Deploying and Managing Wireless LANs

Session WMT-210
Wireless Is Addicting
Once You Use It
You Can’t Live without It

Wireless LANs Have Reached Maturity
They Are Ready for Your Network Today
Agenda

- WLAN Market Background
- RF Technologies FH/DS—2.4GHz/5GHz
- Cisco Wireless LAN Products
- Wireless LAN Topology Basics
- Cisco Aironet Network Services
- Wireless LAN Solutions and Design Examples
- Building-to-Building Bridge Examples

Wireless Growth

“By 2003, 20% of B2B traffic and 25% of B2C traffic will be wireless”

Meta Group Research
Wireless Growth

“By 2004 nearly 50% of business applications will be wireless”

Meta Group Research

Wireless LAN Market

“The Wireless LAN market will grow to $3 billion by 2002”

Cahners In-Stat Group
Mobility Becoming a Requirement

- People on the move
  - Business travel
  - Nomadic sales force
  - 7x24x365 availability
  - The “extended” enterprise
- Anywhere access to services and business applications
- Plethora of mobile devices and technologies available
  - Notebooks, hand-helds, cell phones, pagers

Cisco Internet Mobile Office

- Hotels
- Airports
Wireless at Home

Wireless on the Move: The Mobile Office

Anytime/Anywhere

Customer Sites
Conventions Centers
Airports
Hotel
Office at Home
Branch Offices
Head Office
Building-to-Building Wireless LAN

Instant Access to Information

Building One
- Catalyst 3500 or 2900XL Clusters
- Fast Ethernet Backbone
- Access Point
- Printer
- Workstations

Building Two
- Building-to-Building Wireless Bridge

Building-to-Building Wireless LAN
Instant Access to Information

RF Technology
What's a Wireless LAN?

- **Aironet Wireless LANs:**
  - Ethernet Speed and Range
  - Circuit and Packet Data
  - Cellular, CDPD, RAM, ARDIS

- **Broadband PCS**
- **Satellite**
- **Infrared Wireless LANs**
- **Spread Spectrum Wireless LANs**
- **Narrow Band Wireless LANs**
- **Metricom**
- **Broadband PCS**
- **Infrared Wireless LANs**

**Data Rates**
- 10 Mbps
- 4 Mbps
- 2 Mbps
- 1 Mbps
- 56 Kbps
- 19.6 Kbps
- 9.6 Kbps

**Coverage Area**

**ISM Unlicensed Frequency Bands**

- **Short-Wave Radio AM Broadcast**
- **FM Broadcast Television Cellular (840MHz)**
- **INPCS (1.9GHz)**
- **Infrared Wireless LAN**

- **Audio**
- **Extremely Low**
- **Very Low**
- **Low**
- **Medium**
- **High**
- **Very High**
- **Super High**
- **Infrared**
- **Visible Light**
- **Ultra Violet**
- **X-Rays**

- **902–928 MHz**
  - 26 MHz
- **2.4–2.4835 GHz**
  - 83.5 MHz
  - (IEEE 802.11)
- **5 GHz**
  - (IEEE 802.11)
  - HyperLAN HyperLAN2
5GHz vs. 2.4GHz

- Range of 5GHz is MUCH MUCH less—About 30%
- Overall investment of infrastructure is much higher (more APs)

2 Existing Spread Spectrum Radio Technologies

- Direct sequence spread spectrum (referred to as DS)
  - 2.4 GHz
  - Fully compliant 802.11b
  - Up to 11 Mb today
  - 22Mb + in the future
  - 25-mile bridge links

- Frequency hopping spread spectrum (referred to as FH)
  - 2.4 GHz frequency
  - Fully compliant 802.11
  - 1 and 2 Mb only today
  - 10Mb products in the future
The Present—FH vs DS

- Direct sequence
- Transmits on single 22MHz wide channel
- Different channels used for multiple transmitters
- Frequency hopping
- Transmissions change frequencies at minimum 2.5x/sec
- Different transmitters use different hopping patterns

Advantages

- Direct Sequence
  Throughput
  5–6MBps
  Scalability up to 33Mb datarate
  Range
  2x over FH
- Frequency Hopping
  Slightly lower cost
  Per piece
  ?
  ?
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

