Mandates for radio service for public safety

- Since 9/11, renewed focus on fail-proof emergency communications, especially for first-responders
- 700 & 800 MHz bands allocated for fire and police
- Indoor cellular/PCS service required for E911 location
- NFPA code and best practices call for indoor wireless
- 150+ local municipalities now mandate public safety coverage inside large buildings
- Hundreds of thousands of wireless 911 calls made daily (CTIA Wireless Semi-Annual Survey, July 2009)
Why is indoor coverage poor?

• The building is acting as an RF shield
  – Fortified Construction; Hospitals, Government buildings, etc…
  – Highly tinted windows; Energy efficient, green building efforts
  – Lack of coverage in below grade floors
  – Elevators and center areas of the building

• High rise buildings (typically over 25 floors)
  – Above cell site tower coverage footprint
  – Bottom and below grade floors often shadowed and need a DAS
  – No dominant mobile control channels on upper floors

• The building is blocked from the tower by other buildings

• The WSP/PS Network Cell Site Tower is too far away
  – Some WSP tower locations may be closer than others
Design: Typical Frequency Bands & Technologies

- AT&T: 850/1900 MHz GSM and UMTS/WCDMA
- Verizon: 850/1900 CDMA and EVDO
- Nextel: 800/900 iDEN/SMR
- Sprint PCS: 1900 CDMA and EVDO
- T-Mobile: 1900 GSM and AWS
- Public Safety: Varies, 800 MHz
### Common DAS Venues

- Hospitals
- Universities, Arenas, Stadiums
- Government Buildings
- Multi-tenant High-Rise
- Hotels and Casinos
- Corporate Offices and Campuses

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**Coverage Problems**

- Deep Cavernous Buildings
- Coverage Problems
- Coverage Problems
- Below Grade
- Coverage Problems

**High-Rise Buildings**

- Coverage Problems
DAS System Configurations

• Passive DAS - Coax used to distribute RF signals
  – Only active component – BDA/Repeater
  – Ideal solution for smaller venues <150K ft²
  – Limited growth or expansion capability
  – Parallel systems required for carrier and public safety

• Active DAS - Adds RF ↔ FO conversion, fiber, and distributed amplifiers
  – Scalable – Single to multi-band/operator installations
  – Cost effective multi carrier coverage over 150,000 ft²
  – Flexible for growth and expansion
  – One system for both Cellular Carriers and 700/800/900 Public Safety
How It Works – Single Site

Donor Antenna

In-building Antennas

Fiber Distribution Remote Unit

Bi-directional Amplifier or Repeater

Fiber Distribution Head-End Equipment

Coax Cabling

Head-end Equipment Room

Fiber Cabling

Public Safety Donor Site

Cellular Signal Source
DAS in Multi-Site or Campus Setting

- Fiber Remote Units
- Fiber Links
Unique Challenges by Application (Verticals)

Healthcare

Public Venue

Government & Education

Hospitality

Mixed Use
The Installation Process

- Project and construction management
- Carrier signal-source installation
- Low voltage cabling and coax installation
- Antenna system installation
- System optimization, testing and certification
- WWAN antenna access points
- Public safety compliance and coordination
Partnering with Connectivity Wireless

Connectivity Wireless specializes in-building wireless systems.
In-building Distributed Antenna System (DAS)
Public Safety

• 99% coverage in critical areas include command center, elevator lobbies, and exit stairs
• 90% coverage for remaining areas
• Component enclosures in NEMA 4/4X type enclosure
• Repeater equipment shall be FCC approved and certification
• UPS requirements
  – Primary is dedicated branch circuit
  – Secondary is 12 hour battery backup
• Annual testing required for active components and system
Site Survey

- RF Obstacles such as stairs and elevators
- Interior wall materials
  - Concrete vs. drywall
- Ceiling heights and type
  - Drop-tile or hard ceiling
- Purpose of building
  - Dense or open environment
- Vertical chases
  - Between floors
Design

• We know the scope, carriers, and donor signals
  – Now what?
• Type of DAS
  – Coax vs. Fiber
• Head End Location
• Equipment manufacturers
  – Andrew, LGC, Mobile Access
Design

