 10/100/1000 Copper ports), 10GbE • Content Security Accelerator hardware for faster performance of IPS and ExpressAV • Full UTM[1]; antivirus[1], antispam[1], enhanced Web filtering[1], and content filtering • Intrusion prevention system[1], User role-based firewall, and AppSecure[1] • Threat intelligence for protection from command and control (C&C) botnets, Web application threats, and advanced malware, and policy enforcement based on GeoIP data • 2 GB DRAM default, 2 GB compact flash default • Optional redundant AC power; standard AC power supply that is PoE-ready; PoE power up to 250 watts single power supply or 500 watts dual power supply
SRX650 Services Gateway	• Four fixed ports 10/100/1000 Ethernet LAN ports, 8 GPIM slots or multiple GPIM and XPIM combinations • Support for T1, E1, DS3/E3, Ethernet ports; supports up to 52 Ethernet ports including SFP; 48 switch ports with optional PoE including 802.3at, PoE+, backwards compatible with 802.3af (or 52 non-PoE 10/100/1000 Copper ports), 10GbE • Content Security Accelerator hardware for faster performance of IPS and ExpressAV • Full UTM[1]; antivirus[1], antispam[1], enhanced Web filtering[1], and content filtering • Intrusion prevention system[1], User role-based firewall, and AppSecure[1] • Threat intelligence for protection from command and control (C&C) botnets, Web application threats, and advanced malware, and policy enforcement based on GeoIP data • Modular Services and Routing Engine; future internal failover and hot-swap • 2 GB DRAM default, 2 GB compact flash default, external compact flash slot for additional storage • Optional redundant AC power; standard AC power supply that is PoE-ready; PoE power up to 250 watts single power supply or 500 watts dual power supply

Network Deployments

The SRX Series Services Gateways for the branch are deployed at remote, branch and Enterprise edge locations in the network to provide all-in-one secure WAN connectivity, and connection to local PCs and servers via integrated Ethernet switching.

[1] Unified Threat Management—antivirus, antispam, Web filtering, AppSecure, and IPS require a subscription license option to use the feature. UTM is not supported on the low memory version. Please see the ordering section for options. Content Filtering and UAC are part of the base software with no additional license.

Features and Benefits

Next Generation Firewall

SRX Series Services Gateways deliver next generation firewall protection with application awareness and extensive user role-based control options plus best-of-breed UTM to protect and control your business assets. Next generation firewalls are able to perform full packet inspection and can apply security policies based on layer 7 information. This means you can create security policies based on the application running across your network, the user who is receiving or sending network traffic or the content that is traveling across your network to protect your environment against threats, manage how your network bandwidth is allocated, and control who has access to what.

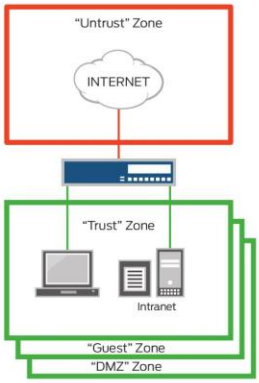

Figure 1: Firewalls, zones, and policies

AppSecure

AppSecure is a suite of application security capabilities for Juniper Networks SRX Series services Gateways that identifies applications for greater visibility, enforcement, control, and protection of the network.

Intrusion Prevention

The intrusion prevention system (IPS) understands application behaviors and weaknesses to prevent application-borne security threats that are difficult to detect and stop.

Unified Threat Management (UTM)

SRX Series can include comprehensive content security against malware, viruses, phishing attacks, intrusions, spam and other threats with unified threat management (UTM). Get a best-of-breed solution with anti-virus, anti-spam, web filtering and content filtering at a great value by easily adding these services to your SRX Series Services Gateway. Cloud-based and on-box solutions are both available.

User Firewall

Juniper offers a range of user role-based firewall control solutions that support dynamic security policies. User role-based firewall capabilities are integrated with the SRX Series Services Gateways for standard next generation firewall controls. More extensive, scalable, granular access controls for creating dynamic policies are available through the integration of SRX with a Juniper Unified Access Control solution.

Adaptive Threat Intelligence

To address the evolving threat landscape that has made it imperative to integrate external threat intelligence into the firewall for thwarting advanced malware and other threats, some SRX Series Services Gateways include threat intelligence via integration with Spotlight Secure. The Spotlight Secure threat intelligence platform aggregates threat feeds from multiple sources to deliver open, consolidated, actionable intelligence to SRX Series Services Gateways across the organization for policy enforcement. These sources include Juniper threat feeds, third party threat feeds and threat detection technologies that the customer can deploy.

Administrators are able to define enforcement policies from all feeds via a single, centralized management point, Junos Space Security Director.

Secure Routing

Many organizations use both a router and a firewall/VPN at their network edge to fulfill their networking and security needs. For many organizations, the SRX Series for the branch can fulfill both roles with one solution. Juniper built best-in-class routing, switching and firewall capabilities into one product..

SRX Series for the branch checks the traffic to see if it is legitimate and permissible, and only forwards it on when it is. This reduces the load on the network, allocates bandwidth for all other mission-critical applications, and secures the network from malicious users.

The main purpose of a secure router is to provide firewall protection and apply policies. The firewall (zone) functionality inspects traffic flows and state to ensure that originating and returning information in a session is expected and permitted for a particular zone. The security policy determines if the session can originate in one zone and traverse to another zone. Due to the architecture, SRX Series receives packets from a wide variety of clients and servers and keeps track of every session, of every application, and of every user. This allows the enterprise to make sure that only legitimate traffic is on its network and that traffic is flowing in the expected direction.

High Availability

Junos Services Redundancy Protocol (JSRP) is a core feature of the SRX Series for the branch. JSRP enables a pair of SRX Series systems to be easily integrated into a high availability network architecture, with redundant physical connections between the systems and the adjacent network switches. With link redundancy, Juniper Networks can address many common causes of system failures, such as a physical port going bad or a cable getting disconnected, to ensure that a connection is available without having to fail over the entire system. This is consistent with a typical active/standby nature of routing resiliency protocols.

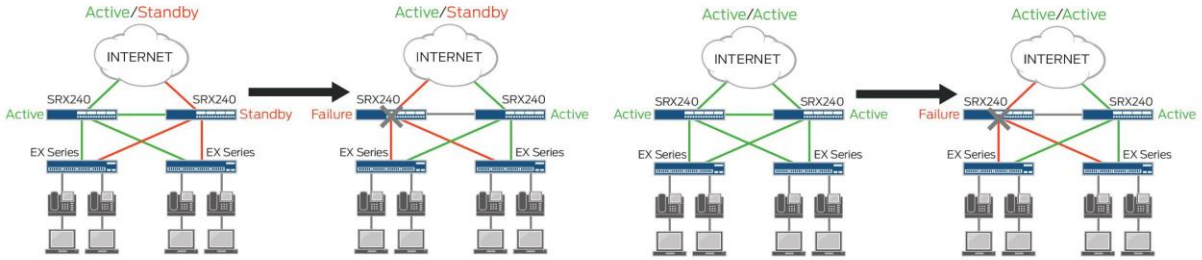

Figure 2: High availability

When SRX Series Services Gateways for the branch are configured as an active/active HA pair, traffic and configuration is mirrored automatically to provide active firewall and VPN session maintenance in case of a failure. The branch SRX Series synchronizes both configuration and runtime information. As a result, during failover, synchronization of the following information is shared: connection/session state and flow information, IPSec security associations, Network Address Translation (NAT) traffic, address book information, configuration changes, and more. In contrast to the typical router active/standby resiliency protocols such as Virtual Router Redundancy Protocol (VRRP), all dynamic flow and session information is lost and must be reestablished in the event of a failover. Some or all network sessions will have to restart depending on the convergence time of the links or nodes. By maintaining state, not only is the session preserved, but security is kept intact. In an unstable network, this active/active configuration also mitigates link flapping affecting session performance.

Session-Based Forwarding Without the Performance Hit

In order to optimize the throughput and latency of the combined router and firewall, Junos OS implements session-based forwarding, an innovation that combines the session state information of a traditional firewall and the next-hop forwarding of a classic router into a single operation. With Junos OS, a session that is permitted by the forwarding policy is added to the forwarding table along with a pointer to the next-hop route. Established sessions have a single table lookup to verify that the session has been permitted and to find the next hop. This efficient algorithm improves throughput and lowers latency for session traffic when compared with a classic router that performs multiple table lookups to verify session information and then to find a next-hop route.

Figure 3 shows the session-based forwarding algorithm. When a new session is established, the session-based architecture within Junos OS verifies that the session is allowed by the forwarding policies. If the session is allowed, Junos OS will look up the next-hop route in the routing table. It then inserts the session and the next-hop route into the session and forwarding table and forwards the packet. Subsequent packets for the established session require a single table lookup in the session and forwarding table, and are forwarded to the egress interface.

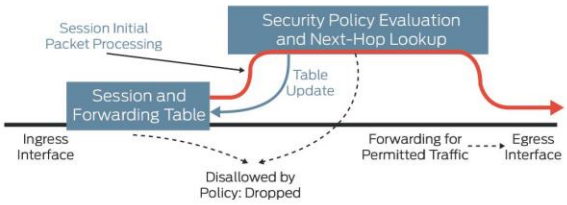

Figure 3: Session-based forwarding algorithm

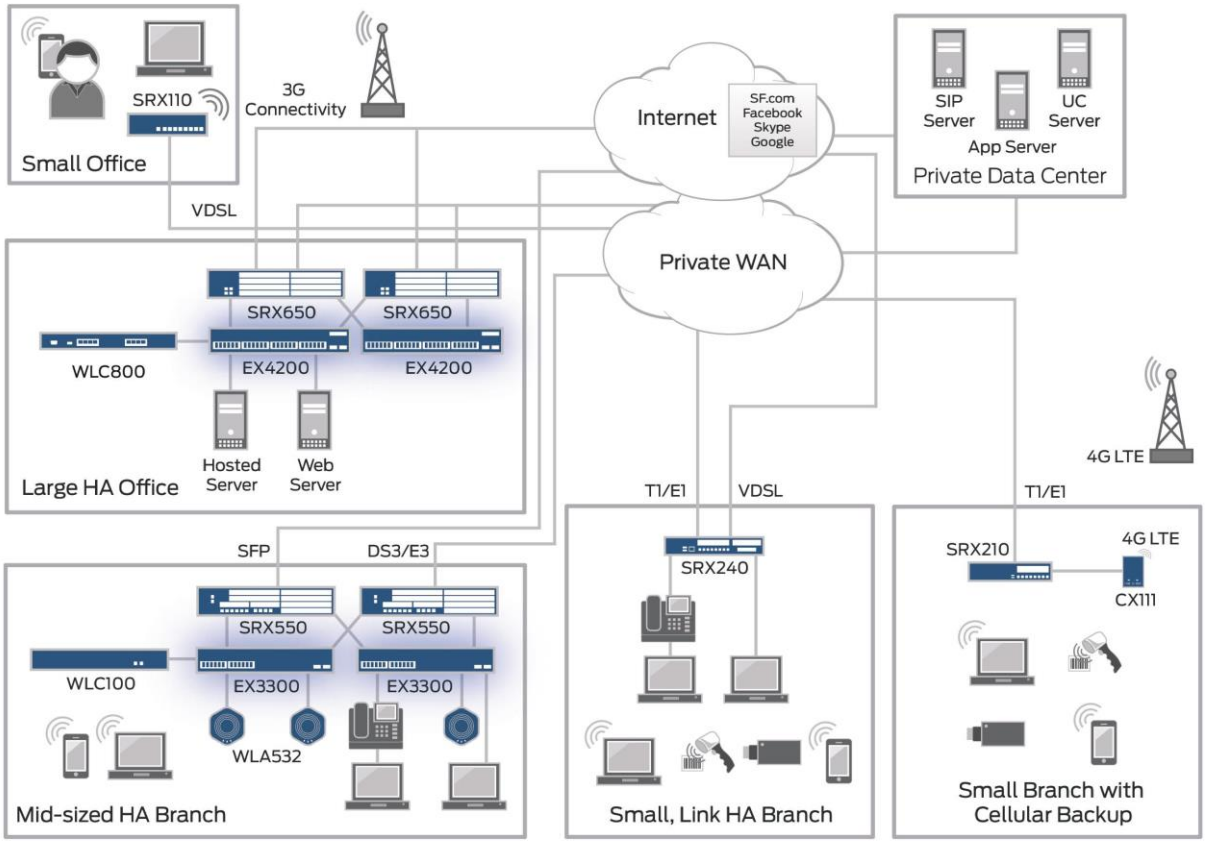

Figure 4: The distributed enterprise


SRX100


SRX110


SRX210


SRX220


SRX240


SRX550


SRX650

Specifications

Protocols

- IPv4, IPv6, ISO Connectionless Network Service (CLNS)

Routing and Multicast

- Static routes
- RIPv2 +v1
- OSPF/OSPFv3
- BGP
- BGP Router Reflector[2]
- IS-IS
- Multicast (Internet Group Management Protocol (IGMPv1/2/3), PIM-SM/DM/SSM, Session Description Protocol (SDP), Distance Vector Multicast Routing Protocol (DVMRP), source-specific, Multicast inside IPsec tunnel), MSDP
- MPLS (RSVP, LDP, Circuit Cross-connect (CCC), Translational Cross-connect (TCC), Layer 2 VPN (VPLS), Layer 3 VPN, VPLS, NGMVPN)

IP Address Management

- Static
- DHCP, PPPoE client
- Internal DHCP server, DHCP Relay

Address Translation

- Source NAT with Port Address Translation (PAT)
- Static NAT
- Destination NAT with PAT
- Persistent NAT, NAT64

Encapsulations

- Ethernet (MAC and VLAN tagged)
- Point-to-Point Protocol (PPP) (synchronous)
  - Multilink Point-to-Point Protocol (MLPPP)
- Frame Relay
  - Multilink Frame Relay (MLFR) (FRF.15, FRF.16), FRF.12, LFI
- High-Level Data Link Control (HDLC)
- Serial (RS-232, RS-449, X.21, V.35, EIA-530)
- 802.1q VLAN support
- Point-to-Point Protocol over Ethernet (PPPoE)

L2 Switching

- 802.1D, RSTP, MSTP, 802.3ad (LACP)
- 802.1x, LLDP, 802.1ad (Q-in-Q), IGMP Snooping
- Layer 2 switching with high availability

Traffic Management Quality of Service (QoS)

- 802.1p, DSCP, EXP
- Marking, policing, and shaping
- Class-based queuing with prioritization
- Weighted random early detection (WRED)
- Queuing based on VLAN, data-link connection identifier (DLCI), interface, bundles, or multi-field (MF) filters
- Guaranteed bandwidth
- Maximum bandwidth
- Ingress traffic policing
- Priority-bandwidth utilization
- DiffServ marking
- Virtual channels

Security

Firewall

- Firewall, zones, screens, policies
- Stateful firewall, stateless filters
- Network attack detection
- Screens denial of service (DoS) and provides distributed denial of service (DDoS) protection (anomaly-based)
- Prevent replay attack; Anti-Replay
- Unified Access Control
  - TCP reassembly for fragmented packet protection
  - Brute force attack mitigation
  - SYN cookie protection
  - Zone-based IP spoofing
  - Malformed packet protection

NGFW/UTM[1]

- Intrusion Prevention System (IPS)
  - Protocol anomaly detection
  - Stateful protocol signatures
  - Intrusion prevention system (IPS) attack pattern obfuscation
  - User role-based policies

[1] Unified Threat Management – antivirus, antispam, Web filtering, AppSecure, and IPS require individual subscription license. UTM is not supported on the low memory version. Please see the ordering section for options.

[2] BGP Route Reflector supported on SRX550 and SRX650. See ordering section for more information.

