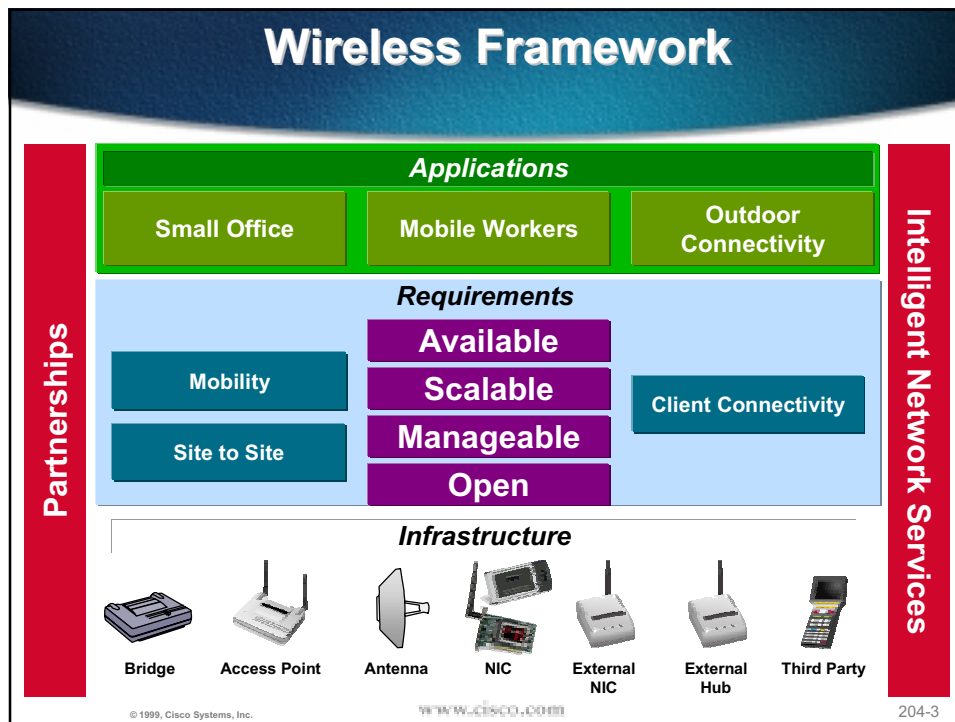


Module Objectives

- Upon the completion of this module, you will be able to understand the design issues associated with in-building and building-to-building WLANs and the procedures for conducting a site survey.

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In-Building Design Considerations

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5

In-Building Design Considerations (Roaming Coverage)

- **Seamless Roaming**
Required for constant on devices
- **Factors for seamless roaming**
 - Coverage for entire path
 - Consistent IP addressing
 - Same subnet

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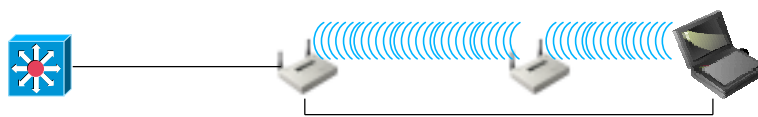
204-6

In-Building Design Considerations (Repeater Mode)

- **Repeater mode**

AP used to extend distance of another AP

Wired AP is the associated connection point



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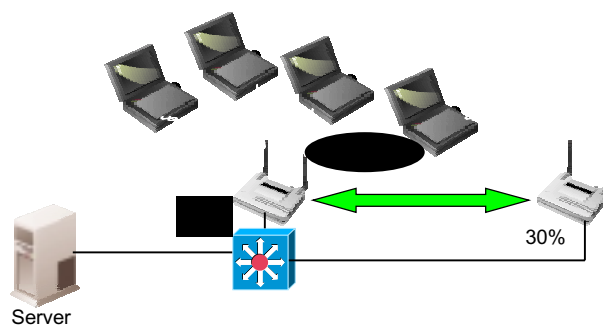
Wireless Roaming - Load Sharing

Load Sharing

- Seamless Roaming when AP hopping

- Client based algorithm
 - Signal strength
 - Packet error rate
 - AP Load

- AP Awareness



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In-Building Design Considerations

- **Bandwidth requirements**
 - Fixed speed
 - Less distance coverage
 - Third Party interoperability
 - Autorate Negotiation
 - Automatic rate reduction as distance increases
- **SSID**
 - SSID must match between client and AP to establish session unless "broadcast" option is selected
 - Default selection is "Allow Broadcast SSID to Associate = Yes"
 - Three possible SSIDs definable on client
 - Default is "tsunami"
 - Define in order of preference
 - Act as a password for AP

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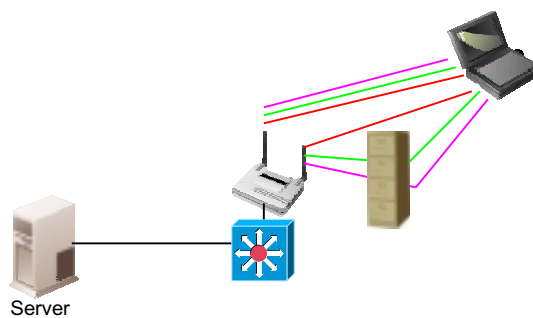
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Wireless Roaming—Diversity and Multipath

Antenna Diversity

- Obstacles can block/deflect path
- RF signals arrive out of phase
- Multiple antennas allow greater coverage



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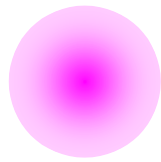
204-10

Wireless Roaming

Antenna Coverage

- Maximum coverage per antenna
- Different increased distances per antenna
- Indoor Vs. Outdoor antenna

Omnidirectional



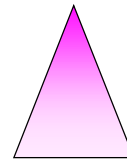
Type

DiPole
Mast mount
Ceiling mount
Ground plane
Omni

Application

Indoor
Outdoor multipoint

Directional



Type

Patch
Yagi
Dish

Application

Indoor
Outdoor P2MP
Outdoor P2P

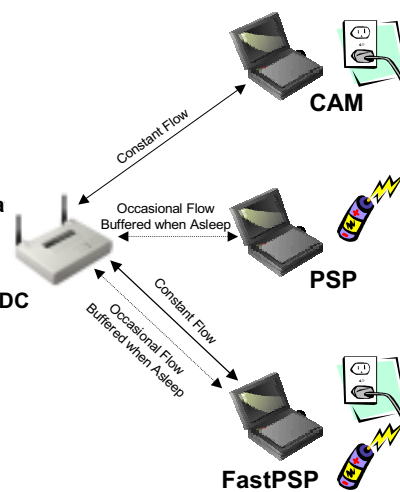
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Power-Consumption Issues