Panel antennas in corridor facing out towards exterior

Panel antennas at windows facing interior core

Omni antennas in corridor or within tenant spaces

Connectivity: Wireless Solutions

Bicsi
Design
Design
Design

Head-End and located in 1st floor Room # 100
Design

Hilton Lobby

Diagram showing connectivity solutions for Hilton Lobby.
Design

Convention Center 1st Floor

ANT1
ANT2
ANT3
ANT4

287.53 ft
156.71 ft
72.81 ft
108.83 ft

ANT5
ANT6
ANT7
ANT3

136.50 ft
120.24 ft
427.27 ft
277.81 ft

RHU1
RHU2

Connectivity Wireless Solutions
Hilton Bonnet Creek
Frank Pulido
9/29/2009
Installation
Installation

• Install In-Building Distributed Antenna Systems of All Sizes (5k - > 5M ft²)
• Offer Turn-Key or Stand-Alone Installation Services
• Manage Standardized Installations Nationwide
• Provide On-Site Project Management for Each Installation
• Maintain “Professionalism is Paramount to Connectivity” Motto
  – Professional Attire (Connectivity Logo Shirts, Brown/Black Steel Toed Boots, Khaki/Brown Pants)
  – Professional Treatment of Customers’ Facilities (Daily Work Site Clean-Ups, Minimal Ceiling Tile Openings, etc.)
  – Professional Installations (Cabling is professionally dressed, building and local codes exceeded)
• Create As-Built Documentation for Each Project
• In-House Installation Team
Installation – Potential Assumptions

- No core boring is required to properly install this distributed antenna system.

- End-user will allow use of existing 110 VAC for all DAS equipment. Any back-up power (UPS or generators) will be provided by the customer or the end-user.

- End-user will allow use of all existing cable trays and other cabling support structures (J-Hooks, etc.)
Installation – Potential Assumptions

• Customer/end-user has secured landlord and all other necessary approvals prior to installation.

• An existing roof penetration is available for donor antenna cabling. In the event that rooftop cabling cannot utilize existing penetrations, the owner of the roof system warranty must create an additional penetration.
Installation: Sample Donor Antenna

**MECHANICAL**

- Weight: 2.2 kg (5 lb)
- Dimensions (LxWxD): 787 x 152 x 25 mm (31 x 6 x 1 in)
- Max. Wind Speed: 201 km/h (125 mph)
- Hardware Material: Galvanized Steel
- Connector Type: N-Type Female (1, Bottom)
- Color: Gold
- Standard Mounting Hardware: V-Bolts
Installation: Sample Roof Mount

Non-Penetrating Flat Roof Mounts

<table>
<thead>
<tr>
<th>Part #</th>
<th>Description</th>
<th>Weight (Lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>103489</td>
<td>FRM Non-Penetrating Roof Mount (1.25&quot; O.D. Tubing, 60&quot; Overall Mast Height)</td>
<td>31.0</td>
</tr>
<tr>
<td>103490</td>
<td>FRM Non-Penetrating Roof Mount (1.50&quot; O.D. Tubing, 30&quot; Overall Mast Height)</td>
<td>29.0</td>
</tr>
<tr>
<td>103491</td>
<td>FRM Non-Penetrating Roof Mount (1.66&quot; O.D. Tubing, 30&quot; Overall Mast Height)</td>
<td>30.0</td>
</tr>
<tr>
<td>103492</td>
<td>FRM Non-Penetrating Roof Mount (2.375&quot; O.D. Tubing, 30&quot; Overall Mast Height)</td>
<td>32.0</td>
</tr>
<tr>
<td>103493</td>
<td>FRM Non-Penetrating Roof Mount (2.375&quot; O.D. Tubing, 60&quot; Overall Mast Height)</td>
<td>37.0</td>
</tr>
</tbody>
</table>
**Installation: Sample Repeater**

<table>
<thead>
<tr>
<th>General Specifications</th>
<th>1900</th>
<th>14.6 x 19.3 x 9.0 inches (370 x 490 x 228 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIMENSION (W x H x D)</strong></td>
<td>1900-1W</td>
<td>14.6 x 19.3 x 9.0 inches (370 x 490 x 250 mm)</td>
</tr>
<tr>
<td><strong>WEIGHT</strong></td>
<td>1900</td>
<td>47 lbs (21.3 kg)</td>
</tr>
<tr>
<td><strong>RF Connector</strong></td>
<td>1900-1W</td>
<td>60 lbs (27.2 kg)</td>
</tr>
<tr>
<td><strong>CONTROL INTERFACE</strong></td>
<td>1900-2W</td>
<td>N-Type (Female)</td>
</tr>
<tr>
<td><strong>WEATHER RESISTANCE</strong></td>
<td>RS232</td>
<td>NEMA 4, IP65</td>
</tr>
<tr>
<td><strong>POWER SUPPLY</strong></td>
<td>NEMA 4, IP65</td>
<td>90 – 130 V, 45 – 65 Hz</td>
</tr>
<tr>
<td><strong>OPERATING TEMPERATURE</strong></td>
<td>IP65</td>
<td>-22 °F to +140 °F (30 °C to +60 °C)</td>
</tr>
<tr>
<td><strong>COOLING</strong></td>
<td>IP65</td>
<td>External Convection</td>
</tr>
</tbody>
</table>