Wireless Ethernet Compatibility Alliance WECA

- Mission Statement—WECA’s mission is to certify interoperability of Wi-Fi™ (IEEE 802.11) products and to promote Wi-Fi™ as the global wireless LAN standard across all market segments
- Goal: Provide users with a comfort level for interoperability
- Presently over 100 different product certified and growing
- Supports ONLY 802.11b 11MB DS products
Wi-Fi Members

Wireless LAN Products
Cisco’s Wireless Initiatives

- Aironet/Clarity
  - Point-Point/Multipoint Wireless
  - Wireless Local Loop
- Aironet
  - Wireless LAN
- Aironet/Clarity
  - Mobile Cellular Voice/Data Communications
- Aironet/Clarity
  - Wireless Local Loop

Comprehensive Wireless LAN Solutions for Large-scale Deployment

- Centralized Access Control Servers
- Web-based Mgmt
- Access Points
- Bridges
- Advanced Network Services
- 802.11 Clients
  - PCMCIA
  - PCI
  - OEM
  - RADIUS
Cisco Aironet 350/340 Series Wireless LAN Solution

The Cisco Aironet 350/340 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

- PC card/PCI client adapters
- Access points
- Line-of-sight bridge products
- Antennas and accessories

Wireless LAN Topologies
**Shared Local Area Network (LAN)**

- Server
- Ethernet
- Shared Hub
- Internet

**Wireless Local Area Network (WLAN)**

- Server
- Ethernet
- Access Point
- Internet

*Remember: An Access Point is a SHARED Device and Has Similar Performance to a SHARED Ethernet Hub*
LAN Topologies

Peer to Peer Configuration (Ad Hoc Mode)

Typical Single Cell Configuration
Typical Multicell Configuration

- Channel 1
  - LAN Backbone
  - Wireless Cell
  - Wireless Clients

- Channel 6
  - Wireless Cell
  - Access Point

Wireless Repeater

- Channel 1
  - LAN Backbone
  - Wireless Cell
  - Access Point
  - Wireless Clients
  - Wireless Repeater
Customer Requirements for Wireless LANs

Security Requirements for WLANs

- First generation SSID
  - Static 40 or 128-bit WEP
- Cisco differentiators
  - Centralized user-based authentication (ACS2000 v2.6) integrated with network logon
  - Dynamic 128-bit WEP
  - Encryption done in h/w
  - VPN
  - Access control lists
- Future plans
  - Rogue AP detection
  - 3rd party RADIUS server support
  - Policy framework

“Wireless is like having an RJ45 in my Parking Lot.”
Reliability Requirements for WLANs

- Auto data-rate negotiation
- Site survey and spectrum analysis tools
- Product differentiators
  - Radio power and quality
  - Load balancing and hot standby redundancy
  - Broad range of antennas
  - Partners for site surveys
  - Channel agility
  - Interference management

“Sometimes it works; sometimes it doesn’t.”

Performance Requirements for WLANs

- NICs under $200
- Integrated chip sets for lower costs
- WI-Fi/802.11b for 11 Mbps performance
- Multiple channel support for higher aggregate throughput
- Ease of wireless integration with switched 10/100 network
- Future plans for upgrades
  - 22 Mbps with backward compatibility to 11 Mbps in the 2.4 GHz spectrum

“Too expensive and too slow.”
Interoperability Requirements for WLANs

- Basic 802.11 interoperability via WECA certifications
- Vendor specific extensions
  - Security
  - Roaming
- Most WLAN vendors offer client and infrastructure to guarantee single vendor solution

Management Requirements for WLANs

- Standard MIBs
- Sniffer and 3rd party tools for analysis
- Vendor differentiators
  - Management integration
  - CDP support and auto discovery
  - Web-based management
  - Common enterprise security framework for wired and wireless
  - Client side utilities and profile management
- Future plans
  - Radio spectrum management
  - Policy-based security

"Different Vendors' Products Don't Work Together."

"A Whole New Ball Game for Debugging and Troubleshooting."
Deployment Requirements for WLANs

- Site survey tools
- Trained partners
- World mode for auto localization
- Wide selection of antennas
- Broad client and OS support
- In-line power
- Plenum-rated access point

Scalability Requirements for WLANs

- Robust roaming for seamless handoff between access point
- Centralized user-based authentication
- Dynamic WEP key distribution and management
- Wireless mobile IP support
- Client support for all popular operating systems
QoS Requirements for WLANs

- Support for 802.11b phones
  - Spectralink
  - Symbol Netvision
- Extensive filtering capabilities
- Standards efforts on QoS (PCF, DCF)
- Support for 802.1p/Q and spanning tree per VLAN
- IP phones integrated with application such as Cisco Call Manager
- Inter-subnet roaming and mobile IP services

“Can I Support Critical Applications?”