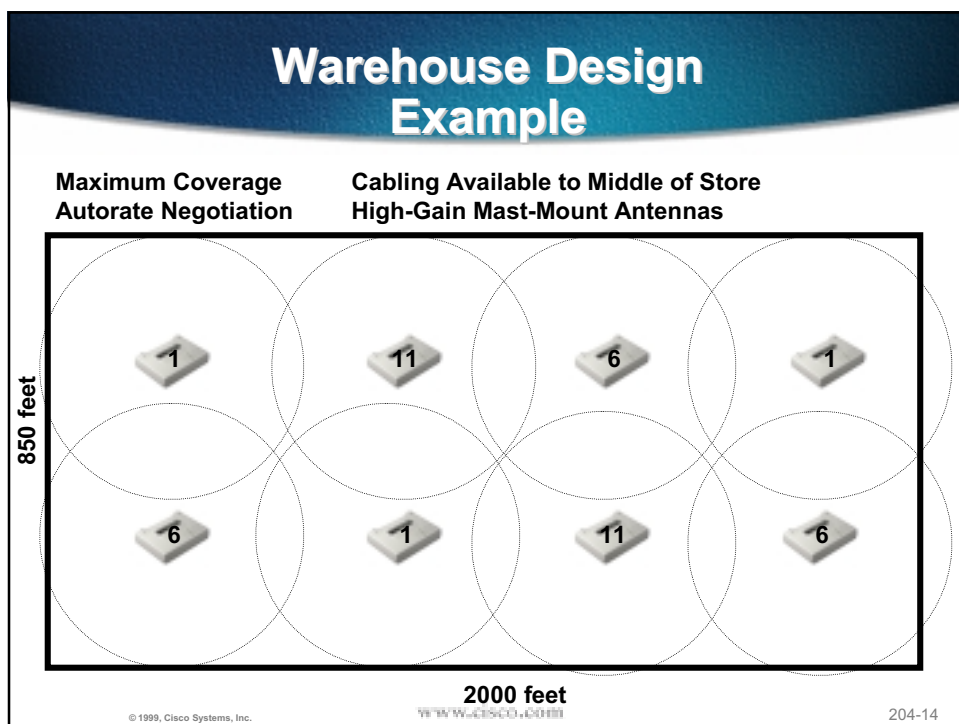
- Three client adapter modes
 - CAM = Constant awake mode**
 - Power not an issue
 - High availability
 - PSP = Power save mode**
 - Power is an issue
 - AP buffers messages
 - Wakes up periodically to retrieve data
 - FastPSP = Fast power save mode**
 - Switch between CAM and PSP
 - Users who switch between AC and DC
- Default is CAM
- Available only on PC cards
- Only one can be selected
 - Windows network properties

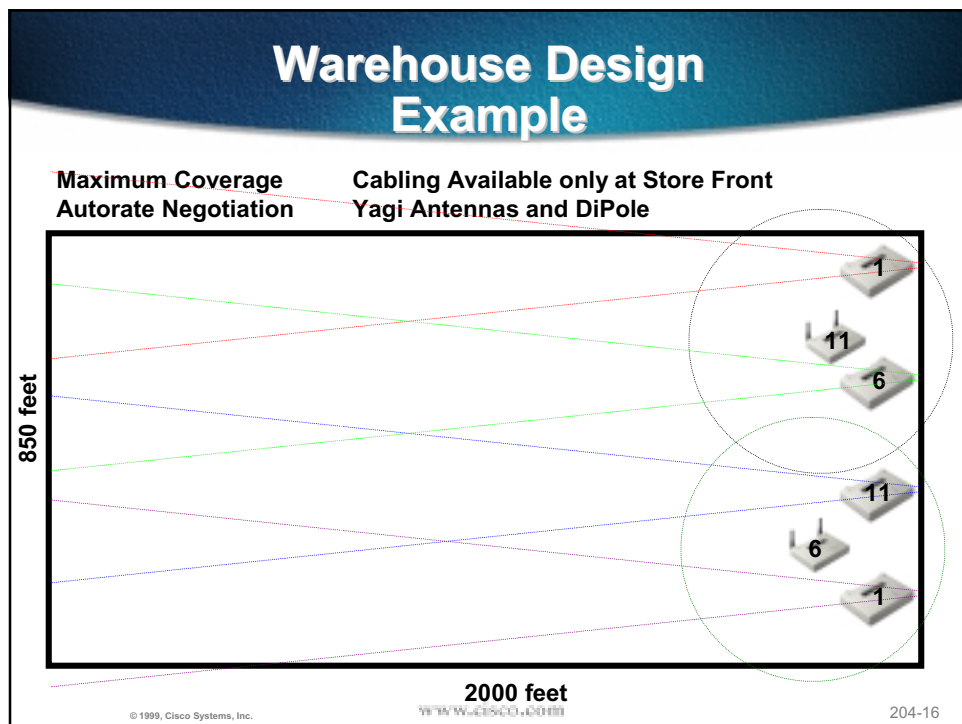
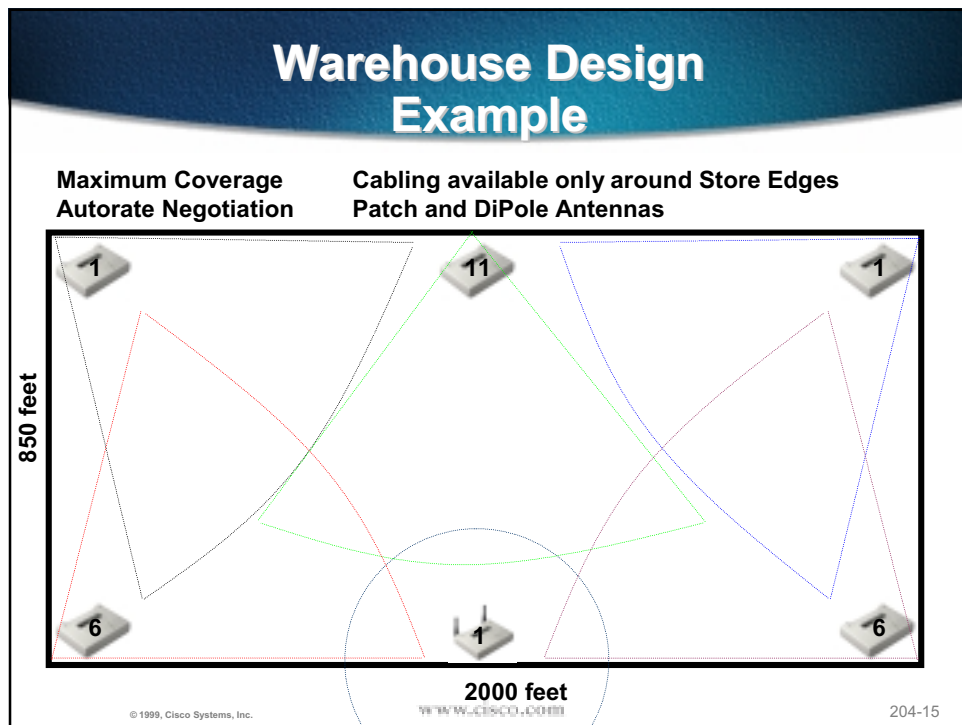


