Design of Metropolitan Broadband Wireless Networks

BRKAGG-2017
Your Sessions Presenters
From Cisco Systems

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Before this Session Starts...

- Please turn off your phone
Agenda

- Role of Broadband Wireless
- Outdoor WiFi Mesh
- WiMAX
- Service Exchange Framework

Associated Sessions and Recommended Readings

- **Associated Sessions**
  - BRKAGG-2010 Design and Deployment of Enterprise WLANs
  - TECAGG-2001 Design and Deployment of Enterprise WLANs with Centralized Controllers

- **Prerequisites**
  - BRKAGG-2014 Design and Deployment of WLAN Security Fundamentals
The Role of Broadband Wireless

Cisco’s Vision for Service Providers
Linking People, Businesses, Cultures, and Countries Through Networks and Services to Deliver the Connected Life
The Connected Life
Will be delivered by service providers who evolve and adapt to provide their customers with:

<table>
<thead>
<tr>
<th>What They Want</th>
<th>When They Want It</th>
<th>Where They Want It</th>
<th>How They Want It</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad Choice</td>
<td>On Demand</td>
<td>Everywhere</td>
<td>Flexible</td>
</tr>
<tr>
<td>Personalized and Simple</td>
<td>Available Always</td>
<td>Any Service, Anywhere</td>
<td>No Platform, Access or Bundle Restrictions</td>
</tr>
</tbody>
</table>

Delivering an experience, not a connection...

The Connected Life
Broadband access is a key enabler of the connected life.

Allowing service innovation to increase alongside bandwidth
Introducing Cisco Broadband Wireless
The Industry’s First End-to-End IP NGN Solution with Integrated Mobile WiMAX and WiFi Mesh Access

Integrating both licensed and unlicensed access technologies into a converged IP service delivery architecture

WiFi-Mesh or WiMAX?
Positioning WiFi-Mesh Against WiMAX

- WiMAX and WiFi Mesh are broadband wireless solutions serving distinct market segments

<table>
<thead>
<tr>
<th>Spectrum</th>
<th>WiMAX</th>
<th>WiFi Mesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basestation Coverage</td>
<td>Licensed</td>
<td>Unlicensed</td>
</tr>
<tr>
<td>Characterization</td>
<td>WAN / MAN</td>
<td>LAN / MAN</td>
</tr>
<tr>
<td>Markets</td>
<td>Digital inclusion, Wireless broadband for business and consumer services, 3G spectrum offload</td>
<td>Municipal WiFi deployments, Enterprise, university, and government campuses</td>
</tr>
<tr>
<td>Interested Parties</td>
<td>Greenfield operators, Incumbent operators for quad-play service delivery, Mobile operators who’ve not invested in 3G spectrum</td>
<td>Municipalities for safety, efficiency, and competitive services, Large enterprises, campuses, Challenger service providers</td>
</tr>
</tbody>
</table>
Outdoor Wireless Mesh

Other Wireless Possibilities

Repeater (lan-to-lan)

Multi-Band Distribution and Access

Relay (lan-to-lan)
Advanced Wireless Bridging/Mesh Architectures

- **RAP**: Root Access Point
- **MAP**: Mesh Access Point

Going Further with Wireless Mesh Access

- **PoP**
- **P2P**
- **5GHz OR WiMAX**
- **2.4GHz**
Outdoor Wireless Products

- Cisco has a comprehensive suite of products for Outdoor Wireless connectivity
  - AP1524 MESH
  - AP1522 MESH
  - AP1510 MESH
  - AP1242/AP1131 indoor Mesh (iMesh)
  - BR1310 2.4GHz Bridging
  - BR1410 5GHz Bridging
  - 3270 Mobile Access Router

The Industry’s 1st Intelligent Wireless Mesh Solution

- Engineered for ease of deployment and management
  - Identical indoor/outdoor management
  - Based on LWAPP (Capwap RFC)

- Self-configuring, self-healing Mesh
  - Zero-touch configuration
  - Cisco’s Adaptive Wireless Path (AWPP) Protocol for fault-tolerant Mesh deployments (base of future 802.11s)

- Robust embedded security
  - EAP Fast encrypted Backhaul links
  - Embedded 802.11i

