Deploying Wireless LAN Infrastructure

Session 2309
Sometimes...

There’s got to be a better way!

Wireless LANs Are Ready for Enterprise Deployment Today!
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
ISM Unlicensed Frequency Bands

Extremely Low | Very Low | Low | Medium | High | Very Ultra High | Super High | Infrared | Visible Light | Ultra-violet | X-Rays

Audio

Short-Wave Radio
AM Broadcast

FM Broadcast
Television
Cellular (840MHz)
NPCS (1.9GHz)

Infrared Wireless LAN

902–928 MHz
26 MHz

2.4–2.4835 GHz
83.5 MHz
(IEEE 802.11)

5 GHz
(IEEE 802.11)

HyperLAN
HyperLAN2

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
We Have Both, But… What’s the Difference?

- **Direct Sequence (DS)**
  - Throughput
  - Range
- **Frequency Hopping (HS)**
  - Multipath interference tolerance

What to Use…FH or DS?

- Cisco provides LAN connections in both worlds
- Decision should be based on the needs of the customer
- Greater coverage needs should be DS
- Greater throughput needs should be DS
- High RF multipath sites should be FH
Range—FH vs. DS

- Range depends on a number of implementation details including:
  - Transmit power
  - Antenna system
  - Radio sensitivity
  - Processing gain (DS only)
  - FCC/IEEE requires minimum of 10 dB

- Because of this processing gain, the DSSS technology will have more range than FHSS at a given data rate

RF Coverage Comparison

- 2 Mbps FHSS
- 2 Mbps DSSS
- 1 Mbps FHSS
- 5.5 Mbps DSSS
- 11 Mbps DSSS
Scalability—DS vs. FH

- Scalability is the ability to locate more than one AP in the same area, increasing the bandwidth of that area for all users local to that AP.
- DS has a limit of three non-overlapping channels, and therefore limits the total AP number to three.
- FH can have as many as 15 AP co-located APs before collisions on hopping channels reduce effective data rate.

Scalability with Frequency Hopping

<table>
<thead>
<tr>
<th>Pattern Number</th>
<th>Channel Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 8 4 9 2 6 5 3 7 0</td>
</tr>
</tbody>
</table>

- For simplicity our example is using only 10 channels as the hopping channels, you transmit on EACH channel before you repeat.
- In the real systems they must use 75 channels.
- Therefore the collision effect will not be as drastic.
## Scalability with Frequency Hopping

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</thead>
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<tr>
<td>1</td>
<td>1 8 4 9 2 6 5 3 7 0</td>
</tr>
<tr>
<td>2</td>
<td>4 6 8 3 2 7 1 0 9 5</td>
</tr>
</tbody>
</table>

RF Contention (Collision)

Time

---

## Scalability with Frequency Hopping

<table>
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<tr>
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<td>4 6 8 3 2 7 1 0 9 5</td>
</tr>
<tr>
<td>3</td>
<td>9 7 2 1 3 8 4 6 0 5</td>
</tr>
</tbody>
</table>

Time
Pattern Number | Channel Number
---|---
1 | 1 8 4 9 2 6 5 3 7 0
2 | 4 6 8 3 2 7 1 0 9 5
3 | 9 7 2 1 3 8 4 6 0 5
4 | 9 3 6 8 4 1 5 0 2 7

- Channel numbers in N print are actually interfering with other channels at the point in time
- In any multi channel scheme, there is the possibility of interference

Scalability—FH vs. DS

**Wireless Capacity per Cell**

1.6 Mbps FH, 2 Mbps FH, 2 Mbps DS, 11 Mbps DS
Scalability—FH vs. DS

Wireless Capacity per Cell

1.6 Mbps FH, 2 Mbps FH, 2 Mbps DS, 11 Mbps DS

Number of Access Points
Scalability—FH vs. DS

Wireless Capacity per Cell

1.6 Mbps FH, 2 Mbps FH, 2 Mbps DS, 11 Mbps DS

- **FH-1.6Mb**
- **FH-2Mb**
- **DS-2Mb**
- **DS-11Mb**

Number of Access Points

Scalability with Direct Sequence

- **Blue=11 MB** Channel 1
- **Green=11 MB** Channel 6
- **Red=11 MB** Channel 11