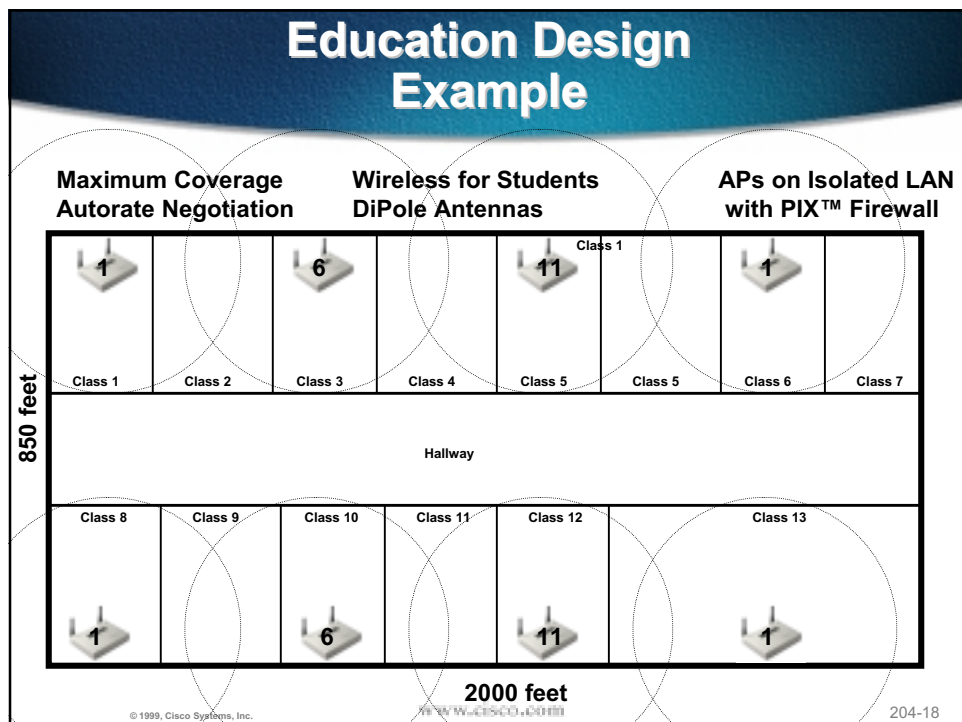
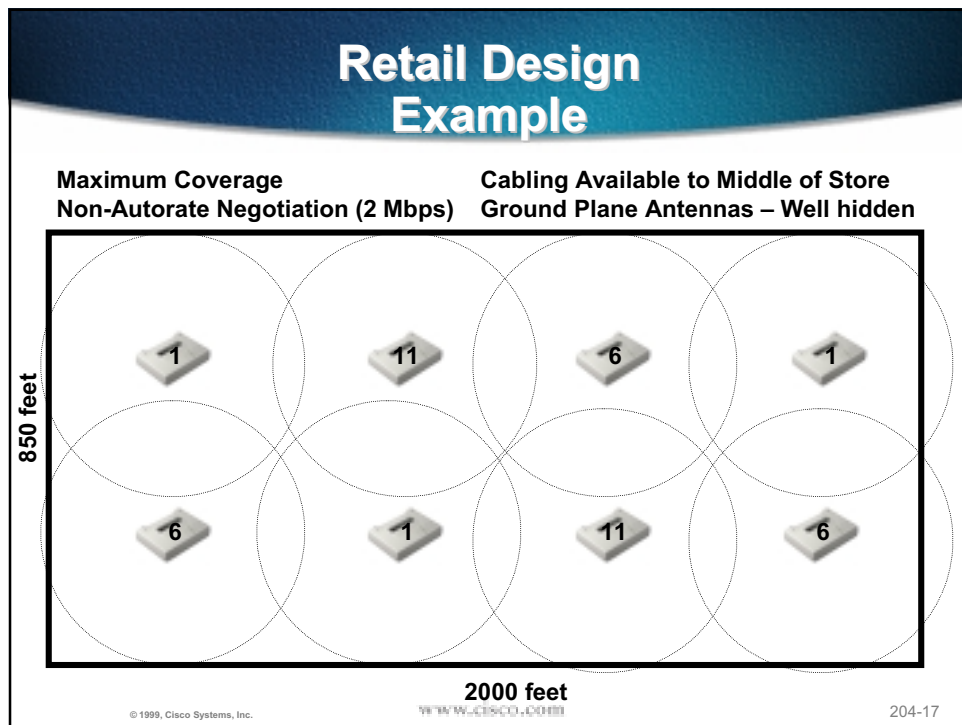
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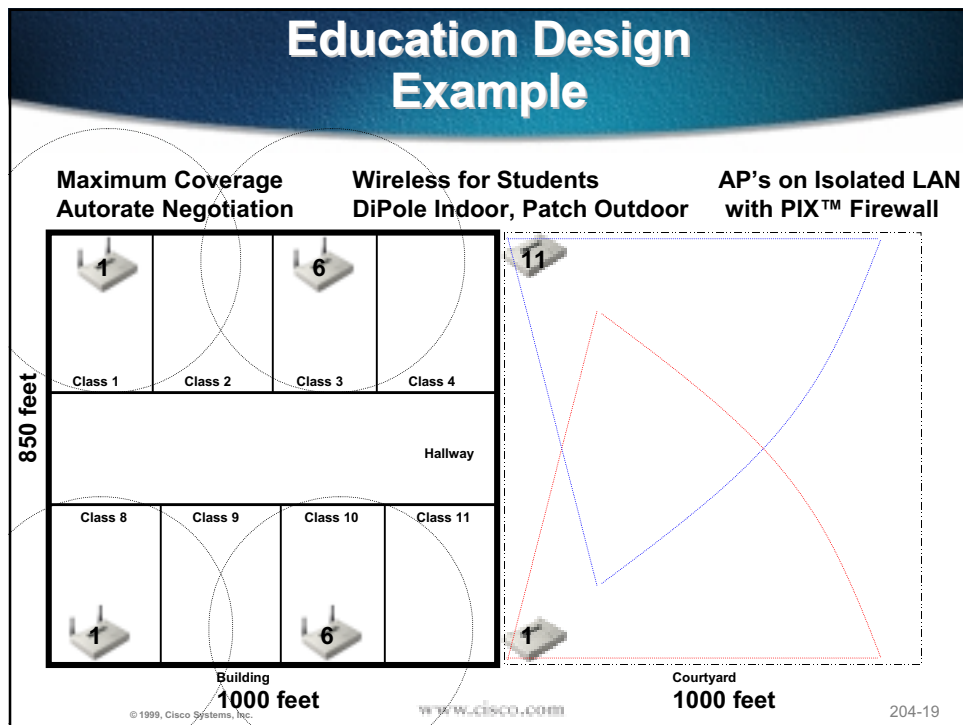
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204-12









Wireless Bridge Alternatives

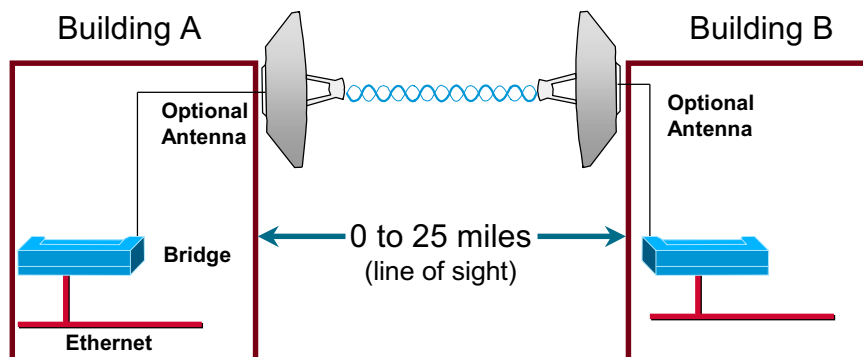
Medium	Drawbacks
Phone lines (56K, T1)	Monthly costs Installation costs Extra equipment needed
Cable	Installation costs Inflexible Physical barriers may preclude
Microwave	FCC Licensing required Difficult installation High cost

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Point-to-Point Bridge Configuration

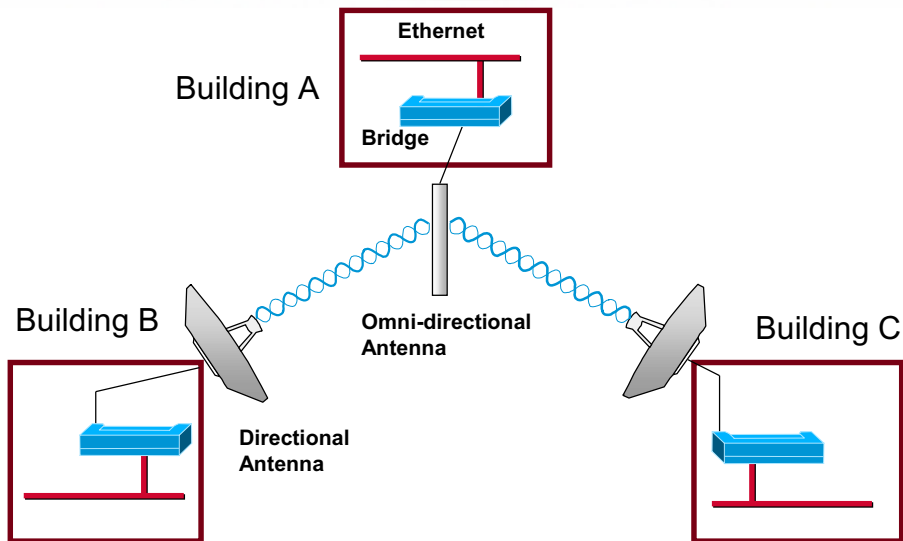


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Point-to-Multipoint Bridge Configuration

