



Agenda

- **Spread Spectrum RF Technologies FH/DS**
- **Wireless LAN Topology Basics**
- **Cisco Wireless LAN Products and Features**
- **Wireless LAN Design Examples**
- **Building-to-Building Bridge Topologies**
- **Bridge Design Examples**

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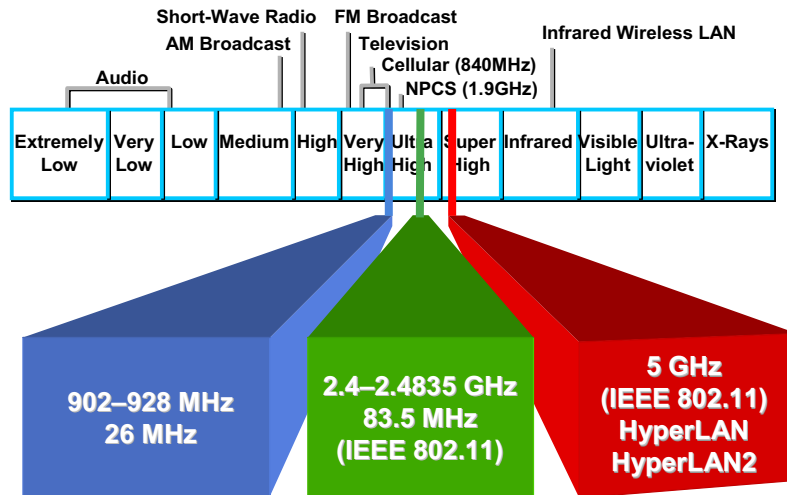
Spread Spectrum Technology

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ISM Unlicensed Frequency Bands



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Cisco Radio Technology

- **Direct sequence spread spectrum (referred to as DS)**
 - 2.4 GHz
 - One piece PCMCIA radio product
 - 1, 2, 5.5 and 11 MB
 - 25-mile bridge links
 - Fully compliant 802.11 at all speeds
- **Frequency hopping spread spectrum (referred to as FH)**
 - 2.4 GHz frequency
 - One piece PCMCIA radio product
 - Fully compliant 802.11
 - One and two MB

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We Have Both, But... What's the Difference?

- **Direct Sequence (DS)**

Throughput
Range

- **Frequency Hopping (FH)**

???????



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The **Past**—FH vs DS

- In years past DS Excelled at:

Range
Throughput
Security

- In years past FH Excelled at:

Scalability
Multipath Resistant
Interference rejection

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The **Present**—FH vs DS

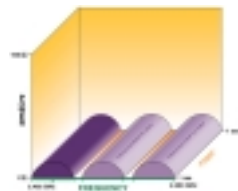
The DS systems have improved!

- **DS Advantages**

Throughput

Scalability

Range

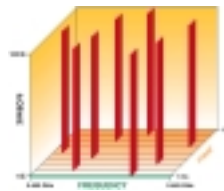


- **FH Advantages**

?

?

?

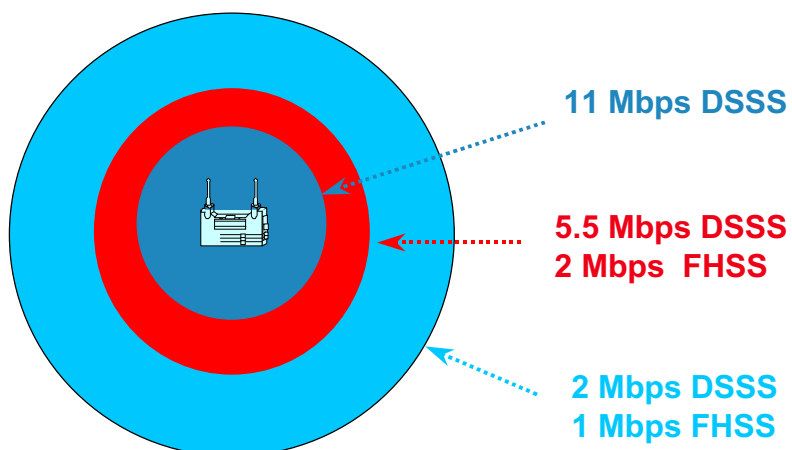


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Range—DS vs. FH



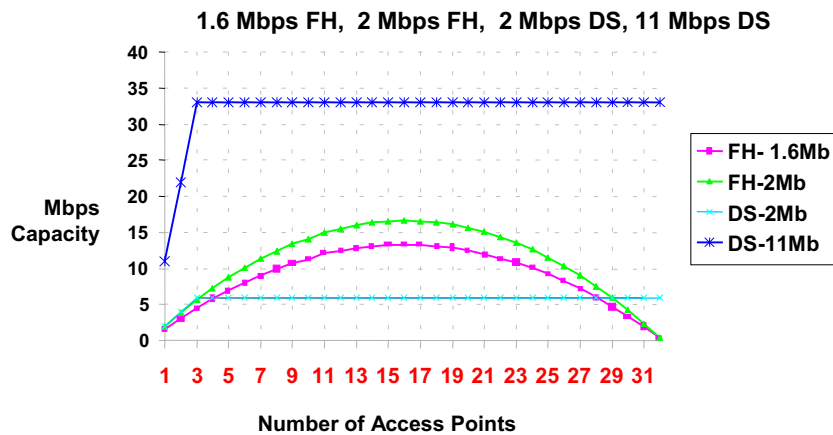
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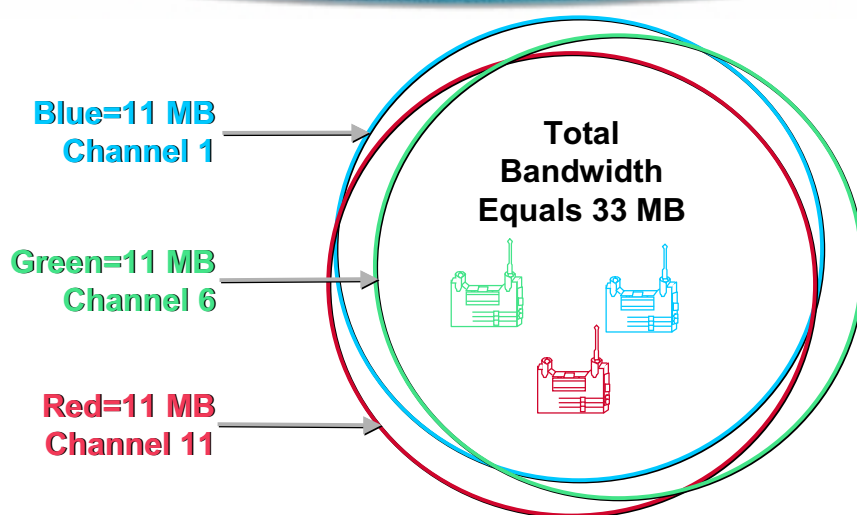
Scalability—FH vs. DS

Wireless Capacity per Cell



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Scalability with Direct Sequence



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Standards in Wireless

- The IEEE 802.11 is the Wireless Standard (July 1997) for 1 and 2 Mb, FH and DS
- The IEEE802.11b is the latest standard (Sept 1999) for 11 Mb using only DS
- WI-FI certification for interoperability at 11Mb DS Only

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IEEE 802.11 Compliance Offers You...

