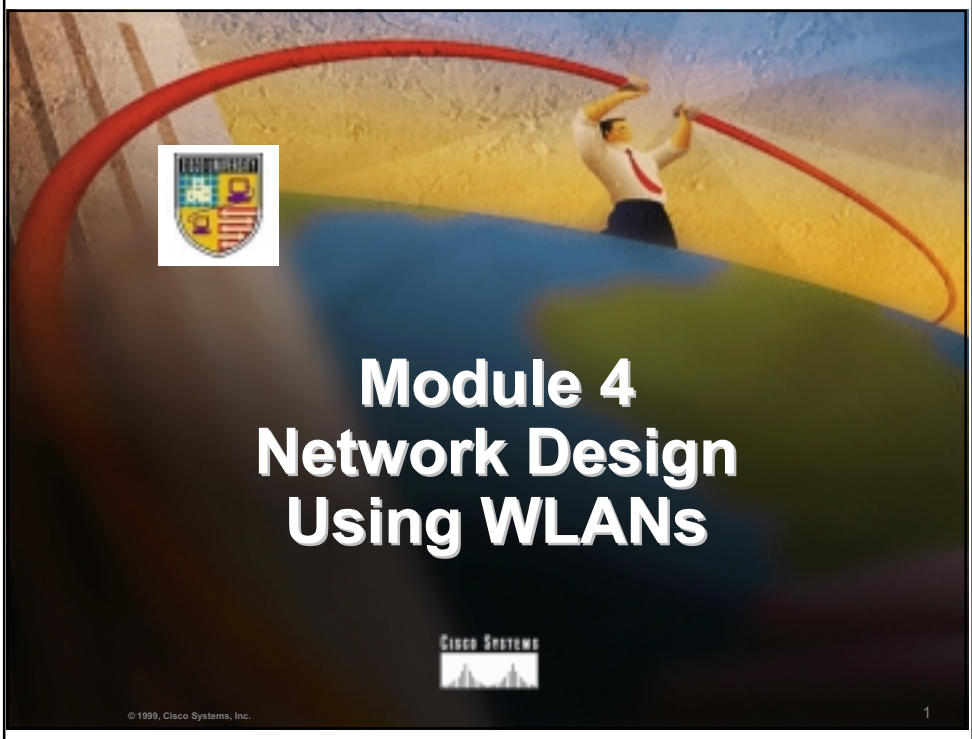
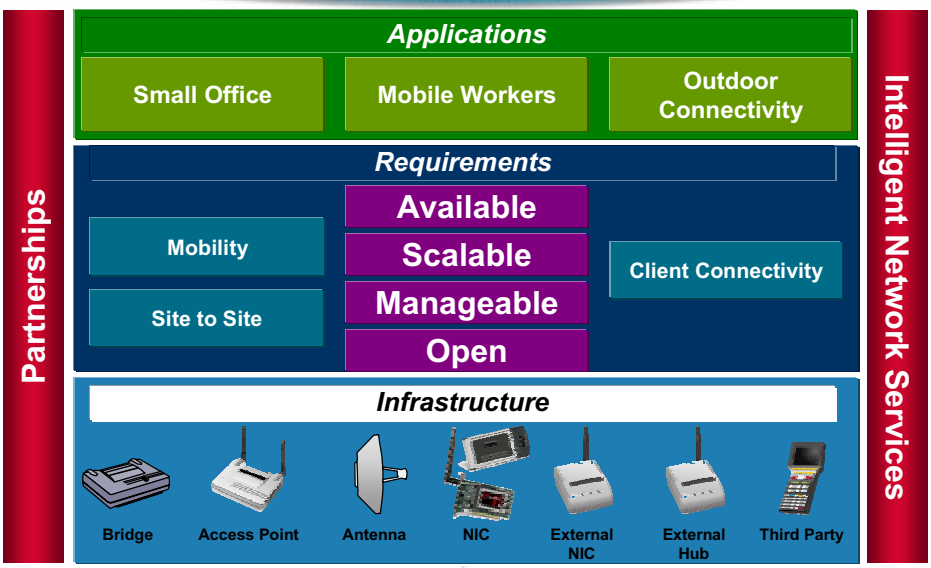


Module Objectives

- 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.

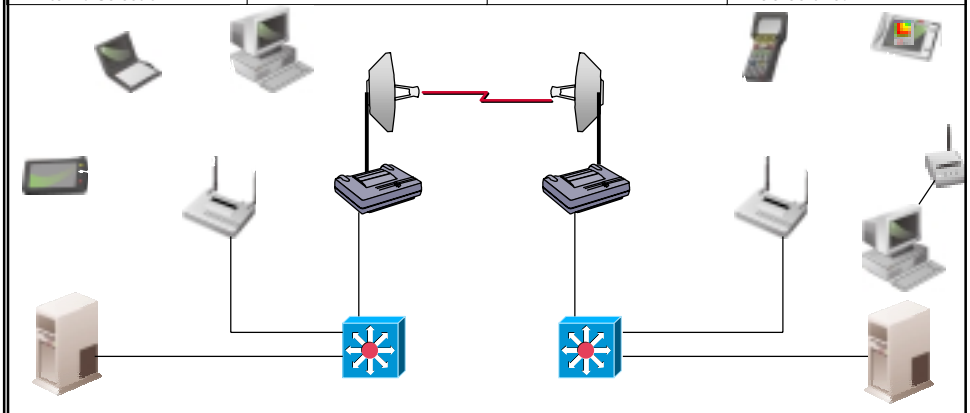
Presentation_ID.scr

Wireless Framework



Wireless Key Requirements

Available	Scalable	Manageable	Open
•Dual Antenna •Roaming •Rate Negotiation •Antenna Selection	•Load Balancing •Repeatable	•Site Survey Tools •RF Monitoring	•IEEE 802.11/b •2.4 GHz •Flexible Drivers •FCC Certified

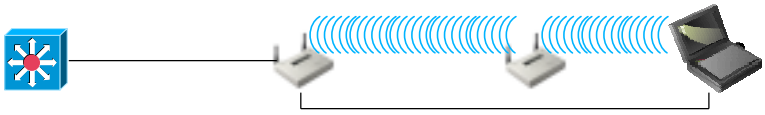


In-Building Design Considerations (Roaming Coverage)

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

In-Building Design Considerations (Repeater Mode)

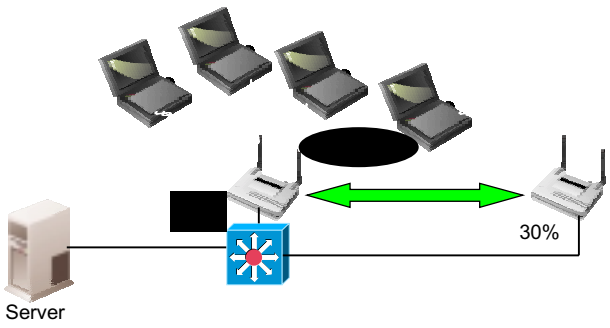
- **Repeater mode**
  - **AP used to extend distance of another AP**
  - **Wired AP is the associated connection point**



Wireless Roaming - Load Sharing

Load Sharing

- Seamless Roaming when AP hopping
- Client based algorithm
  - **Signal strength**
  - **Packet error rate**
  - **AP Load**
- AP Awareness