Specifications (continued)

UTM[1] (continued)

- Customer signatures creation
- Multiple times a week and emergency updates
- AppSecure
  - AppTrack (application visibility and tracking)
  - AppFirewall (policy enforcement by application name)
  - Custom signatures
  - AppQoS (network traffic prioritization and bandwidth management)
  - Dynamic signature updates
  - User-based application policy enforcement
- Antivirus
  - Express AV (stream-based AV, not available on SRX100 and SRX110)
  - File-based antivirus
    - Signature database
    - Protocols scanned: POP3, HTTP, SMTP, IMAP, FTP
    - Antispyware
    - Anti-adware
    - Antikeylogger
  - Cloud-based antivirus
- Antispam
- Integrated enhanced Web filtering
  - Category granularity (90+ categories)
  - Real time threat score
- Redirect Web filtering
- Content Security Accelerator in SRX210 high memory, SRX220, SRX240, SRX550, and SRX650[1]
- ExpressAV option in SRX210 high memory, SRX220 high memory, SRX240, SRX550, and SRX650[1]
- Content filtering
  - Based on MIME type, file extension, and protocol commands

VPN

- Auto VPN (Zero Touch Hub)
- Tunnels (GRE, IP-IP, IPsec)
- IPsec, Data Encryption Standard (DES) (56-bit), triple Data Encryption Standard (3DES) (168-bit), Advanced Encryption Standard (AES) (128-bit+) encryption
- Message Digest 5 (MD5),SHA-1 , SHA-128, SHA-256 authentication
- Junos Pulse Dynamic VPN client; browser-based remote access feature requiring a license
- IPv4 and IPv6 VPN
- Multi-Proxy ID for site-to-site VPN

Multimedia Transport

- Compressed Real-Time Transport Protocol (CRTP)

High Availability

- VRRP
- JSRP
- Stateful failover and dual box clustering
- SRX550/SRX650:
  - Redundant power (optional)
  - GPIM hot swap
  - Future internal failover and SRE hot swap (OIR) on SRX650
- Backup link via 3G/4G LTE wireless or other WAN
- Active/active—L3 mode[2]
- Active/passive—L3 mode[2]
- Configuration synchronization[2]
- Session synchronization for firewall and VPN[2]
- Session failover for routing change[2]
- Device failure detection[2]
- Link failure detection[2]
- IP Monitoring with route and interface failover

IPv6

- OSPFv3
- RIPng
- IPv6 Multicast Listener Discovery (MLD)
- BGP
- ISIS

Wireless

- CX111 Cellular 3G/4G/LTE Broadband Data Bridge supported on all branch SRX Series devices
- 3G USB modem support for SRX100, SRX110, and SRX210

SLA, Measurement, and Monitoring

- Real-time performance monitoring (RPM)
- Sessions, packets, and bandwidth usage
- Juniper J-Flow monitoring and accounting services
- IP Monitoring

Logging

- Syslog
- Traceroute
- Extensive control- and data-plane structured and unstructured syslog

Administration

- Juniper Networks Network and Security Manager support (NSM)
- Juniper Networks Junos Space Security Director support
- Juniper Networks STRM Series Security Threat Response Managers support
- Juniper Networks Advanced Insight Solutions support
- External administrator database (RADIUS, LDAP, SecureID)
- Auto-configuration
- Configuration rollback
- Rescue configuration with button
- Commit confirm for changes
- Auto-record for diagnostics
- Software upgrades (USB upgrade option)
- Juniper Networks J-Web
- Command-line interface
- Smart image download

Certifications

- NEBS Compliance for SRX240, SRX650[3]
- Department of Defense (DoD) Certification for SRX Series Services Gateways, including testing and certification by the Department of Defense Joint Interoperability Test Command (JITC) for interoperability with DoD networks and addition of the SRX Series Services Gateways to the Unified Capabilities Approved Product List (UC APL)

[1] Unified Threat Management – antivirus, antispam, Web filtering, AppSecure and IPS require individual subscription license. UTM is not supported on the low memory version. Please see the ordering section for options.
[2] SRX100B installed with 1 GB DRAM, with 512 MB accessible. Optional upgrade to 1 GB DRAM is available with purchase of memory software license key.
[3] Coming soon for SRX110 and SRX550.

Product Comparison

	SRX100	SRX110	SRX210	SRX220	SRX240	SRX550	SRX650
Maximum Performance and Capacity							
Junos OS version tested	Junos OS 12.1X44-D15	Junos OS 12.1X44-D15	Junos OS 12.1X44-D15	Junos OS 12.1X44-D15	Junos OS 11.4R5	Junos OS 12.1	Junos OS 11.4R5
Firewall performance (large packets)	700 Mbps	700 Mbps	850 Mbps	950 Mbps	1.8 Gbps	5.5 Gbps	7 Gbps
Firewall performance (IMIX)	200 Mbps	200 Mbps	250 Mbps	300 Mbps	600 Mbps	1.7 Gbps	2.5 Gbps
Firewall + routing PPS (64 Byte)	70 Kpps	70 Kpps	95 Kpps	125 Kpps	200 Kpps	700 Kpps	850 Kpps
Firewall performance[3] (HTTP)	100 Mbps	100 Mbps	290 Mbps	350 Mbps	830 Mbps	1.5 Gbps	2 Gbps
IPsec VPN throughput (large packets)	65 Mbps	65 Mbps	85 Mbps	100 Mbps	300 Mbps	1.0 Gbps	1.5 Gbps
IPsec VPN tunnels	128	128	256	512	1,000	2,000	3,000
AppSecure firewall throughput[3]	90 Mbps	90 Mbps	250 Mbps	300 Mbps	750 Mbps	1.5 Gbps	1.9 Gbps
IPS (intrusion prevention system)	75 Mbps	75 Mbps	65 Mbps	80 Mbps	230 Mbps	800 Mbps	1 Gbps
Antivirus	25 Mbps (Sophos AV)	25 Mbps (Sophos AV)	30 Mbps (Sophos AV)	35 Mbps (Sophos AV)	85 Mbps (Sophos AV)	300 Mbps (Sophos AV)	350 Mbps (Sophos AV)
Connections per second	1,800	1,800	2,200	2,800	8,500	27,000	35,000
Maximum concurrent sessions	32 K[1]	32 K[1]	64 K[1]	96 K[1]	256 K[1]	375 K	512 K
DRAM options	2 GB DRAM	2 GB DRAM	2 GB DRAM	2 GB DRAM	2 GB DRAM	2 GB DRAM	2 GB DRAM
Maximum security policies	384	384	512	2,048	4,096	7,256	8,192
Maximum users supported	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted
Network Connectivity							
Fixed I/O	8 x 10/100	8 x 10/100 VDSL/ADSL2+ WAN (Annex A or B)	2 x 10/100/1000 BASE-T + 6 x 10/100	8 x 10/100/1000 BASE-T	16 x 10/100/1000 BASE-T	6 x 10/100/1000 BASE-T + 4 SFP	4 x 10/100/1000 BASE-T
I/O slots	N/A	N/A	1 x SRX Series Mini-PIM	2 x SRX Series Mini-PIM	4 x SRX Series Mini-PIM	2 x SRX Series Mini-PIM, 6 x GPIM or multiple GPIM and XPIM combinations	8 x GPIM or multiple GPIM and XPIM combinations
Services and Routing Engine slots	No	No	No	No	No	No	2[2]
ExpressCard slot (3G WAN)	No	No	Yes	No	No	No	No
WAN/LAN interface options	N/A	N/A	See ordering information	See ordering information	See ordering information	See ordering information	See ordering information
Maximum number of PoE ports (PoE optional on some SRX Series models)	N/A	N/A	Up to 4 ports of 802.3af with maximum 50 W	Up to 8 ports of 802.3af/at with maximum 120 W	Up to 16 ports of 802.3af/at with maximum 150 W	Up to 40 ports of 802.3af/at with maximum 247 W	Up to 48 ports of 802.3af/at with maximum 247 W
USB	1	2	2	2	2	2	2 per SRE

[1] Based on 2 GbE memory models, which require Junos OS 12.1X44-D15 (exception: Junos OS 11.4r5 for SRX240 only).
[2] SRX650 supports a single Services and Routing Engine (SRE) as of software release 11.4.
[3] Throughput numbers based on HTTP traffic with 44 kilobyte transaction size.

Product Comparison (continued)

	SRX100	SRX110	SRX210	SRX220	SRX240	SRX550	SRX650
Routing							
Routing (Packet Mode) PPS	100Kpps	100Kpps	150Kpps	200Kpps	300Kpps	1000Kpps	1000Kpps
BGP instances	5	5	10	16	20	56	64
BGP peers	8	8	16	16	32	192	256
BGP routes	8 K	8 K	16 K	32 K	600 K	712 K	800 K
OSPF instances	4	4	10	16	20	56	64
OSPF routes	8 K	8 K	16 K	32 K	200 K	712 K	800 K
RIP v1 / v2 instances	4	4	10	16	20	56	64
RIP v2 routes	8 K	8 K	16 K	32 K	200 K	712 K	800 K
Static routes	8 K	8 K	16 K	32 K	256 K	712 K	800 K
Source-based routing	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Policy-based routing	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equal-cost multipath (ECMP)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reverse path forwarding (RPF)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IPsec VPN							
Concurrent VPN tunnels	128	128	256	512	1,000	2,000	3,000
Tunnel interfaces	10	10	64	64	128	456	512
DES (56-bit), 3DES (168-bit) and AES (256-bit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MD-5, SHA-1 and SHA-2 authentication	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual key, Internet Key Exchange (IKE v1+v2), public key infrastructure (PKI) (X.509)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Perfect forward secrecy (DH Groups)	1, 2, 5	1, 2, 5	1, 2, 5	1, 2, 5	1, 2, 5	1, 2, 5	1, 2, 5
Prevent replay attack	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dynamic remote access VPN	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IPsec NAT traversal	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Redundant VPN gateways	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of remote access users	25 users	25 users	50 users	150 users	250 users	500 users	500 users
User Authentication and Access Control							
Third-party user authentication	RADIUS, RSA SecureID, LDAP	RADIUS, RSA SecureID, LDAP	RADIUS, RSA SecureID, LDAP	RADIUS, RSA SecureID, LDAP	RADIUS, RSA SecureID, LDAP	RADIUS, RSA SecureID, LDAP	RADIUS, RSA SecureID, LDAP
RADIUS accounting	Yes	Yes	Yes	Yes	Yes	Yes	Yes
XAUTH VPN, Web-based, 802.X authentication	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PKI certificate requests (PKCS 7 and PKCS 10)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Certificate Authorities supported	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Virtualization							
Maximum number of security zones	10	10	12	24	64	96	128
Maximum number of virtual routers	3	3	10	15	64	128	128
Maximum number of VLANs	16	16	64	128	2,000	3,967	3,967

Product Comparison (continued)

	SRX100	SRX110	SRX210	SRX220	SRX240	SRX550	SRX650
Encapsulations							
PPP/MLPPP	N/A	N/A	Yes	Yes	Yes	Yes	Yes
PPPoE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PPPoA	N/A	Yes	Yes	Yes	Yes	Yes	Yes
MLPPP maximum physical interfaces	N/A	N/A	1	2	4	12	12
Frame Relay	N/A	N/A	Yes	Yes	Yes	Yes	Yes
MLFR (FRF .15, FRF .16)	N/A	N/A	Yes	Yes	Yes	Yes	Yes
MLFR maximum physical interfaces	N/A	N/A	1	2	4	12	12
HDLC	N/A	N/A	Yes	Yes	Yes	Yes	Yes
Wireless							
CX111 3G /4G LTE Bridge support	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Junos/SRX Series management of CX111	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Internal 3G ExpressCard slot support	No	No	Yes	No	No	No	No
USB 3G support	Yes	Yes	Yes	No	No	No	No
Max WLAN access points supported with AX411	2	2	4	4	4	4	4
WLA Series access points and WLC Series controllers supported	> 4	> 4	> 4	> 4	> 4	> 4	> 4
Flash and Memory							
Memory (DRAM)	2 GB	2 GB	2 GB	2 GB	2 GB	2 GB	2 GB
Memory slots	Fixed memory	Fixed memory	Fixed memory	Fixed memory	Fixed memory	2 DIMM	4 DIMM
Flash memory	2 GB	2 GB CF, externally accessible	2 GB	2 GB CF, externally accessible	2 GB	2 GB CF internal	2 GB CF internal on SRE, external slot empty, up to 2 GB CF supported
USB port for external storage	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dimensions and Power							
Dimensions (W x H x D)	8.5 x 1.4 x 5.8 in (21.6 x 3.6 x 14.7 cm)	11.02 x 1.72 x 8.385 in (28 x 4.37 x 21.3 cm)	11.02 x 1.73 x 7.12 in (28.0 x 4.4 x 18.1 cm)	14.31 x 1.73 x 7.11 in (36.3 x 4.4 x 18.1 cm)	17.5 x 1.75 x 15.1 in (44.4 x 4.4 x 38.5 cm)	17.5 x 3.5 x 18.2 in (44.4 x 8.8 x 46.2 cm)	17.5 x 3.5 x 18.2 in (44.4 x 8.8 x 46.2 cm)
Weight (device and power supply)	2.5 lb (1.1 kg)	6.7 lb (3.06 kg)	3.3 lb (1.5 kg) non-PoE / 4.4 lb (2 kg) PoE No interface modules	3.43 lb (1.56 kg) non-PoE No interface modules	For LM and HM-AC: 11.2 lb (5.1 kg) For HM - DC: 12.56 lb (5.7 kg) / 12.3 lb (5.6 kg) PoE No interface modules	21.96 lb (9.96 kg) No interface modules 1 power supply	24.9 lb (11.3 kg) No interface modules 1 power supply
Rack-mountable	Yes, 1 RU	Yes, 1 RU	Yes, 1 RU	Yes, 1 RU	Yes, 1 RU	Yes, 2 RU	Yes, 2 RU
Power supply (AC)	100-240 VAC, 30 W	100-240 VAC, 60 W	100–240 VAC, 60 W non-PoE/ 150 W PoE	100–240 VAC, 60 W non-PoE / 200 W PoE	150 W for LM and HM 190 W for HM with DC 360 W for PoE	100–240 VAC, single 645 W or dual 645 W	100–240 VAC, single 645 W or dual 645 W
Maximum PoE power	N/A	N/A	50 W	120 W	150 W	247 W redundant, or 494 W non-redundant	247 W redundant, or 494 W non-redundant

Product Comparison (continued)