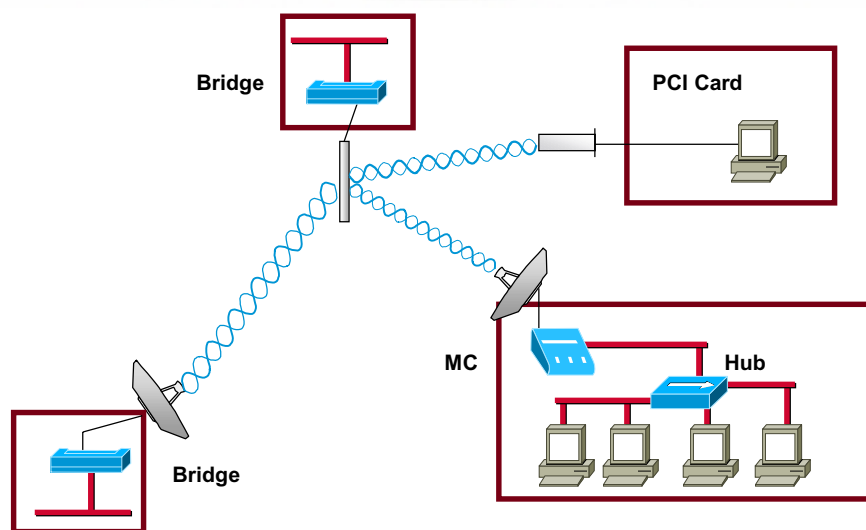


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New Addition to The system!

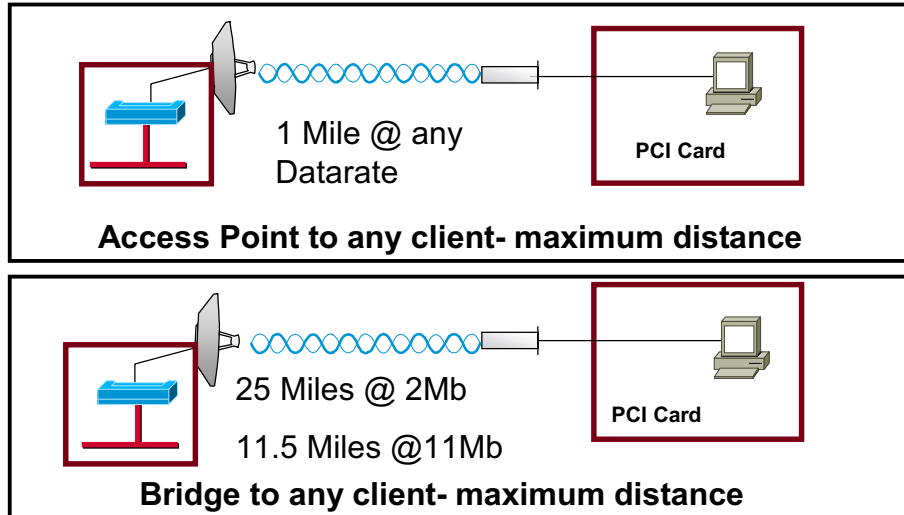


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Distances Limited by 802.11 Specification



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Products: Wireless Bridges

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

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Optional Antennas for Long Range



13.5dBi Yagi
Distances over
6.5 Miles @ 2Mbps and
2Miles @ 11Mb



21dBi Solid Dish
For distances up to
25+ Miles @ 2Mbps
11.5 Miles @ 11Mb.

Note: Distances include 50 feet of Cisco Low Loss Cable and 10dB fade margin

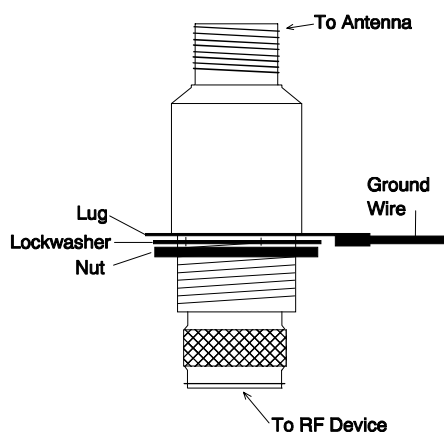
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Lightning Arrestor

- Designed to protect LAN devices from static electricity and lightning surges that travel on coax transmission lines
- Good for both 900 MHz and 2.4 GHz systems
- RP-TNC connectors used on all Cisco antennas



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Coax Connection Sealing



- The number one problem with bridges is water in the connectors
- Proper sealing is important
- Coax-Seal is one product that is inexpensive and works great

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How to Determine Distance

• Distance Calculation

Distance = $(300/\text{Freq}) * (\text{conversion to metric to miles}) * \text{EXP}((\text{antenna/radio parameters} - \text{first wavelength loss} - \text{margin}) / 6 * \text{natural log}(2))$

Ant. radio parameters = TX pwr = ant. 1 - cable 1 + ant2 - cable2 + RX sensitivity

Distance = $(300/2442) * (39/12) * (1/5280) * \text{EXP}((\text{Ant/Radio Parms} - 22 - 10) / 6 * \text{LN}(2))$

• 13dB Yagi Example for 11 and 2 Mbps on a 340

11Mbps {RX sens = -80dBm} $(20 + 13.5 - 1.34 + 13.5 - 1.34 + 80) = 124.32$

2Mbps {RX sens = -90dBm} $(20 + 13.5 - 1.34 + 13.5 - 1.34 + 90) = 134.32$

11Mb $(300/2442) * (39/12) * (1/5280) * \text{EXP}((124.32 - 22 - 10) / 6 * \text{LN}(2)) = 3.24 \text{ miles}$

2Mb $(300/2442) * (39/12) * (1/5280) * \text{EXP}((134.32 - 22 - 10) / 6 * \text{LN}(2)) = 10.28 \text{ miles}$

• Cisco provides a spreadsheet calculator

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Bridge Distance Calculations

Select Product -----> Select Data rate ----->

Select Antenna 1 Here -----> Select Antenna 2 Here ----->

For other Antenna. Enter Gain Here -----> For other Antenna. Enter Gain Here ----->

Select Cable 1 -----> Select Cable 2 ----->

For Non-Raised Cable Enter Cable Loss/100 ft here -----> For Non-Raised Cable Enter Cable Loss/100 ft here ----->

Enter in Length Here -----> Enter in Length Here ----->

Antenna 1		Cable 1		Antenna 2		Cable 2		Misc.	Max. Distance w/ 10dB margin		
Model	Gain dBi	Length	Loss dB	Model	Gain dBi	Length	Loss dB	Loss	Miles	Feet	Km
Parabolic Dish	21	99	3.35	Parabolic Dish	21	99	3.35	0	11.52	60812	18.71

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Bridge Path Considerations

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Path Considerations

- Radio line of sight
- Earth bulge
- Fresnel Zone
- Antenna and cabling
- Data rate

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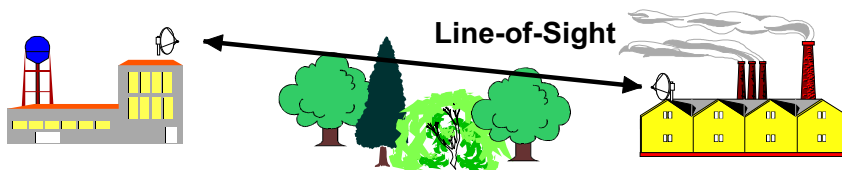
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Line-of-Sight

The following obstructions might obscure a visual link:

- Topographic features, such as mountains.
- The curvature of the earth.
- Buildings and other man-made objects
- Trees



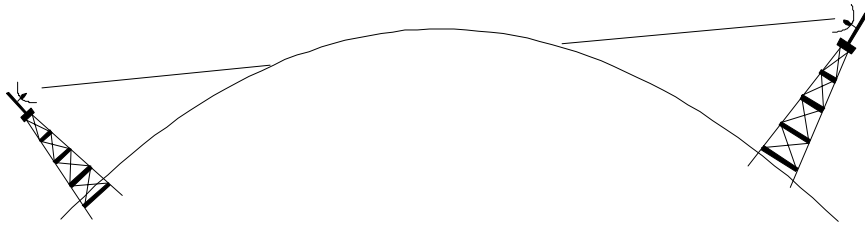
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Longer distances