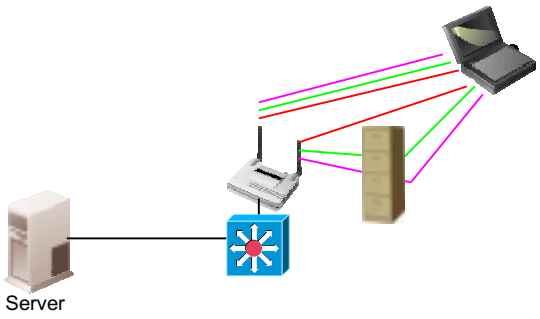
In-Building Design Considerations

- **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 selections 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**

Wireless Roaming—Diversity and Multipath

Antenna Diversity

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



Wireless Roaming

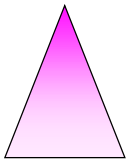
Antenna Coverage

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

Omnidirectional

Type	Application
DiPole	Indoor
Mast mount	Outdoor multipoint
Ceiling mount	
Ground plane	
Omni	

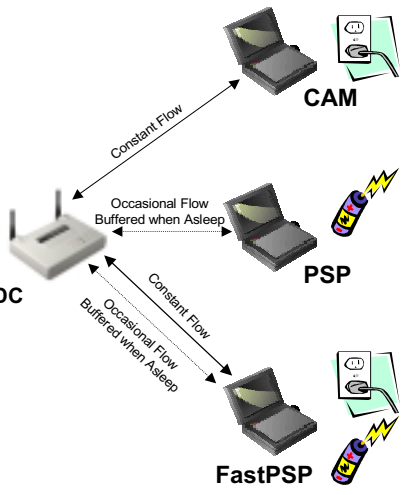
Directional

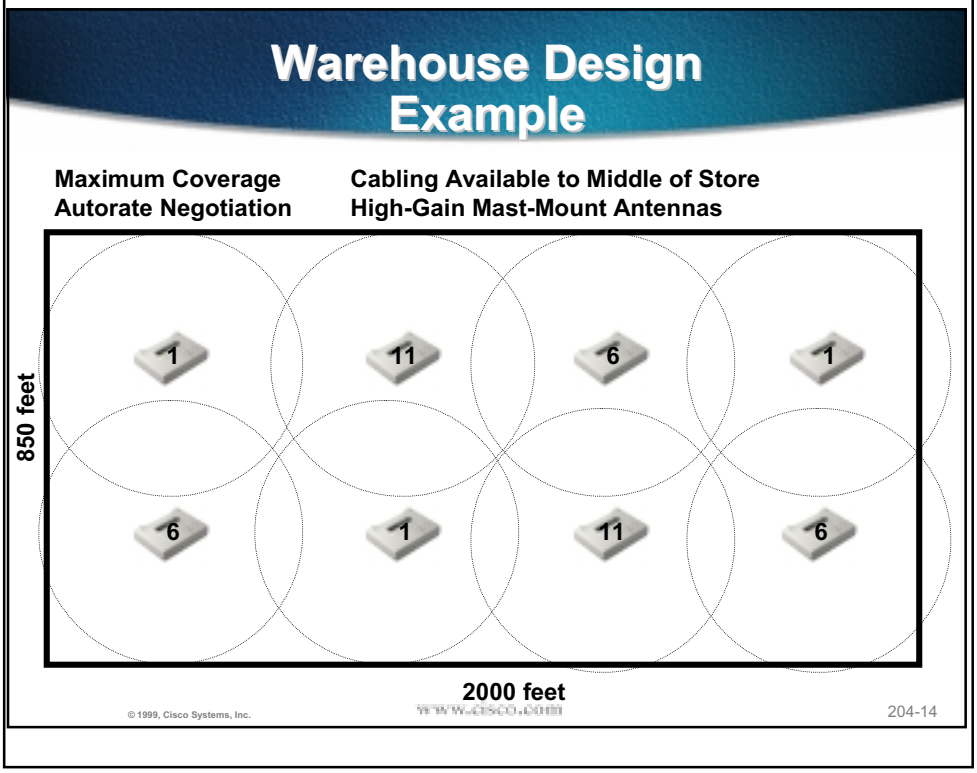


Type	Application
Patch	Indoor
Yagi	Outdoor P2MP
Dish	Outdoor P2P

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 da**
  - **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**

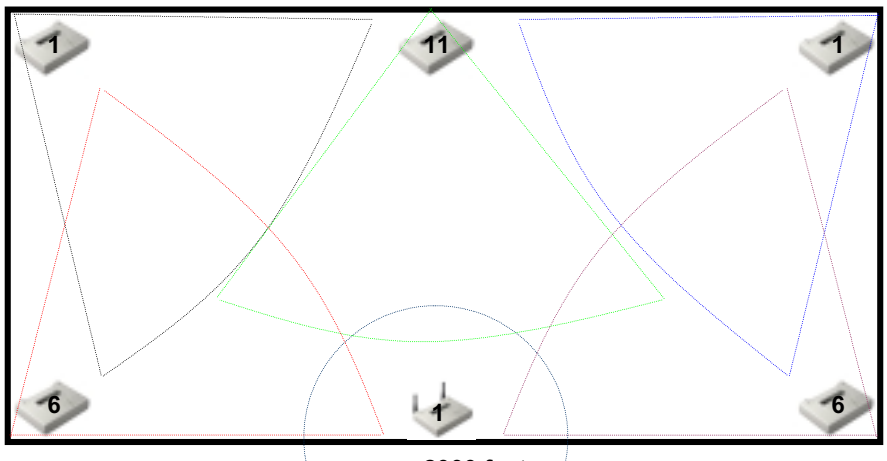




Warehouse Design Example

Maximum Coverage
Autorate Negotiation

Cabling available only around Store Edges
Patch and DiPole Antennas

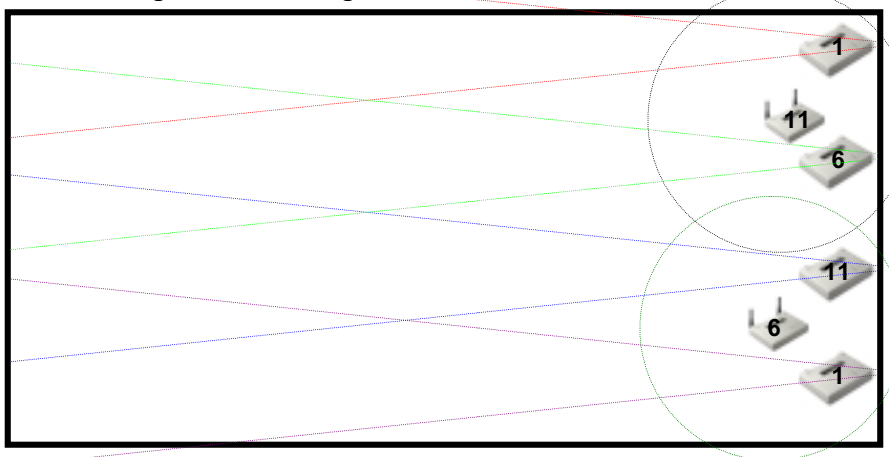


204-15

Warehouse Design Example

Maximum Coverage
Autorate Negotiation

Cabling Available only at Store Front
Yagi Antennas and DiPole

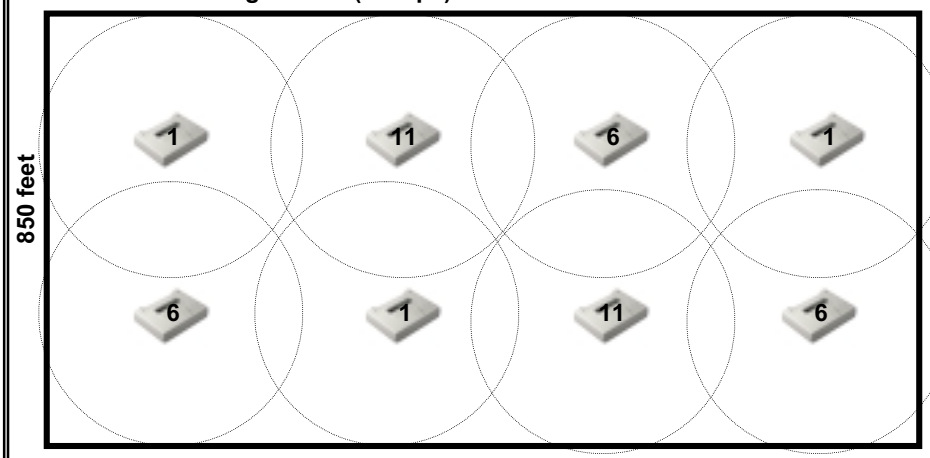


204-16

Retail Design Example

Maximum Coverage
Non-Autorate Negotiation (2 Mbps)