	SRX100	SRX110	SRX210	SRX220	SRX240	SRX550	SRX650
Dimensions and Power (continued)							
Average power consumption	10 W	24 W	27 W (LM), 28 W (HM), 84 W (PoE)	28 W (LM)	SRX240B - 71 W SRX240H - 74 W SRX240H-DC - 72 W SRX240H-PoE- 86 W	85 W	122 W
Input frequency	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz	50-60 Hz
Maximum current consumption	0.25 A @ 100 VAC	1.75 A @ 100 VAC	0.41 A @ 100 VAC (LM), 0.44 A @ 100 VAC (HM), 1.13 A @ 100 VAC (PoE)	0.44 A @ 100 VAC (HM)	1.0 A @ 100 VAC (LM), 1.1 A @ 100 VAC (HM), 3.0 A @ 100 VAC (PoE)	7.5 A @ 100 VAC with single PSU with PoE, 10.5 A @ 100 VAC with dual PSU with PoE	5.3 A @ 100 VAC with single PSU with PoE, 8.3 A @ 100 VAC with dual PSU with PoE
Maximum inrush current	60 A	70 A	80 A for LM/HM, 60 A for PoE	80 A for HM	40 A for LM/HM, 45 A for PoE	45 A for ½ cycle	45 A for ½ cycle
Average heat dissipation	35 BTU/hr	81 BTU/hr	92 BTU/hr (SRX210BE) 95 BTU/hr (SRX210HE) 116 BTU/hr (SRX210HE-PoE)	126 BTU/hour (SRX220H)	242 BTU/hr (SRX240B) 253 BTU/hr (SRX240H) 246 BTU/hr (SRX240H-DC 294 BTU/hr (SRX40H-PoE)	238 BTU/hr	319 BTU/hr
Maximum heat dissipation	80 BTU/hr	99 BTU/hr	1,120 BTU/hr (SRX210BE) 126 BTU/hr (SRX210HE) 157 BTU/hr (SRX210HE-PoE)	126 BTU/hour (SRX220H)	396 BTU/hr (SRX240B) 427 BTU/hr (SRX240H) 409 BTU/hr (SRX240H-DC) 560 BTU/hr (SRX240H-PoE)	1,449 BTU/hr	699 BTU/hr
Redundant power supply (hot swappable)	No	No	No	No	No	Yes (up to maximum capacity of single PSU)	Yes (up to maximum capacity of single PSU)
Acoustic noise level (Per ISO 7779 Standard)	0 dB (fanless)	0 dB (fanless)	29.1 dB	51.1 dB	70.0 dB	51.8 dB	60.9 dB
Environment							
Operational temperature	32º to 104º F (0º to 40º C)	32º to 104º F (0º to 40º C)	32º to 104º F (0º to 40º C)	32º to 104º F (0º to 40º C)	32º to 104º F (0º to 40º C)	32º to 104º F (0º to 40ºC)	32º to 104º F (0º to 40ºC)
Nonoperational temperature	4º to 158º F, (-20º to 70º C)	4º to 158º F, (-20º to 70º C)	4º to 158º F, (-20º to 70º C)	4º to 158º F, (-20º to 70º C)	-40º to 158º F, (-40º to 70º C)	4º to 158º F, (-20º to 70º C)	4º to 158º F, (-20º to 70º C)
Humidity (operating)	10% to 90% noncondensing	10% to 90% noncondensing	10% to 90% noncondensing	10% to 90% noncondensing	10% to 90% noncondensing	10% to 90% noncondensing	10% to 90% noncondensing
Humidity (nonoperating)	5% to 95% noncondensing	5% to 95% noncondensing	5% to 95% noncondensing	5% to 95% noncondensing	5% to 95% noncondensing	5% to 95% noncondensing	5% to 95% noncondensing
Mean time between failures (Telcordia model)	24.8 years (SRX100B) 24.8 years (SRX100H)	24.8 years	14.03 years (SRX210HE) 10.26 years (SRX210HE-PoE)	13.46 years (SRX220H) 11.06 years (SRX220H-PoE)	11.97 years (SRX240B) 11.63 years (SRX240H) 9.92 years (SRX240H-PoE)	9.6 years with redundant power	9.6 years with redundant power

*There are several models available for the SRX210 and SRX240 including the enhanced version. Please contact your Juniper or partner account representative for more information.

Product Comparison (continued)

	SRX100	SRX110	SRX210	SRX220	SRX240	SRX550	SRX650
Certifications and Network Homologation							
USA							
Safety certifications	UL 60950-1	UL 60950-1	UL 60950-1	UL 60950-1	UL 60950-1	UL 60950-1	UL 60950-1
EMC certifications	FCC Class B	FCC Class B	FCC Class B[1]	FCC Class A	FCC Class A	FCC Class A	FCC Class A
Network homologation	TIA-968	TIA-968	TIA-968	TIA-968	TIA-968	TIA-966	TIA-966
Canada							
Safety certifications	CSA 60950-1	CSA 60950-1	CSA 60950-1	CSA 60950-1	CSA 60950-1	CSA 60950-1	CSA 60950-1
EMC certifications	ICES class B	ICES class B	ICES class B[1]	ICES Class A	ICES class A	ICES class A	ICES class A
Network homologation	CS-03	CS-03	CS-03	CS-03	CS-03	CS-03	CS-03
Australia							
Safety certifications	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1
EMC certifications	AS / NZS CISPR22 Class B	AS / NZS CISPR22 Class B	AS / NZS CISPR22 Class B[1]	AS / NZS CISPR22 Class A	AS / NZS CISPR22 Class A	AS / NZS CISPR22 Class A	AS / NZS CISPR22 Class A
Network homologation	AS / ACIF S 002, S 016, S 043.1, S043.2	AS / ACIF S 002, S 016, S 043.1, S043.2	AS / ACIF S 002, S 016, S 043.1, S043.2	AS / ACIF S 002, S 016, S 043.1, S043.2	AS / ACIF S 002, S 016, S 043.1, S043.2	AS / ACIF S 016	AS / ACIF S 016
New Zealand							
Safety certifications	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1	AS / NZS 60950-1
EMC certifications	AS / NZS CISPR22 Class B	AS / NZS CISPR22 Class B	AS / NZS CISPR22 Class B[1]	AS / NZS CISPR22 Class A	AS / NZS CISPR22 Class A	AS / NZS CISPR22 Class A	AS / NZS CISPR22 Class A
Network homologation	PTC 217, PTC 273	PTC 217, PTC 273	PTC 217, PTC 273	PTC 217, PTC 273	PTC 217, PTC 273	PTC 217	PTC 217
Japan							
Safety certifications	Comply safety certifications (UL/CUL/CSA) by CB Scheme						
EMC certifications	VCCI Class B	VCCI Class B	VCCI Class B[1]	VCCI Class A	VCCI Class A	VCCI Class A	VCCI Class A
European Union							
Safety certifications	EN 60950-1	EN 60950-1	EN 60950-1	EN 60950-1	EN 60950-1	EN 60950-1	EN 60950-1
EMC certifications	EN 55022 Class B, EN 300 386	EN 55022 Class B, EN 300 386	EN 55022 Class B[1], EN 300 386	EN 55022 Class A, EN 300 386	EN 55022 Class A, EN 300 386	EN 55022 Class A, EN 300 386	EN 55022 Class A, EN 300 386
Network homologation	CTR 12/13, CTR 21, DoC	CTR 12/13, CTR 21, DoC	CTR 12/13, CTR 21, DoC	CTR 12/13, CTR 21, DoC	CTR 12/13, CTR 21, DoC	CTR 12/13, DoC	CTR 12/13, DoC
Software Certifications							
NIST FIPS-140-2 Level 2	Yes	Yes	Yes	Yes	Yes	In Progress	Yes
ISO Common Criteria NDPP+TFFW EP	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ICSA Network Firewall	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ICSA IPsec	Yes	Yes	Yes	Yes	Yes	Yes	Yes
USGv6	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit **www.juniper.net/us/en/products-services**.

*There are several models available for the SRX210 and SRX240 including the enhanced version. Please contact your Juniper or partner account representative for more information.

[1] SRX210H-POE is class A.

Interface Modules Compatibility Matrix

Component	Description	SRX100	SRX110	SRX210	SRX220	SRX240	SRX550	SRX650
SRX-GP-16GE	16-port 10/100/1000BASE-T XPIM	X	X	X	X	X	✓	✓
SRX-GP-16GE-POE	16-port 10/100/1000BASE-T PoE XPIM	X	X	X	X	X	✓	✓
SRX-GP-2XE-SFPPTX	2-port 10GbE SFP+/10GbE BASE-T Copper XPIM	X	X	X	X	X	✓	✓
SRX-GP-24GE	24-port 10/100/1000BASE-T XPIM, includes 4 SFP slots	X	X	X	X	X	✓	✓
SRX-GP-24GE-POE	24-port 10/100/1000BASE-T PoE XPIM, includes 4 SFP slots	X	X	X	X	X	✓	✓
SRX-GP-8SFP	8-port GbE copper, fiber SFP XPIM	X	X	X	X	X	✓	✓
SRX-GP-DUAL-T1-E1	Dual T1/E1 GPIM	X	X	X	X	X	✓	✓
SRX-GP-QUAD-T1-E1	Quad T1/E1 GPIM	X	X	X	X	X	✓	✓
SRX-GP-1DS3-E3	1-port clear channel DS3/E3 GPIM single GPIM slot	X	X	X	X	X	✓	✓
SRX-GP-8SERIAL	Eight-port Sync Serial GPIM	X	X	X	X	X	✓	✓
SRX-MP-1SERIAL	1-port Sync Serial Mini-PIM	X	X	✓	✓	✓	✓	X
SRX-MP-1ADSL2-A	1-port ADSL2+ Mini-PIM supporting ADSL/ADSL2/ADSL2+ Annex A	X	X	✓	✓	✓	✓	X
SRX-MP-1ADSL2-B	1-port ADSL2+ Mini-PIM supporting ADSL/ADSL2/ADSL2+ Annex B	X	X	✓	✓	✓	✓	X
SRX-MP-1VDSL2-A	1-port VDSL2 Mini-PIM supporting Annex A, with fallback to ADSL2/ADSL2+	X	X	✓	✓	✓	✓	X
SRX-MP-8GSHDSL	8-wire (4-pair) G.SHDSL Mini-PIM	X	X	✓	✓	✓	✓	X
SRX-MP-1SFP-GE	1-port SFP Mini-PIM	X	X	✓	✓	✓	✓	X
SRX-MP-1T1E1	1-port T1 or E1 Mini-PIM	X	X	✓	✓	✓	✓	X

Ordering Information

Model Number	Description
SRX650 Base System	
SRX650-BASE-SRE6-645AP	SRX650 Services Gateway with SRE 6, 645 W AC PoE PSU; includes 4 onboard 10/100/1000BASE-T ports, 2 GB DRAM, 2 GB CF, 247 W PoE power, fan tray, power cord and rack-mount kit
SRX650-BASE-SRE6-645DP	SRX650 Services Gateway with SRE 6, 645 W DC PoE PSU; includes 4 onboard 10/100/1000BASE-T ports, 2 GB DRAM, 2 GB CF, 247 W PoE power, fan tray, power cord and rack-mount kit
SRX650B-SRE6-645AP-TAA	Trade Agreement Act-compliant SRX650 Services Gateway with SRE 6, 645 W AC PoE PSU; includes 4 onboard 10/100/1000BASE-T ports, 2 GB DRAM, 2 GB CF, 247 W PoE power, fan tray, power cord and rack-mount kit
SRX650 Power Supplies and Accessories	
SRX600-PWR-645AC-POE	Spare 645 W AC PoE power supply unit for SRX650, SRX550 systems—one is included in SRX650, SRX550 base system (SRX650-BASE-SRE6-645AP, SRX550-645AP)
SRX600-PWR-645DC-POE	645 W DC source power supply for SRX550 and SRX650; provides 397 W system power @ 12 V and 248 W PoE power @ 50 VDC; works with 43-56 VDC input—no power cord
SRX600-SRE6H	Spare SRE6-H for SRX650—one is included in SRX650 base system (SRX650-BASE-SRE6-645AP)
SRX650-CHAS	SRX650 chassis including fan tray—no system processor (SRE) and no power supply unit
SRX650-FAN-01	Spare SRX650 fan tray, one is included in SRX650 chassis spare (SRX650-CHAS), and included in SRX650 base system (SRX650-BASE-SRE6-645AP)
SRX650-FILT-01	Not included in SRX650 chassis spare (SRX650-CHAS), and not included in SRX650 base system (SRX650-BASE-SRE6-645AP)—optional, as this is not required for normal operations, but recommended for dusty environments
SRX650 Additional Software Feature Licenses	
SRX650-K-AV	One year subscription for Juniper-Kaspersky antivirus updates on SRX650
SRX650-S-AV	One year subscription for Juniper-Sophos antivirus updates on SRX650
SRX650-IDP	One year subscription for IDP updates on SRX650
SRX650-S2-AS	One year subscription for Juniper-Sophos antispam updates on SRX650
SRX650-W-WF	One year subscription for Juniper-Websense Web filtering updates on SRX650
SRX650-SMB4-CS	One year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX650
SRX650-S-SMB4-CS	One year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX650
SRX650-K-AV-3	Three year subscription for Juniper-Kaspersky AV updates on SRX650
SRX650-S-AV-3	Three year subscription for Juniper-Sophos AV updates on SRX650
SRX650-IDP-3	Three year subscription for IDP updates on SRX650
SRX650-S2-AS-3	Three year subscription for Juniper-Sophos antispam updates on SRX650
SRX650-W-WF-3	Three year subscription for Juniper-Websense Web filtering updates on SRX650
SRX650-SMB4-CS-3	Three year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX650
SRX650-S-SMB4-CS-3	Three year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX650
SRX-BGP-ADV-LTU	Advanced BGP License for SRX550 and SRX650 only
SRX650-K-AV-5	Five year subscription for Juniper-Kaspersky AV updates on SRX650
SRX650-S-AV-5	Five year subscription for Juniper-Sophos AV updates on SRX650
SRX650-IDP-5	Five year license for IDP updates for SRX650
SRX650-W-WF-5	Five year subscription for Juniper-Websense Web filtering updates on SRX650
SRX650-SMB4-CS-5	Five year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX650
SRX650-S-SMB4-CS-5	Five year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX650
SRX-RAC-5-LTU	Dynamic VPN Client: 5 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-10-LTU	Dynamic VPN Client: 10 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-25-LTU	Dynamic VPN Client: 25 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-50-LTU	Dynamic VPN Client: 50 simultaneous users for SRX210, SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-100-LTU	Dynamic VPN Client: 100 simultaneous users for SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-150-LTU	Dynamic VPN Client: 150 simultaneous users for SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-250-LTU	Dynamic VPN Client: 250 simultaneous users for SRX240, SRX550, and SRX650 only
SRX-RAC-500-LTU	Dynamic VPN Client: 500 simultaneous users for SRX550 and SRX650 only
SRX650-APPSEC-A-1	One year subscription for Application Security and IPS updates for SRX650
SRX650-APPSEC-A-3	Three year subscription for Application Security and IPS updates for SRX650
SRX650-APPSEC-A-5	Five year subscription for Application Security and IPS updates for SRX650

Ordering Information (continued)

Model Number	Description
SRX550 Base System	
SRX550- 645AP	SRX550 Services Gateway, 2 RU height, 6 GPIM slots, 2 Mini-PIM slots, 6 10/100/1000BASE-T ports, 4 GbE SFP ports, dual PS slots, fans; ships with one 645 watt AC power supply with 247 W PoE power (power cord and rack-mount kit included)
SRX550- 645DP	SRX550 Services Gateway, 2 RU height, 6 GPIM slots, 2 Mini-PIM slots, 6 10/100/1000BASE-T ports, 4 GbE SFP ports, dual PS slots, fans; ships with one 645 watt DC power supply with 247 W PoE power (no power cord and rack-mount kit Included)
SRX550 Power Supplies and Accessories	
SRX600-PWR-645AC-POE	Spare 645 W AC PoE power supply unit for SRX550 and SRX650 systems—one is included in SRX550 and SRX650 base systems (SRX650-BASE-SRE6-645AP, SRX550-645AC)
SRX600-PWR-645DC-POE	645 W DC source power supply for SRX550, SRX650 provides 397 W system power @ 12 V and 248 W PoE power @ 50 VDC; works with 43-56 VDC input—no power cord
SRX550-CHAS	SRX550 Services Gateway, 2 RU height, 6 GPIM slots, 2 Mini-PIM slots, 6 10/100/1000BASE-T ports, 4 GbE SFP ports, dual PS slots, fans (power supply not included)
SRX550-FILT-01	Not included in SRX550 systems, optional, as this is not required for normal operations, but recommended for dusty environments
SRX550 Additional Software Feature Licenses	
SRX550-K-AV	One year subscription for Juniper-Kaspersky antivirus updates on SRX550
SRX550-S-AV	One year subscription for Juniper-Sophos antivirus updates on SRX550
SRX550-IDP	One year subscription for IDP updates on SRX550
SRX550-S2-AS	One year subscription for Juniper-Sophos antispam updates on SRX550
SRX550-W-WF	One year subscription for Juniper-Websense Web filtering updates on SRX550
SRX550-SMB4-CS	One year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX550
SRX550-S-SMB4-CS	One year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX550
SRX550-K-AV-3	Three year subscription for Juniper-Kaspersky AV updates on SRX550
SRX550-S-AV-3	Three year subscription for Juniper-Sophos AV updates on SRX550
SRX550-IDP-3	Three year subscription for IDP updates on SRX550
SRX550-S2-AS-3	Three year subscription for Juniper-Sophos antispam updates on SRX550
SRX550-W-WF-3	Three year subscription for Juniper-Websense Web filtering updates on SRX550
SRX550-SMB4-CS-3	Three year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX550
SRX550-S-SMB4-CS-3	Three year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX550