- A very high-performance WLAN system
 - Efficient MAC and high-quality radio
 - 802.11 products perform better than proprietary systems
 - Client interoperability
- WEP standard privacy and authentication
- Standards-based migration path for system growth

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Wi-Fi Certification



- **WECA certifies Interoperability between products**
- **This provides assurance to customers of migration and integration options**
- **Cisco is a founding member of WECA**
- **Certified products can be found at www.wi-fi.com**

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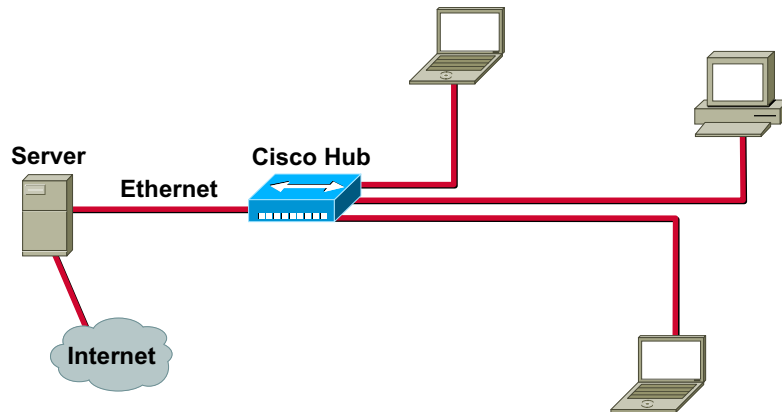
Wireless LAN Topologies

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Local Area Network (LAN)

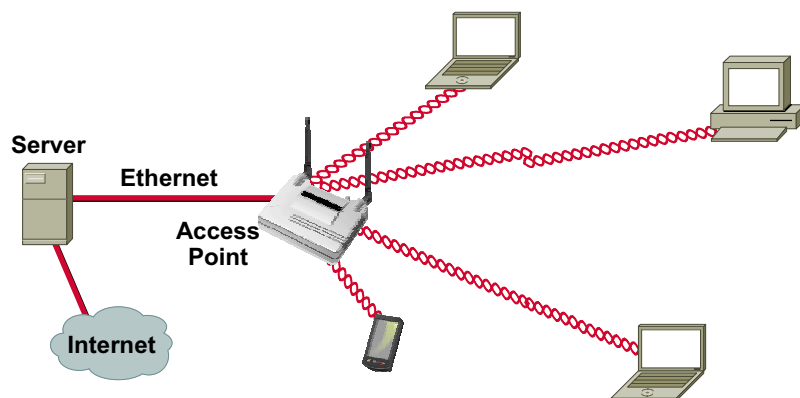


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Wireless Local Area Network (WLAN)



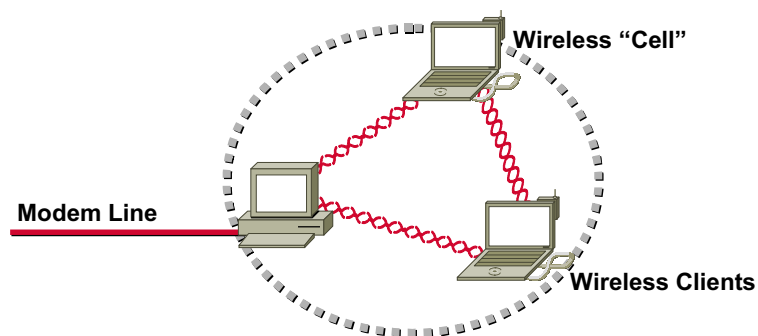
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LAN Topologies

Peer to Peer Configuration (Ad Hoc Mode)

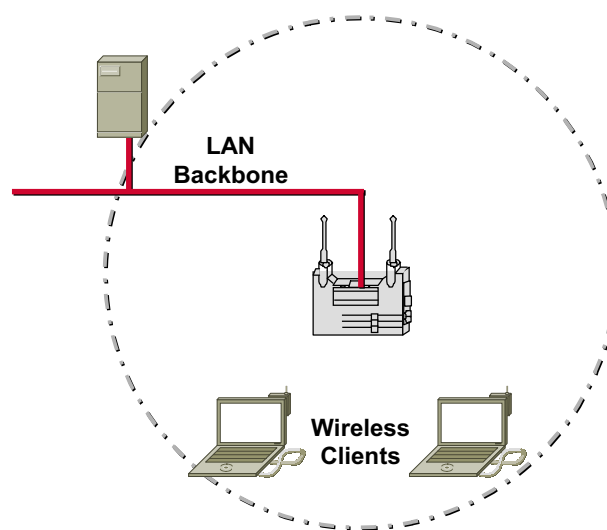


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Typical Single Cell Configuration

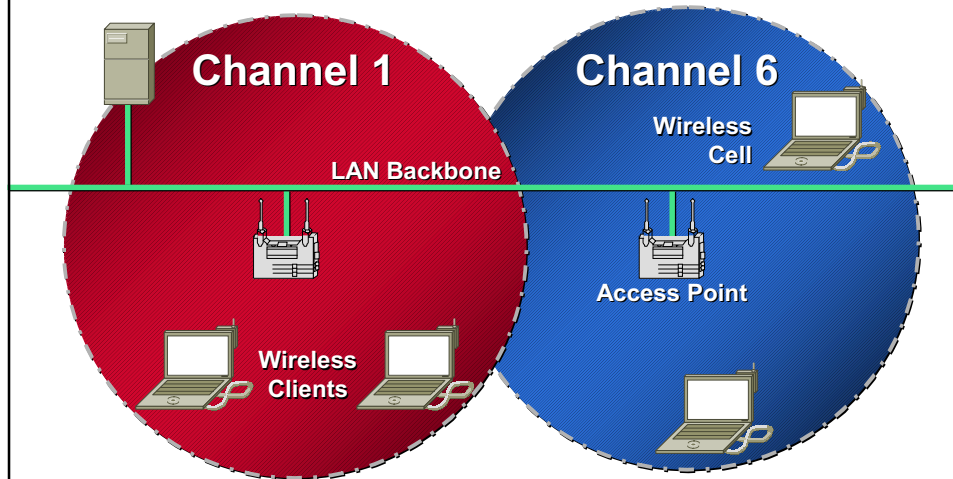


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Typical Multicell Configuration

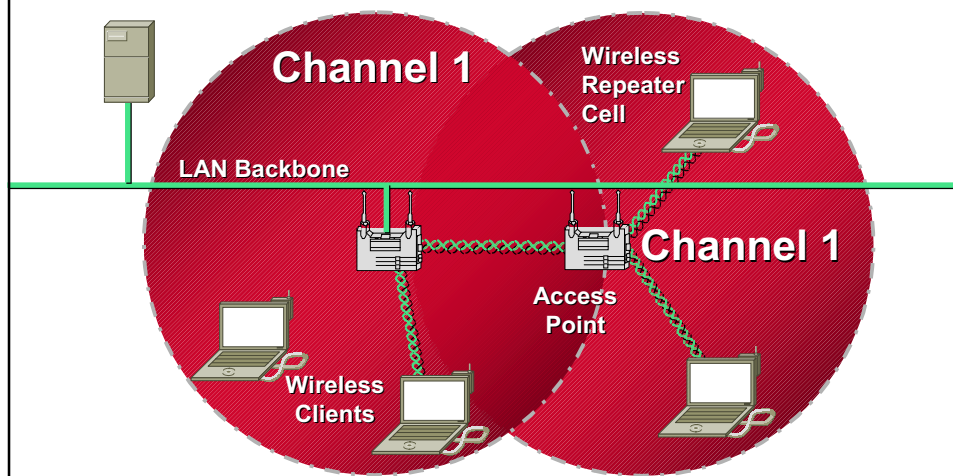


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Wireless Repeater



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Introducing the Cisco Aironet 340 Series Wireless LAN Solutions

The new Cisco Aironet 340 Series of 802.11b compliant high speed wireless solutions offers the best performance, manageability, scalability and security for both in-building and building to building wireless applications



Three Cisco Aironet 340 Series products are shown: a PC card/PCI and USB client adapter (bottom left), an access point (center), and a line-of-sight bridge product (top right). Each product is shown with a blue glow effect beneath it.