Cabling Available to Middle of Store
Ground Plane Antennas – Well hidden



850 feet

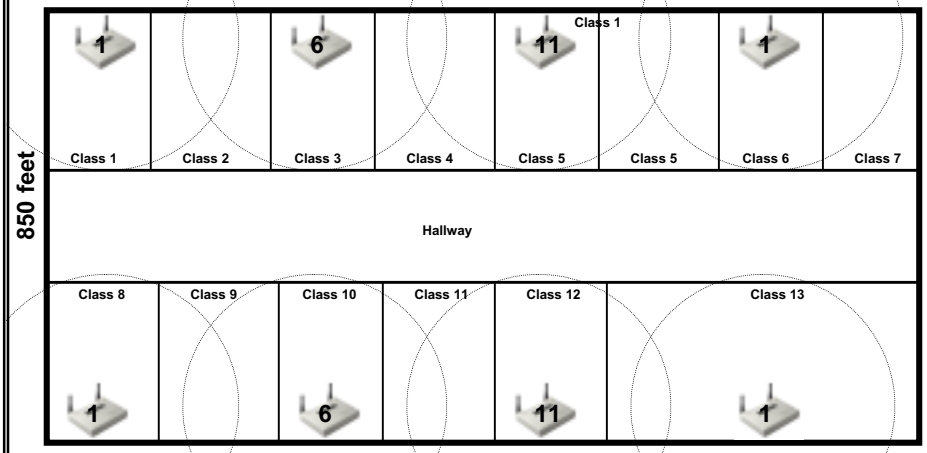
2000 feet

Education Design Example

Maximum Coverage
Autorate Negotiation

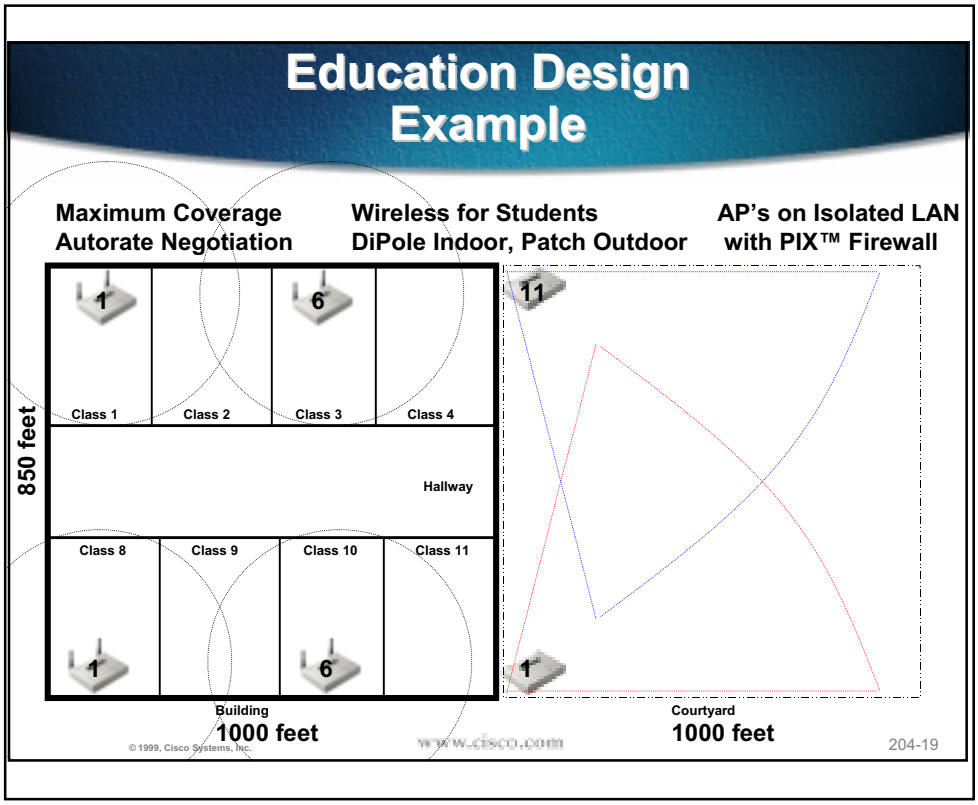
Wireless for Students
DiPole Antennas

APs on Isolated LAN
with PIX™ Firewall



850 feet

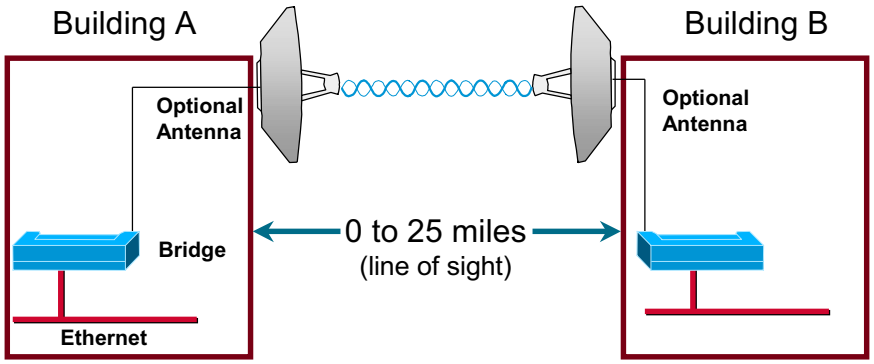
2000 feet

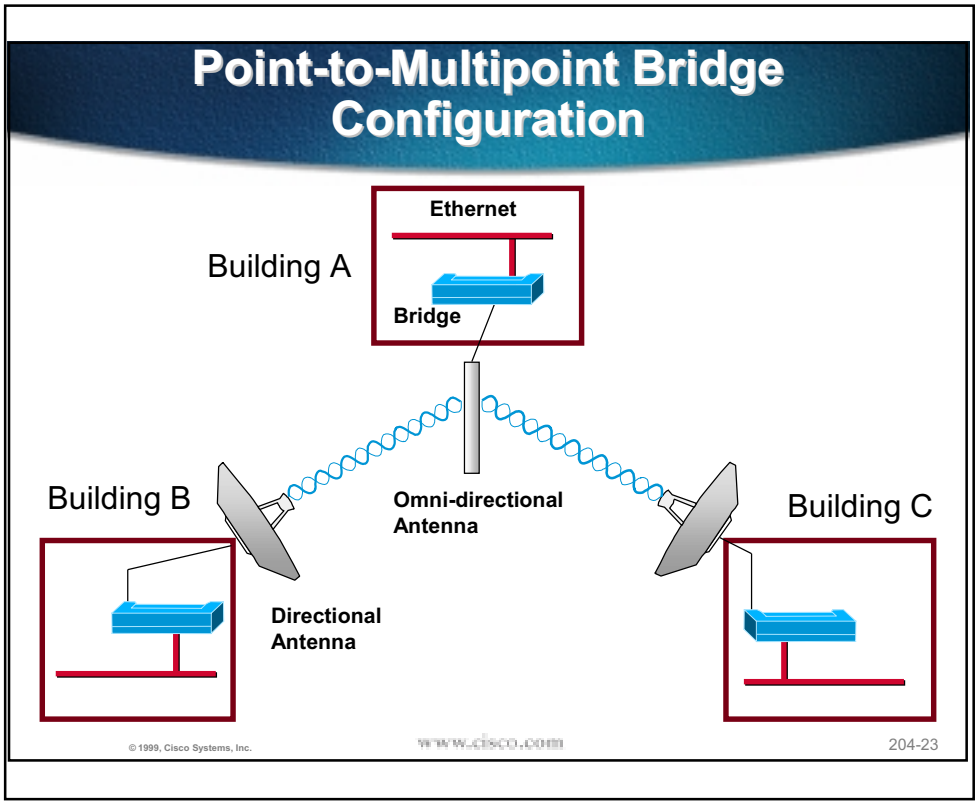


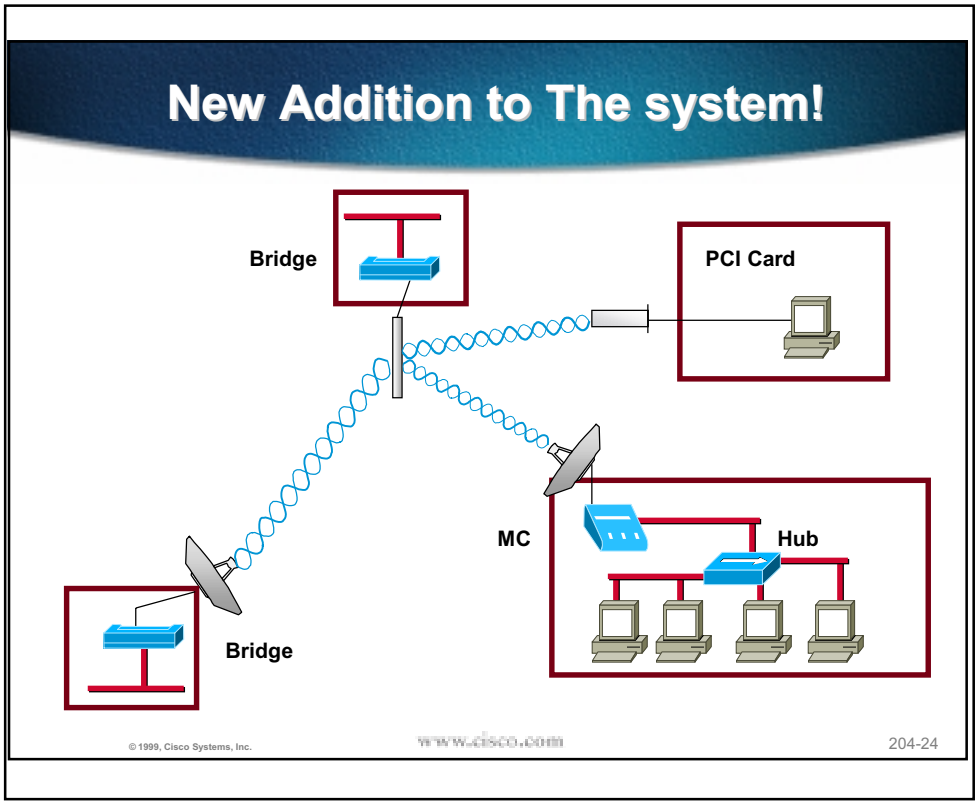
Wireless Bridge Alternatives

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

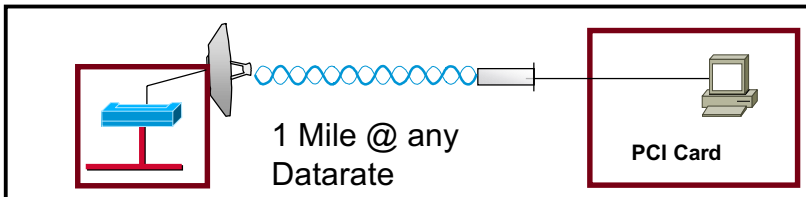
Point-to-Point Bridge Configuration



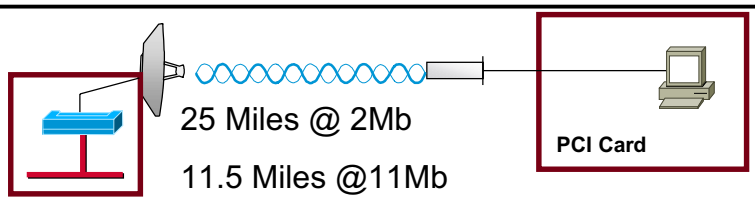




Distances Limited by 802.11 Specification



Access Point to any client- maximum distance



Bridge to any client- maximum distance

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