Model Number	Description
SRX-BGP-ADV-LTU	Advanced BGP License for SRX550 and SRX650 only
SRX550-K-AV-5	Five year subscription for Juniper-Kaspersky AV updates on SRX550
SRX550-S-AV-5	Five year subscription for Juniper-Sophos AV updates on SRX550
SRX550-IDP-5	Five year license for IDP updates for SRX550
SRX550-W-WF-5	Five year subscription for Juniper-Websense Web filtering updates on SRX550
SRX550-SMB4-CS-5	Five year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX550
SRX550-S-SMB4-CS-5	Five year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX550
SRX-RAC-5-LTU	Dynamic VPN Client: 5 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-10-LTU	Dynamic VPN Client: 10 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-25-LTU	Dynamic VPN Client: 25 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-50-LTU	Dynamic VPN Client: 50 simultaneous users for SRX210, SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-100-LTU	Dynamic VPN Client: 100 simultaneous users for SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-150-LTU	Dynamic VPN Client: 150 simultaneous users for SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-250-LTU	Dynamic VPN Client: 250 simultaneous users for SRX240, SRX550, and SRX650 only
SRX-RAC-500-LTU	Dynamic VPN Client: 500 simultaneous users for SRX550 and SRX650 only
SRX550-APPSEC-A-1	One year subscription for Application Security and IPS updates for SRX550
SRX550-APPSEC-A-3	Three year subscription for Application Security and IPS updates for SRX550
SRX550-APPSEC-A-5	Five year subscription for Application Security and IPS updates for SRX550
SRX240 Base System	
SRX240H2	SRX240 Services Gateway with 16 x GbE ports, 4x mini-PIM slots, and high memory (2 GB DRAM, 2 GB Flash); integrated power supply with power cord, and 19" rack mount kit included
SRX240H2-POE	SRX240 Services Gateway with 16 x GbE ports, 4x mini-PIM slots, and high memory (2 GB RAM, 2 GB Flash), with 16 ports PoE (150 W); integrated power supply with power cord, and 19" rack mount kit included
SRX240H2-DC	SRX240 Services Gateway with 16 x GbE ports, 4x mini-PIM slots, and high memory (2 GB RAM, 2 GB Flash); integrated -48 V DC power supply with 19" rack mount kit included
SRX240B2	SRX240 Services Gateway with 16 x GbE ports, 4x mini-PIM slots, and base memory (1 GB DRAM, 2 GB Flash); integrated power supply with power cord, and 19" rack mount kit included (No UTM, AppSecure, or IDP support)

Ordering Information (continued)

Model Number	Description
SRX240 Base Systems (continued)	
SRX240-RMK	SRX240 rack-mount kit for 19 in rack (holds one unit)
SRX240H-TAA	Trade Agreement Act-compliant SRX240 Services Gateway with 16 GbE ports, 4 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash)
SRX240H-POE-TAA	Trade Agreement Act-compliant SRX240 Services Gateway with 16 GbE ports, 4 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash), with 16 ports PoE (150 W)
SRX240B	SRX240 Services Gateway with 16 GbE ports, 4 Mini-PIM slots, and base memory (512 MB RAM, 1 GB Flash)
SRX240H	SRX240 Services Gateway with 16 GbE ports, 4 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash)
SRX240H-POE	SRX240 Services Gateway with 16 GbE ports, 4 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash), with 16 ports PoE (150 W)
SRX240H-DC	SRX240 Services Gateway with 16 GbE ports, 4 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash)
SRX240 Additional Software Feature Licenses	
SRX240-K-AV	One year subscription for Juniper-Kaspersky antivirus updates on SRX240
SRX240-S-AV	One year subscription for Juniper-Sophos antivirus updates on SRX240
SRX240-IDP	One year subscription for IDP updates on SRX240
SRX240-S2-AS	One year subscription for Juniper-Sophos antispam updates on SRX240
SRX240-W-WF	One year subscription for Juniper-Websense Web filtering updates on SRX240
SRX240-SMB4-CS	One year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX240
SRX240-S-SMB4-CS	One year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX240
SRX240-K-AV-3	Three year subscription for Juniper-Kaspersky antivirus updates on SRX240
SRX240-S-AV-3	Three year subscription for Juniper-Sophos antivirus updates on SRX240
SRX240-IDP-3	Three year subscription for IDP updates on SRX240
SRX240-S2-AS-3	Three year subscription for Juniper-Sophos antispam updates on SRX240
SRX240-W-WF-3	Three year subscription for Juniper-Websense Web filtering updates on SRX240
SRX240-SMB4-CS-3	Three year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX240
SRX240-S-SMB4-CS-3	Three year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX240
SRX240-K-AV-5	Five year subscription for Juniper-Kaspersky antivirus updates on SRX240
SRX240-S-AV-5	Five year subscription for Juniper-Sophos antivirus updates on SRX240
SRX240-IDP-5	Five year subscription for IDP updates on SRX240

Model Number	Description
SRX240-S2-AS-5	Five year subscription for Juniper-Sophos antispam updates on SRX240
SRX240-W-WF-5	Five year subscription for Juniper-Websense Web filtering updates on SRX240
SRX240-SMB4-CS-5	Five year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX240
SRX240-S-SMB4-CS-5	Five year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX240
SRX240-S2-AS-5	Five year subscription for Juniper-Sophos antispam updates on SRX240
SRX240-W-WF-5	Five year subscription for Juniper-Websense Web filtering updates on SRX240
SRX240-SMB2-CS-5	Five year security subscription for enterprise—includes Kaspersky antivirus, Web filtering, Sophos antispam, and IDP on SRX240
SRX240-S-SMB-CS-5	Five year security subscription for enterprise—includes Sophos antivirus, Web filtering, Sophos antispam and IPS on SRX240
SRX-RAC-5-LTU	Dynamic VPN Client: 5 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-10-LTU	Dynamic VPN Client: 10 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-25-LTU	Dynamic VPN Client: 25 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-50-LTU	Dynamic VPN Client: 50 simultaneous users for SRX210, SRX22, SRX240, SRX550 and SRX650 only
SRX-RAC-100-LTU	Dynamic VPN Client: 100 simultaneous users for SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-150-LTU	Dynamic VPN Client: 150 simultaneous users for SRX220, SRX240, SRX550, and SRX650 only
SRX-RAC-250-LTU	Dynamic VPN Client: 250 simultaneous users for SRX240, SRX550, and SRX650 only
SRX240-APPSEC-A-1	One year subscription for Application Security and IPS updates for SRX240
SRX240-APPSEC-A-3	Three year subscription for Application Security and IPS updates for SRX240
SRX240-APPSEC-A-5	Five year subscription for Application Security and IPS updates for SRX240
SRX220 Base System	
SRX220H2	SRX220 Services Gateway with 8 GbE ports, 2 Mini-PIM slots, and high memory (2 GB RAM, 2 GB Flash)—external power supply and cord included
SRX220H2-POE	SRX220 Services Gateway with 8 GbE ports, 2 Mini-PIM slots, and high memory (2 GB RAM, 2 GB Flash), with 8 ports PoE (120 W)*
SRX220-RMK	SRX220 rack-mount kit for 19 in rack (holds one unit)
SRX220-WALL-KIT	SRX220 wall mount kit (holds one unit)
SRX220-PWR-60W*	Spare SRX220 switching power supply, 60 W (non-POE)

*See price list for country-specific power cord model numbers.

Ordering Information (continued)

Model Number	Description
SRX220 Base System (continued)	
SRX220H	SRX220 Services Gateway with 8 GbE ports, 2 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash)—external power supply and cord included
SRX220H-POE	SRX220 Services Gateway with 8 GbE ports, 2 Mini-PIM slots, and high memory (1 GB RAM, 1 GB Flash), with 8 ports PoE (120 W)*
SRX220 Additional Software Feature Licenses	
SRX220-K-AV	One year subscription for Juniper-Kaspersky antivirus updates on SRX220
SRX220-S-AV	One year subscription for Juniper-Sophos antivirus updates on SRX220
SRX220-IDP	One year subscription for IDP updates on SRX220
SRX220-S2-AS	One year subscription for Juniper-Sophos antispam updates on SRX220
SRX220-W-WF	One year subscription for Juniper-Websense Web filtering updates on SRX220
SRX220-SMB4-CS	One year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX220
SRX220-S-SMB4-CS	One year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX220
SRX220-K-AV-3	Three year subscription for Juniper-Kaspersky antivirus updates on SRX220
SRX220-S-AV-3	Three year subscription for Juniper-Sophos antivirus updates on SRX220
SRX220-IDP-3	Three year subscription for IDP updates on SRX220
SRX220-S2-AS-3	Three year subscription for Juniper-Sophos antispam updates on SRX220
SRX220-W-WF-3	Three year subscription for Juniper-Websense Web filtering updates on SRX220
SRX220-SMB4-CS-3	Three year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX220
SRX220-S-SMB4-CS-3	Three year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX220
SRX220-K-AV-5	Five year subscription for Juniper-Kaspersky antivirus updates on SRX220
SRX220-S-AV-5	Five year subscription for Juniper-Sophos antivirus updates on SRX220
SRX220-IDP-5	Five year subscription for IDP updates on SRX220
SRX220-W-WF-5	Five year subscription for Juniper-Websense Web filtering updates on SRX220
SRX220-SMB4-CS-5	Five year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX220
SRX220-S-SMB4-CS-5	Five year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX220
SRX-RAC-5-LTU	Dynamic VPN Client: 5 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-10-LTU	Dynamic VPN Client: 10 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-25-LTU	Dynamic VPN Client: 25 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-50-LTU	Dynamic VPN Client: 50 simultaneous users for SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-100-LTU	Dynamic VPN Client: 100 simultaneous users for SRX220, SRX240, SRX550, and SRX650
SRX-RAC-150-LTU	Dynamic VPN Client: 150 simultaneous users for SRX220, SRX240, SRX550, and SRX650
SRX220-APPSEC-A-1	One year subscription for Application Security and IPS updates for SRX220
SRX220-APPSEC-A-3	Three year subscription for Application Security and IPS updates for SRX220
SRX220-APPSEC-A-5	Five year subscription for Application Security and IPS updates for SRX220
SRX210 Base System	
SRX210HE2	SRX210 Services Gateway with 2 GbE+ 6 Fast Ethernet ports, 1 Mini-PIM slot, 1 ExpressCard slot and high memory (2 GB RAM, 2 GB Flash)
SRX210HE2-POE	SRX210 Services Gateway with 2 GbE + 6 Fast Ethernet ports, 1 Mini-PIM slot, 1 ExpressCard slot and high memory (2 GB RAM, 2 GB Flash), with 4 ports PoE (50 W)
SRX210BE	SRX210 Services Gateway with 2 GbE + 6 Fast Ethernet ports, 1 Mini-PIM slot, 1 ExpressCard slot and base memory (512 MB RAM, 1 GB Flash)
SRX210HE	SRX210 Services Gateway with 2 GbE+ 6 Fast Ethernet ports, 1 Mini-PIM slot, 1 ExpressCard slot and high memory (1 GB RAM, 1 GB Flash)
SRX210HE-POE	SRX210 Services Gateway with 2 GbE + 6 Fast Ethernet ports, 1 Mini-PIM slot, 1 ExpressCard slot and high memory (1 GB RAM, 1 GB Flash), with 4 ports PoE (50 W)
SRX210 Additional Hardware	
SRX210-DESK-STAND	SRX210 desk top stand (holds one unit)
SRX210-RMK	SRX210 rack-mount kit for 19 in rack (holds one unit)
SRX210-WALL-KIT	SRX210 wall mount kit (holds one unit)
SRX210-PWR-60W-*	Spare SRX210 switching power supply, 60 W (non-PoE)
SRX210-PWR-150W-*	Spare SRX210 switching power supply, 150 W (PoE)
SRX210 Additional Software Feature Licenses	
SRX210-K-AV	One year subscription for Juniper-Kaspersky antivirus updates on SRX210
SRX210-S-AV	One year subscription for Juniper-Sophos antivirus updates on SRX210
SRX210-IDP	One year subscription for IDP updates on SRX210
SRX210-S2-AS	One year subscription for Juniper-Sophos antispam updates on SRX210
SRX210-W-WF	One year subscription for Juniper-Websense Web filtering updates on SRX210
SRX210-SMB4-CS	One year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX210
SRX210-S-SMB4-CS	One year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX210

*See price list for country-specific power cord model numbers.

Ordering Information (continued)

Model Number	Description
SRX210 Additional Software Feature Licenses (continued)	
SRX210-K-AV-3	Three year subscription for Juniper-Kaspersky antivirus updates on SRX210
SRX210-S-AV-3	Three year subscription for Juniper-Sophos antivirus updates on SRX210
SRX210-IDP-3	Three year subscription for IDP updates on SRX210
SRX210-S2-AS-3	Three year subscription for Juniper-Sophos antispam updates on SRX210
SRX210-W-WF-3	Three year subscription for Juniper-Websense Web filtering updates on SRX210
SRX210-SMB4-CS-3	Three year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX210
SRX210-S-SMB4-CS-3	Three year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX210
SRX210-K-AV-5	Five year subscription for Juniper-Kaspersky antivirus updates on SRX210
SRX210-S-AV-5	Five year subscription for Juniper-Sophos antivirus updates on SRX210
SRX210-IDP-5	Five year subscription for IDP updates on SRX210
SRX210-S2-AS-5	Five year subscription for Juniper-Sophos antispam updates on SRX210
SRX210-W-WF-5	Five year subscription for Juniper-Websense Web filtering updates on SRX210
SRX210-SMB4-CS-5	Five year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX210
SRX210-S-SMB4-CS-5	Five year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP on SRX210
SRX-RAC-5-LTU	Dynamic VPN Client: 5 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-10-LTU	Dynamic VPN Client: 10 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-25-LTU	Dynamic VPN Client: 25 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-50-LTU	Dynamic VPN Client: 50 simultaneous users for SRX210, SRX220, SRX240, SRX550, and SRX650 only
SRX210-APPSEC-A-1	One year subscription for Application Security and IPS updates for SRX210
SRX210-APPSEC-A-3	Three year subscription for Application Security and IPS updates for SRX210
SRX210-APPSEC-A-5	Five year subscription for Application Security and IPS updates for SRX210

Model Number	Description
Small Form Factor Pluggable (SFP) Transceivers	
SRX-SFP-1GE-LH	SFP 1000BASE-LH Optical Transceiver
SRX-SFP-1GE-LX	SFP 1000BASE-LX Optical Transceiver
SRX-SFP-1GE-SX	SFP 1000BASE-SX Optical Transceiver
SRX-SFP-1GE-T	SFP 1000BASE-T Copper Transceiver
SRX-SFP-FE-FX	SFP 100BASE-FX Optical Transceiver
SRX-MP-1SFP-GE	Single-port SFP Mini-PIM
SRX-GP-8SFP	8-port GbE copper, fiber SFP XPIM
SRX110 Base System	
SRX110H2-VA	SRX110 Services Gateway with 8xFE ports, 2 GB RAM and Flash, 1-port VDSL2/ADSL2+ over POTS, USB port for cellular modem connectivity, and external PS and cord included
SRX110H2-VB	SRX110 Services Gateway with 8xFE ports, 2 GB RAM and Flash, 1-port VDSL2/ADSL2+ over ISDN BRI, USB port for cellular modem connectivity, and external PS and cord included
SRX110H-VA	SRX110 Services Gateway with 8xFE ports, 1 GB RAM and Flash, 1-port VDSL2/ADSL2+ over POTS, USB port for cellular modem connectivity, and external PS and cord included
SRX110H-VB	SRX110 Services Gateway with 8xFE ports, 1 GB RAM and Flash, 1-port VDSL2/ADSL2+ over ISDN BRI, USB port for cellular modem connectivity, and external PS and cord
SRX110 Additional Hardware	
SRX110-DESK-STAND	SRX110 desktop stand; holds one unit
SRX110-RMK	SRX110 rack-mount kit; holds one unit
SRX110-WALL-KIT	SRX110 wall mount kit; holds one unit
SRX100 Base System	
SRX100H2	SRX100 Services Gateway with 8xFE ports and high memory (2 GB RAM, 2 GB Flash)
SRX100B	SRX100 Services Gateway with 8xFE ports and base memory (On-board 1 GB RAM w/ 512 MB accessible, 1 GB Flash)
SRX100H	SRX100 Services Gateway with 8xFE ports and high memory (1 GB RAM, 1 GB Flash)
SRX100 Additional Hardware	
SRX100-PWR-30W-*	Spare SRX100 switching power supply, 30 W (non-PoE)
SRX-100-RMK	SRX100 19" rack-mount kit (holds two units)
SRX100-WALL-KIT	SRX100 wall mount kit (holds one unit)
SRX100-DESK-STAND	SRX100 desk stand (holds one unit)

*See price list for country-specific power cord model numbers.