Total Bandwidth Equals 33 MB
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
Local Area Network (LAN)

- Server
- Ethernet
- Cisco Hub
- Internet

Wireless Local Area Network (WLAN)

- Server
- Ethernet
- Access Point
- Internet
LAN Topologies

Peer to Peer Configuration (Ad Hoc Mode)

Typical Single Cell Configuration

Wireless "Cell"
Typical Multicell Configuration

Channel 1
- LAN Backbone
- Wireless Clients

Channel 6
- Wireless Cell
- Access Point

Wireless Repeater

Channel 1
- LAN Backbone
- Wireless Clients
- Access Point
Cisco Wireless LAN Products

Wireless LAN Product Families

- Cisco 330—2.4 GHz FH, 2 Mbps (802.11)
- Cisco 340—2.4 GHz DS, 11 Mbps (802.11b)

- Access points
  10/100 Mb Ethernet (340)
- LAN adapters
  PC Card
  PCI Card
  Ethernet clients
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

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
Access Point Menus

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

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
- Supports most popular network operating systems
Encryption

- Encryption options
  - No encryption
  - 40-bit encryption
  - 128-bit encryption
- Hardware-based encryption
  - 3% performance hit (@128 bit)
- Encryption choices (defined at access point)
  - No encryption
  - Allow client to specify (optional)
  - Forced (required)

Common Questions

<table>
<thead>
<tr>
<th></th>
<th>Cisco 330 Series</th>
<th>Cisco 340 Series</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How Fast</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Data Rate</td>
<td>2 MB</td>
<td>11 MB</td>
</tr>
<tr>
<td>Typical Throughput</td>
<td>1.2 MB</td>
<td>5.5 MB</td>
</tr>
<tr>
<td><strong>How Far (at Max DataRate)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoors</td>
<td>1000 Feet</td>
<td>500 Feet</td>
</tr>
<tr>
<td>Indoors</td>
<td>500 Feet</td>
<td>100 Feet</td>
</tr>
<tr>
<td><strong>How Many Max Clients per AP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical Clients per AP</td>
<td>1024 Ethernet</td>
<td>2048</td>
</tr>
<tr>
<td>Co-located APs</td>
<td>20% of Seg. 15</td>
<td>Same as Ethernet 3</td>
</tr>
</tbody>
</table>
Wireless LAN Design Considerations

- Channel mapping

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

Site Survey Channel Mapping

Channel 1
Channel 11
Channel 6
Channel 11
Channel 6
Channel 6
Channel 1
Channel 11
Channel 1
Channel 11
**Site Survey**

**Bandwidth Layout**

- 2 Mbps
- 5.5 Mbps
- 11 Mbps

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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
In-Building Design Considerations

- Bandwidth requirements
  - Fixed speed
  - Less distance coverage
- Third-party interoperability
- AutoRate negotiation
  - Automatic rate reduction as distance increases

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
Aironet Client Utility—Main Screen

Aironet Client Utility—Site Survey
Warehouse Design Sample

Maximum Coverage
Autorate Negotiation

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

Channel 1
Channel 11
Channel 6
Channel 1

Channel 6
Channel 1
Channel 11
Channel 6

850'

2000

Warehouse Design Sample

Maximum Coverage
Autorate Negotiation

Cabling Only Available at Store Front
Yagi Antennas and DiPole

Channel 1
Channel 11
Channel 6

Channel 6
Channel 1
Channel 11
Channel 6

850'

2000
As You Can See from the Information So Far...

Wireless LANs Are Ready for Enterprise Deployment Today!
Wireless Bridges

Point-to-Point Configuration

Building A
- Bridge
- Optional Antenna
- Ethernet

Building B

0 to 25 Miles
(Line of Sight)
Point-to-Multipoint Configuration

Building A

Building B

Building C

Omni-Directional Antenna

Directional Antenna

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 best on the market
### How Fast?
*Max Data Rate* | *Typical Throughput*
---|---
11 Mbps | 2 Mbps
5.5 Mbps | 1.4 Mbps

### How Far? (At Max. Rate)
*Yagi Antenna* | *Dish Antenna*
---|---
2 Miles | 6.5 Miles
11.5 Miles | 25+ Miles

### BR340 Wireless Bridge

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

Building-to-Building Design Considerations
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

- Signal Strength
  Strong          Med        Weak
  Low            Med        High
  More Noise, Less Bandwidth

- Noise Level
  Up to 33 Mbps

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
Path Loss Considerations

How Far Will It Go?