Optional Antennas for Long Range

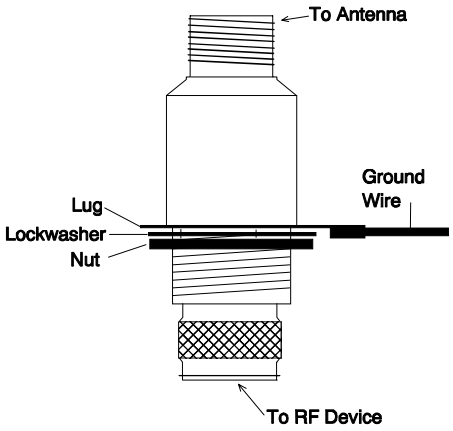
13.5dBi Yagi
Distances over
6.5 Miles @ 2Mbps and
2Miles @11Mb

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

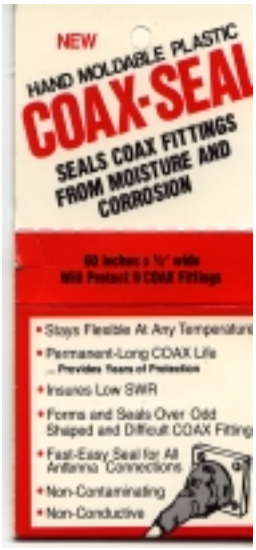
Note: Distances include 50 feet of Cisco Low Loss Cable and 10dB fade margin

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**



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

How to Determine Distance

- **Distance Calculation**

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

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

  Distance= (300/2442)*(39/12)*(1/5280)*EXP((Ant/Radio Parms-22-10)/6*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

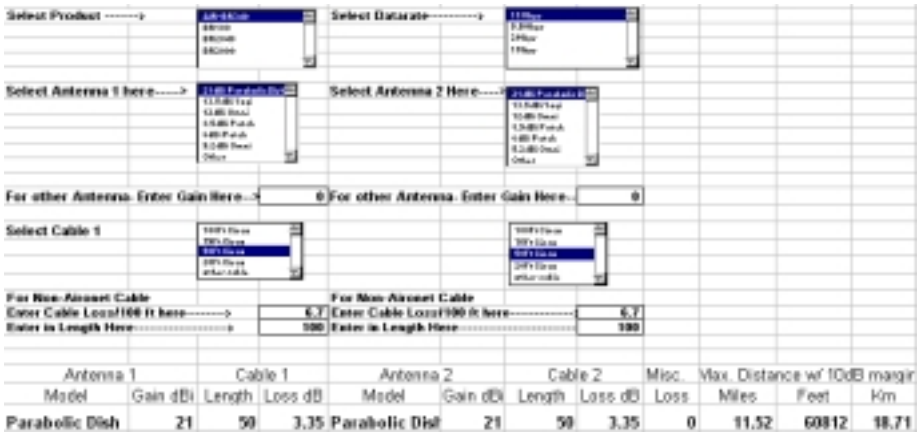
  2MBps {RX sens= -90dBm} (20+13.5-1.34+13.5-1.34+90)= 134.32