Line-of-Sight disappears at 6 miles due to the earth curve



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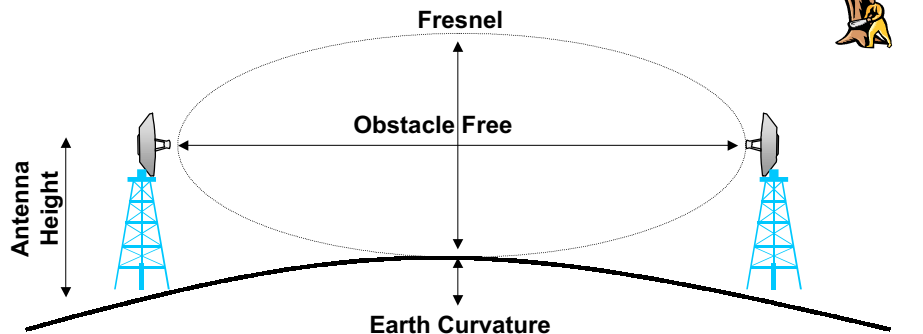
204-35

Building-to-Building Fresnel Zone

- **Antenna height**

Line of Sight is really ellipse

Clear of all obstacles year round



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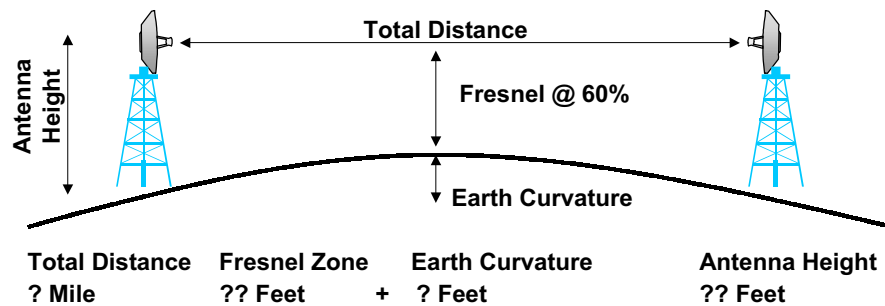
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Building-to-Building Fresnel Zone

- Antenna height

Fresnel zone consideration

Line of Sight over 25 Miles hard to implement



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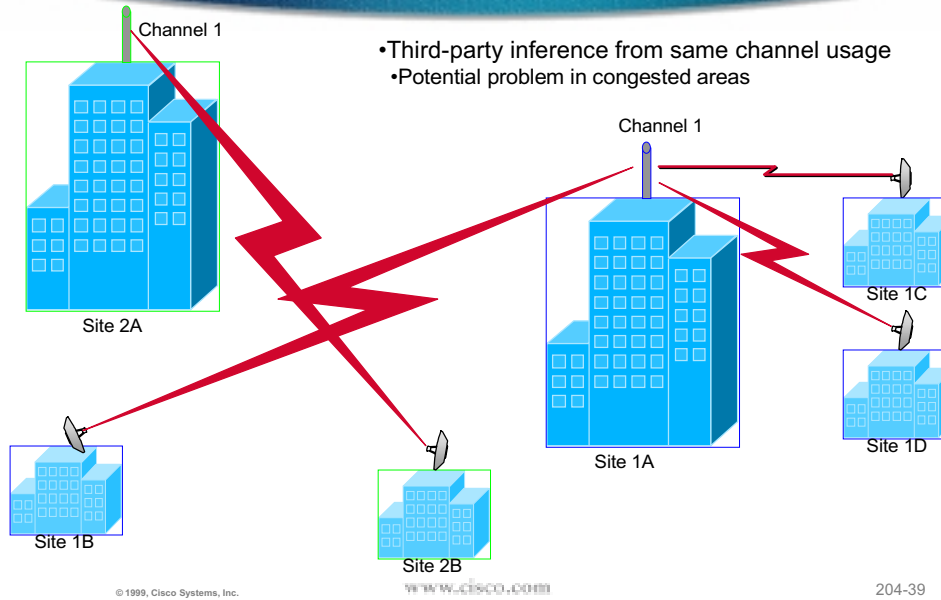
Building-to-Building Design Examples

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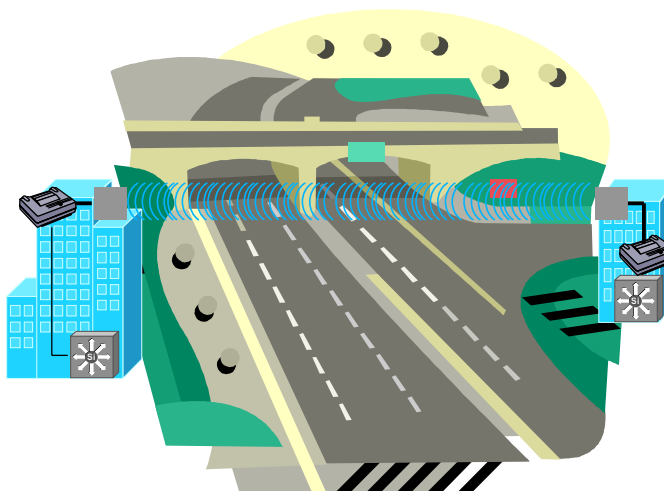
38

Building-to-Building Design Considerations



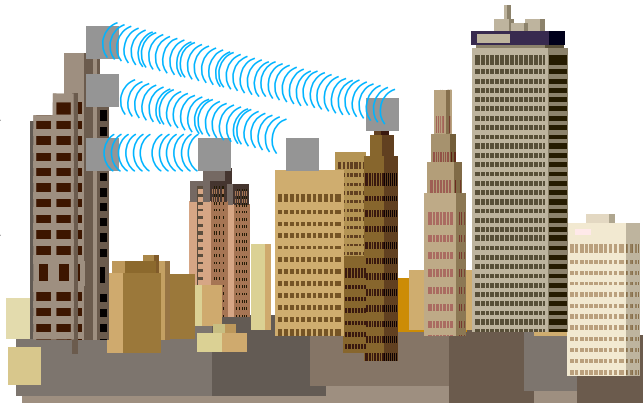
Site-to-Site P2P Design Sample

- **Required Distance**
 - ½ mile
- **Building A**
 - Antenna 8.5 dBi patch
 - Antenna height 13 feet
 - Cable 20 feet
- **Building B**
 - Antenna 8.5 dBi patch
 - Antenna Height 13 feet
 - Cable 50 feet
- **Possible Distance**
 - 11 Mbps 0.81 miles
 - 2 Mbps 2.57 miles



Site-to-Site P2P Design Sample

- **Required Distance**
 - < 1 mile
- **Building A**
 - Antenna 6 dBi patch
 - Antenna height N/A
 - Cable 20 ft.
- **Building B**
 - Antenna 6 dBi patch
 - Antenna height N/A
 - Cable 20 ft.
- **Building C**
 - Antenna 6 dBi patch
 - Antenna height (N/A)
 - Cable 20 ft.
- **Possible Distance**
 - 11 Mbps .57 miles
 - 2 Mbps 1.82 miles



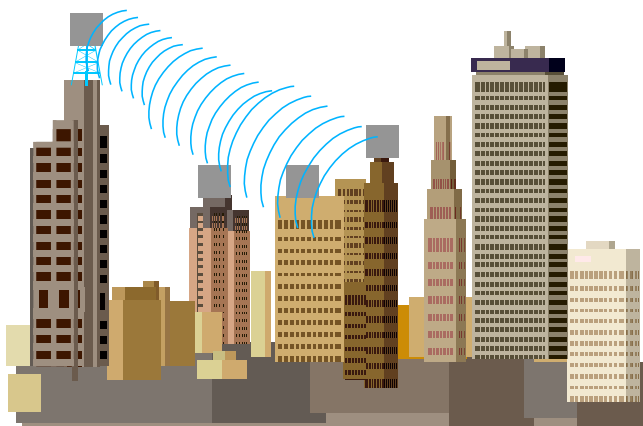
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Site-to-Site P2MP Design Sample

- **Required Distance**
 - < 1 mile
- **Building A**
 - Antenna 6 dBi patch
 - Antenna height (N/A)
 - Cable 20 feet
- **Building B**
 - Antenna 6 dBi patch
 - Antenna Height (N/A)
 - Cable 20 ft.
- **Building C**
 - Antenna 6 dBi patch
 - Antenna Height (N/A)
 - Cable 20 ft.
- **Possible Distance**
 - 11 Mbps .57 miles
 - 2 Mbps 1.82 miles



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Common Questions

- Can I use a bigger antenna with more gain?
- Can I use an amplifier?
- Can I have five sites at 2 Mb to a single 11 Mb center site for better throughput?
- Can I use a splitter and two antennas?
- Can I double my distance with a repeater?