**The additional software feature licenses apply to both the SRX100 and the SRX110.

Model Number	Description
SRX100/SRX110 Dynamic VPN Client	
SRX-RAC-5-LTU	5 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-10-LTU	10 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX-RAC-25-LTU	25 simultaneous users for SRX100, SRX110, SRX210, SRX220, SRX240, SRX550, and SRX650
SRX100/SRX110 Additional Software Feature Licenses **	
SRX1XX-K-AV	One year subscription for Juniper-Kaspersky AV updates
SRX1XX-K-AV-3	Three year subscription for Juniper-Kaspersky AV updates
SRX1XX-K-AV-5	Five year subscription for Juniper-Kaspersky AV updates
SRX1XX-S-AV	One year subscription for Juniper-Sophos AV updates
SRX1XX-S-AV-3	Three year subscription for Juniper-Sophos AV updates
SRX1XX-S-AV-5	Five year subscription for Juniper-Sophos AV updates
SRX1XX-S2-AS	One year subscription for Juniper-Sophos antispam updates
SRX1XX-S2-AS-3	Three year subscription for Juniper-Sophos antispam updates
SRX1XX-S2-AS-5	Five year subscription for Juniper-Sophos antispam updates
SRX1XX-W-EWF	One year subscription for Juniper-Websense enhanced Web filtering updates
SRX1XX-W-EWF-3	Three year subscription for Juniper-Websense enhanced Web filtering updates
SRX1XX-W-EWF-5	Five year subscription for Juniper-Websense enhanced Web filtering updates
SRX1XX-SMB4-CS	One year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-SMB4-CS-3	Three year security subscription for Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-SMB4-CS-5	Five year security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-S-SMB4-CS	One year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure, AppSecure and IDP
SRX1XX-S-SMB4-CS-3	Three year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-S-SMB4-CS-5	Five year security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-IDP	One year license for IDP updates
SRX1XX-IDP-3	Three year license for IDP updates
SRX1XX-IDP-5	Five year license for IDP updates
SRX1XX-K-AV-3-R	Three year renewal subscription for Juniper-Kaspersky AV updates

Model Number	Description
SRX100/SRX110 Additional Software Feature Licenses ** (continued)	
SRX1XX-K-AV-5-R	Five year renewal subscription for Juniper-Kaspersky AV updates
SRX1XX-K-AV-R	One year renewal subscription for Juniper-Kaspersky AV updates
SRX1XX-S-AV-3-R	Three year renewal subscription for Juniper-Sophos AV updates
SRX1XX-S-AV-5-R	Five year renewal subscription for Juniper-Sophos AV updates
SRX1XX-S-AV-R	One year renewal subscription for Juniper-Sophos AV updates
SRX1XX-S2-AS-3-R	Three year renewal subscription for Juniper-Sophos antispam updates
SRX1XX-S2-AS-5-R	Five year renewal subscription for Juniper-Sophos antispam updates
SRX1XX-S2-AS-R	One year renewal subscription for Juniper-Sophos antispam updates
SRX1XX-W-EWF-3-R	Three year renewal subscription for Juniper-enhanced Websense enhanced Web filtering updates
SRX1XX-W-EWF-5-R	Five year renewal subscription for Juniper-enhanced Websense enhanced Web filtering updates
SRX1XX-W-EWF-R	One year renewal subscription for Juniper-enhanced Websense enhanced Web filtering updates
SRX1XX-SMB4-CS-R	One year renewal security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-SMB4-CS-3-R	Three year renewal security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-SMB4-CS-5-R	Five year renewal security subscription for enterprise—includes Kaspersky AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-S-SMB4-CS-R	One year renewal security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-S-SMB4-CS-3-R	Three year renewal security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-S-SMB4-CS-5-R	Five year renewal security subscription for enterprise—includes Sophos AV, enhanced WF, Sophos AS, AppSecure and IDP
SRX1XX-IDP-R	One year renewal subscription for IDP Signature service
SRX1XX-IDP-3-R	Three year renewal subscription for IDP Signature service
SRX1XX-IDP-5-R	Five year renewal subscription for IDP Signature service
SRX100-APPSEC-A-1	One year subscription for Application Security and IPS updates for SRX100
SRX100-APPSEC-A-3	Three year subscription for Application Security and IPS updates for SRX100
SRX100-APPSEC-A-5	Five year subscription for Application Security and IPS updates for SRX100

** The additional software feature licenses apply to both the SRX100 and the SRX110.

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at **www.juniper.net**.

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DATASHEET

Product Overview

High-performance businesses demand high-performance networking solutions. The Juniper Networks EX2200 Ethernet Switch offers an economical, entry-level, stand-alone solution for access-layer deployments in branch and remote offices, as well as campus networks.

The EX2200 also supports Juniper Networks Virtual Chassis technology, allowing up to four interconnected switches to be managed as a single logical device, delivering a scalable, pay-as-you-grow solution for expanding networks.

Product Description

Featuring complete Layer 2 and basic Layer 3 switching capabilities, the Juniper Networks® EX2200 line of fixed configuration Ethernet switches with Virtual Chassis technology satisfies the branch and low-density wiring closet connectivity requirements of today's high-performance businesses. Four platform configurations are available offering 24 and 48 10/100/1000BASE-T ports with or without Power over Ethernet (PoE). The PoE-enabled EX2200 models include a maximum system budget of 405 W to deliver up to 15.4 watts of standards-based 802.3af Class 3 PoE or 30 watts of standards-based 802.3at PoE+ for supporting networked devices such as telephones, video cameras, multiple radio IEEE 802.11n wireless LAN (WLAN) access points and video phones in converged networks.

Additional features include:

- Four front panel small form-factor pluggable transceiver (SFP) GbE uplink ports provide high-speed connectivity to aggregation layer switches or other upstream devices.
- Uplink ports can be configured as Virtual Chassis interfaces and connected via standard GbE optics interfaces. The last two uplinks are preconfigured by default as Virtual Chassis ports.
- Fixed power supply and uplink ports ensure operational simplicity.
- Low power consumption, low acoustic fans, and small 10-inch wide footprint enable flexible, environmentally friendly deployment.
- Support for L2 protocols as well as L3 protocols like RIP and static routing in base license.
- Optional enhanced license for supporting additional L3 protocols such as OSPF, Internet Group Management Protocol (IGMP v1/v2/v3), Protocol Independent Multicast (PIM), IEEE 802.1 Q-in-Q, Bidirectional Forwarding Detection (BFD), Virtual Router Redundancy Protocol (VRRP) and Virtual Router / VRF-Lite.
- IPv6 management support including neighbor discovery, telnet, SSH, DNS, syslog and NTP.
- Single release train for Juniper Networks Junos® operating system ensures consistent control plane feature implementation.
- Modular Junos OS prevents a switch reboot if a single protocol feature fails.
- Managed through a single application, Juniper Networks Network and Security Manager.
- Integrates with Juniper Networks Unified Access Control to provide per-user access control and policing.
- Enhanced limited lifetime switch hardware warranty.
- Built-in Web interface (Juniper Networks J-Web Software).

Product Overview

The Juniper Networks EX2200 line of Ethernet switches offers a compact, high-performance solution for supporting today's converged network access deployments.

Each EX2200 switch includes an application-specific integrated circuit (ASIC)-based Packet Forwarding Engine (PFE) with an integrated CPU to consistently deliver wire-rate forwarding, even with all control plane features enabled. Based on existing, field proven Juniper Networks technology, the PFE brings the same level of carrier-class performance and reliability to the EX2200 switches that Juniper Networks routers bring to the world's largest service provider networks.

Architecture and Key Components

The EX2200 occupies a single rack unit, delivering a compact solution for crowded wiring closets and access locations where space and power are at a premium. The EX2200 switch's 10-inch depth and low acoustics also make it ideal for open office deployments.

Each EX2200 switch supports four fixed front panel GbE uplink ports with pluggable optics (purchased separately) for high-speed backbone or link aggregation connections between wiring closets and upstream aggregation switches. The EX2200 also features a front panel mode button that offers a simple interface for bringing devices up and selecting LED modes.

A dedicated rear panel RJ-45 Ethernet port is available for out-of-band management, while a rear panel USB port can be used to easily upload the Junos operating system and configuration files.

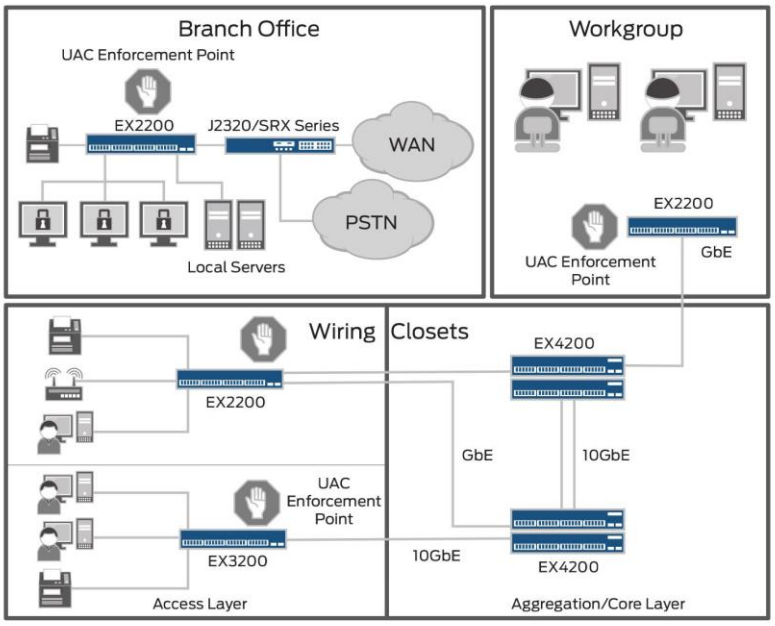

Figure 1: The EX2200 line provides a high-performance solution for converged networks in branch offices as well as campus wiring closets.

Virtual Chassis Technology

The EX2200 supports Juniper's unique Virtual Chassis technology, enabling up to four interconnected EX2200 switches to be managed as a single logical device, delivering a scalable, pay-as-you-grow solution for expanding network environments.

While EX2200 switches can be interconnected over any of the front-panel uplink ports, the last two ports are configured by default as Virtual Chassis ports, automating deployments when using standard GbE SFP transceivers (sold separately). These two ports can also be configured as GbE uplinks to aggregation devices by disabling the Virtual Chassis technology.

When deployed in a Virtual Chassis configuration, the EX2200 switches elect a master and a backup switch based on a set of preconfigured policies or criteria. The master switch automatically creates and updates the switching and optional routing tables on all other Virtual Chassis switch members. Switches can be added to or removed from the Virtual Chassis configuration without service disruption.

EX2200 Virtual Chassis configurations operate as highly resilient unified systems, providing simplified management using a single IP address, single telnet session, single command-line interface (CLI), automatic version checking, and automatic configuration. The EX2200 switches are also capable of local switching, so packets coming into a port destined for another port on the same switch do not have to traverse the Virtual Chassis, increasing forwarding capacities.

EX2200 Virtual Chassis configurations implement the same slot/module/port numbering schema as other Juniper Networks chassis-based products, providing true chassis-like operations. By using a consistent operating system and a single configuration file, all switches in a Virtual Chassis configuration are treated as a single device, simplifying overall system maintenance and management.

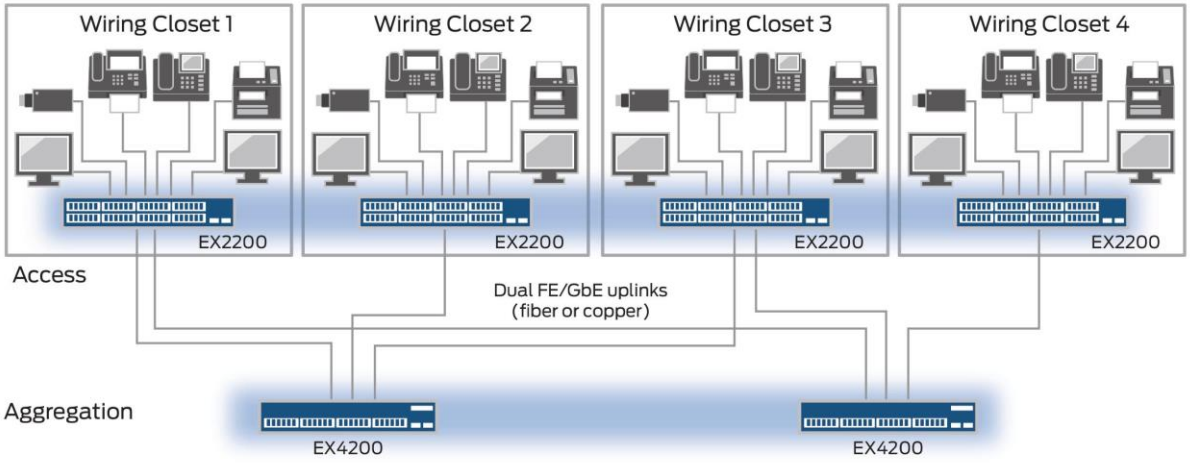

Figure 2: The EX2200 Ethernet switches support Virtual Chassis technology, enabling up to four interconnected switches to operate as a single, logical device.

Features and Benefits

High Availability Features

- Redundant Trunk Group (RTG): To avoid the complexities of the Spanning Tree Protocol (STP) without sacrificing network resiliency, the EX2200 employs a redundant trunk group to provide the necessary port redundancy and simplify switch configuration.
- Power resiliency through external redundant power supply: The EX2200 supports an optional redundant power supply (RPS) unit which provides power resiliency.