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

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

- **Cisco provides a spreadsheet calculator**

Bridge Distance Calculations



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	50	3.35	Parabolic Dish	21	50	3.35	0	11.52	60812	18.71

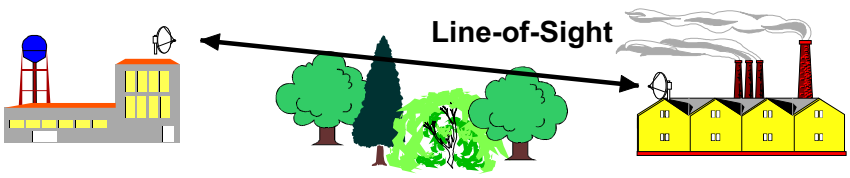
Path Considerations

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

Line-of-Sight

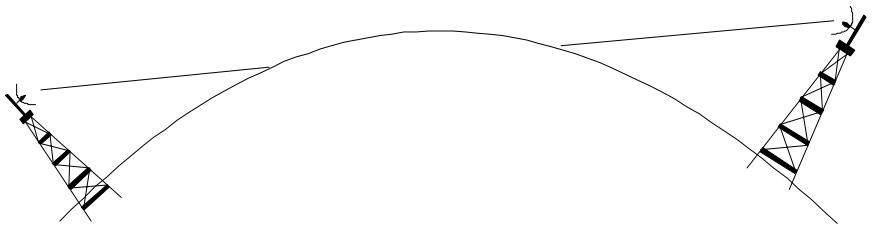
The following obstructions might obscure a visual link:

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



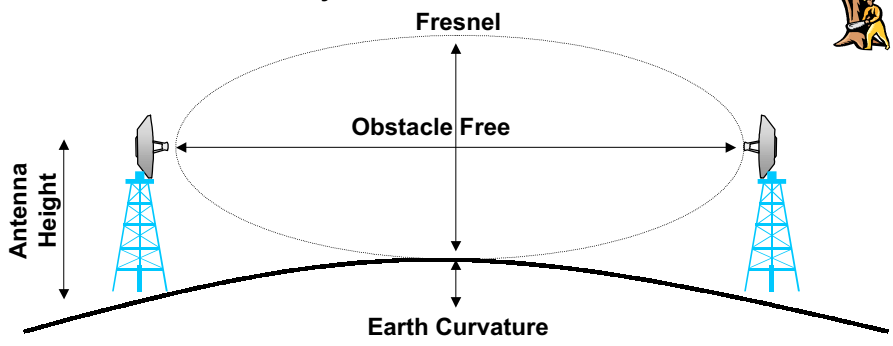
Longer distances

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



Building-to-Building Fresnel Zone

- **Antenna height**
  - **Line of Sight is really ellipse**
  - **Clear of all obstacles year round**

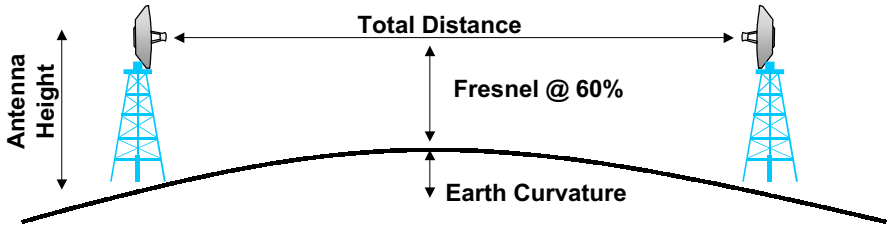


Building-to-Building Fresnel Zone

- Antenna height

  Fresnel zone consideration

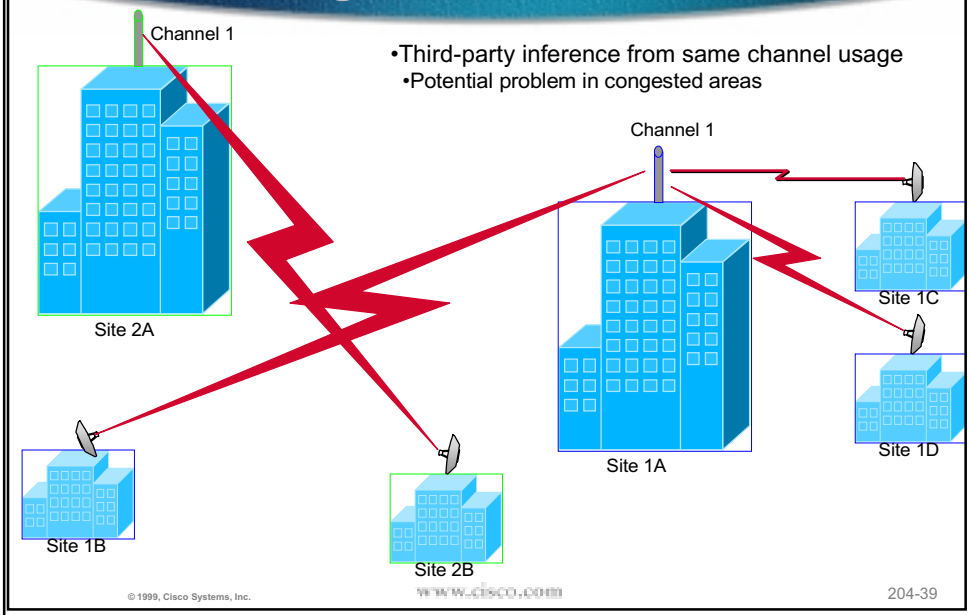
  Line of Sight over 25 Miles hard to implement



Total Distance	Fresnel Zone		Earth Curvature	Antenna Height
? Mile	?? Feet	+	? Feet	?? Feet

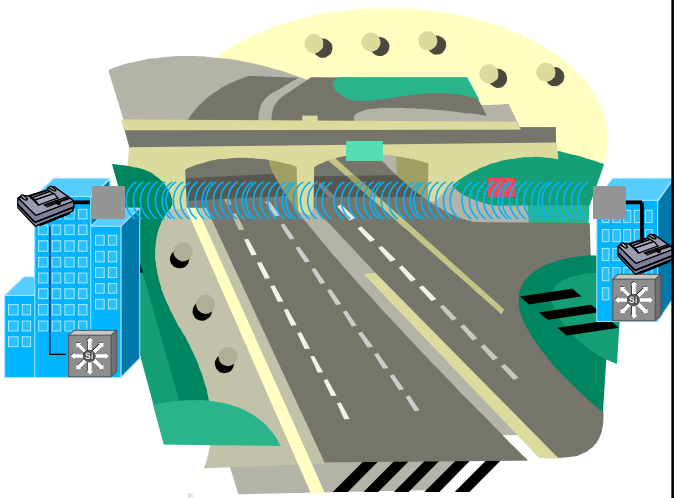
Building-to-Building Design Examples

Building-to-Building Design Considerations



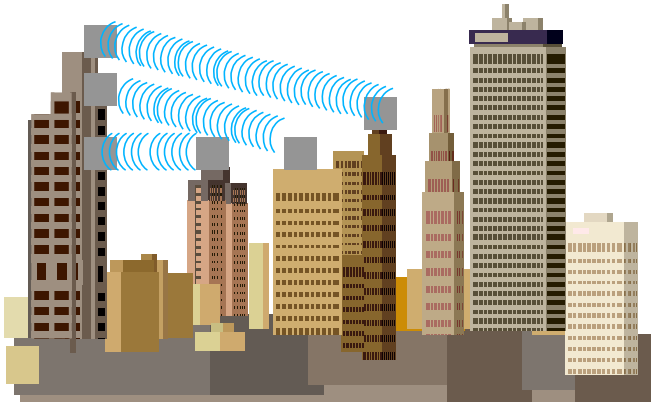
Site-to-Site P2P Design Sample

- **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 50feet**
- **Possible Distance**
  - **11 Mbps 0.81 miles**
  - **2 Mbps 2.57 miles**