Network Services that should Be Part of Your WLAN

- Scalable, extensible security
- Load balancing and redundancy
- WLAN management
- WLAN roaming
- QoS
If We Can Overcome All These Requirements Wouldn’t You Agree that...

**Wireless Is Ready for Your Network**

Design Issues
Designing Wireless Systems

- Key issues for designing wireless systems:
  - Required bandwidth per user
  - Connectivity
  - Security
  - Redundancy
  - Specific physical installation requirements

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)
Centralized User-Based Authentication

Semi-Public Network/Enterprise Edge

EAP over Wireless/LAN (EAPOL/EAPOW)

Supplicant

EAP over Radius

Enterprise Intranet

RADIUS

Authentication Server Such as ACS2000 v2.6

Extended Enterprise (Branch Office, Home, etc.)

Authenticator (e.g. Access Point, Catalyst Switch)

Dynamic WEP Key Management

Laptop computer

Fast Ethernet

802.11 Associate

EAPOL-Start

EAP-Request/Identity

EAPW-Key (WEP)

Access Blocked

Access Allowed

RADIUS
AC Power Requirements

- Cost of AC cabling is astronomical
- As much as $30K for a building like Ciscos 4 story building #19 in San Jose
- In line power will reduce this cost
- Cisco end-to-end solution
Aironet 350 Ethernet In-Line Power

Ethernet In-line Power Source:
- Catalyst 3524 Power Switch
- Catalyst 6000 Power Blade
- Catalyst 4000 Power Blade
- 48 Port Power Patch Panel

Ethernet In-line Power Source:
- Aironet Power Injector

- Aironet 350 uses Ethernet in-line power only
- Eliminates need for local power and AC infrastructure cost
- Draws in-line power from edge devices (-48 Volts)
- Catalyst power switches support device discovery mode

Cost-effective WLAN Building Block

- Up to 11 Mbps peak data rate
- Graceful degradation based on distance and error rate
- Support for 1, 2, 5.5 and 11 Mbps performance
- Web-based management
- Lower total cost of ownership
Instant Branch Office Using WLAN

- 50– to– 150-user network
- WLAN AP powered using in-line power from 3524-PWR
- Cisco 1700/2600 for WAN access

A Growing Small Business with Integrated WLAN

- 50- to 250-user network
- 10/100 connectivity with stacked Catalyst 3500 XLs
- WLAN AP powered using in-line power from 3524-PWR
- Cisco 1700/2600 for WAN access
Campus WLAN Design

- Catalyst 3500XL Stacks/Clusters
- Catalyst 6500 Campus Backbone
- Cisco 7xxx WAN Aggregation
- B/W Reservation
- TOS Mapping WRR
- Classification Queuing
- IP Phones
- Workstations
- Printer
- Servers
- Cisco CallManager
- Cache Engine (Optional)
- Wireless Section
- Campus Backbone
- Catalyst 4000 Wiring Closet
- Powerful Diagnostics and Troubleshooting Tools
- Web-based WLAN Management
- Support for Std MIBs CDP MIB, and 802.11 MIB
- Site-survey tools
- Client-side utilities
- Auto-localization and channel agility
Office Design Issues

Obstacles and Challenges

- Provide 10BaseT like Ethernet speeds
- Provide seamless roaming
- Provide wireless connections campus wide
- Integrate into existing network management
- Secure RF link using 128 bit WEP
Wireless Benefits Study

• Conducted survey during pilot in Dec ’99–Jan ’00 to assess effectiveness at a large software company
• About 600 users, 36% product managers, 23% software engineers, 20% test engineers
• Used wireless 1–3 hours per day, saving 1.5 hours per day
• About 2/3 felt could use wireless entirely
• About 88% interested in wireless home use
• Advantages: Reduced cable clutter, demos, common areas, roaming ability