Junos Operating System

The EX2200 runs the same Junos OS used by other Juniper Networks EX Series Ethernet Switches, as well as all of Juniper's routers and Juniper Networks SRX Series Services Gateways. By utilizing a common operating system, Juniper delivers a consistent implementation and operation of control plane features across all products. To maintain that consistency, Junos OS adheres to a highly disciplined development process that uses a single source code, follows a single quarterly release train, and employs a highly available modular architecture that prevents isolated failures from bringing down an entire system.

These attributes are fundamental to the core value of the software, enabling all Junos OS-powered products to be updated simultaneously with the same software release. All features are fully regression-tested, making each new release a true superset of the previous version; customers can deploy the software with complete confidence that all existing capabilities will be maintained and operate in the same way.

Converged Environments

The EX2200 provides the highest levels of flexibility and features in its class for the most demanding converged data, voice, and video environments, delivering a reliable platform for unifying enterprise communications.

By providing a full 15.4 watts of Class 3 PoE to VoIP telephones, closed-circuit security cameras, wireless access points, and other IP-enabled devices, the EX2200 delivers a future proofed solution for converging disparate networks onto a single IP infrastructure. The EX2200 PoE switches also support 802.3at standards-based PoE+ for powering networked devices like multiple radio IEEE 802.11n wireless access points, and video phones that may require more power than available with IEEE 802.3af.

To ease deployment, the EX2200 supports the industry-standard Link Layer Discovery Protocol (LLDP) and LLDP-Media Endpoint Discovery (LLDP-MED) protocol, enabling the switches to automatically discover Ethernet-enabled devices, determine their power requirements, and assign virtual LAN (VLAN) membership. LLDP-MED-based granular PoE management allows the EX2200 to negotiate PoE usage down to a fraction of a watt on powered devices, enabling more efficient PoE utilization across the switch.

In addition, the EX2200 supports rich quality-of-service (QoS) functionality for prioritizing data, voice, and video traffic. The switches support eight class-of-service (CoS) queues on every port, enabling them to maintain multilevel, end-to-end traffic prioritizations. The EX2200 also support a wide range of policy options, including strict priority, low-latency, weighted random early detection (WRED), and shaped deficit weighted round-robin (SDWRR) queuing.

Security

The EX2200 fully integrates with Juniper Networks Unified Access Control, which consolidates all aspects of a user's identity, device, and location. This enables administrators to enforce access control and security down to the individual port or user levels.

Working as an enforcement point within UAC, the EX2200 provides both standards-based 802.1X port-level access control for multiple devices per port, as well as Layer 2-4 policy enforcement based on user identity, location, and/or device. A user's identity, device type, machine posture check, and location can be used to determine whether access should be granted and for how long. If access is granted, the switch assigns the user's device to a specific VLAN based on authorization policy. The switch can also apply security policies, QoS policies, or both, or it can mirror user traffic to a central location for logging, monitoring, or threat detection by intrusion prevention systems.

The EX2200 also provides a full complement of integrated port security and threat detection features, including Dynamic Host Configuration Protocol (DHCP) snooping, Dynamic ARP Inspection (DAI), and media access control (MAC) limiting to defend against internal and external spoofing, man-in-the-middle and denial of service (DoS) attacks.

Simplified Management and Operations

When deployed in a Virtual Chassis configuration, the EX2200 dramatically simplifies network management. Up to four interconnected EX2200 switches can be managed as a single device utilizing a single Junos OS image file and a single configuration file, reducing the overall number of units to monitor and manage. When the Junos OS is upgraded on the master switch in an EX2200 Virtual Chassis configuration, the software is automatically upgraded on all other member switches at the same time.

The EX2200 includes port profiles that allow network administrators to automatically configure ports with security, QoS, and other parameters based on the type of device connected to the port. Six preconfigured profiles are available, including default, desktop, desktop plus IP phone, WLAN access point, routed uplink, and Layer 2 uplink. Users can select from the existing profiles or create their own and apply them through the command-line interface (CLI), J-Web Software interface, or management system.

In addition, a feature called system snapshot makes a copy of all software files used to run the switch—including the Junos operating system, the active configuration and the rescue configuration—that can be used to reboot the switch at the next power-up or as a backup boot option. The Junos OS software can also be pre-installed on a flash drive and used to boot the EX2200 at any time.

Another feature, called automatic software download, enables network administrators to easily upgrade the EX2200 using the DHCP message exchange process to download and install software packages. Users simply configure the automatic software download feature on EX2200 switches acting as DHCP clients and establish a path to the server where the software package file is installed. The server then communicates the path to the software package file through DHCP server messages.

An EZ touchless provisioning feature allows a DHCP server to push configuration details and software images to multiple switches at bootup.

Three system management options are available for the EX2200 line. The standard Junos OS CLI management interface offers the same granular capabilities and scripting parameters found in any router powered by the Junos operating system. The EX2200 also includes the integrated J-Web interface, an embedded web-based device manager that allows users to configure, monitor, troubleshoot, and perform system maintenance on individual switches via a browser-based graphical interface.

Finally, EX2200 fault, configuration, and performance data can be exported to leading third-party management systems such as HP OpenView, IBM Tivoli, and Computer Associates Unicenter software, providing a complete, consolidated view of network operations.

Junos Space

Juniper also offers a comprehensive suite of network management tools that provide a smart, simple, and open approach for automating the deployment and operation of a Juniper infrastructure.

These tools are based on a single network application platform called Juniper Networks Junos® Space, an open, programmable application platform for hosting network infrastructure and operational applications across the entire management life cycle of the network. Explicitly designed to allow partners and customers to build and deploy smart, simple, and easy-to-use applications, Junos Space provides multiple management and infrastructure applications for managing Juniper resources and assets, including inventory management, device and interface configuration, automated software management and deployment, and event-driven fault management. These platform applications are embedded within the core product, allowing users to control any part of their environment when used in conjunction with multiple add-on applications. Junos Space will support a full portfolio of applications for automating network infrastructure and operations covering the campus LAN and data center network environments.

Designed to automate the configuration, visualization, monitoring, and administration of large switch and router networks, these Junos Space applications offer predefined automation schemes and best practice templates to enable rapid and accurate deployments. When managing a group of EX2200 switches, the Junos Space platform and associated applications provide network-level management across all Juniper Networks switches from a single console.

Enhanced limited Lifetime Warranty

The EX2200 includes an enhanced limited lifetime hardware warranty that provides next business day advance hardware switch replacement for as long as the original purchaser owns the product. The warranty includes lifetime software updates, advanced shipping of spares within one business day, and 24x7 JTAC support for 90 days after the purchase date. Power supplies and fan trays are covered for a period of five years. For complete details, please visit **www.juniper.net/support/warranty**.

EX2200-24T

EX2200-24P

EX2200-48T

EX2200-48P

EX2200 Ethernet Switch Specifications

Physical Specifications

Dimensions (W x H x D)

- Width: 17.4 in (44.1 cm) for desktop installations
  17.5 in (44.6 cm) with rack-mount brackets
- Height: 1.75 in (4.45 cm) for 1U installations
- Depth: 10 in (25.43 cm)

Weight

- EX2200-24T: 6 lb (2.7 kg)
- EX2200-24P: 8 lb (3.6 kg)
- EX2200-48T: 8 lb (3.6 kg)
- EX2200-48P: 10 lb (4.5 kg)

Environmental Ranges

- Operating temperature: 32° to 113° F (0° to 45° C)
- Storage temperature: -40° to 158° F (-40° to 70° C)
- Operating altitude: up to 10,000 ft (3,048 m)
- Non-operating altitude: up to 16,000 ft (4,877 m)
- Relative humidity operating: 10% to 85% (noncondensing)
- Relative humidity non-operating: 0% to 95% (noncondensing)

Power Options

Model	Maximum System Power Consumption (Input Power without PoE)	Total PoE Power Budget
EX2200-24T-4G	50 W AC	0
EX2200-24P-4G	65 W AC	405 W
EX2200-48T-4G	76 W AC	0
EX2200-48P-4G	91 W AC	405 W

Cooling

Airflow:

- 24T/48T: 11 cfm
- 24P/48P: 16.4 cfm

Hardware Specifications

- Switching Engine Model: Store and forward
- DRAM: 512 MB
- Flash: 1 GB
- CPU: 800 MHz ARM CPU
- GbE port density per system:
  - 24P/24T: 28 (24 host ports + four-port GbE uplinks)
  - 48P/48T: 52 (48 host ports+ four-port GbE uplinks)

Optics

- 100 Mbps optic/connector type: LC SFP fiber supporting 100BASE-FX SFP (multimode) and BX (single strand)
- 10/100/1000BASE-T connector type RJ-45
- GbE SFP optic/connector type: RJ-45, or LC SFP fiber supporting 1000BASE-T SFP, SX (multimode), LX (single-mode), or LH/ZX (single-mode)

Physical Layer

- Physical port redundancy: Redundant Trunk Group (RTG)
- Time-domain reflectometry (TDR) for detecting cable breaks and shorts
- Auto MDI/MDIX (medium-dependent interface/medium-dependent interface crossover) support
- Port speed downshift/setting maximum advertised speed on 10/100/1000BASE-T ports
- Digital optical monitoring for optical ports

Packet Switching Capacities

- 24P/24T: 56 Gbps
- 48P/48T: 104 Gbps

Layer 2 Throughput (Mpps)

- 24P/24T: 41.7 Mpps (wire speed)
- 48P/48T: 77.4 Mpps (wire speed)

Layer 2 Switching

- Maximum MAC addresses in hardware: 16,000
- Jumbo frames: 9216 bytes
- Number of VLANs: 1,024 (VLAN IDs: 4,096)
- Port-based VLAN
- MAC-based VLAN
- Voice VLAN
- Private VLAN (PVLAN)
- IEEE 802.1ak: Multiple VLAN Registration Protocol (MVRP)
- Multicast VLAN Registration (MVR)
- Compatible with Per-VLAN Spanning Tree Plus (PVST+)
- RVI (Routed VLAN Interface)
- IEEE 802.1AB: Link Layer Discovery Protocol (LLDP)
- LLDP-MED with VoIP integration
- IEEE 802.1D: Spanning Tree Protocol
- IEEE 802.1p: CoS prioritization
- IEEE 802.1Q: VLAN tagging
- IEEE 802.1Q-in-Q: VLAN Stacking
- IEEE 802.1s: Multiple Spanning Tree Protocol (MSTP)
- Number of MST instances supported: 64
- IEEE 802.1w: Rapid Spanning Tree Protocol (RSTP)
- IEEE 802.1X: Port Access Control
- IEEE 802.3: 10BASE-T
- IEEE 802.3u: 100BASE-T
- IEEE 802.3ab: 1000BASE-T
- IEEE 802.3z: 1000BASE-X
- IEEE 802.3af: PoE

Specifications (continued)

Layer 2 Switching (continued)

- IEEE 802.3at: PoE+
- IEEE 802.3x: Pause Frames/Flow Control
- IEEE 802.3ad: Link Aggregation Control Protocol (LACP)
- IEEE 802.3ah: Ethernet in the First Mile
- IEEE 802.1ag: Connectivity Fault Management (CFM)
- G.8032 (Ethernet Ring Protection)

Layer 3 Features: IPv4

- Maximum number of Address Resolution Protocol (ARP) entries: 2,000
- Maximum number of IPv4 unicast routes in hardware: 6500
- Routing protocols:
- RIP v1/v2
- OSPF v1/v2 (with 4 active interfaces)
- Static routing
- Bidirectional Forwarding Detection (BFD)
- IP directed broadcast
- VRF-Lite

Layer 3 Features: IPv6 Management Functionality

- Neighbor discovery, Syslog, Telnet, SSH, J-Web, SNMP, NTP, DNS
- Static routing

Supported RFCs

- RFC 3176 sFlow
- RFC 2925 MIB for remote ping, trace
- RFC 1122 Host requirements
- RFC 768 UDP
- RFC 791 IP
- RFC 783 Trivial File Transfer Protocol (TFTP)
- RFC 792 Internet Control Message Protocol (ICMP)
- RFC 793 TCP
- RFC 826 ARP
- RFC 894 IP over Ethernet
- RFC 903 Reverse ARP (RARP)
- RFC 906 TFTP bootstrap
- RFC 1027 Proxy ARP
- RFC 2068 HTTP server
- RFC 1812 Requirements for IP Version 4 routers
- RFC 1519 Classless Interdomain Routing (CIDR)
- RFC 1256 IPv4 ICMP Router Discovery (IRDP)
- RFC 1058 RIP v1
- RFC 2453 RIP v2
- RFC 1492 TACACS+
- RFC 2138 RADIUS authentication
- RFC 2139 RADIUS accounting
- RFC 3579 RADIUS Extensible Authentication Protocol (EAP) support for 802.1X
- RFC 5176 Dynamic Authorization Extensions to RADIUS
- RFC 2267 Network ingress filtering
- RFC 2030 Simple Network Time Protocol (SNTP)
- RFC 854 Telnet client and server
- RFC 951, 1542 BootP
- RFC 2131 BOOTP/DHCP relay agent and DHCP server
- RFC 1591 Domain Name System (DNS)
- RFC 2474 DiffServ Precedence, including 8 queues/port
- RFC 2598 DiffServ Expedited Forwarding (EF)
- RFC 2597 DiffServ Assured Forwarding (AF)
- LLDP Media Endpoint Discovery (LLDP-MED), ANSI/TIA-1057, draft 08

Security

- MAC limiting
- Allowed MAC addresses—configurable per port
- Sticky MAC (persistent MAC address learning)
- Dynamic ARP inspection (DAI)
- Proxy ARP
- Static ARP support
- DHCP snooping
- IP source guard
- 802.1X port-based
- 802.1X multiple supplicants
- 802.1X with VLAN assignment
- 802.1X with authentication bypass access (based on host MAC address)
- 802.1X with VoIP VLAN support
- 802.1X dynamic ACL based on RADIUS attributes
- 802.1X Supported EAP types: Message Digest 5 (MD5), Transport Layer Security (TLS), Tunneled Transport Layer Security (TTLS), Protected Extensible Authentication Protocol (PEAP)
- Captive Portal
- Trusted Network Connect (TNC) certified
- Static MAC authentication
- MAC-RADIUS
- Control plane DoS protection
- Fallback Authentication

Access control lists (ACLs) (Junos OS firewall filters)

- Port-based ACL (PACL)—ingress
- VLAN-based ACL (VACL)—ingress and egress
- Router-based ACL (RACL)—ingress and egress
- ACL entries (ACE) in hardware per system: 1,500
- ACL counter for denied packets
- ACL counter for permitted packets
- Ability to add/remove/change ACL entries in middle of list (ACL editing)
- L2-L4 ACL

*Unless explicitly specified for any particular MIB table or variables, Junos OS does not support SNMP set operations.