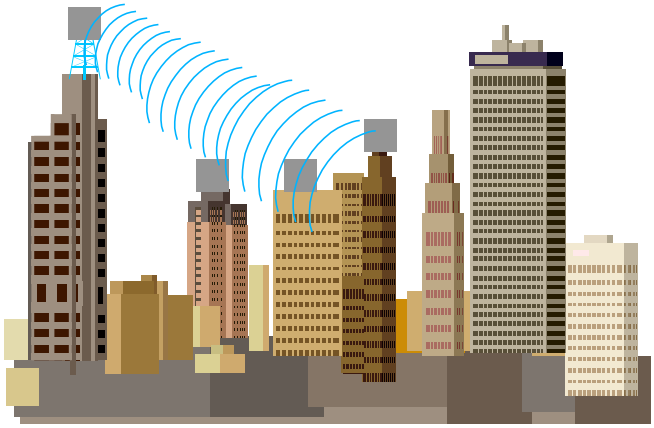
Site-to-Site P2P Design Sample

- **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**



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**



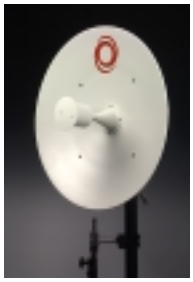
Common Questions

- 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?

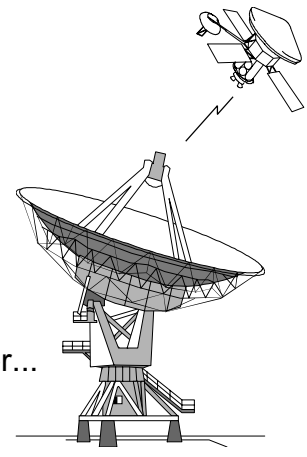
Bigger Antennas?

If 13.5dB is good

and…..



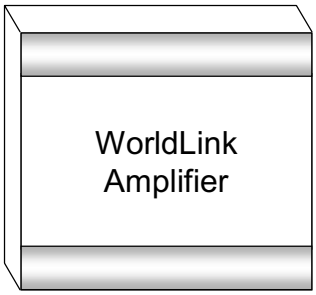
21dBi is better...



Is 50dBi even better?

Amplifiers?

Cisco-20dBm
(100mW)

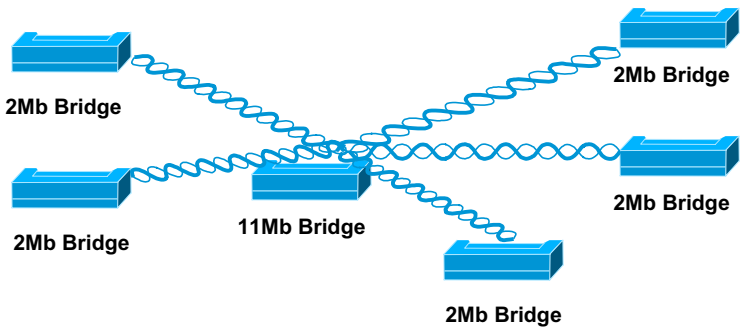


50dBm(100Watts)

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

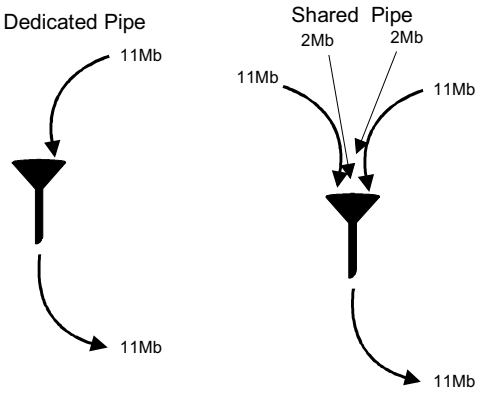
Can I Have 5 Sites at 2-Mb to a Single 11-Mb Center Site for Better Throughput?

- 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.



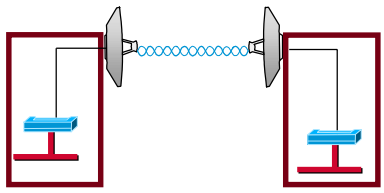
Throughput Questions

- 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.

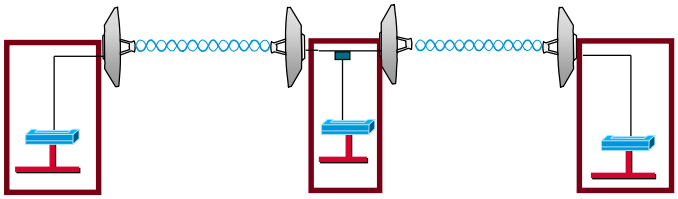


Two Directional Antennas and Splitters?

If I can go 25 miles like this...

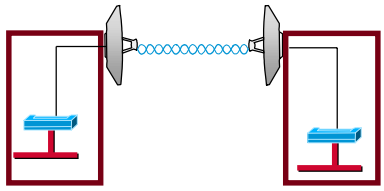


Then I should be able to go 50 here?

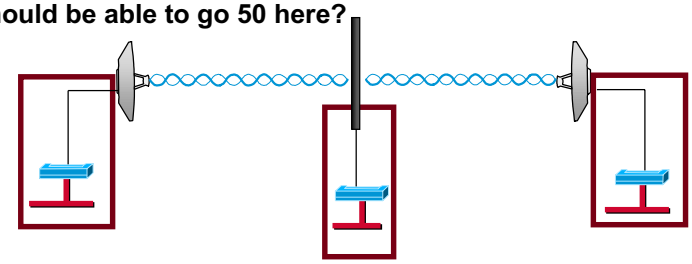


Add a Repeater to Double the Distance?

If I can go 25 miles like this...



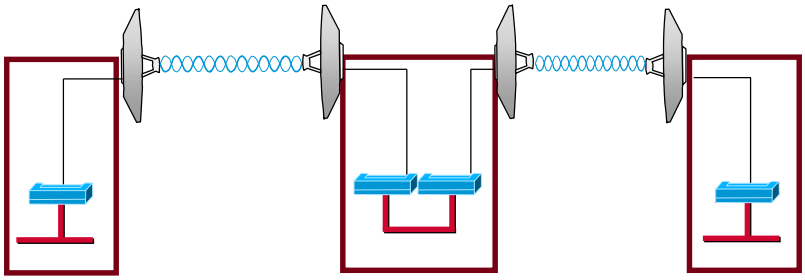
Then I should be able to go 50 here?