- Provides seamless L3 mobility
  - Fast, secure intra and inter subnet roaming, maintaining 802.1x security
Mesh Overview

Outdoor Wireless Mesh Solution Components

**Mesh Access Point**
- 802.11b/g client access
- Connects to Root AP via 802.11a
- AC/DC power, PoE capable
- Ethernet port for connecting peripheral devices (POE)
- Battery backup

**Root Access Point**
- Serves as “Root” AP to the wired network
- Typically located on roof-tops or towers
- Connects up to 35 Mesh APs using 802.11a
- Access QoS and encryption

**Wireless LAN Controller**
- 7600 Module
- Links Wireless Mesh APs to wired network
- Handles RF algorithms and optimization
- Seamless WiFi mobility
- Provides security/mobility mgmt

**Wireless Control System (WCS)**
- Wireless Mesh Management System enables network-wide policy configuration and device management
- SNMPv3, Syslog, IPSec, AAA, etc

**Back Office Systems**
- Bandwidth Monitoring and Management
- Policy Definitions
- Subscriber Database Management
- Billing and OSS Systems

**Industry Proven Devices at Every Layer**
- Reliable Hardware

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Dynamic, Intelligent Path Selection
Cisco Extends Routing Leadership to Wireless

- Adaptive Wireless Path Protocol (AWPP)
  - Cisco AWPP is part of the IEEE 802.11s committee
- AWPP establishes an best (easiest) path to the Root
- Background Scanning maintains neighbor and feasible successor list
- Optimal parent selection selects the path ease across each available backhaul channel
- AWPP integrates 802.11h DFS for radar detection and avoidance

Note: AWPP Uses a “Parent Sticky” Value to Mitigate Route Flaps

Mesh Easily Scales as the Network Grows

- Increase AP density
- Add additional RAPs
  - Mesh APs will join new RAPs with better path metrics
- Easily add Controllers
  - Up to 24 Controllers can be part of an N+1 cluster
- Up to 3 Mobility Groups
  - (24 Controllers in each Mobility Group)
- Architecture is ready for additional radios when extra capacity is required
- Mesh radio links can be viewed and managed graphically using WCS
- WCS Navigator manages up to 20 WCSs & 20,000 APs
Cisco Wireless Controller Family
4400, WISM(6500/7600) & 2106 Platforms supported for Mesh

Network Device Limits

4400 (100 APs)
- RAPs: 1
- MAPs: 149
- ISR WLC Module: 6 AP
- REAP: 6 APs

3750G WLC Switch
- 25-50AP
- 75
- 375

Cisco 4404
- 100 APs

Cisco WISM
- 300 APs

Deployment Size

1-2 APs >=2-6 APs >=12 APs >=25 APs >=100 APs

Cisco 4402
- 25 APs
- 50 APs
- 100 APs

Cisco 4402-12
- 12 APs

Cisco 4402-25
- 25 APs

Cisco 4402-50
- 25 APs

Cisco 4400 (100 APs)

RAPS Are Counted as 1, Since MAPs Are Not Connected Directly to the Controller, Each MAP Is Considered as .5 (Half) an AP for the Purposes of Supported Controller Count

X + 0.5 Y = Supported AP Count
Key: X = RAP, Y = MAP

Providing Security at Each Step
The Most Robust Security in the Outdoor Wireless Industry

- EAP encrypted backhaul links
- Honey pot AP detection and blacklisting
- Encrypted control traffic between AP and Controller
- Integrated Wireless IDS and Attack correlation software
- Dynamic WLAN VLAN assignment + 802.11i WPA/WPA2 security
- Mobile IPSec VPNs for "confidential" mesh client traffic

Cisco's new Mobile VPN Client uninterrupted IPSec roaming between Wi-Fi, cellular, etc. networks

Secure Control
Delivering Mission-Critical Wi-Fi Access
Mesh Backhaul Security
Minimum Configuration for Provisioning Security

- EAP Authentication of APs
  - Certificate-based Authentication of APs
  - 4-way handshake and key derivation
- PSK Authentication
  - Hard Coded Pre Shared Key (PMK)
  - 4-way handshake and key derivation