Specifications (continued)

High Availability

- External redundant power system (RPS) option
- Link Aggregation
- 802.3ad (LACP) support:
  - Number of LAGs supported: 32
  - Maximum number of ports per LAG: 8
- LAG load sharing algorithm—Bridged Unicast Traffic:
  - IP: S/D MAC, S/D IP
  - TCP/UDP: S/D MAC, S/D IP, S/D Port
  - Non-IP: S/D MAC
- LAG sharing algorithm—Routed Unicast Traffic:
  - IP: S/D IP
  - TCP/UDP: S/D IP, S/D Port
- LAG load sharing algorithm—Bridged Multicast Traffic:
  - IP: S/D MAC, S/D IP
  - TCP/UDP: S/D MAC, S/D IP, S/D Port
  - Non-IP: S/D MAC
- LAG sharing algorithm—Routed Multicast Traffic:
  - IP: S/D IP
  - TCP/UDP: S/D IP, S/D Port
- Tagged ports support in LAG
- Uplink Failure Detection (UFD)

Quality of Service (QoS)

- Layer 2 QoS
- Layer 3 QoS
- Ingress policing: 1 rate 2 color
- Hardware queues per port: 8
- Scheduling methods (egress): Strict Priority (SP), shaped deficit weighted round-robin (SDWRR)
- 802.1p, DSCP /IP precedence trust and marking
- L2-L4 classification criteria: Interface, MAC address, Ethertype, 802.1p, VLAN, IP address, DSCP/IP precedence, TCP/UDP port numbers
- Congestion avoidance capabilities: Tail drop

Multicast

- IGMP snooping entries: 1,000
- IGMP: v1, v2, v3
- IGMP snooping
- PIM-SM, PIM-SSM, PIM-DM

Services and Manageability

- Junos OS CLI
- Web interface (J-Web)
- Out-of-band management: Serial, 10/100BASE-T Ethernet
- ASCII configuration
- Rescue configuration
- Configuration rollback
- Image rollback
- Element management tools: Junos Space Network Management Platform
- Real-time Performance Monitoring (RPM)
- Simple Network Management Protocol (SNMP): v1, v2c, v3
- Remote monitoring (RMON) (RFC 2819) Groups 1, 2, 3, 9
- Network Time Protocol (NTP)
- DHCP server
- DHCP client and DHCP proxy
- DHCP relay and helper
- RADIUS authentication
- TACACS+ authentication
- SSHv2
- Secure copy
- HTTP/HTTPs
- DNS resolver
- Syslog logging
- Temperature sensor
- Configuration backup via FTP/secure copy
- Interface range

Supported MIBs*

- RFC 2464 Transmission of IPv6 Packets over Ethernet Networks
- RFC 4862 IPv6 Stateless Address Autoconfiguration
- RFC 4443 ICMPv6 for the IPv6 Specification
- RFC 4213 Basic Transition Mechanisms for IPv6 Hosts and Routers
- RFC 1155 Structure of Management Information (SMI)
- RFC 1157 SNMPv1
- RFC 1905 RFC 1907 SNMP v2c, SMIv2 and revised MIB-II
- RFC 2570-2575 SNMPv3, user-based security, encryption, and authentication
- RFC 2576 Coexistence between SNMP Version 1, Version 2 and Version 3
- RFC 1212, RFC 1213, RFC 1215 MIB-II, Ethernet-like MIB, and TRAPs
- RFC 2578 SNMP Structure of Management Information MIB
- RFC 2579 SNMP Textual Conventions for SMIv2
- RFC 2925 Ping/traceroute MIB
- RFC 2665 Ethernet-like interface MIB
- RFC 1643 Ethernet MIB
- RFC 1493 Bridge MIB
- RFC 2096 IPv4 Forwarding Table MIB
- RFC 2011 SNMPv2 for IP using SMIv2
- RFC 2012 SNMPv2 for transmission control protocol using SMIv2
- RFC 2013 SNMPv2 for user datagram protocol using SMIv2
- RFC 2863 Interface MIB
- RFC 3413 SNMP Application MIB
- RFC 3414 User-based security model for SNMPv3
- RFC 3415 View-based Access Control Model for SNMP
- RFC 3621 PoE-MIB (PoE switches only)
- RFC 1724 RIPv2 MIB
- RFC 2863 Interface Group MIB
- RFC 2819 RMON MIB
- RFC 2287 System Application Packages MIB
- RFC 4188 STP and extensions MIB
- RFC 4363 Definitions of managed objects for bridges with traffic classes, multicast filtering, and VLAN extensions
- RFC 2922 LLDP MIB
- RFC 1981 Path MTU discovery for IPv6
- RFC 2460 IPv6 Specification
- RFC 3484 Default address selection for IPv6
- RFC 4291 IPv6 Addressing architecture
- RFC 4861 Neighbor discovery for IPv6
- Draft – blumenthal – aes – usm - 08
- Draft – reeder - snmpv3 – usm - 3desede -00

*Each switch comes with RJ-45-to-DB-9 serial port adapter, 19" rack mount kit and connector retainer. Each system also ships with a power cord for the country for which it is shipped.

Specifications (continued)

Troubleshooting

- Debugging: CLI via console, telnet, or SSH
- Diagnostics: Show and debug command statistics
- Traffic mirroring (port)
- Traffic mirroring (VLAN)
- ACL-based mirroring
- Mirroring destination ports per system: 1
- LAG port monitoring
- Multiple destination ports monitored to 1 mirror (N:1)
- Maximum number of mirroring sessions: 1
- Mirroring to remote destination (over L2): 1 destination VLAN
- IP tools: Extended ping and trace
- Juniper Networks commit and rollback

Warranty

- Enhanced limited lifetime switch hardware warranty

Safety Certifications

- UL-UL60950-1 (Second Edition)
- C-UL to CAN/CSA 22.2 No.60950-1 (Second Edition)
- TUV/GS to EN 60950-1 (Second Edition)
- CB-IEC60950-1 (Second Edition with all country deviations)
- EN 60825-1 (Second Edition)

Electromagnetic Compatibility Certifications

- FCC 47CFR Part 15 Class A
- EN 55022 Class A
- ICES-003 Class A
- VCCI Class A
- AS/NZS CISPR 22 Class A
- CISPR 22 Class A
- EN 55024
- EN 300386
- CE

NEBS

- GR-63-Core: NEBS, Physical Protection
- GR-1089-Core: EMC and Electrical Safety for Network Telecommunications Equipment
- All models except EX2200-24P-4G, EX2200-48P-4G and EX2200-24T-4G-DC

Telecom Quality Management

- TL9000

Environmental

- Reduction of Hazardous Substances (ROHS) 6

Noise Specifications

Noise measurements based on operational tests taken from bystander position (front) and performed at 25° C in compliance with ISO 7779

Model	Acoustic Noise in DBA
EX2200-24T-4G	32.7
EX2200-24P-4G	37.2
EX2200-48T-4G	33.5
EX2200-48P-4G	38.1

Telco

- CLEI code

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit **www.juniper.net/us/en/products-services**.

Ordering Information

Model Number	Description
Switches*	
EX2200-24T-4G	24-port 10/100/1000BASE-T Ethernet Switch with four SFP Gigabit Ethernet uplink ports
EX2200-24P-4G	24-port 10/100/1000BASE-T Ethernet Switch with PoE+ and four SFP Gigabit Ethernet uplink ports
EX2200-48T-4G	48-port 10/100/1000BASE-T Ethernet Switch with four SFP Gigabit Ethernet uplink ports
EX2200-48P-4G	48-port 10/100/1000BASE-T Ethernet Switch with PoE+ and four SFP Gigabit Ethernet uplink ports
EX2200-24T-4G-DC	24-port 10/100/1000BASE-T Ethernet Switch with four SFP Gigabit Ethernet uplink ports and internal DC power supply
EX2200-24P-4G-TAA	Trade Agreement Act-compliant, 24-port 10/100/1000BaseT (24-ports PoE) with 4 SFP uplink ports
EX2200-24T-4G-TAA	Trade Agreement Act-compliant, 24-port 10/100/1000BaseT with 4 SFP uplink ports
EX2200-48P-4G-TAA	Trade Agreement Act-compliant, 48-port 10/100/1000BaseT (48-ports PoE+) with 4 SFP uplink ports
EX2200-48T-4G-TAA	Trade Agreement Act-compliant, 48-port 10/100/1000BaseT with 4 SFP uplink ports
Mounting Options	
EX-RMK	Rack mount kit for EX2200
EX-4PST-RMK	Adjustable 4-post Rack mount kit for EX2200
EX-WMK-BFL	Wall mount kit with baffle for EX2200
Enhanced Feature License	
EX-24-EFL	Enhanced Feature License for EX2200-24T and EX2200-24P switches. Includes licenses for OSPF v1/v2, IGMP v1/v2/v3, PIM, IEEE 802.1 Q-in-Q, Bidirectional Forwarding Detection (BFD), Real-time Performance Monitoring (RPM), IEEE 802.1ag (Connectivity Fault Management) and VRF-Lite.
EX-48-EFL	Enhanced Feature License for EX2200-48T and EX2200-48P switches. Includes licenses for OSPF v1/v2, IGMP v1/v2/v3, PIM, IEEE 802.1 Q-in-Q, Bidirectional Forwarding Detection (BFD), Real-time Performance Monitoring (RPM), IEEE 802.1ag (Connectivity Fault Management) and VRF-Lite.

Model Number	Description
Pluggable Optics	
EX-SFP-1FE-FX	SFP 100BASE-FX; LC connector; 1310 nm; 2 km reach on multimode fiber
EX-SFP-FE20KT13R15	SFP 100BASE-BX; LC connector; TX 1310 nm/RX 1550 nm; 20 km reach on single-strand, single-mode fiber
EX-SFP-FE20KT15R13	SFP 100BASE-BX; LC connector; TX 1550 nm/RX 1310 nm; 20 km reach on single-strand, single-mode fiber
EX-SFP-1GE-T	SFP 10/100/1000BASE-T copper; RJ-45 connector; 100 m reach on UTP
EX-SFP-1GE-SX	SFP 1000BASE-SX; LC connector; 850 nm; 550 m reach on multimode fiber
EX-SFP-1GE-LX	SFP 1000BASE-LX; LC connector; 1310 nm; 10 km reach on single-mode fiber
EX-SFP-1GE-LH	SFP 1000BASE-LH; LC connector; 1550 nm; 70 km reach on single-mode fiber
EX-SFP-1FE-LH	SFP 100BASE-LX; LC connector; 1310 nm; 80 km reach on single-mode fiber
EX-SFP-1FE-LX	SFP 100BASE-LX; LC connector; 1310 nm; 10 km reach on single-mode fiber
EX-SFP-1FE-LX40K	SFP 100BASE-LX; LC connector; 1310 nm; 40 km reach on single-mode fiber
EX-SFP-1GE-LX40K	SFP 1000BASE-LX; LC connector; 1310 nm; 40 km reach on single-mode fiber
EX-SFP-GE10KT13R14	SFP 1000BASE-BX; TX 1310 nm/RX 1490 nm for 10 km transmission on single-strand, single-mode fiber
EX-SFP-GE10KT13R15	SFP 1000BASE-BX; TX 1310 nm/RX 1550 nm for 10 km transmission on single-strand, single-mode fiber
EX-SFP-GE10KT14R13	SFP 1000BASE-BX; TX 1490 nm/RX 1310 nm for 10 km transmission on single-strand, single-mode fiber
EX-SFP-GE10KT15R13	SFP 1000BASE-BX; TX 1550 nm/RX 1310 nm for 10 km transmission on single-strand, single-mode fiber
EX-SFP-GE40KT13R15	SFP 1000BASE-BX; TX 1310 nm/RX 1550 nm for 40 km transmission on single-strand, single-mode fiber
EX-SFP-GE40KT15R13	SFP 1000BASE-BX; TX 1550 nm/RX 1310 nm for 40 km transmission on single-strand, single-mode fiber

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at **www.juniper.net**.

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Data Sheet

Cisco Aironet 1600 Series Access Point

Wi Fi CERTIFIED

Industrial Design

- Sleek design with internal antennas, ideal for office environments
- Extended operating temperature, ideal for factories, warehouses, and other indoor industrial environments
- Versatile RF coverage with optional external antennas
- UL 2043 plenum-rated for above-ceiling installation options or suspended from drop ceilings

Easy Installation and Power Efficient

- 802.11n performance with existing PoE switches
- Sleek design blends into a variety of indoor environments

Easy-to-Install Multipurpose Mounting Bracket

- Designed for easy replacement of existing access points
- Locks for theft protection

Deployment Options

- Controller-based or standalone deployment options

Secure Connections

- Supports rogue access point detection and denial-of service attacks
- Management frame protection detects malicious users and alerts network administrators

Cisco ClientLink 2.0 Beamforming

- Faster mobile client connections
- Support for all client types without any client requirements or dependencies
- More efficient use of mobile device batteries

Cisco CleanAir Express* Spectrum Intelligence

- Identifies, classifies and provides automatic remedial actions for different types of interference
- Locates and visualizes sources of interference

Cisco VideoStream Technology

- Efficient multicast-to-unicast conversion
- Video call admission control to prevent oversubscription
- Queue prioritization to help ensure best user experience for corporate videos

The new Cisco Aironet® 1600 Series Access Point is an enterprise-class, entry-level, 802.11n-based access point designed to address the wireless connectivity needs of small and medium-sized enterprise networks.

The Aironet 1600 Series delivers great performance at an attractive price for customers while providing advanced functionality such as CleanAir Express* for better cover through spectrum intelligence and Clientlink 2.0 for entry level networks that have a mixed client base. In addition to these features, the Aironet 1600 series includes 802.11n-based 3x3 multiple-input multiple-output (MIMO) technology with two spatial streams, making it ideal for small and medium-sized enterprises.

The Aironet 1600 Series also provides at least six times the throughput of existing 802.11a/g networks. As part of the Cisco® Aironet Wireless portfolio, the Cisco Aironet 1600 Series access point provides low total cost of ownership and investment protection by integrating seamlessly with the existing network. With an entry-level path to 802.11n migration, the Aironet 1600 Series can add capacity to the network for future growth for expanding applications and bandwidth.

Designed with rapidly evolving mobility needs in mind, the Cisco Aironet 1600 Series Access Point addresses the bring-your-own-device (BYOD) trend by providing advanced functionality at the right price point.

* Available via future release.

RF Excellence

Building on the Cisco Aironet heritage of RF excellence, the Cisco Aironet 1600 Series delivers secure and reliable wireless connections. Enterprise-class chipsets and optimized radios deliver a robust mobility experience with:

- 802.11n with 3x3 multiple-input multiple-output (MIMO) technology with two spatial streams, which sustains 300-Mbps rates over a greater range for more capacity and reliability than competing access points
- Radio resource management (RRM): Automated self-healing optimizes the unpredictability of RF to reduce dead spots and help ensure high-availability client connections
- CleanAir Express: Effectively detects RF interference and provides basic spectrum analysis capability while simplifying ongoing operations
- Cisco ClientLink 2.0 technology: Improves downlink performance to all mobile devices including 802.11n while improving battery life on mobile devices such as smartphones and tablets
- Cisco BandSelect technology: Improves 5-GHz client connections in mixed-client environments

  Cisco VideoStream technology: Uses multicast to improve rich-media applications
- Building on the Cisco All of these features help ensure the best possible end-user experience on the wireless network. Cisco also offers the industry's broadest selection of 802.11n antennas delivering optimal coverage for a variety of deployment scenarios

Scalability

The Cisco Aironet 1600 Series is a component of the Cisco Unified Wireless Network, which can scale to up to 18,000 access points with full Layer 3 mobility across central or remote locations on the enterprise campus, in branch offices, and at remote sites. The Cisco Unified Wireless Network is the industry's most flexible, resilient, and scalable architecture delivering secure access to mobility services and applications, and offering the lowest total cost of ownership and investment protection by integrating seamlessly with the existing wired network

Cisco Network Assistant

For quick and easy setup of your access points, Cisco Network Assistant provides a centralized network view with a user-friendly GUI that simplifies configuration, management and troubleshooting. Using Cisco Network Assistant you can easily discover and initialize your network of stand-alone access points.

Cisco Network Assistant is available free, and can be downloaded here: http://www.cisco.com/go/cna.

Product Specifications

Table 1 lists the product specifications for Cisco Aironet 1600 Series Access Points.