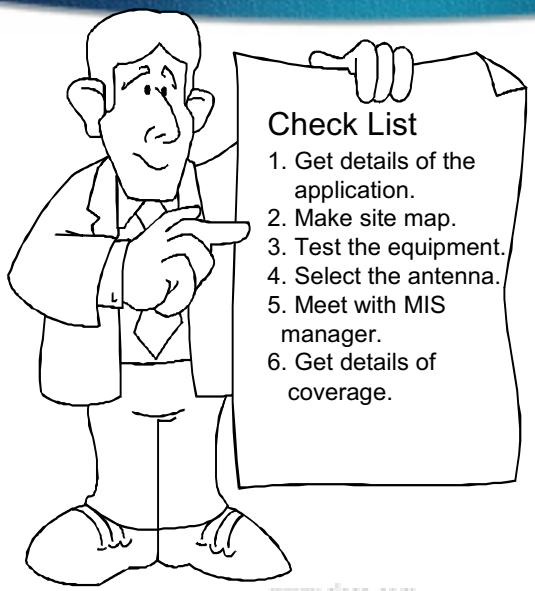
Alternative Method of Increasing Distance.

Channel 1

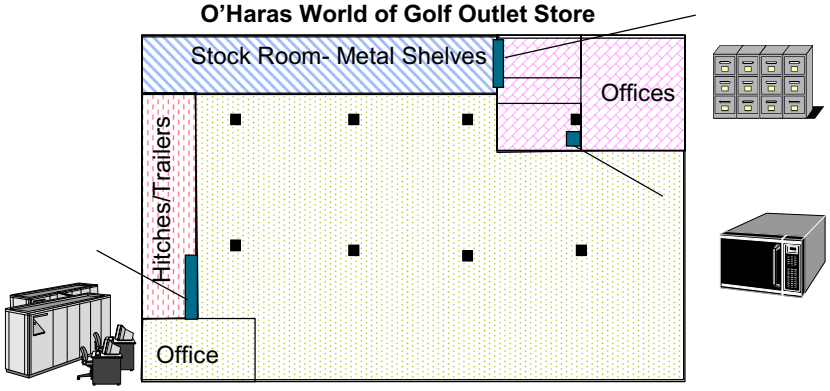
Channel 11



Performing Site Surveys

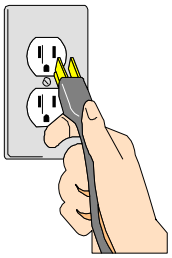


Performing Site Surveys

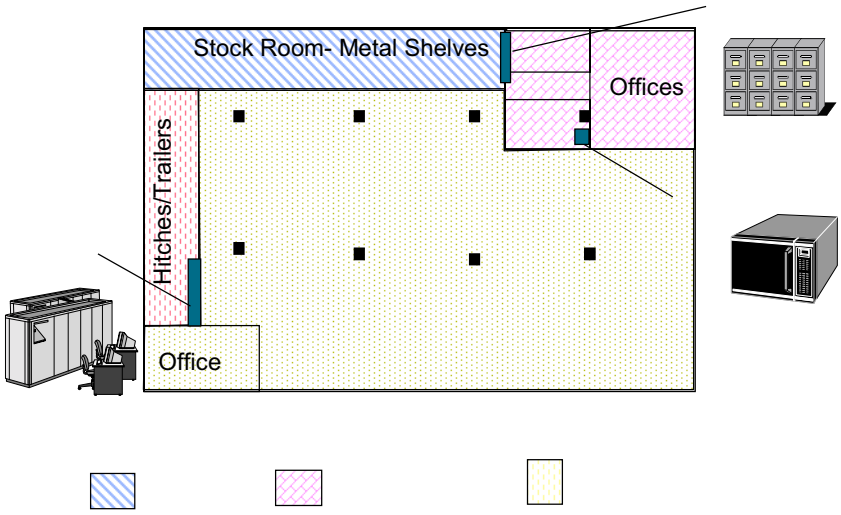


Survey Equipment

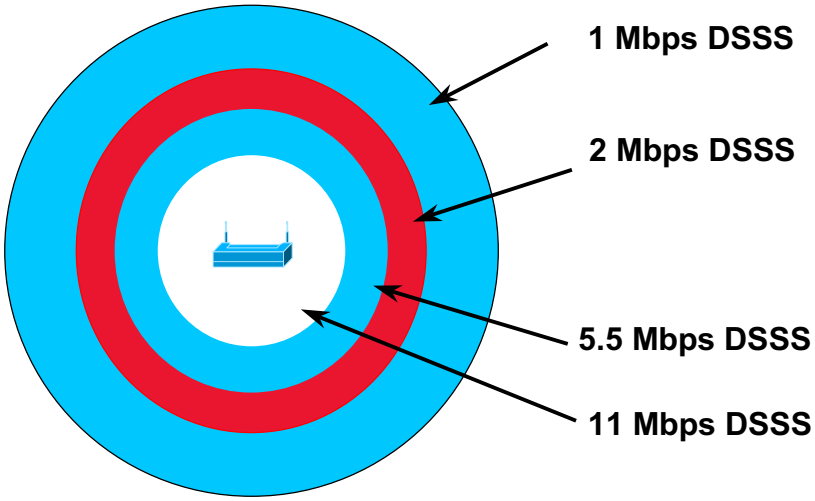
- Access point
- Client device
- Laptop PC
- AP battery pack
- Antennas
- Digital camera
- Misc.
  - Tie wraps, duct tape, small flashlight



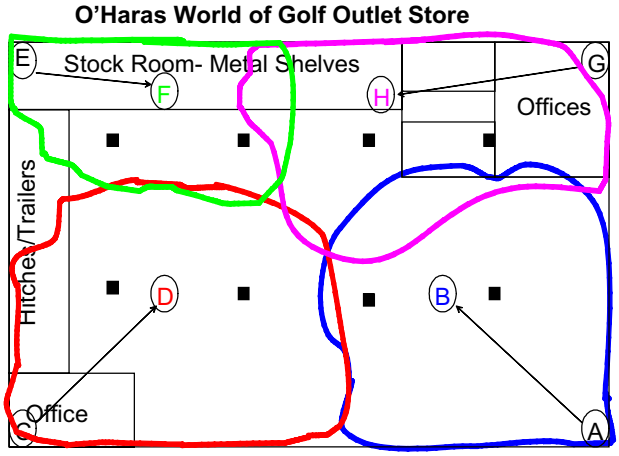
Build a Layout of the Site



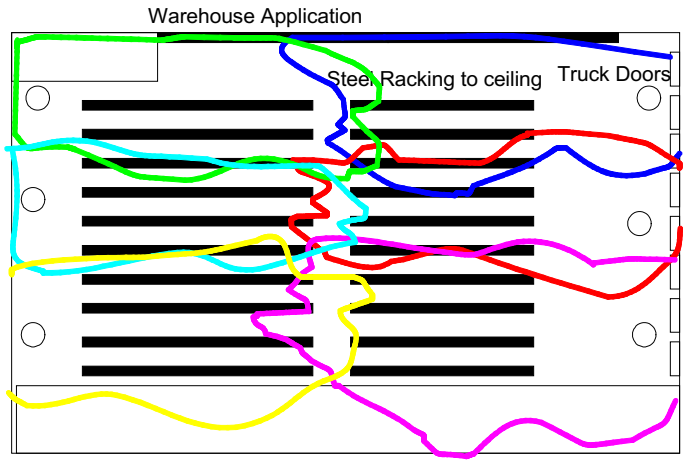
Access Point Coverage and Data-Rate Shifting Review