Fully-integrated family of wireless LAN products:

- PC Card/PCI and USB Client Adapters
- Access Points
- Line-of-Sight Bridge Products
- Antennas & Accessories

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Products: Wireless Access Points

- **340 series wireless access point**
- **802.11-bit compliant 1, 2, AND at 5.5 and 11 Mbps**
 - 10/100 MB Ethernet
 - 2048 association entries
- **128-bit WEP encryption**
- **All operate as either wired root node or wireless repeater**
- **Configuration is stored in non-volatile flash memory**



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Access Points

- **Menu driver configuration**
- **Minimum setup required for normal operation**
 - (Plug and play for default operation)
- **Maximum flexibility with option menus**
- **Internal testing for RF link**
- **Configuration/management methods**
 - HTML (Web browser), Telnet,
BootP/DHCP, SNMP, FTP

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Access Point Menus

- **Menu driver configuration**
Menus include:
Configuration
Diagnostics
Statistics
- **Web browser interface preferred**
- **Serial communication—9600, N, 8, 1**
Straight through nine-pin cable
Standard ANSI terminal

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Cisco Aironet 340 Series Client Adapters

- **Client access for both notebook and desktop systems**
- **Broad Operating Systems Support:**
Windows 95, 98,
Windows NT 4.0
Windows 2000
Windows CE
Novell Netware clients
- **Easy, simple installation**
- **Lifetime limited warranty**



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PC Cards

- Unique diversity antenna
- Small form factor—single piece PC card
- Channel agile clients with smart scanning
- Data-rate shifting for maximum range
- Sleep mode maintains network connections, and provides low power consumption for small battery powered devices like WinCE.



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Linux Driver

- The installation procedure can be performed only by root users (those with administrative rights)
- Currently supports version 2.2.XX of the Linux kernel
- Leap functionality is supported
- PCI is supported

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Macintosh Client Support

- Mac OS9.x **only**
- G3 models of the Powerbook **only**
- PCI not supported
- LEAP functionality is supported

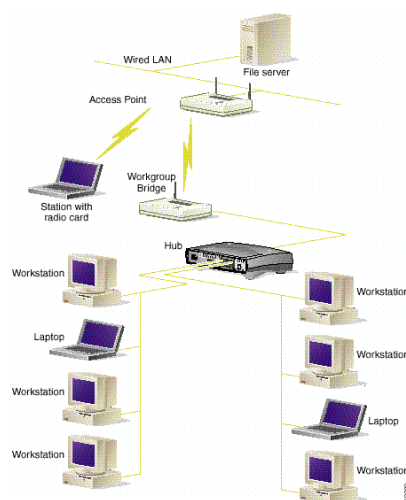
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WGB340 Product

- Allows up to 8 MAC devices to use the same RF device, with the use of a hub
- Stand alone device, no drivers needed
- Excellent product for hospitality applications



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WGB 340 and Interoperability

- The WGB is a Bridge-
Bridges are NOT covered
by 802.11
- The WGB will communicate
with only two devices- a
Cisco Access Point, or a
Cisco Bridge.



- Does not inter-
operate with other
vendors products
- Does not work in
ADHOC mode

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Cisco Aironet 350 Series Product and Software Update

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Agenda

- **350 Series Hardware**
- **Software enhancements**
- **Configuration of systems components**
- **Cisco's Next Generation Security Architecture**
- **ACU**

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350 Hardware

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350 Product Listing

- **AIR-AP35xE2C**
- **AIR-AP35xE2R**
- **PCM35x**
- **LMC35x**
- **PCI35x**
- **AIR-PWRINJ1**

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Transmit Power

- **The 350 Uses the Mercury Radio**
- **Transmit power is 100mW (+20dBm)**
- **Other supported power levels will include:**
50, 30, 20, 5, and 1mW

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Receiver Performance

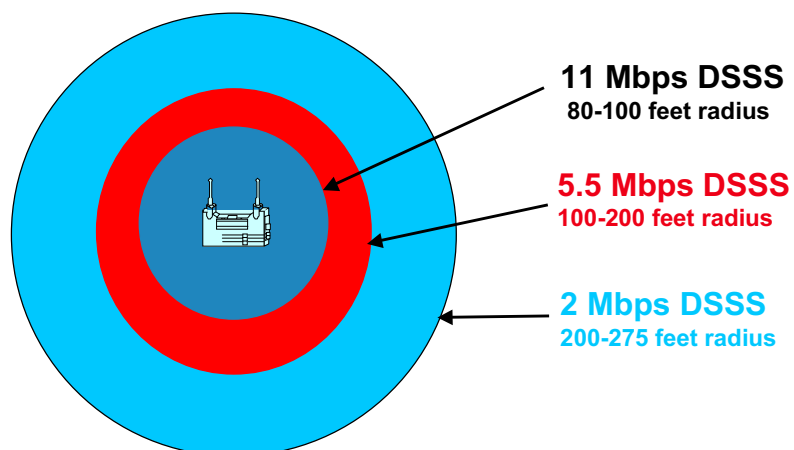
- The redesigned receiver has better sensitivity than the 4800 or the 340 radios (@ 10-5BER)
 - 85 dBm @ 11mb
 - 89 dBm @ 5.5mb
 - 91 dBm @ 2mb
 - 94 dBm @ 1mb
- The new receiver also has better multipath performance, resulting in better range

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30mW Cell Size Comparison

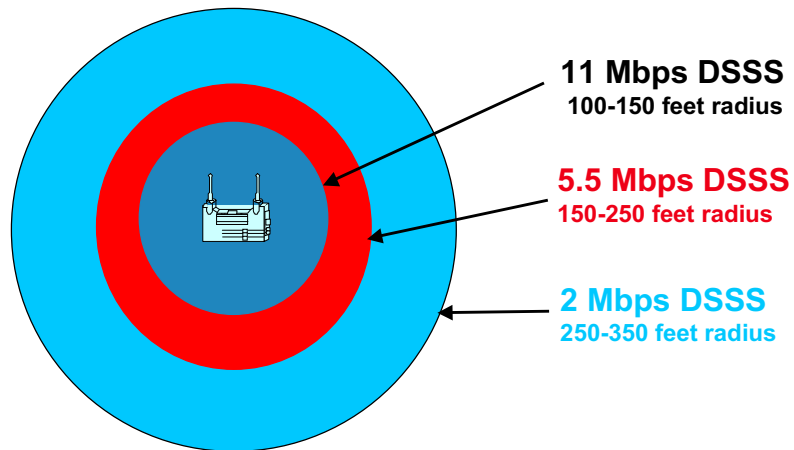


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100mW Cell Size Comparison



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Environmental Characteristics

- **Temperature ranges**
 - Access Point—0 to +50deg C**
 - Radio Card—-20 to +70deg C**
 - Extended Temperature Access Point—
(Future release as Bridge) -20 to +55C**

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AC Power Requirements

- **Cost of AC cabling is astronomical**
- **As much as \$30K for a building like bldg.# 19 in San Jose**
- **In line power will reduce this cost**
- **Cisco end to end solution**

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Inline Power

- **Source operating current from the Ethernet port, over the Catalyst 5 cable**
- **Line power configuration is compliant with all of Cisco's line power enabled devices such as switches and line power patch panels**
- **An optional line power injector is an available option**
- **Distances up to 100 meters**

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Inline Power (Cont.)