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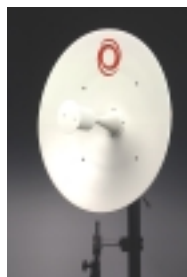
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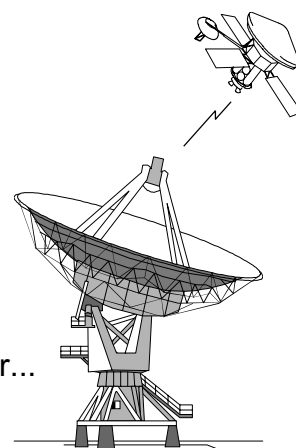
Bigger Antennas?



If 13.5dB is good
and.....



21dBi is better...



Is 50dBi even
better?

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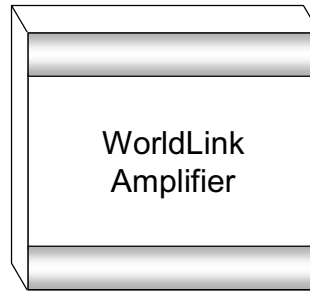
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204-44

Amplifiers?



**Cisco-20dBm
(100mW)**



50dBm(100Watts)

If this = 25Miles—then this must = 250 miles?

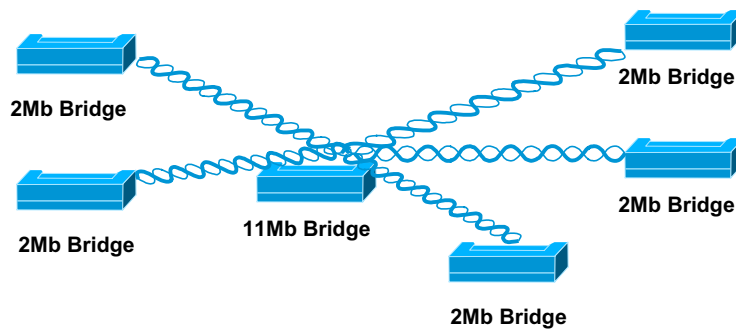
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Can I Have 5 Sites at 2-Mb to a Single 11-Mb Center Site for Better Throughput?

- Will this give me 10+ Mb to the center site, and 2Mb to each remote site?
- No - It will only provide 2Mb total or 400K worst case to each remote.



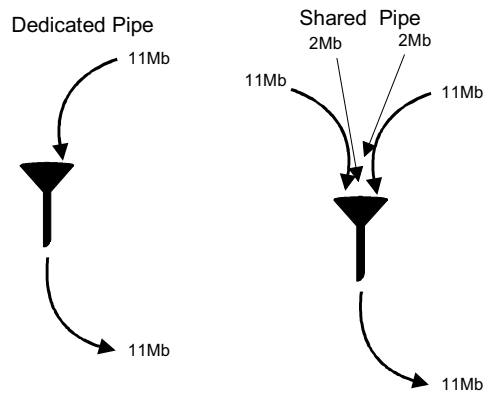
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Throughput Questions

- If Data rate=11-Mb, why do I only see 5.5-Mb of data?
- Throughput= data+overhead
- 10Mb Ethernet has approximately 6 or 7-Mb of throughput.



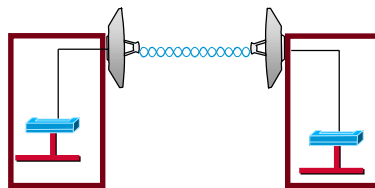
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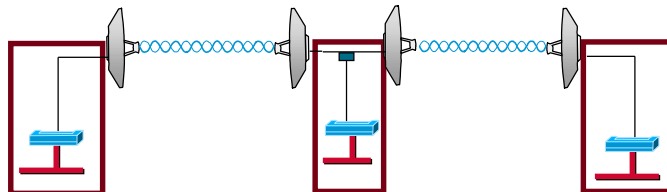
204-47

Two Directional Antennas and Splitters?

If I can go 25 miles like this...



Then I should be able to go 50 here?



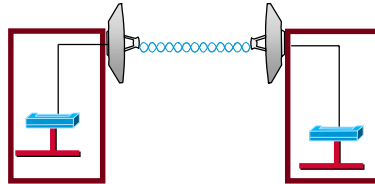
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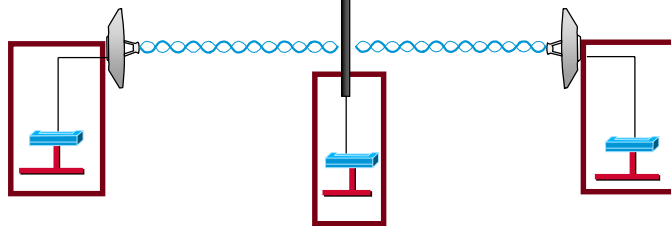
204-48

Add a Repeater to Double the Distance?

If I can go 25 miles like this...



Then I should be able to go 50 here?



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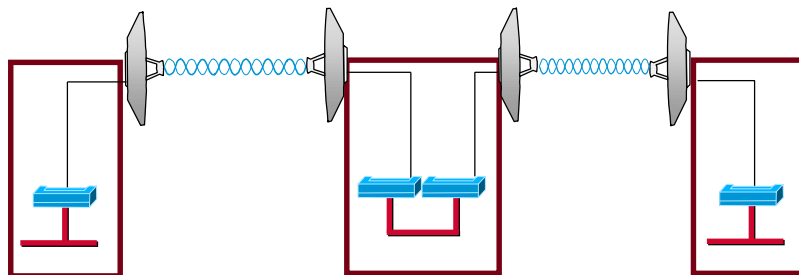
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Alternative Method of Increasing Distance.

Channel 1

Channel 11



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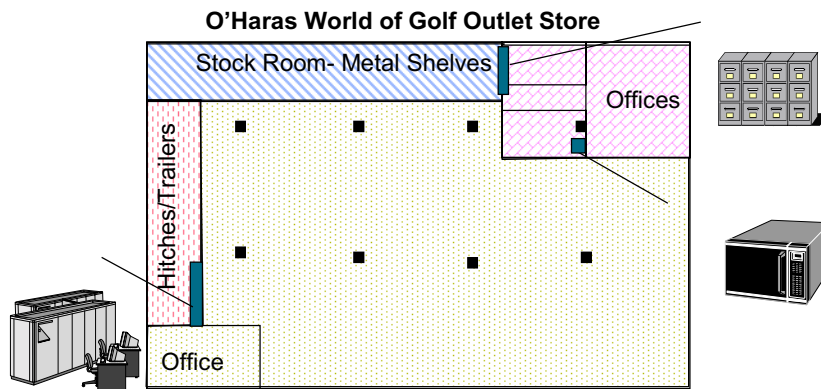
Performing Site Surveys

Check List

1. Get details of the application.
2. Make site map.
3. Test the equipment.
4. Select the antenna.
5. Meet with MIS manager.
6. Get details of coverage.