Design for ‘Standard’ Office Study

• Standard office usage:
  • 20–25 users per AP
  • Determine population density
  • Determine maximum cell size
  • Select appropriate antenna
    Typically Omnis, squint ceiling mount and patch antennas are used in offices
Installation/Deployment for Study

- Above ceiling required plenum ratings
- The electrical contractor installed APs, cat5 cable, power, NEMA enclosures
  Many APs are now plenum rated—look for these if the installation requires
- The installation team configured APs, installed and configured switches and terminal servers, patch panel cabling, set RF channels, conducted site survey
  Complete turnkey system

Standard Office Application

- Use three non-overlapping channels
- Rotate channels to fill in
Dense Populations

- Trading stock floor issue:
  - 1000 users in 300x300 facility
  - Need 9 APs in the area to provide bandwidth that is defined by customer
  - 3 or 4 APs will cover the system (in range)
- How do we get more bandwidth

Dense Population of Users

- There are only 3 non-overlapping channels
- 4 APs will cover the entire building with attached dipole antennas
Dense Populations

- Reduce cell size
- Reduce antenna gain or transmitter power to create smaller cell size
- Enable Load Balancing

Dynamic Bandwidth

- Best for high-performance requirements
- Requires two Aironet 350 access-points
- Seamless and transparent load balancing between up to three Active units
WLAN Building Block for High Aggregation

- Up to 33 Mbps peak data rate
- Load Balancing and redundancy
- Policy based on number of users, bit error rate, or signal strength
- Web-based management
- Very high aggregation with sectored antennas

Mission Critical Application

- Redundancy requirements
- Healthcare ICU/ER
- Production flow Automotive—JIT
High Availability WLAN Building Block

- 1 hot standby AP per channel
- Tolerant to any single AP or link or switch failure
- Web-based management

Education Market Designs
Obstacles and Challenges

- Requirements for spontaneous use and user mobility
- Eliminate constant move, add and changes
- Requirement for good network performance based on applications in use
- Severe cost/performance/convenience issues with wireless prior to 11-Mbps DSSS

Common Requirements

- Provide internet connectivity to all students
- Provide network access to teachers in ever changing environment
- Provide cost effective system
- Provide mobile IP phone connectivity
Education Applications

- Tie schools together for internet (Bridging)
- Connect remote classrooms (portables) to main building
- Provide portable network connection to students

Campus Wide Wireless Access

Greenville College

Outdoor Access Throughout the Campus Grounds

Indoor Access within all Buildings on Campus
Cost Effective Wireless Classroom

• Mobility: Allows teachers to have internet access anywhere within the school
• Cost: A dedicated computer room is not needed for internet access
• One Ethernet drop per classroom make any classroom a computer lab
• Concept: Bring the lab to the student

Education Design Sample

Maximum Coverage
Autorate Negotiation

Wireless for Students
DiPole Indoor, Patch Outdoor

Class 1
Class 2
Class 3
Class 4

Class 5
Class 6
Class 7
Class 8

Class 9
Class 10
Class 11

Hallway 1000'

850'

Building 1000'

Courtyard 1000'

Channel 1

Channel 11

Channel 6

Channel 1

Channel 11

Channel 6
Retail/Manufacturing

Retail Challenges and Obstacles

- Real-time updates for bar coding applications, including:
  - Price shelf audits—verifies register price matches shelf labels (products no longer individually labeled)
  - Price labeling—change shelf price, produce new label, and update cash register all within seconds
  - Inventory—fewer errors, faster restock
  - Faster ‘Letdowns’ and ‘Putaways’ in and out of stock areas
Retail and Warehousing

- POS/cash register downloads
  - Update new pricing structures in real-time from a central site
- Customer kiosks
  - Provide coupon generation, based on demographics
  - Customer price verification
- Lift truck terminals

Wireless ROI (Why They Purchase)

- RF price label tags—
  - Cut man hours
  - More product information (i.e. pricing per unit)
  - Immediate price change from a central site
- Multi-vendor end node devices—
  - Propriety solutions are falling to the way side
  - Allows the best technology devices
  - Leverage multiple manufactures for best pricing
- Fewer lost goods in warehouse
- Over all lower cost of ownership
New “Customer Focused” Ventures