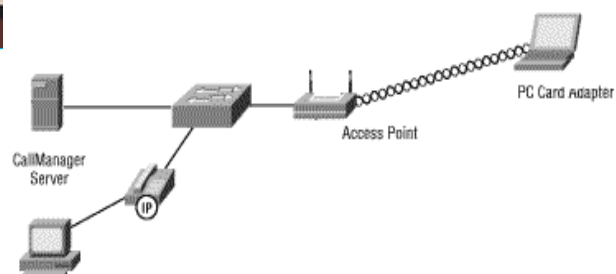
- Can only be used with the 350 series product and not the 340 series
- AP350 series responds to the phone-discovery algorithm sent by the Cisco powered switches

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Inline Power with 3524-PWR-XL



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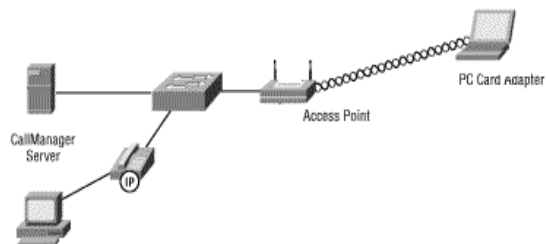
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Inline Power with WS-X6348



Uses the WS-F6K-VPWR Daughter card

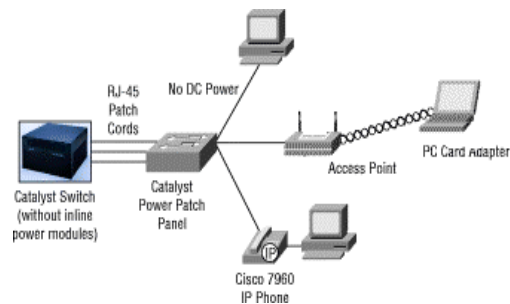


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Inline Power with WS-PWR-PANEL

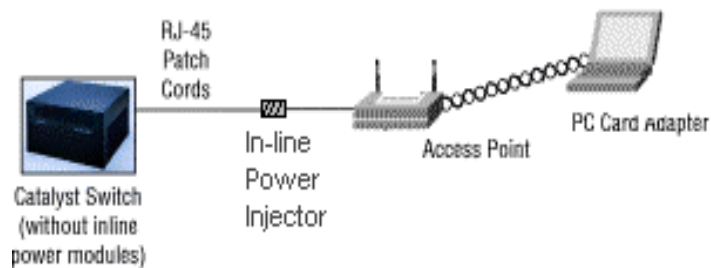


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Inline Power with Power Injector Module



NOTE: There is NO Phone Discovery circuitry in the power injector. Plugging into the wrong device (i.e. 340, PC, etc) means damage!!!

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New Software Features

- Packet filtering options
- Hot standby
- World mode
- CDP
- Logging

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Wired Equivalent Privacy (WEP)

- Based on RSA RC-4
- Encryption options
 - No encryption
 - 40-bit encryption
 - 128-bit encryption
- Hardware-based encryption
 - <3% performance hit (@128 bit)
 - (Competitors using software based WEP have as much as 20% hit)



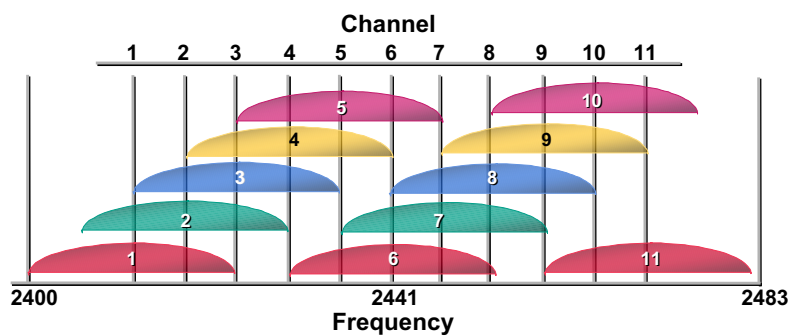
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Wireless LAN Design Considerations

- Channel mapping
 - Three concurrent non-overlapping channels—1, 6, and 11

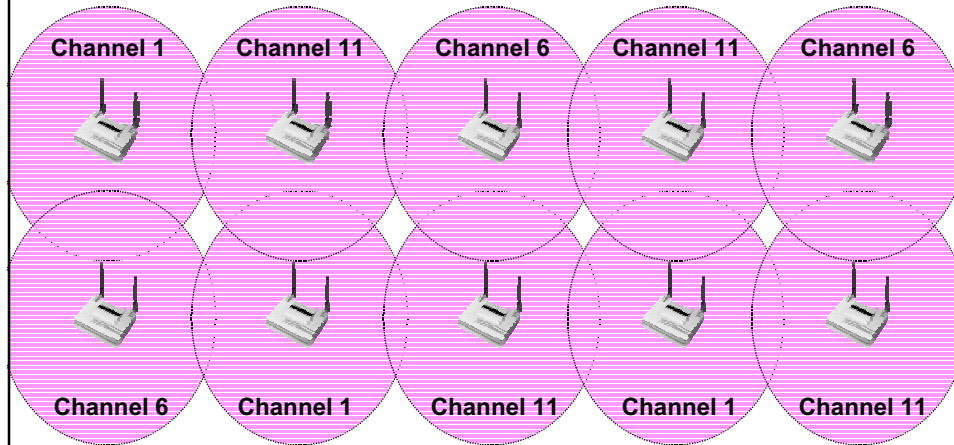


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Site Survey Channel Mapping

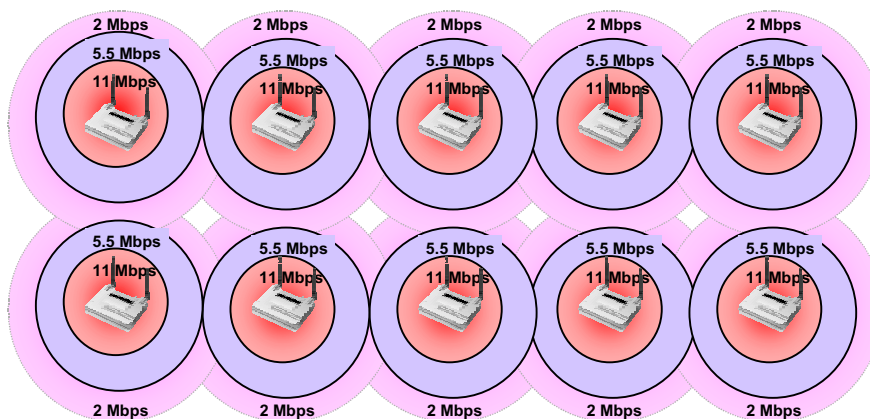


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Site Survey Bandwidth Layout



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In-Building Design Considerations

- **Consider access point load**
 - Number of potential concurrent clients**
 - Wireless is shared LAN**
 - AP utilization increases with associated clients**
 - Consider second or third overlapping access point**
 - Available bandwidth to client reduced**

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In-Building Design Considerations

- **System Set Identifier (SSID)**
 - Four possible SSIDs definable on client**
 - Act as a password for AP/client authentication**
 - Can work like a “workgroup” to separate client**
 - SSID must match between client and AP to establish session**

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Security for Next Generation Wireless LANs

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Past Security Methods

- **SSID (Service Set Identifier)**
 - Commonly used feature in Wireless LANs which provides a rudimentary level of security**
 - Serves to logically segment the users and Access Points that form part of a Wireless subsystem**
 - May be advertised or manually pre-configured at the station**

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SSID Problem

- 32 ASCII character string
- Under 802.11, any client with a 'NULL' string will associate to any AP regardless of SSID setting on AP
- This is **not** a security feature!