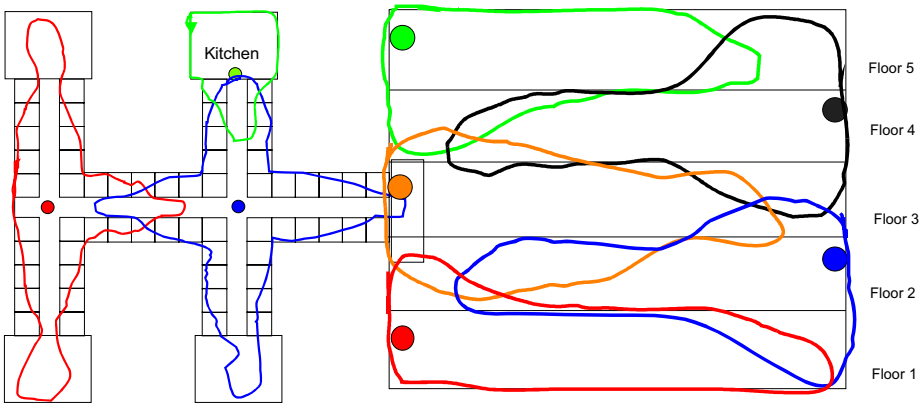
Performing a Survey- From the Outside Looking In



Warehouse Example



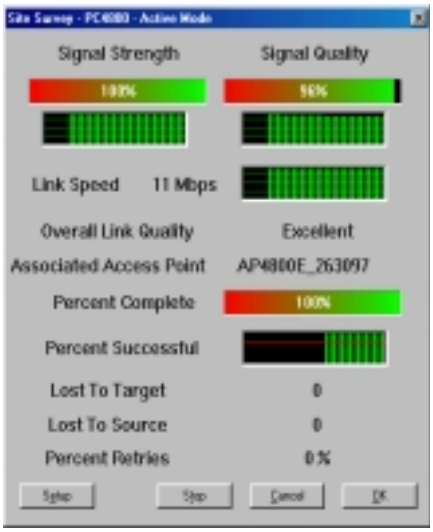
Medical Facility Example



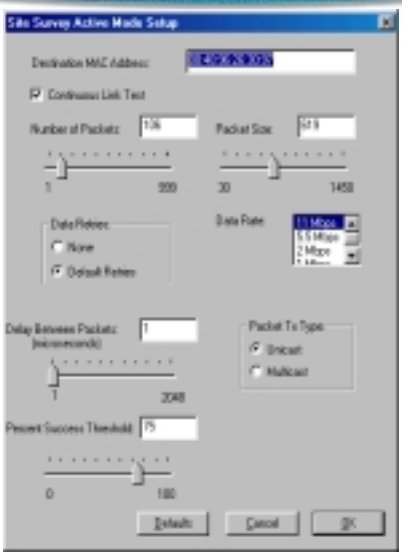
Side View- Five Floors Using Patch Antennas

Pictures

ACU Utility

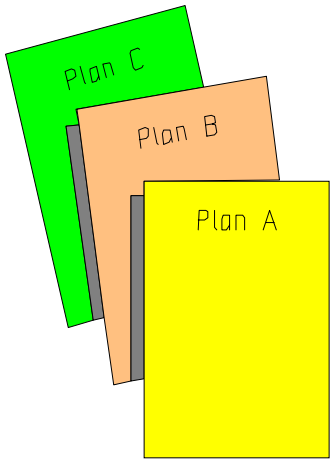


Site-Survey Parameters Setup



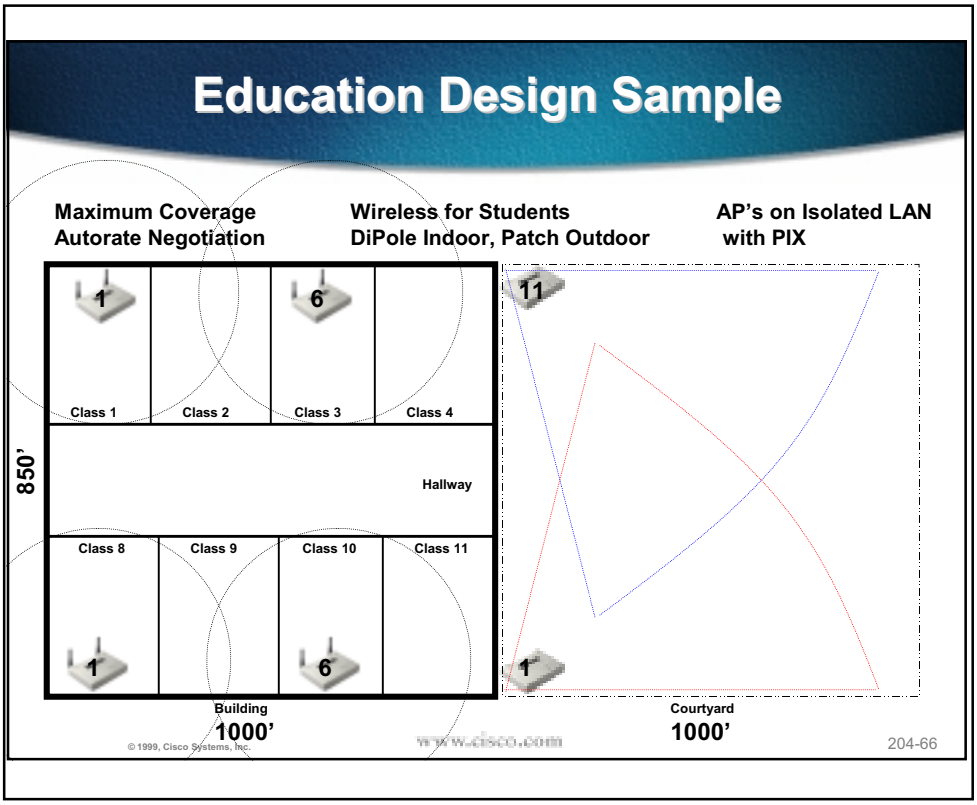
Final Report

- A good site survey report includes:
  - Locations of devices
  - Description of devices, including antennas
  - Suggested configuration
  - Photographs for unusual situations
  - Description of coverage areas



Considerations

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

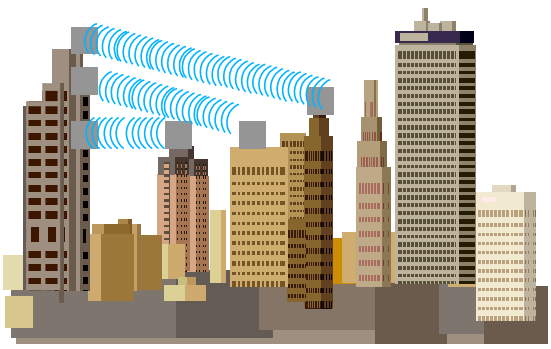


Product to be ordered

	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

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

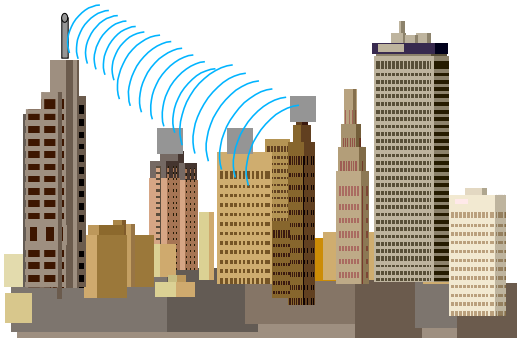


What to Order

	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)

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



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

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