Mesh Platforms
Announcing: Next Generation Wireless Broadband Platform

Versatile  Extensible  Fortified

Cisco Aironet® 1520 Series

Cisco Aironet 1520 Series: Platform Introduction

Versatile  Extensible  Fortified

- Universal radio slot allows rapid deployment of new radio technology
- Radio modularity (1524) provides flexibility to meet dynamic customer requirements
- Easily extends services integrating 3rd party applications IP devices (video cameras, automated meter reader, etc.)
- Rugged NEMA 4X enclosure
- Cisco Unified Wireless Network/Cisco Self-Defending Network Architecture
Cisco 1520 Series: Platform Overview

- Next-generation outdoor mesh AP portfolio
  - New Cisco IOS® software platform
  - Modularity for increased flexibility
- Enhanced capabilities to support muni wireless and enterprise campus mesh
- Extension to new markets
  - Service provider and cable MSO
  - Public safety
  - Industrial wireless verticals
  - Oil and gas, mining, power and utilities
Cisco 1520 Series: Platform Overview (Cont.)

- **Flexible backhaul/uplink options**
  - Fiber interface with SFP port
  - 1000BT Gig Ethernet
  - Cable modem DOCSIS 2.0 with cable power
- **Integrated battery backup option**
- **PoE out (802.3af) to connect and power devices**
- **Power input options**
  - AC: 90–480 VAC
  - DC: 48 VDC PoE power injector
  - 12 VDC for powering from alternative sources
  - Cable power (PoC)

**Ruggedized enclosure**
- -40 to +55°C with solar loading
- IP67, NEMA-4X
- 165 mph wind gusts, 100 mph sustained winds
- Hazardous safe option
  - Class 1, zone 2/division 2
  - (specific part number required)

- **LEDs for troubleshooting**
- **Reset Button**
- **Paintable chassis**
- **FIPS-140-2 certifiable**
Cisco 1520 Multi-Radio Platform

- Multi-radio mesh platform up to 4 radios
- 5 levels of transmit power
  - 5.8GHz: 28 dBm
  - 2.4GHz: 28 dBm / 14dBm ETSI
  - 4.9GHz: 26 dBm (Mask M), 20/10/5 MHz channels
- Multiple Antennas for Maximizing Rx Sensitivity (MRC)
- Improved client coverage, throughput and link reliability
- AP1524
  - Public Safety configuration supports 3 Radios
  - Band-specific radios 802.11b/g-2.4GHz (Access), 802.11a-4.9 GHz (Access), 802.11a-5.8GHz (Backhaul)
- AP1522
  - Supports 2 Radios
  - 802.11b/g 2.4 GHz (Access), 802.11a–4.9 to 5.8 GHz (Backhaul)

Cisco 1524 Public Safety Solution

- Dedicated 4.9 GHz radio
  - Single AP for both Public Safety and public access supports Public-Private partnership business models
- 5, 10, and 20 MHz-wide channels for greater channelization
- High-speed roaming with MAR 3200
- 5.8 GHz Backhaul
- 2.4GHz Public Access
- 4.9 GHz Public Safety
- Cisco 3200 Mobile Router
- 2.4, 4.9, or 5GHz Vehicle Access Point
- 4.9GHz Client Card 3rd Party
Current State of 5 GHz Bridging Spectrum

**US (FCC)**
- Radiated Power EIRP (with Antenna) 33 dBm + Unlimited Antenna Gain
- UNII-1: 17 dBm
- UNII-2: 27 dBm
- TXmax: 26 dBm
- 8 Channels

**Europe**
- Radiated Power EIRP (with Antenna)
- UNII-1: 17 dBm
- UNII-2: 27 dBm
- TXmax: 22 dBm
- 11 Channels

**Japan**
- Hub Radios Licensed
- DFS + TPC
- Dynamic Frequency Selection (DFS)
- Target Power Control (TPC)
- Dynamic Range of 6 dB provided for every Antenna for Static TPC