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Deployment issues with 802.11 today

- Lack of integrated user administration
 - Integration with existing user administration tools required (RADIUS, LDAP-based directories)
 - Identification via User-Name easier to administer than MAC address identification
 - Usage accounting and auditing desirable
- Lack of key management solution
 - Static keys difficult to manage on clients, access points
 - Proprietary key management solutions require separate user databases

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802.11 Security Issues

- **User loses wireless NIC, doesn't report it**
 - Without user authentication, Intranet now accessible by attackers**
 - Without centralized accounting and auditing, no means to detect unusual activity**
 - Users who don't log on for periods of time**
 - Users who transfer too much data, stay on too long**
 - Multiple simultaneous logins**
 - Logins from the "wrong" machine account**
 - With global keys, large scale re-keying required**

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Berkeley Paper on WEP Security

- **University of California, at Berkeley, published a document identifying "security flaws in the 802.11 security protocol (WEP)"**
- **These weaknesses exist regardless of the length of the encryption key used, so a longer key does not help**

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Response to the Berkeley Paper

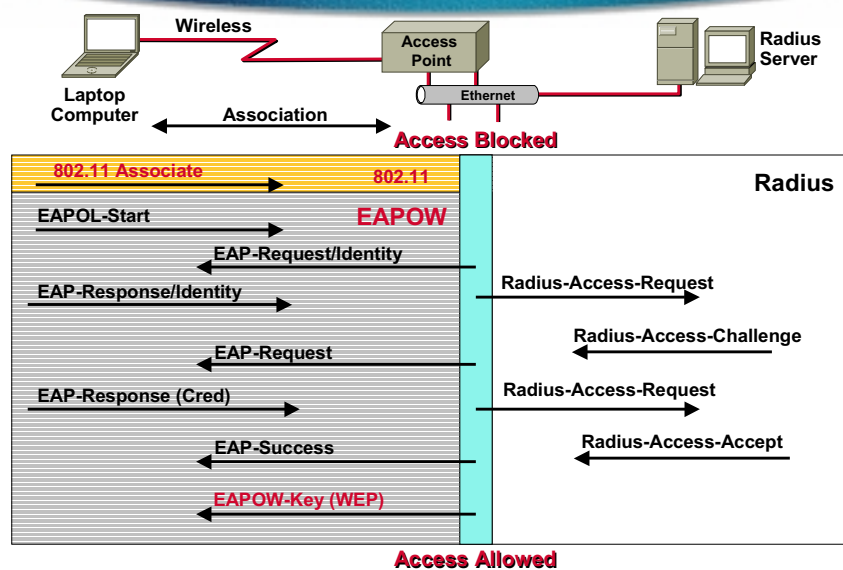
- **Ciscos LEAP and Radius server application allows for Dynamic, per-user, per-session WEP and integrated network logon.**
- **WECA is introducing requirements for Initialization vector changes per packet.**
- **Microsoft is adding EAP to the next generation OS (Windows XP). This will become the 'defacto' standard**

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IEEE 802.1X Over 802.11



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Advantages of 802.1X for 802.11

- **Open, extensible and standards based**
 - Enables interoperable user identification, centralized authentication, key management
 - Leverages existing standards: EAP (extensible authentication protocol), Radius
 - Compatible with existing roaming technologies, enabling use in hotels and public places
- **User-based identification**
- **Dynamic key management**
- **Centralized user administration**
 - Support for Radius (RFC 2138, 2139) enables centralized authentication, authorization and accounting

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Why LEAP ?

- **Cisco Lightweight EAP (LEAP) Authentication type**
 - No native EAP support currently available on legacy operating systems
 - EAP-MD5 does not do mutual authentication
 - EAP-TLS (certificates/PKI) too intense for security baseline feature-set
 - Quick support on multitude of host systems
 - Lightweight implementation reduces support requirements on host systems
 - Need support in backend for delivery of session key to access points to speak WEP with client

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Aironet Client Utility—Main Screen



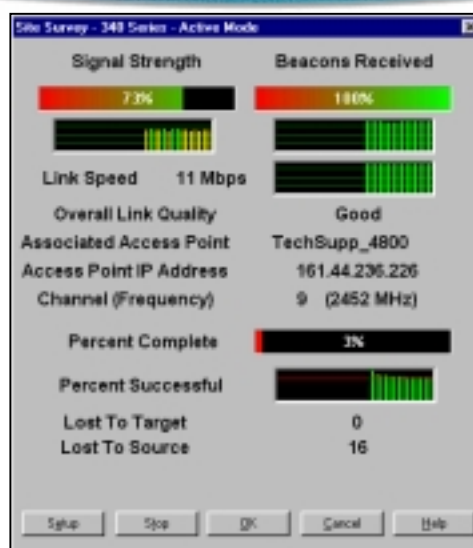
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Aironet Client Utility—Site Survey



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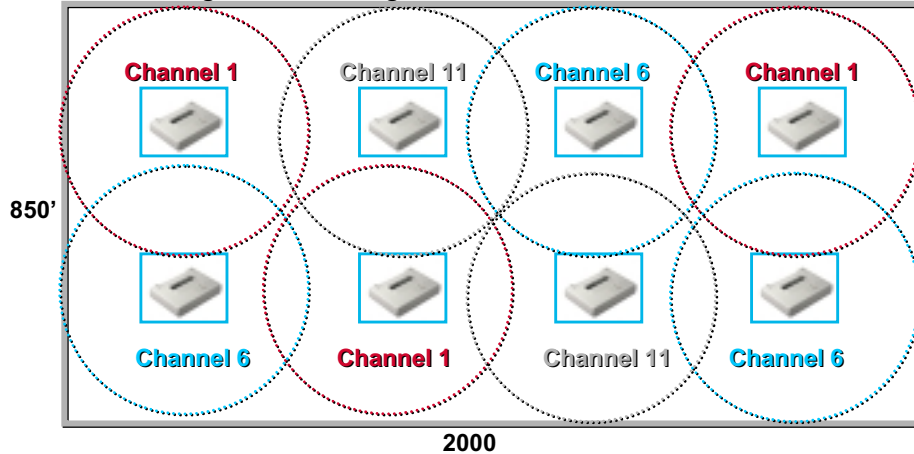
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Warehouse Design Sample

Maximum Coverage
Autorate Negotiation

Cabling Available to Middle of Store
High-Gain Mast Mount Antennas



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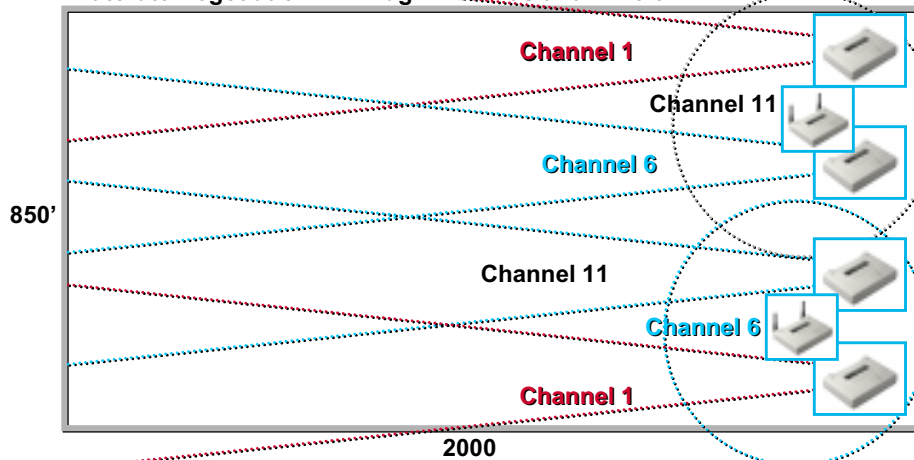
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Warehouse Design Sample