**Connectivity: Wireless Solutions**

**Bicsi**
Installation: Sample ½” Coax

**Premium Performance Cable**

**Center Conductor**
The center conductor of the cable consists of a copper-clad electrical grade aluminum wire, nominal 10% copper by volume which conforms to ASTM B-565, class 1DA. This lightweight conductor provides both high quality and strength.

**Conductor Adhesive**
The center conductor is coated with a proprietary adhesive that ensures the discs are securely bonded to the center conductor.

**Dielectric Discs**
The dielectric discs are injection molded from virgin polyethylene (ASTM D-1248). These discs are regularly spaced to provide structural integrity while minimizing attenuation.

**Aluminum Outer Conductor**
The outer conductor is a continuously formed corrugated and welded electrical grade aluminum tube. In-process monitoring assures weld integrity maintains proper aluminum thickness, and corrects physical dimensions.

**Jacket**
The jacket is composed of a highly flame retardant, low smoke material meeting the fire resistant provisions for plenum applications. Consequently, this cable is certified according to the test methods of UL 910 and the listing requirements of NEC 820.31 and NEC 820.53 (a) for CAT5P cables. In addition, it exceeds F16 provisions of the Canadian Electric Code.

**Mechanical Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Single</th>
<th>Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Bend. Radius, in (mm)</td>
<td>2 (50.8)</td>
<td>5 (127)</td>
</tr>
<tr>
<td>Cable Weight, lb/ft (kg/m)</td>
<td>0.129 (0.192)</td>
<td></td>
</tr>
<tr>
<td>Bending Moment, ft-lb (N·m)</td>
<td>1 (1.4)</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength, lb (kg)</td>
<td>250 (114)</td>
<td></td>
</tr>
<tr>
<td>Flat Plate Crush, lb/in (kg/mm)</td>
<td>78 (1.39)</td>
<td></td>
</tr>
<tr>
<td>Number of Bends, minimum</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Number of Bends, typical</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Temperature, °F (°C)</td>
<td>+5 to 194 (-15 to 90)</td>
<td></td>
</tr>
<tr>
<td>Recommended Install</td>
<td>+5 to 194 (-15 to 90)</td>
<td></td>
</tr>
<tr>
<td>Recommended Storage</td>
<td>+5 to 194 (-15 to 90)</td>
<td></td>
</tr>
<tr>
<td>Operating</td>
<td>+5 to 194 (-15 to 90)</td>
<td></td>
</tr>
</tbody>
</table>
# Installation: Sample Distribution Antenna

## CELLMAX-O-25
Cell-Max™ Omnidirectional In-building Antenna, 806–960 MHz and 1710–2700 MHz

### Mechanical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>Thru-hole ceiling mount (optional)</td>
</tr>
<tr>
<td>Pigtail Length</td>
<td>254.0 mm</td>
</tr>
</tbody>
</table>

### Environmental Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Indoor</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 °C to +60 °C (-40 °F to +140 °F)</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>Up to 100%</td>
</tr>
</tbody>
</table>

### Dimensions

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter, maximum</td>
<td>165.00 mm</td>
</tr>
<tr>
<td>Height</td>
<td>85.00 mm</td>
</tr>
<tr>
<td>Length</td>
<td>165.00 mm</td>
</tr>
<tr>
<td>Net Weight</td>
<td>0.30 kg</td>
</tr>
<tr>
<td>Width</td>
<td>165.00 mm</td>
</tr>
</tbody>
</table>
Commissioning
Commissioning

Commissioning Services

– Coaxial Cable and Fiber Testing
  • Coaxial Cable Sweeps
  • Fiber OTDR Results

– Active Component Commissioning
  • Bi-Directional Amplifier Set-Up
  • Fiber DAS Commissioning (LGC, Andrew)
  • Measure and Record RF Input/Output Levels for All Active DAS Components

– Customer Defined “Checklists”