4.9 GHz Channels

<table>
<thead>
<tr>
<th>Center Frequency (MHz)</th>
<th>5 MHz Channel Number</th>
<th>10 MHz Channel Number</th>
<th>20 MHz Channel Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4942.5</td>
<td>1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>4945</td>
<td>2</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>4947.5</td>
<td>3</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>4950</td>
<td>4</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>4952.5</td>
<td>5</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>4955</td>
<td>6</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>4957.5</td>
<td>7</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>4960</td>
<td>8</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>4965</td>
<td>9</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>4967.5</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bandwidth**
- 5 MHz: 1.5, 2.25, 3, 4.5, 6*, 9, 12, 13.5
- 10 MHz: 3, 4.5, 6, 9, 12*, 18, 24, 27
- 20 MHz: 6, 9, 12, 18, 24*, 36, 48, 54

**Note**: default Mesh Backhaul rate
Orderable Antennas

2.4 GHz Antennas

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR-ANT2450V-N</td>
<td>2.4 GHz, 5 dBi Compact Omni-Directional</td>
</tr>
<tr>
<td>AIR-ANT2480V-N</td>
<td>2.4 GHz, 8 dBi Omni-Directional</td>
</tr>
</tbody>
</table>

4.9/5 GHz Antennas

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR-ANT5180V-N</td>
<td>4.9 to 5.85 GHz, 8 dBi Compact Omni-Directional</td>
</tr>
<tr>
<td>AIR-ANT58G10SSA-N</td>
<td>5.725 to 5.825 GHz, 9.5 dBi Sector</td>
</tr>
<tr>
<td>AIR-ANT5114P-N</td>
<td>4.9 to 5.85 GHz, 14 dBi Patch</td>
</tr>
<tr>
<td>AIR-ANT5117S-N</td>
<td>4.9 to 5.85 GHz, 17 dBi 90° Sector</td>
</tr>
</tbody>
</table>

“Compact” Antennas Mount Directly on the Access Point (10.8”)

Non-Cisco Antenna/Cable Support

- RF connectivity and compliance is customer’s responsibility
- Cisco doesn’t track or have any idea about the quality, performance or reliability of the Non Certified Antennas/Cables
- Cisco Technical Assistance Center will have no training or customer history with regard to non-Cisco antennas/cables
- Cisco’s compliance is only guaranteed with Cisco antennas or antennas that are of the same design and gain as Cisco antennas
- The Cable Loss reduces the Effective Isotropic Radiated Power coming out from Antenna
### Full Interoperability

Full Interoperability Between 1524, 1522, 1510, 1242, 1131

<table>
<thead>
<tr>
<th>RAP</th>
<th>MAP 1505</th>
<th>MAP 1510</th>
<th>MAP 1522</th>
<th>MAP 1524</th>
<th>MAP 1242</th>
<th>MAP 1131</th>
</tr>
</thead>
<tbody>
<tr>
<td>1505</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
</tr>
<tr>
<td>1510</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>1522</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>1524</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>1242</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>1131</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

- **1524** and **1522** support Full Interoperability between 1524, 1522, 1510, 1242, and 1131.
- **1510** supports all except 1131.
- **1522** supports all except 1131.
- **1242** supports all except 1131.
- **1131** supports Full Interoperability with 1524, 1522, 1510, 1242, and 1131.

### Universal Access

Backhaul radio allows Client Association

- Allows both 2.4 and 5/4.9 GHz clients on the same AP

Backhaul radio beacons for clients

Channel for client access is same as being used for Backhaul

(Note: Performance may be impacted)

If backhaul radio is used in 4.9 GHz licensed band, non-PS traffic CANNOT be given Access (e.g. no Public traffic on 2.4 GHz)

**Note:** Universal Access only available on 1522, NOT on 1524
Support of Workgroup Bridges (WGBs)

LWAPP Infrastructure will associate Cisco IOS WGBs
Connects multiple wired devices to the WLAN

This is NOT Mesh AP acting as a WGB
WGBs only in Client (BSS) mode is supported
No .1Q trunking
WGB multicast mode client
Cisco IOS WGBs must be upgraded to 12.4(3)JA or later (Iodine)
WCS support of WGB device management in 4.2 or later

3200 WMICs as WGB (release 12.4(3)JK):
- 3201 - 2.4 GHz
- 3205 - 5.0 GHz
- 3202 - 4.9 GHz