Maximum Coverage
Autorate Negotiation

Cabling Only Available at Store Front
Yagi Antennas and DiPole

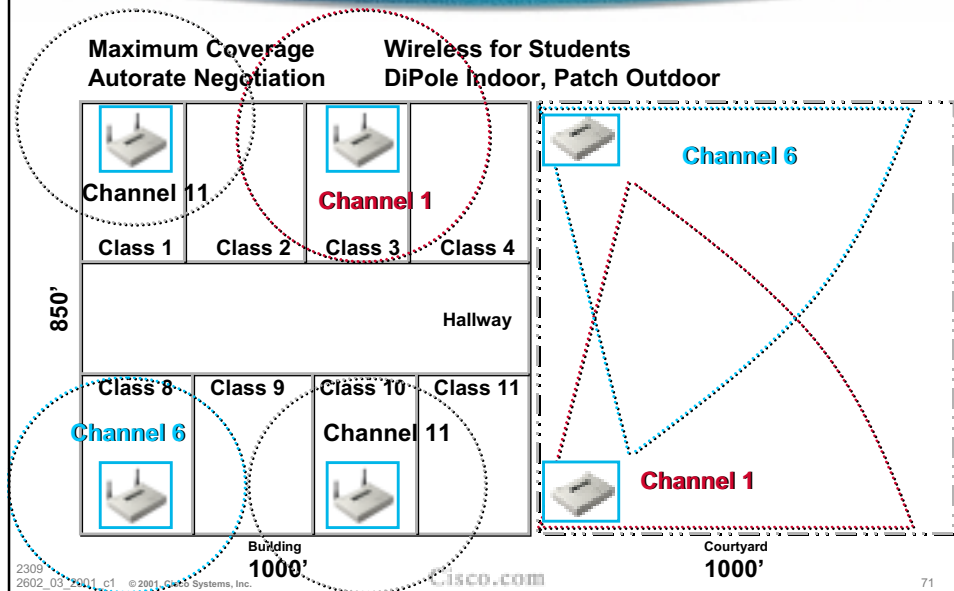


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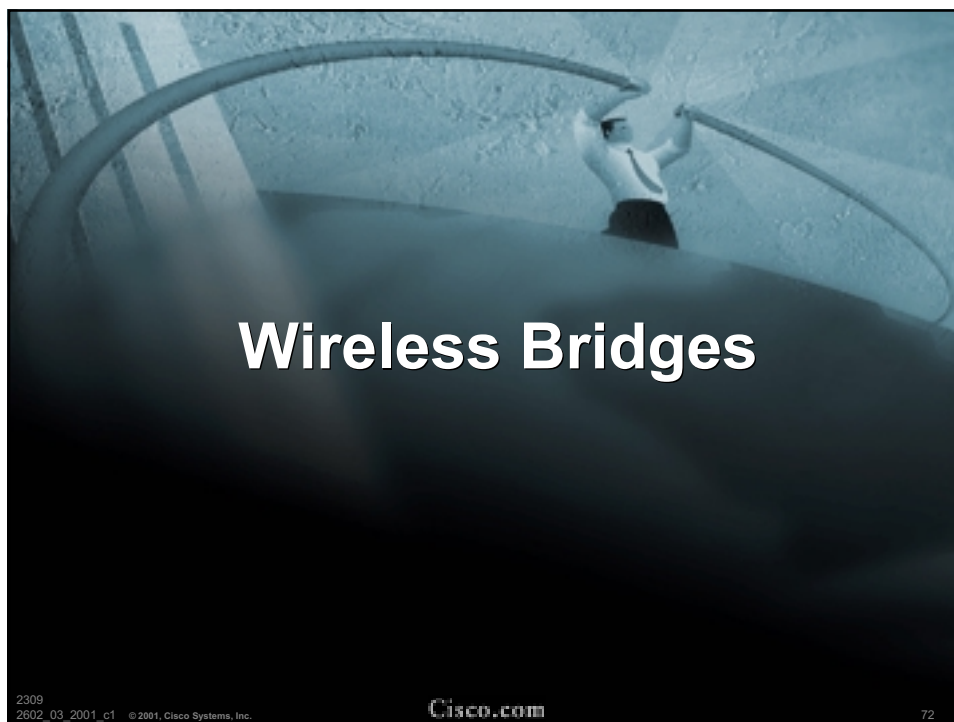
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Education Design Sample



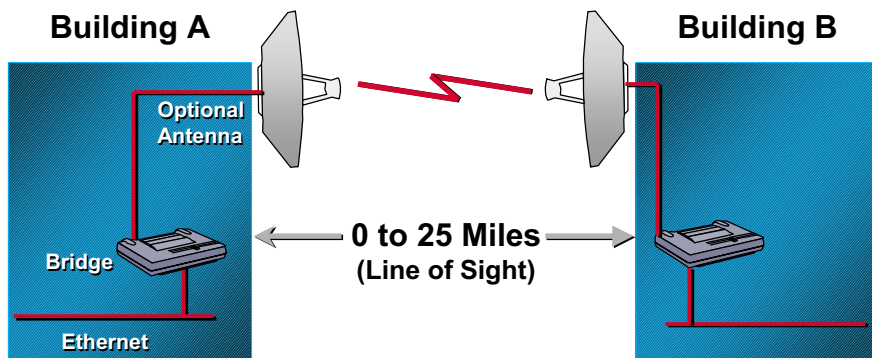
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Wireless Bridges



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Point-to-Point Configuration

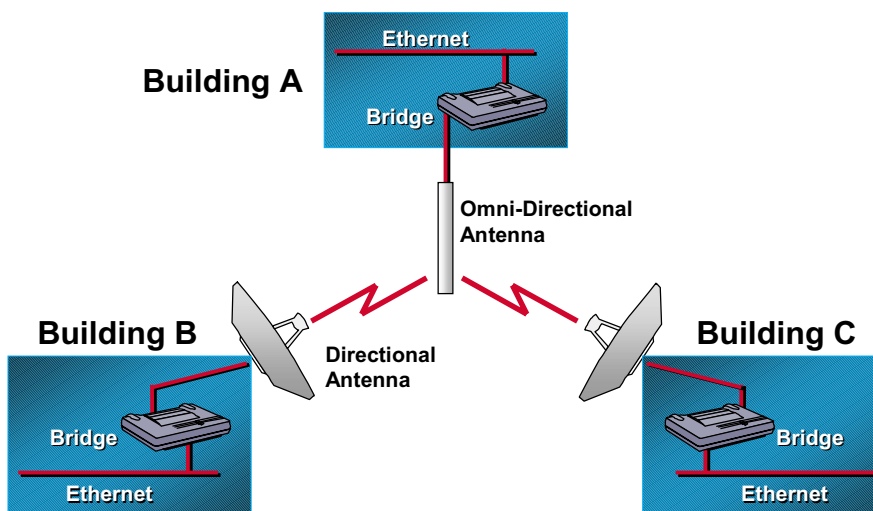


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Point-to-Multipoint Configuration