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Performing Site Surveys



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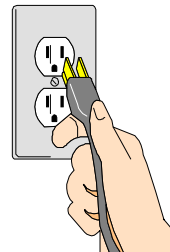
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204-53

Survey Equipment



- Access point
 - Client device
 - Laptop PC
 - AP battery pack
 - Antennas
 - Digital camera
 - Misc.
- Tie wraps, duct tape, small flashlight

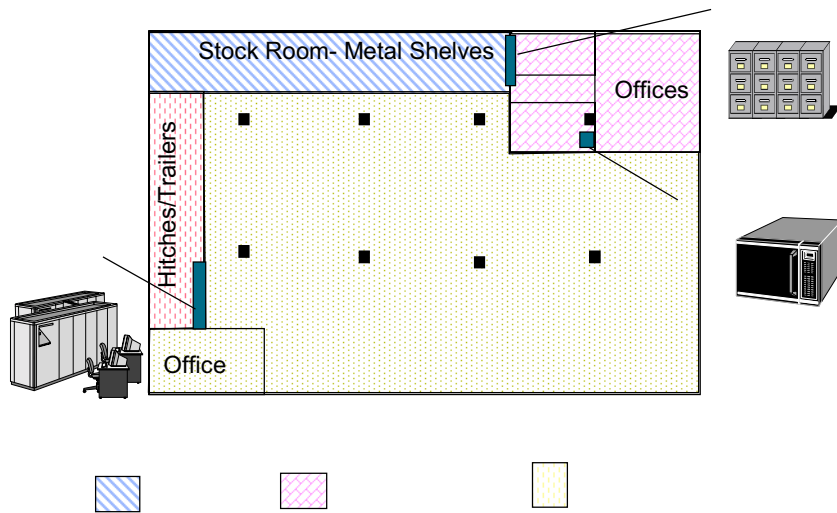


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Build a Layout of the Site

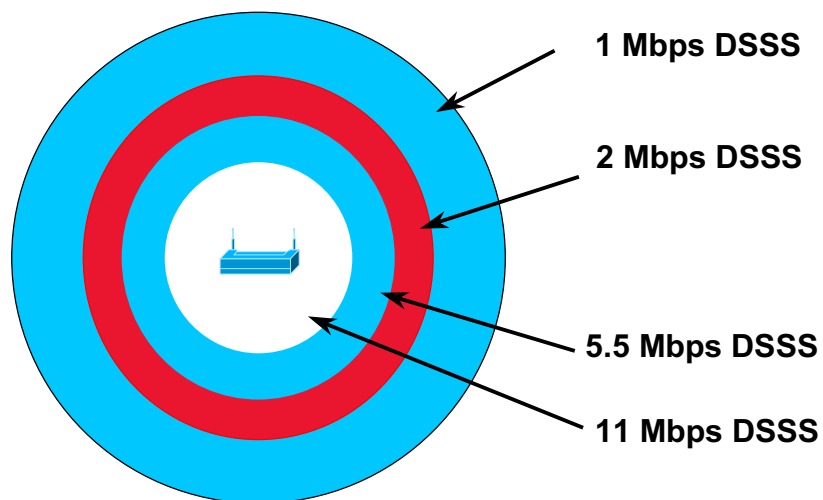


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Access Point Coverage and Data-Rate Shifting Review

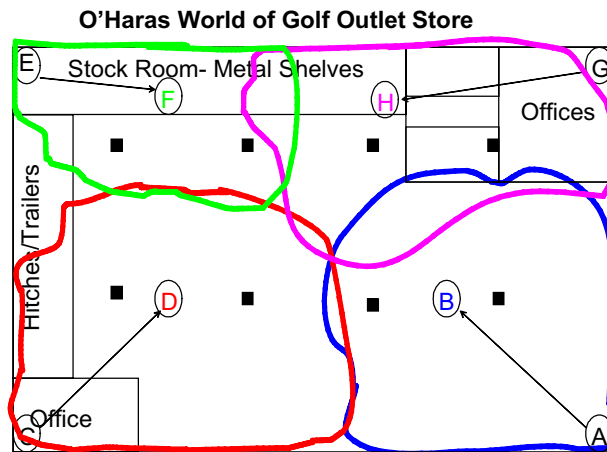


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Performing a Survey- From the Outside Looking In

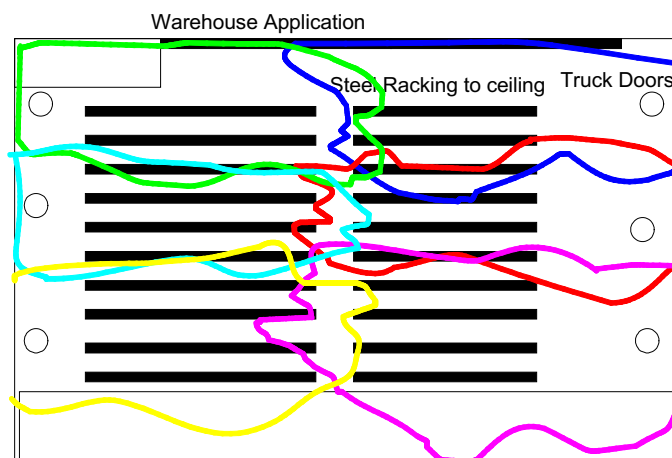


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Warehouse Example

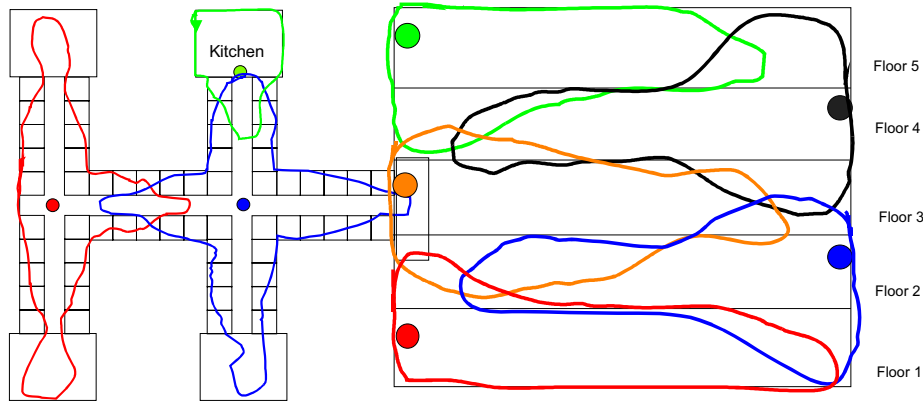


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Medical Facility Example



Side View- Five Floors Using Patch Antennas

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Pictures

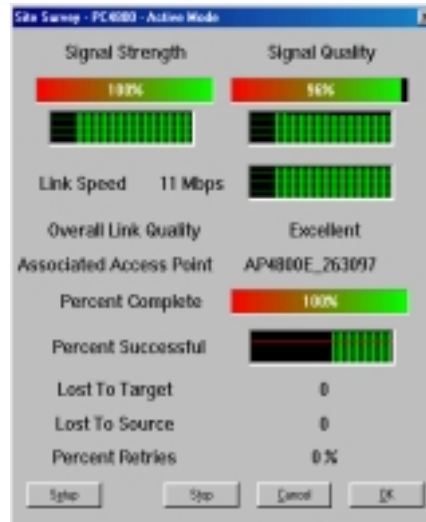


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ACU Utility



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Site-Survey Parameters Setup

The screenshot shows the 'Site Survey Active Mode Setup' window with the following configuration options:

- Destination MAC Address:** 00:00:00:00:00:00
- ☒ **Continuous Link Test**
- Number of Packets:** 100 (range 1 to 999)
- Packet Size:** 1418 (range 30 to 1458)
- Data Retries:**
 - ☐ None
 - ☒ Default Retries
- Data Rate:** 11 Mbps (dropdown menu)
- Delay Between Packets (milliseconds):** 1 (range 1 to 2048)
- Packet To Type:**
 - ☒ Unicast
 - ☐ Multicast
- Percent Success Threshold:** 75 (range 0 to 100)

Buttons at the bottom include 'Defaults', 'Cancel', and 'OK'.