- Interactive touch display attached to cart providing
  - Store directory
  - Product information
  - Associated products
    - *ROI—Paid advertisements from major manufacturers
- Web touch-screen stations for Internet services—
  - Locate manufacture information
  - Price and value comparison
  - Manufactures receive orders direct
    - Combined with a CDN solution, retailers have the ability to mine data that the internet users are referencing
- PDA internet access—
  - Customer bring in their .11b PDA with their shopping lists shopping map to benefit the customers’ experiences

Retail Design Issues

- Range
  - Many times retail and Warehousing do not require high bandwidth
- Cost
  - Always a factor—Sometimes margins are only 2–4%
- Ergonomics
  - Must blend into retail—‘Out of sight—out of mind’
- Multi-vendor operation
  - Barcode scanners and specialty devices
Retail Design Parking Lot

Spontaneous Coverage
Repeater Mode

Extend Wireless Coverage
when Needed...

No LAN Wiring

Parking Lot

Warehouse Design Sample

Maximum Coverage
Autorate Negotiation

Cabling Only Available at Store Front

Yagi Antennas and Dipole

Channel 1

Channel 11

Channel 6

850'

2000'

Channel 1

Channel 11

Channel 6
Multipath Distortion

Ceiling

TX

Obstruction

Floor

Received Signals

Time

Combined Results

Time

Diversity and Multipath

• In a multipath environment, signal null points are located throughout the area
  
• Moving the antenna slightly will allow you to move out of a null point and receive the signal correctly
  
• Dual diversity antennas typically mean if one antenna is in a null, the other one will not be, therefore providing better performance in multipath environments
Internet Mobile Office for the Hospitality Market

Obstacles and Challenges

- Providing seamless RF coverage throughout the property
- Security issues
- Billing/revenue sharing for the property
- Compatibility concerns w/802.11b cards from disparate vendors
Obstacles and Challenges

- Eliminate constant move, adds and changes
- Provide guests with total internet mobility

Two Phase Connectivity

- Phase one
  Hotel provides connectivity the internet
  In-room, meeting rooms
- Phase two
  Corporation provides connectivity back into company
  Secure VPN tunnels
  Killer application
Phase One

- In-room connectivity
  No changes to laptops
  Plug and Play
  Ubiquitous availability

- Meeting rooms
  High density
  Wires not an option

Wireless Computer Details

- Laptops without NICs
- Ethernet cable attaches Computer to wireless station

- Laptops with NICs
- IEEE 802.11B compliant
- Full roaming
Cisco Hotel Networking Solutions

- Cisco subscriber gateway
  - Integrated with hotel billing
  - Plug-and-play for guests
  - Security for guests and hotel
  - Advertising portal
  - Guest network service registration
- Meeting rooms
  - Hard wired
  - Wireless
- Guest rooms
  - Long reach Ethernet
  - Wireless
  - Cable
  - Cat 5 Ethernet

Current Cisco Hotel Networking Solutions

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<thead>
<tr>
<th>Wireless</th>
<th>Cable</th>
<th>Wired Ethernet</th>
<th>Long Reach Ethernet</th>
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</thead>
<tbody>
<tr>
<td>Meeting Rooms and In-Room</td>
<td>In-Room</td>
<td>In-Room</td>
<td>In-Room</td>
</tr>
<tr>
<td>Bar, Dining, Pool, Health Club</td>
<td>Uses Existing Wiring (Coax)</td>
<td>Requires Cat 5</td>
<td>Uses Existing telephone</td>
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<tr>
<td>IEEE 802.11B 11 Mbps</td>
<td>May Not Be Owned by Hotel</td>
<td>Multimedia Support</td>
<td>Wiring Cat3</td>
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<tr>
<td>Requires Wireless NIC</td>
<td>Internet Access</td>
<td>10–100 Mbps</td>
<td>10–26 Mbps</td>
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<td></td>
<td></td>
<td>Subscriber Gateway</td>
<td>Multimedia Support</td>
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<td></td>
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<td>Self-Enrollment</td>
<td>Self-Enrollment</td>
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</table>
Wireless Solution

Advantages

• No wires to end devices
• Excellent mobility
• Minimal new wiring required
  Only to access points

Disadvantages

• Open infrastructure
  PC provides protection
• Shared bandwidth
  No MultiMedia

Wireless Room Details

Hotel
Guest Floor

Main Closet

Guest Room

PC Connection

200'
As You Can See So Far...

Wireless Has Come a Long Way

Wireless LANs Are Ready for Your Deployment...