Table 1. Product Specifications for Cisco Aironet 1600 Series Access Points

Item	Specification
Part Numbers	**The Cisco Aironet 1600i Access Point: Indoor environments, with internal antennas** • AIR-CAP1602I-x-K9 Dual-band controller-based 802.11a/g/n • AIR-CAP1602I-xK910 Eco-pack (dual-band controller-based 802.11a/g/n) 10 quantity access points • AIR-SAP1602I-x-K9 Dual-band stand-alone 802.11a/g/n • AIR-SAP1602I-xK9-5 Eco-pack (dual-band stand-alone 802.11a/g/n) 5 quantity access points **The Cisco Aironet 1600e Access Point: Indoor, challenging environments, with external antennas** • AIR-CAP1602E-x-K9 Dual-band controller-based 802.11a/g/n • AIR-CAP1602E-xK910 Eco-pack (dual-band 802.11a/g/n) 10 quantity access points • AIR-SAP1602E-x-K9 Dual-band stand-alone 802.11a/g/n • AIR-SAP1602E-xK9-5 Eco-pack (dual-band stand-alone 802.11a/g/n) 5 quantity access points

Item	Specification			
	Cisco SMARTnet® Service for the Cisco Aironet 1600 Series Access Point with internal and external antennas • CON-SNT-C1602I*x* - SMARTnet 8x5xNBD 1600i access point (dual-band 802.11 a/g/n, Controller-based), (e.g. CON-SNT-C1602IE for AP1600 internal antenna for E Domain, Controller based) • CON-SNT-C1602E*x* - SMARTnet 8x5xNBD 1600e access point (dual-band 802.11 a/g/n, Controller-based), (e.g. CON-SNT-C1602EA for AP1600 external antenna for A Domain, Controller based) • CON-SNT-S1602I*x* - SMARTnet 8x5xNBD 1600i access point (dual-band 802.11 a/g/n, Stand-alone), (e.g. CON-SNT-S1602IE for AP1600 internal antenna for E Domain, stand-alone) • CON-SNT-S1602E*x* - SMARTnet 8x5xNBD 1600e access point (dual-band 802.11 a/g/n, Stand-alone), (e.g. CON-SNT-S1602EA for AP1600 external antenna for A Domain, Stand-alone) **Cisco Wireless LAN Services** • AS-WLAN-CNSLT Cisco Wireless LAN Network Planning and Design Service • AS-WLAN-CNSLT Cisco Wireless LAN 802.11n Migration Service • AS-WLAN-CNSLT Cisco Wireless LAN Performance and Security Assessment Service **Regulatory domains: (x = regulatory domain)** Customers are responsible for verifying approval for use in their individual countries. To verify approval and to identify the regulatory domain that corresponds to a particular country, please visit: http://www.cisco.com/go/aironet/compliance. Not all regulatory domains have been approved. As they are approved, the part numbers will be available on the Global Price List.			
Software	• Cisco Unified Wireless Network Software (available in Q4CY12) • Cisco IOS® Software Release (available in Q4CY12)			
802.11n	• 3 x 3 multiple-input multiple-output (MIMO) with two spatial streams • Maximal ratio combining (MRC) • 20- and 40-MHz channels • PHY data rates up to 300 Mbps • Packet aggregation: A-MPDU (Tx/Rx), A-MSDU (Tx/Rx) • 802.11 dynamic frequency selection (DFS) (Bin 5) • Cyclic shift diversity (CSD) support			
Data Rates Supported	**802.11a: 6, 9, 12, 18, 24, 36, 48, and 54 Mbps**			
	802.11g: 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, and 54 Mbps			
	802.11n data rates (2.4 GHz[1] and 5 GHz):			
	MCS Index[2]	**GI[3] = 800ns**		**GI = 400ns**
		20-MHz Rate (Mbps)	**40-MHz Rate (Mbps)**	**20-MHz Rate (Mbps)**	**40-MHz Rate (Mbps)**
	0	**6.5**	13.5	7.2	15
	1	13	27	14.4	30
	2	19.5	40.5	21.7	45
	3	26	54	28.9	60
	4	39	81	43.3	90
	5	52	108	57.8	120
	6	58.5	121.5	65	135
	7	65	135	72.2	150
	8	13	27	14.4	30
	9	26	54	28.9	60
	10	39	81	43.3	90
	11	52	108	57.8	120
	12	78	162	86.7	180
	13	104	216	115.6	240

[1] 2.4 GHz: 2 GHz does not support 40 MHz.

[2] MCS Index: The Modulation and Coding Scheme (MCS) index determines the number of spatial streams, the modulation, the coding rate, and data rate values.

[3] GI: A Guard Interval (GI) between symbols helps receivers overcome the effects of multipath delays.

Item	Specification				
	14	117	243	130	270
	15	130	270	144.4	300
Frequency Band and 20-MHz Operating Channels	**A Regulatory Domain:** • 2.412 to 2.462 GHz; 11 channels • 5.180 to 5.320 GHz; 8 channels • 5.500 to 5.700 GHz; 8 channels (excludes 5.600 to 5.640 GHz) • 5.745 to 5.825 GHz; 5 channels **C Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.745 to 5.825 GHz; 5 channels **E Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.180 to 5.320 GHz; 8 channels • 5.500 to 5.700 GHz; 8 channels (excludes 5.600 to 5.640 GHz) **I Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.180 to 5.320 GHz; 8 channels **K Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.180 to 5.320 GHz; 8 channels • 5.500 to 5.620 GHz; 7 channels • 5.745 to 5.805 GHz; 4 channels		**N Regulatory Domain:** • 2.412 to 2.462 GHz; 11 channels • 5.180 to 5.320 GHz; 8 channels • 5.745 to 5.825 GHz; 5 channels **Q Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.180 to 5.320 GHz; 8 channels • 5.500 to 5.700 GHz; 11 channels **R Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.180 to 5.320 GHz; 8 channels • 5.660 to 5.700 GHz; 3 channels • 5.745 to 5.805 GHz; 4 channels **S Regulatory Domain:** • 2.412 to 2.472 GHz; 13 channels • 5.180 to 5.320 GHz; 8 channels • 5.500 to 5.700 GHz; 11 channels • 5.745 to 5.825 GHz; 5 channels **T Regulatory Domain:** • 2.412 to 2.462 GHz; 11 channels • 5.280 to 5.320 GHz; 3 channels • 5.500 to 5.700 GHz; 8 channels (excludes 5.600 to 5.640 GHz) • 5.745 to 5.825 GHz; 5 channels **Z Regulatory Domain:** • 2.412 to 2.462 GHz; 11 channels • 5.180 to 5.320 GHz; 8 channels • 5.500 to 5.700 GHz; 8 channels (excludes 5.600 to 5.640 GHz) • 5.745 to 5.825 GHz; 5 channels	
Note: This varies by regulatory domain. Refer to the product documentation for specific details for each regulatory domain.					
Maximum Number of Nonoverlapping Channels	**2.4 GHz** • 802.11b/g: ◦ 20 MHz: 3 • 802.11n: ◦ 20 MHz: 3		**5 GHz** • 802.11a: ◦ 20 MHz: 24 • 802.11n: ◦ 20 MHz: 24 ◦ 40 MHz: 11		
Note: This varies by regulatory domain. Refer to the product documentation for specific details for each regulatory domain.					
Receive Sensitivity	**2.4 GHz** **802.11b** -101 dBm @ 1 Mb/s -99 dBm @ 2 Mb/s -92 dBm @ 5.5 Mb/s -89 dBm @ 11 Mb/s	**2.4 GHz** **802.11g** -93 dBm @ 6 Mb/s -93 dBm @ 9 Mb/s -92 dBm @ 12 Mb/s -90 dBm @ 18 Mb/s -87 dBm @ 24 Mb/s -85 dBm @ 36 Mb/s -80 dBm @ 48 Mb/s -79 dBm @ 54 Mb/s	**5 GHz** **802.11a** -92 dBm @ 6 Mb/s -91 dBm @ 9 Mb/s -91 dBm @ 12 Mb/s -89 dBm @ 18 Mb/s -86 dBm @ 24 Mb/s -83 dBm @ 36 Mb/s -79 dBm @ 48 Mb/s -78 dBm @ 54 Mb/s		

Item	Specification					
	2.4 GHz **802.11n (HT20)** -93 dBm @ MCS0 -91 dBm @ MCS1 -89 dBm @ MCS2 -86 dBm @ MCS3 -83 dBm @ MCS4 -78 dBm @ MCS5 -77 dBm @ MCS6 -76 dBm @ MCS7 -93 dBm @ MCS8 -90 dBm @ MCS9 -88 dBm @ MCS10 -85 dBm @ MCS11 -81 dBm @ MCS12 -77 dBm @ MCS13 -76 dBm @ MCS14 -74 dBm @ MCS15		**5 GHz** **802.11n (HT20)** -92 dBm @ MCS0 -89 dBm @ MCS1 -88 dBm @ MCS2 -85 dBm @ MCS3 -82 dBm @ MCS4 -77 dBm @ MCS5 -76 dBm @ MCS6 -75 dBm @ MCS7 -91 dBm @ MCS8 -88 dBm @ MCS9 -87 dBm @ MCS10 -84 dBm @ MCS11 -81 dBm @ MCS12 -76 dBm @ MCS13 -75 dBm @ MCS14 -73 dBm @ MCS15	**5 GHz** **802.11n (HT40)** -88 dBm @ MCS0 -87 dBm @ MCS1 -85 dBm @ MCS2 -82 dBm @ MCS3 -79 dBm @ MCS4 -74 dBm @ MCS5 -73 dBm @ MCS6 -72 dBm @ MCS7 -88 dBm @ MCS8 -86 dBm @ MCS9 -84 dBm @ MCS10 -81 dBm @ MCS11 -78 dBm @ MCS12 -73 dBm @ MCS13 -72 dBm @ MCS14 -70 dBm @ MCS15
Maximum Total Transmit Power	**2.4 GHz** • 802.11b ◦ 22 dBm (3 antennas enabled) • 802.11g ◦ 22 dBm (3 antennas enabled) • 802.11n (HT20) ◦ 22 dBm (3 antennas enabled)			**5 GHz** • 802.11a ◦ 22 dBm (3 antennas enabled) • 802.11n non-HT duplicate mode ◦ 22 dBm (3 antennas enabled) • 802.11n (HT20) ◦ 22 dBm (3 antennas enabled) • 802.11n (HT40) ◦ 22 dBm (3 antennas enabled)		
Note: The maximum power setting will vary by channel and according to individual country regulations. Refer to the product documentation for specific details.						
Available Total Transmit Power Settings	**2.4 GHz**			**5 GHz**		
	Enabled antennas:			Enabled antennas:		
	1	2	3	1	2	3
	17 dBm 14 dBm 11 dBm 8 dBm 5 dBm 2 dBm	20 dBm 17 dBm 14 dBm 11 dBm 8 dBm 5 dBm	22 dBm 19 dBm 16 dBm 13 dBm 10 dBm 7 dBm	17 dBm 14 dBm 11 dBm 8 dBm 5 dBm 2 dBm	20 dBm 17 dBm 14 dBm 11 dBm 8 dBm 5 dBm	22 dBm 19 dBm 16 dBm 13 dBm 10 dBm 7 dBm
Note: The maximum power setting will vary by channel and according to individual country regulations. Refer to the product documentation for specific details.						
Integrated Antenna	• 2.4 GHz, gain 4.0 dBi, horizontal beamwidth 360° • 5 GHz, gain 4.0 dBi, horizontal beamwidth 360°					
External Antenna (Sold Separately)	• Certified for use with antenna gains up to 6 dBi (2.4 GHz and 5 GHz) • Cisco offers the industry's broadest selection of 802.11n antennas delivering optimal coverage for a variety of deployment scenarios					
Interfaces	• 10/100/1000BASE-T autosensing (RJ-45) • Management console port (RJ-45)					
Indicators	• Status LED indicates boot loader status, association status, operating status, boot loader warnings, boot loader errors					
Dimensions (W x L x H)	• Access point (without mounting bracket): 8.7 x 8.7 x 1.84 in. (22.1 x 22.1 x 4.7 cm)					
Weight	• 1.9 lbs. (0.86 kg)					

Item	Specification
Environmental	**Cisco Aironet 1600i** • Nonoperating (storage) temperature: -22 to 158°F (-30 to 70°C) • Nonoperating (storage) Altitude Test -25°C, 15,000 ft. • Operating temperature: 32 to 104°F (0 to 40°C) • Operating humidity: 10 to 90% percent (noncondensing) • Operating Altitude Test -40°C, 9843 ft. **Cisco Aironet 1600e** • Nonoperating (storage) temperature: -22 to 158°F (-30 to 70°C) • Nonoperating (storage) Altitude Test - 25°C, 15,000 ft. • Operating temperature: -4 to 122°F (-20 to 50°C) • Operating humidity: 10 to 90 percent (noncondensing) • Operating Altitude Test -40°C, 9843 ft
System Memory	• 256 MB DRAM • 32 MB flash
Input Power Requirements	• AP1600: 44 to 57 VDC • Power Supply and Power Injector: 100 to 240 VAC; 50 to 60 Hz
Powering Options	• 802.3af Ethernet Switch • Cisco AP1600 Power Injectors (AIR-PWRINJ4=, AIR-PWRINJ5=) • Cisco AP1600 Local Power Supply (AIR-PWR-B=)
Power Draw	• AP1600: 12.95 W **Note:** When deployed using PoE, the power drawn from the power sourcing equipment will be higher by some amount dependent on the length of the interconnecting cable. This additional power may be as high as 2.45W, bringing the total system power draw (access point + cabling) to 15.4W.
Warranty	Limited Lifetime Hardware Warranty
Compliance	**Standards** • **Safety:** ◦ UL 60950-1 ◦ CAN/CSA-C22.2 No. 60950-1 ◦ UL 2043 ◦ IEC 60950-1 ◦ EN 60950-1 • **Radio approvals:** ◦ FCC Part 15.247, 15.407 ◦ RSS-210 (Canada) ◦ EN 300.328, EN 301.893 (Europe) ◦ ARIB-STD 33 (Japan) ◦ ARIB-STD 66 (Japan) ◦ ARIB-STD T71 (Japan) ◦ AS/NZS 4268.2003 (Australia and New Zealand) ◦ EMI and susceptibility (Class B) ◦ FCC Part 15.107 and 15.109 ◦ ICES-003 (Canada) ◦ VCCI (Japan) ◦ EN 301.489-1 and -17 (Europe) ◦ EN 60601-1-2 EMC requirements for the Medical Directive 93/42/EEC • **IEEE Standard:** ◦ IEEE 802.11a/b/g, IEEE 802.11n, IEEE 802.11h, IEEE 802.11d • **Security:** ◦ 802.11i, Wi-Fi Protected Access 2 (WPA2), WPA ◦ 802.1X ◦ Advanced Encryption Standards (AES), Temporal Key Integrity Protocol (TKIP) • **EAP Type(s):** ◦ Extensible Authentication Protocol-Transport Layer Security (EAP-TLS) ◦ EAP-Tunneled TLS (TTLS) or Microsoft Challenge Handshake Authentication Protocol Version 2 (MSCHAPv2) ◦ Protected EAP (PEAP) v0 or EAP-MSCHAPv2

Item	Specification
	◦ Extensible Authentication Protocol-Flexible Authentication via Secure Tunneling (EAP-FAST) ◦ PEAPv1 or EAP-Generic Token Card (GTC) ◦ EAP-Subscriber Identity Module (SIM) • **Multimedia:** ◦ Wi-Fi Multimedia (WMM™) • **Other:** ◦ FCC Bulletin OET-65C ◦ RSS-102

Limited Lifetime Hardware Warranty

The Cisco Aironet 1600 Series Access Point comes with a Limited Lifetime Warranty that provides full warranty coverage of the hardware for as long as the original end user continues to own or use the product. The warranty includes 10-day advance hardware replacement and ensures that software media is defect-free for 90 days. For more details, visit: http://www.cisco.com/go/warranty.

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For more information about the Cisco Aironet 1600 Series, visit http://www.cisco.com/go/wireless or contact your local account representative.

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