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Final Report

- **A good site survey report includes:**

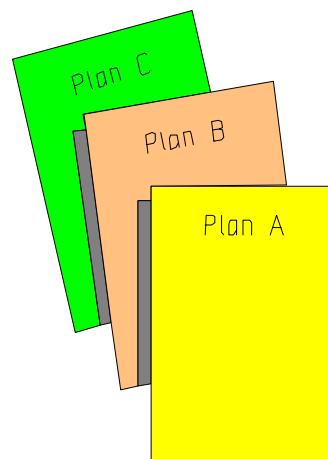
Locations of devices

**Description of devices,
including antennas**

Suggested configuration

**Photographs for unusual
situations**

**Description of coverage
areas**



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Considerations

- **Nothing replaces training and experience.**
- **Site surveys are more an art than a science.**
- **Use your imagination!**
- **Be creative!**

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Case Study on Ordering Aironet Products

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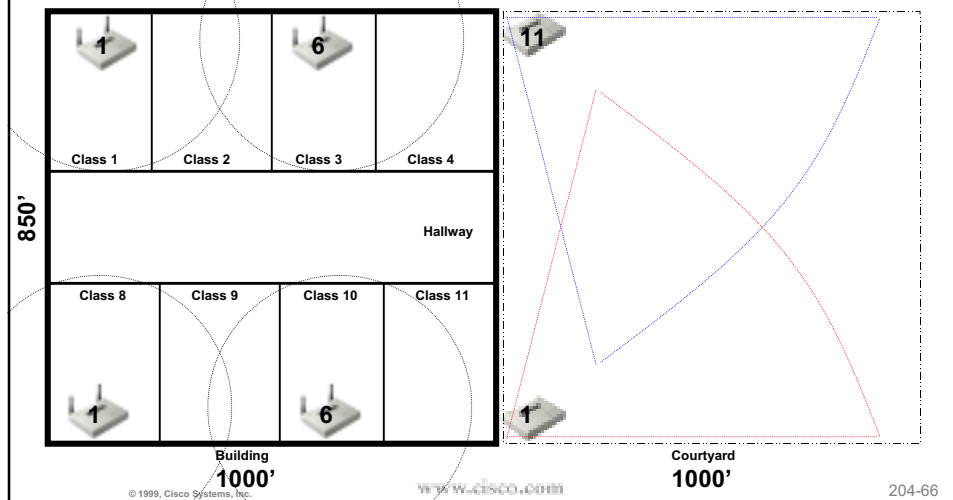
65

Education Design Sample

Maximum Coverage
Autorate Negotiation

Wireless for Students
DiPole Indoor, Patch Outdoor

AP's on Isolated LAN
with PIX



Product to be ordered



NO Encryption

Qty	Product Code	Descriptions
4	AIR-AP340E2C	340 Series 11Mbps DSSS AP w/ no WEP & 2 Integrated Antennas
2	AIR-AP340E2R	340 Series 11Mbps DSSS AP w/ no WEP & 2 RP-TNC Connectors
2	AIR-ANT1729	6 dBi Patch Wall Mount Antenna
20	AIR-PCM340	340 Series 11Mbps DSSS PC Card Adapter

With 128 Encryption

Qty	Product Code	Descriptions
4	AIR-AP342E2C	340 Series 11Mbps DSSS AP w/128-bit WEP & 2 Int. Ant.
2	AIR-AP342E2R	340 Series 11Mbps DSSS AP w/128-bit WEP & 2 RP-TNC
2	AIR-ANT1729	6 dBi Patch Wall Mount Antenna
20	AIR-PCM342	340 Series 11Mbps DSSS PC Card Adapter with 128-bit WEP

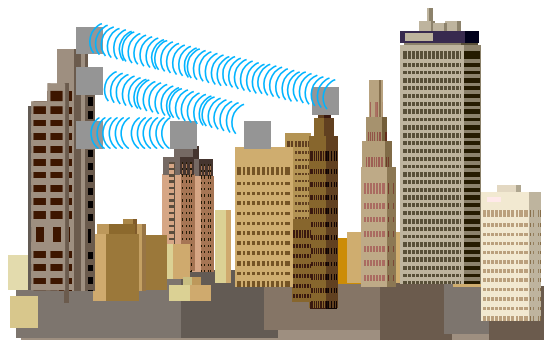
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Site-to-Site P2P Design Sample

- **Required Distance**
< 1 Mile
- **Building A**
Antenna 6 dBi Patch
Antenna Height N/A
Cable 20'
- **Building B**
Antenna 6 dBi Patch
Antenna Height N/A
Cable 20'
- **Building C**
Antenna 6 dBi Patch
Antenna Height N/A
Cable 20'
- **Possible Distance**
11 Mbps .57 Miles
2 Mbps 1.82 Miles



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What to Order



NO Encryption		
Qty	Product Code	Descriptions
6	AIR-BRI340	340 Series 11Mbps DSSS Bridge, 50mW Output
6	AIR-ACC3354	Lightning Arrestor w/ grounding ring
6	AIR-420-003346-020	20 ft. (6m) low-loss antenna cable
6	AIR-ANT1729	6 dBi Patch Wall Mount Antenna (For Indoor Use)
With 128 Encryption		
Qty	Product Code	Descriptions
6	AIR-BRI342	340 Series 11Mbps DSSS Bridge, 50mW Output with 128-bit WEP
6	AIR-ACC3354	Lightning Arrestor w/ grounding ring
6	AIR-420-003346-020	20 ft. (6m) low-loss antenna cable
6	AIR-ANT1729	6 dBi Patch Wall Mount Antenna (For Indoor Use)

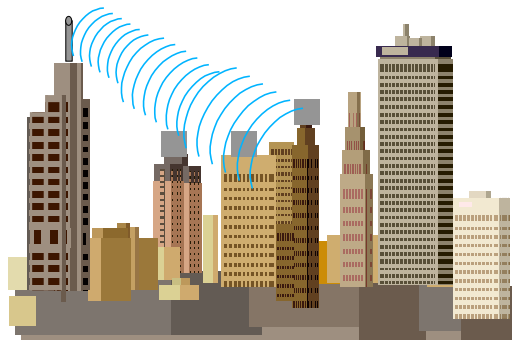
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Site-to-Site P2MP Design Sample

- **Required Distance**
< 1 Mile
- **Building A**
Antenna 5.2 dBi Omni
Antenna Height N/A
Cable 20'
- **Building B and C**
Antenna 6 dBi Patch
Antenna Height N/A
Cable 20'
- **Building D**
Antenna 6 dBi Patch
Antenna Height N/A
Cable 20'
- **Possible Distance**
11 Mbps .52 Miles
2 Mbps 1.66 Miles



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What to Order



NO Encryption

Qty	Product Code	Descriptions
4	AIR-BRI340	340 Series 11Mbps DSSS Bridge, 50mW Output
4	AIR-ACC3354	Lightning Arrestor w/ grounding ring
4	AIR-420-003346-020	20 ft. (6m) low-loss antenna cable
3	AIR-ANT1729	6 dBi Patch Wall Mount Antenna (For Indoor Use)
1	AIR-ANT2506	5.2 dBi Omnidirectional Mast Mount Antenna

With 128 Encryption

Qty	Product Code	Descriptions
4	AIR-BRI342	340 Series 11Mbps DSSS Bridge, 50mW Output with 128-bit WEP
4	AIR-ACC3354	Lightning Arrestor w/ grounding ring
4	AIR-420-003346-020	20 ft. (6m) low-loss antenna cable
3	AIR-ANT1729	6 dBi Patch Wall Mount Antenna (For Indoor Use)
1	AIR-ANT2506	5.2 dBi Omnidirectional Mast Mount Antenna

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Review Quiz - Finding the Opportunity

- 1) List three of the target industries for wireless LANs
- 2) What does an AP in repeater mode means?
- 3) List three questions to ask to aid in qualifying a prospective customer

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