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BR340 Features

- **Flexibility:** point-to-point and multipoint
- **Management capabilities:**
SNMP, Telnet, FTP, HTML
802.1d Spanning Tree
- **Breadth of product line:**
1, 2, 4, 5.5 and 11 Mbps
Antenna/range options
- **Price/performance makes it the the best on the market**



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Common Questions

	Cisco 340 Wireless Bridge	
How Fast? Max Data Rate Typical Throughput	11 Mbps 5.5 Mbps	2 Mbps 1.4 Mbps
How Far? (At Max. Rate) Yagi Antenna Dish Antenna	2 Miles 11.5 Miles	6.5 Miles 25+ Miles

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Cable and Data-Rate Effects

Bridge Model	Data Rate	Max. Distance	Optional Antenna	Cable (6.7 dB/100 Ft.)
340	11 Mb	11.5 Miles	21 dBi Dish	50 Ft./Side
	11 Mb	18 Miles	21 dBi Dish	20 Ft./Side
	5.5 Mb	16 Miles	21 dBi Dish	50 Ft./Side
	2 Mb	25+ Miles	21 dBi Dish	50 Ft./Side
	1 Mb	25+ Miles	21 dBi Dish	50 Ft./Side

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Optional Antennas for Long Range



13.5dBi Yagi
18 in. Long, 3 in. Dia.
Distances over
6.5 Miles @ 2 Mbps and
2 Miles @ 11 MB



21dBi Solid Dish
24 in. Parabolic Dish
For Distances up to
25+ Miles @ 2 Mbps
11.5 Miles @ 11 MB

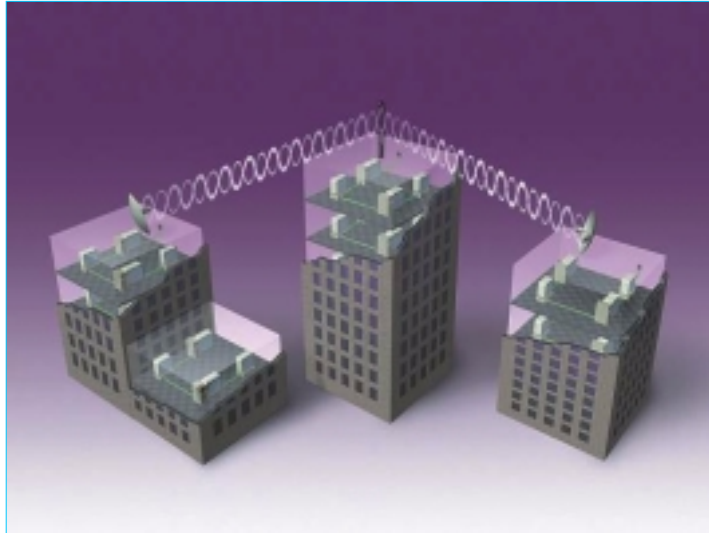
Note: Distances include identical antennas on each site, 50 feet of Low Loss Cable (6.7dB/100 ft) and 10dB fade margin

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Building-to-Building Design Considerations



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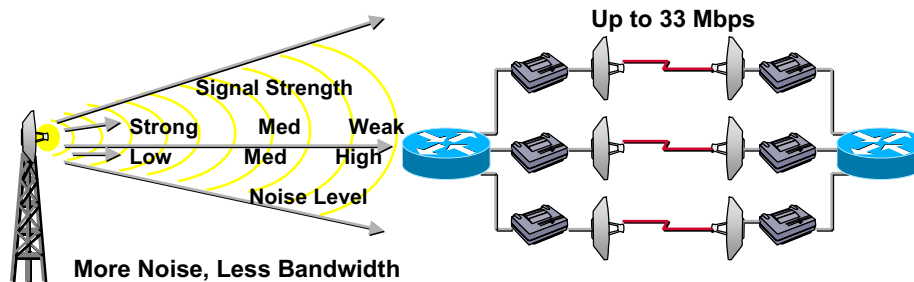
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Building-to-Building Design Considerations

- **Distance or bandwidth**

Greater distances possible at slower speed

**Aggregation using FEC or multilink
bond up to three bridge links**



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Building-to-Building Design Considerations

- **Improve performance by sending only necessary data**
- **Bridges include filtering options to reduce unnecessary RF traffic**
- **Run a router in front of the bridge to selectively send desired traffic**

The diagram illustrates a network architecture for building-to-building communication. On the left, a cloud represents a local network containing protocols: IP, ARP, AppleTalk, NetBeui, and IPX. A red line connects this cloud to a blue router. Another red line connects the router to a bridge. A third red line connects the bridge to a satellite dish. The satellite dish is labeled with 'IP' and 'ARP', indicating that only these specific protocols are being transmitted via the satellite link.

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- ## selectively send desired traffic
-
- The diagram illustrates a network path where traffic is selectively sent. On the left, a cloud represents a network segment containing protocols: IP, ARP, AppleTalk, NetBeui, and IPX. A red line connects this cloud to a blue router. From the router, another red line connects to a grey modem. Finally, a red line connects the modem to a satellite dish. The satellite dish is labeled with IP and ARP, indicating that only these specific protocols are being sent to it.

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Building-to-Building Design Considerations

- Third Party inference from same channel usage
- Potential problem in congested areas

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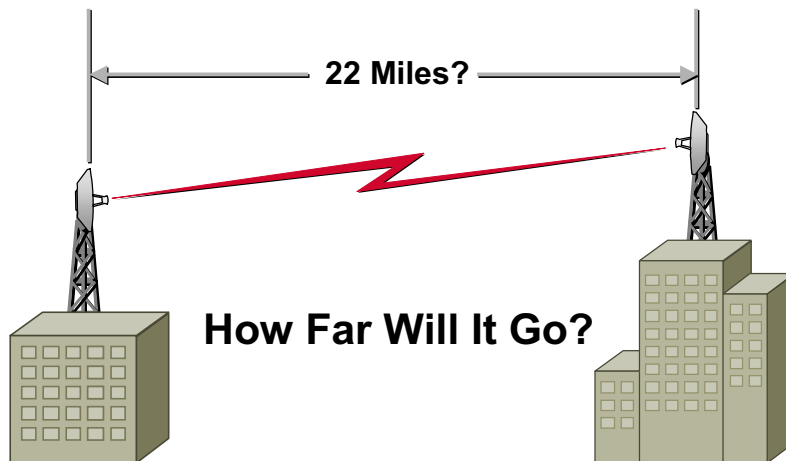
-
- Third Party inference from same channel usage
•Potential problem in congested areas

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Path Loss Considerations



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Bridge Distance Calculations

Cisco Systems

Cisco Technical Support
For Cisco/Aironet 2.4GHz Outdoor Links ONLY
Models Supported- Cisco/Aironet BR340, BR500, WGB340 and PCI340