Today

Management Requirements
Web-Based Management

- Advantages of browser access point management
  - Easy, fast configuration
  - Use any workstation on the network
  - No special software required

SNMP

- Standard MIB support
- 802.11 MIB support
- Ability to configure devices
- Traps for events
‘Extra’ Features to Look For

• Ability to ‘distribute’ new firmware or configuration files to all APs
• RF link testing
• SYSLOG functions for logging
• ‘World Mode’ for international companies

Client Side Management

• GUI configuration tool
• Ability to change configuration/profile
• Encryption settings
• Site survey tools
Wireless ‘Sniffers’

- Two new recent products on the market
  
  Network Associates **Sniffer Pro**
  
  AiroPeek from Wildpackets
  
- Permits over the air packet sniffing, including 802.11 packets

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Wireless Bridges
Cisco BR350 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

Optional Antennas for Long Range

- 13.5dBi Yagi
  - 18 in. Long, 3in. Diameter
  - Distances over
  - 11.5 Miles @ 2 Mbps and
  - 5.7 Miles @11 MB

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

Note: Distances calculated using Cisco BR350, and include identical antennas on each site, 20 feet of Cisco Low Loss Cable (6.7dB/100 ft) and 10dB fade margin
Bridging Applications

Site-to-Site P2P Design Sample

- **Required distance**
  - ½ Mile
- **Building A**
  - Antenna 8.5 dBi patch
  - Antenna height—13’
  - Cable—20’
- **Building B**
  - Antenna 8.5 dBi patch
  - Antenna height—13’
  - Cable—50’
- **Possible distance**
  - 11 Mbps—.81 miles
  - 2 Mbps—2.57 miles
**Campus WLAN**

Channel 1

Omni-Directional Antenna

Channel 1

Main Office

<1 Mile

Bldg 1

<1 mile

Bldg 2

<1 mile

Bldg 3

Local Area Network

**School-to-School WLAN**

Channel 1

11 Mbps data rate up to 25 miles line of sight

School 1

Channel 6

11 Mbps data rate up to 25 miles line of sight

Switch/Router

Local Area Network

District Office

School 2
Case Study: Truck Stops

- Truckstops of America
- Petro stopping centers
- Bridges replaced dial-up modems at remote buildings
- Real-time connectivity to all POS locations
- Operational savings: cost of phone lines
- Installation savings: cost of trenching

San Antonio Emergency System

- Bridges used to connect EMS vehicle to existing Highway Infrastructure
- Infrastructure has a bridge every 1 mile of highway—tied into camera/traffic routing infrastructure
- 400+ bridges installed throughout the main highway links
- Ambulance has a bridge tied to camera/patient monitoring equipment
- Provides video tele-conference link between Hospital and Paramedics/patients
Bridge Design Issues

What Bridges Are/Are Not

- Bridges are typically part of a **fixed** Wireless system
- They are not intended as ‘city wide’ devices
- Designed to provide 11Mb datarate for the ‘system’, in a shared environment
- Designed for ranges up to about 25 miles
Building-to-Building Interference Considerations

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

Interference

- This is an unlicensed band
- In some cases there may be other users in the area
- A good spectral search should be done
- Selection proper antennas and sites
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, water

*Radio LOS Is Not the Same as Visual LOS: Fresnel Zone

Fresnel Zone

Fresnel Zone: is an elliptical area immediately surrounding the visual path—It varies depending on the length of the signal path and the frequency of the signal—The Fresnel zone can be calculated, and it must be taken into account when designing a wireless link.
Improving Fresnel Effect

- Raise the antenna mounting point on the existing structure
- Build a new structure, i.e. radio tower, tall enough to mount the antenna
- Increase the height of an existing tower
- Locate a different mounting point, for the antenna
- Cut down problem trees

Site to Site Fresnel Zone

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

Antenna Height (Value “H”) Total Distance

Fresnel @ 60% (Value “F”) Earth Curvature (Value “C”)
Bandwidth

- Bridges operate in a shared mode
  - 4 bridges connected to a single central bridge results in a shared 11Mb network
  - Worst case provides a total of 2.75Mb per remote site
  - To increase this, add a second central bridge, on a separate channel—Assign a different SSID to this bridge and to two of the remote sites