22 Miles?

Bridge Distance Calculations

Cisco Technical Support
For Cisco 2.4GHz Bridges ONLY
Models Supported: Cisco AIR-BR340, Aironet BR100, BR2040 and BR2000
Calculations for Maximum Distance possible with given parameters

<table>
<thead>
<tr>
<th>Select Product</th>
<th>Select Datarate</th>
<th>Select Antenna 1</th>
<th>Select Antenna 2</th>
<th>For other Antenna</th>
<th>Enter Gain Here</th>
<th>For other Antenna</th>
<th>Enter Gain Here</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR340</td>
<td>11Mb ps</td>
<td>21dBi Parabolic Dish</td>
<td>13.5dBi Yagi</td>
<td>0</td>
<td>100Ft Cisco</td>
<td>75Ft Cisco</td>
<td>50Ft Cisco</td>
</tr>
<tr>
<td>BR2040</td>
<td>5.5Mb ps</td>
<td>12dBi Omni</td>
<td>8.5dBi Patch</td>
<td>120Ft Cisco</td>
<td>100Ft Cisco</td>
<td>75Ft Cisco</td>
<td>50Ft Cisco</td>
</tr>
<tr>
<td>BR2000</td>
<td>2Mbps</td>
<td>8.5dBi Patch</td>
<td>6dBi Patch</td>
<td>20Ft Cisco</td>
<td>20Ft Cisco</td>
<td>20Ft Cisco</td>
<td>20Ft Cisco</td>
</tr>
<tr>
<td></td>
<td>1Mbps</td>
<td>6dBi Patch</td>
<td>5.2dBi Omni</td>
<td>Other</td>
<td>Other</td>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

For Non-Aironet Cable
Enter Cable Loss/100 ft here: 6.7
Enter in Length Here: 100

<table>
<thead>
<tr>
<th>Antenna 1</th>
<th>Cable 1</th>
<th>Antenna 2</th>
<th>Cable 2</th>
<th>Misc.</th>
<th>Max. Distance w/ 10dB margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parabolic Dish</td>
<td>21</td>
<td>50</td>
<td>3.35</td>
<td>Parabolic Dish</td>
<td>21</td>
</tr>
</tbody>
</table>
Building-to-Building Fresnel Zone

- Antenna height
  Line-of-site is really ellipse
  Clear of all obstacles year round
Building-to-Building Fresnel Zone

- **Antenna height**
  
  Fresnel zone consideration
  
  Line-of-site over 25 miles hard to implement

![](image1)

**Building-to-Building Antenna Height—25 Mile**

- **Antenna height**
  
  Total distance 25 Mile
  
  Fresnel zone 72 Feet
  
  Earth curvature 78 Feet
  
  Required antenna height 150 Feet

![](image2)
Bridge Application: School District

Roberts Middle School Dish
Richardson Elementary Yagi
Bode Elementary Yagi
Price Elementary Yagi

High School 2 Bridges
One 12 dB omni
One Dish
Weaver Special Education Dish
Lincoln Elementary Yagi
Bolich Middle School Yagi
Dewitt Elementary Yagi

Channel #1
Channel #6
Channel #11

Administration
2 Bridges
One 12 dB omni
One Yagi

Two Directional Antennas and Splitters?

If I Can Go 25 Miles Like This…

…Then I Should Be Able to Go 50 Here!
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
Wireless LANs Are Ready for Enterprise Deployment Today!

Other Information Areas for Wireless Systems

- Networker’s sessions:
  - Introduction to Wireless Technology (2307)
  - Deploying Mobile IP in Wireless Architectures (2306)
- Antenna calculation utility:
- Cisco wireless products:
Deploying Wireless LAN Infrastructure

Session 2309

Please Complete Your Evaluation Form

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