Select Product #1	Aironet 340 Aironet 500 Aironet PCI340 Aironet WGB340	Select Product #2	Aironet 340 Aironet 500 Aironet PCI340 Aironet WGB340							
Select Data Rate	11Mbps 5.5Mbps 2Mbps 1Mbps									
Select Antenna 1 here	21dB Parabolic Dish 11.5dBi Yagi 12dBi Omni 8.5dBi Patch 6dBi Patch 5.2dBi Omni Other	Select Antenna 2 Here	21dB Parabolic Dish 11.5dBi Yagi 12dBi Omni 8.5dBi Patch 6dBi Patch 5.2dBi Omni Other							
For other Antenna- Enter Gain Here	6.7	For other Antenna- Enter Gain Here	6.7							
Select Cable 1	100ft Cisco 250ft Cisco 500ft Cisco other cable	Select Cable 2	100ft Cisco 250ft Cisco 500ft Cisco other cable							
For Non-Aironet Cable Enter Cable Loss/100 ft here	6.7	For Non-Aironet Cable Enter Cable Loss/100 ft here	6.7							
Enter in Length Here	100	Enter in Length Here	43							
Antenna 1	Cable 1	EIRP	Antenna 2	Cable 2	EIRP	Max allowable				
Model	Gain dBi	Length	Loss dB	Model	Gain dBi	Length	Loss dB	dBm	Path Loss (dB)	
Parabolic Dish	21	50	3.35	37.65	Parabolic Dish	21	50	3.35	37.65	135.3
Required Antenna Height above obstacles (in feet)				75				Feet		
(For MAX distance Listed)				Fresnel Zone				47	Feet	
				Earth Curve				28	Feet	

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Bridge Calculation (ETSI)

CISCO SYSTEMS Cisco Technical Support
For Cisco/Aironet 2.4GHz ETSI EUROPEAN outdoor ONLY
Models Supported- ETSI European Cisco /Aironet BR340, BR500 WGB340, and PCI340 ONLY

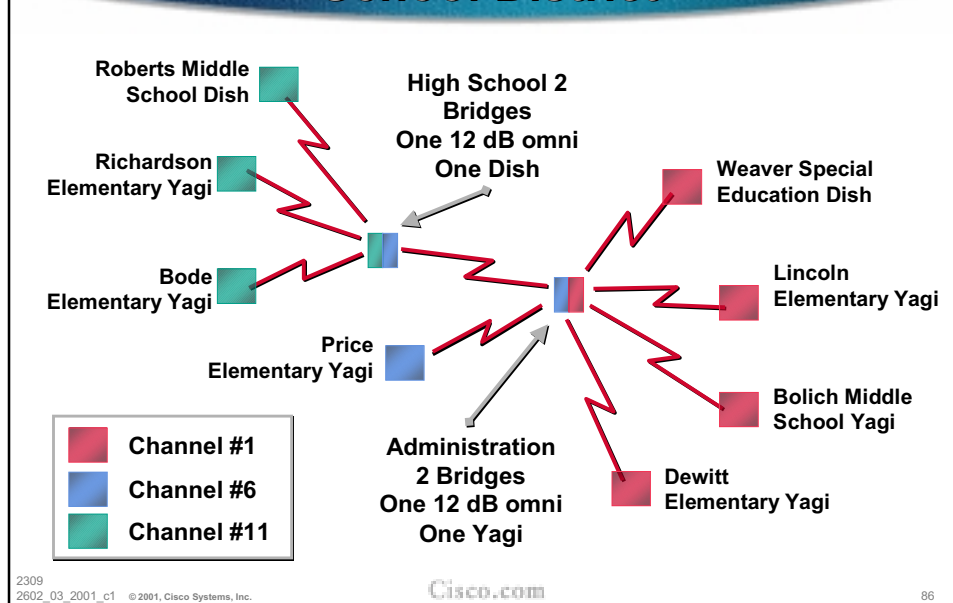
Select Product #1-->	AIR-CT5500 AIR-PC134x AIR-WGB34x	Select Product #2-->	AIR-CT5500 AIR-PC134x AIR-WGB34x
Select Power Setting Of Bridge #1-->	50mW (17dBm) 20mW (13dBm) 5mW (7dBm) 1mW (0dBm)	Select Power Setting Of Bridge #2-->	50mW (17dBm) 20mW (13dBm) 5mW (7dBm) 1mW (0dBm)
Select Data Rate-->	11Mbps 5.5Mbps 2Mbps 1Mbps		
Select Antenna 1 here-->	21dBi Parabolic Dish 11.5dBi Yagi 12dBi Omni 8.5dBi Patch 6dBi Patch 5.2dBi Omni Other	Select Antenna 2 Here-->	21dBi Parabolic Dish 11.5dBi Yagi 12dBi Omni 8.5dBi Patch 6dBi Patch 5.2dBi Omni Other
For other Antenna- Enter Gain Here-->	0	For other Antenna- Enter Gain Here-->	0
Select Cable 1-->	100ft Cisco 75ft Cisco 50ft Cisco 25ft Cisco Other cable	Select Cable 2-->	100ft Cisco 75ft Cisco 50ft Cisco 25ft Cisco Other cable
For Non-Aironet Cable, Enter the following: Cable Loss in dB/100 Meters here-->	6.7	For Non-Aironet Cable, Enter the following: Cable Loss in dB/100 Meters here-->	6.7
Length in Meters Here-->	100	Length in Meters Here-->	100

Antenna 1	Cable 1	EIRP	Antenna 2	Cable 2	EIRP	Max allowable	Max. Distan				
Model	Gain dBi	Length	Loss dB	dBm	Model	Gain dBi	Length	Loss dB	dBm	Path Loss (dB)	Miles
Parabolic Dish	21	20	1.34	19.66	Parabolic Dish	21	20	1.34	19.66	119.32	1.82

Required Antenna Height above obstacles (meters)-----> 21 Meters
(For MAX distance Listed) Fresnel Zone-----> 19 Meters
Earth Curve-----> 2 Meters

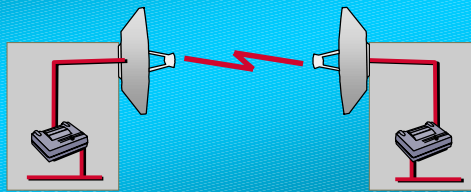
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Bridge Application: School District

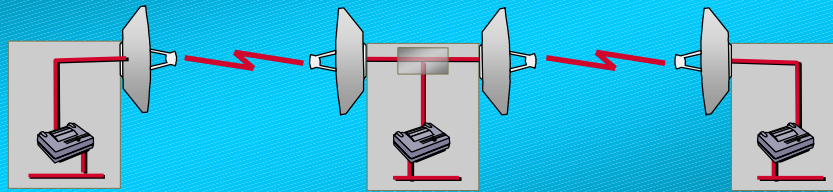


Repeater, Two Directional Antennas and Splitter?

If I Can Go 25 Miles
Like This...



...Then I Should Be Able to Go 50 Here!

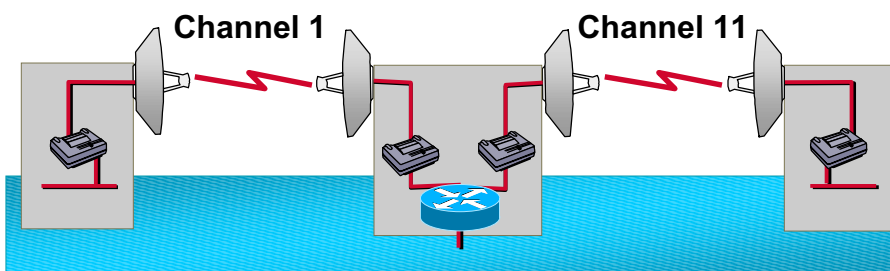


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Alternative Method of Increasing Distance



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Summary

- **2.4 GHz products are mature**
- **Cisco WLAN products are very stable**
- **11 MB performance is here now**
- **IEEE 802.11b is the industry standard**
- **Customer/industry acceptance**

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Other Information Areas for Wireless Systems

- **Cisco Aironet Wireless LAN products**
<http://www.cisco.com/warp/public/3/kr/aironet/index.html>

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