Range Calculator

- Theoretical distance can be calculated
- Make sure to include cable losses and use antenna gain in dBi
- Add in, at minimum, 10dB for environmental fade margin
- Cisco outdoor bridge range calculator is located at:
Last Mile Designs

- Shared connections to POP
- Line of sight required—Requires external antennas and towers in some cases
- Customer premises devices
  - Cost effective—
  - Easy to install—No truck rolls

Wide Area Designs

- Use 120 degree sectorial antennas
- Place 3 bridges at a site
- Provides a full 360 degree coverage, and 33Mb aggregate datarate
- Average range will vary based on antennas
Antenna Issues

- Antennas have both horizontal and vertical beamwidth
- In outdoor applications **downtilt** plays an important part
- Provides coverage and dead spots both

![Antenna Beamwidth Diagram](image)

Wide Area Design (con’t)

- Using the previous setup, reuse the channels
- Place cells to prevent overlapping coverage
- Provides wide area coverage
Cisco Airwaves of the Future

WLAN Vision: Performance

- Higher performance
- Backward compatibility
- Multi-band options

<table>
<thead>
<tr>
<th>Speed</th>
<th>Network</th>
<th>Radio</th>
</tr>
</thead>
<tbody>
<tr>
<td>11Mbps</td>
<td>802.11b Standard</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>22+Mbps</td>
<td>.11b Ext.</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>6-54 Mbps</td>
<td>.11a Standard</td>
<td>5 GHz</td>
</tr>
<tr>
<td>100 Mbps</td>
<td>Superset</td>
<td>5 GHz</td>
</tr>
</tbody>
</table>

- IEEE 802.11a/b Ratified

- 1999 2000 2001 2002
WLAN Vision: Client Options

- Ethernet clients
  Plug and play wireless
- Multi-function client devices
- Embedded wireless
  OEM to laptop vendors
- Client drivers/services
  Macintosh/Linux drivers
- Automatic profile manager
  (home, office, public access)

AP Authentication and Rogue AP Detection

- Only IT installed/configured devices deliver infrastructure access
  Authenticated clients learn trusted APs in area
- Untrusted APs are detected, reported and if possible isolated and shut down
- Investigating best way to control non-desired APs
Cisco Integrated Solution

Cisco Delivers Wired and Wireless End-to-End Solution for Voice, Video and Data

Enterprise Campus
- Cisco 7xxx
- Catalyst 6500
- Campus Backbone
- Cluster of Switches
- Servers
- Call Manager
- Workstations/IP Phone
- Ethernet Switches
- 10/100 Hubs
- 10/100 Switches
- 10/100 Switches
- Wireless Access Points

Enterprise Branch SMB
- Cisco 17xx/26xx/36xx
- WAN Access
- Cluster of Switches
- WAN Aggregation
- LAN PBX
- Servers
- Call Manager
- Workstations/IP Phone
- Ethernet Switches
- 10/100 Hubs
- 10/100 Switches
- 10/100 Switches
- Wireless Access Points

Summary

- 2.4 GHz products are mature
- WLAN products are very stable
- 11 MB performance is here now
- IEEE 802.11b is the industry standard
- Wi-Fi has given customer confidence
- Customer/industry acceptance
Wireless LANs Have Reached Maturity
They are Ready for Your Network
Today!

For More Information…

- Wireless pages
  http://www.cisco.com/warp/public/cc/pd/witc/a
  o340ap/index.shtml
  http://www.cisco.com/warp/public/cc/pd/witc/a
  o350ap/index.shtml

- Customer profiles
  http://www.cisco.com/warp/public/cc/pd/witc/a
  o340ap/profiles/index.shtml

- Outdoor bridge range calculator
  http://www.cisco.com/warp/public/cc/pd/witc/a
  o340ap/prodlit/index.shtml
For More Wireless Information...

- Other networkers breakout sessions on wireless:
  - WMT-101—Introduction to wireless access technology
  - WMT-230—Deploying fixed wireless wide area networks
  - WMT-240—Deploying mobile wireless applications and services
  - WMT-241—Deploying packet data services in mobile wireless networks
  - WMT-31—Troubleshooting wireless LANs

Don’t Delay—Get “UN”-Hooked with Wireless...

Today

Cat 5
Please Complete Your Evaluation Form
Session WMT-210

Deploying and Managing Wireless LANs
Session WMT-210