Workshop:
Distributed Antenna Systems in Hospitals
Requirements and Best Practices

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Goals of the Workshop

• Provide a market and technology overview of DAS.
• Provide the audience with a clear understanding of the capabilities of a DAS, and the best practices for deployment.
• What is the impact of public safety ordinances?
• What is the “user model” experience in healthcare?
• How do I plan and what are the questions to ask?
• What is the future of DAS new offerings such as LTE and WIMAX?
• Questions and Answers.
Integra Systems, Inc. - Background

• In the medical device and connectivity space for over twenty years. This experience has also extended to the complete wireless ecosystem for the in-building space.

• Experience has enabled companies to design and architect solutions for the medical device space. From this we have enabled product launches, case studies, white papers, and provided global field sales support for these launches.

• We can help with all of the above, but also to include testing, guidelines for regulatory approval, as well as RFI and RFP preparation for enterprise deployments.

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What is a DAS (Distributed Antenna System)

“A Distributed Antenna system (DAS) is a network of spatially separated antenna nodes connected to a common source via a transport medium that provides wireless service within a geographic area or structure. DAS antenna elevations are generally at or below the clutter level and node installations are compact.”

“The Definition as defined by PCIA - The wireless infrastructure Association and its DAS Forum.”
Issues requiring a DAS

- Up to 80% of cellular phone calls originate inside a building environment today.
- New LEED building requirements tend to keep the signals from the macro environment to penetrate the in-building environment.
- Pervasive use of cellular devices, PCS, Public Safety, and Blackberries are the norm today. The I-Phone!
- Customers expectations are that they desire the same in-building experience as outside in the macro environment. Basic requirements are “five bars” all the time.
Applications driving the requirement for a DAS

- AirStrip Technologies. [www.airstriptech.com](http://www.airstriptech.com)
- New I-Phone applications.

- Pervasive use of cellular devices, PCS, Public Safety, and the mobile use of the I-Pad for wide area medical device applications.
- Customers expectations are that they desire the same in-building experience as outside in the macro environment. Basic requirements are “five bars” all the time. 4G and LTE here now.
Frequencies Typically Desired

- 150 MHz, 450 MHz, 700MHz, 800MHz - Public Safety
- 900 MHz - Paging
- Cellular 850 MHz, ATT&T/Cingular (GSM+WCDMA), Verizon (CDMA).
- PCS 1900 MHz, ATT&T/Cingular/Verizon, Sprint, T-Mobile.
- iDEN 900 MHz
- AWS 2.1GHz, (AWS (ATT&T/Cingular, Verizon, T-Mobile))
**Hospital Construction**  
**LEED environment**  
**Challenges to signal penetration**

- LEED [http://www.usgbc.org](http://www.usgbc.org) is defining the standards for the new green building environment.

- The use of reflective coatings on building to preserve energy consumption, acts as a major barrier to the penetration of cellular, PCS, and public safety signals.

- Hospital construction using poured concrete metal pan construction acts as Faraday cage on each specific floor.
NFPA Annex O permits the (AHJ), Authority Having Jurisdiction to require with Annex O.

New construction will need to have in-building public safety coverage to obtain (TCO) Temporary Certificate of Occupancy.

At the discretion of the AHJ, existing buildings may be required to have in-building public safety coverage which must be in operation with 18 months of notification by the AHJ.

Healthcare customers that are active to pursue a DAS and consult with their local authority are generally able to negotiate through some of the specifics of Annex O that permits cost savings.
Public Safety Mandate
Requirements

- Sub-grade floors on all new construction.
- Floors in buildings with 25K sq. ft. per floor.
- All floors of buildings greater than 3 stories, Type I and Type II construction.
- All individual dwelling units are exempt.
- Depends on multiple variables, but generally requires -95dBm over 90% of building coverage.
- Must be tested, installed, and certified before certificate of occupancy.
- General requirement for at least hospital emergency area.
Public Safety and Radio Paging

**Public Safety & Private Radio/Paging Bands**
- VHF (136-174MHz)
- UHF (385-512MHz)
- 700PS (764-776)
- 800PS (851-869)
- 900 Paging (929-930)
- 900 SMR (929-940)

**Public Safety & Private Radio Awareness**
- Local first responders communicate with facilities & engineering regarding adoption of local ordinances to amend the fire/building code to align with national standards (IFC/NFPA)
- Private radios & pagers are often used to by facilities & engineering and may benefit from indoor enhancement

**Possible Local and National Codes**
- NFPA 2011 Standards
- IFC 2009 Standards
- NEMA4X Requirement
- UL Certification

Need to provide SAW filtering on ALL public safety bands to eliminate interference and allow all services on a single DAS platform
Public Safety Mandates
Jurisdictional

- Use of handheld radios necessitates in building amplification.
- First coded city Burbank, CA in 1991.
- Large metropolitan areas were the first to mandate this requirement. It is spreading nationally to counties/cities, 11 in 2002, 63 today.
Business Models

- DAS equipment vendors.
- Equipment vendors that design & install.
- Third party operators.
Financing a DAS
The single carrier and multi-carrier model?

- The single carrier model works best where the end customer can be controlled. This simply means that the carrier will negotiate a contract with the end customer for a number of handsets and/or use. The carrier will then offset the cost of a DAS by the guaranteed use model.

- Opposite of this is the multi-carrier model. Hospitals cannot control their end customer. Carriers may often fund the cost of the DAS because they cannot control the use model. Ideal owner operated.

- Hospital will often fund these systems to ensure that all carrier coverage is provided for.

- 3rd Parties to take on the entire capital cost, risk, and continue to operate the DAS as a business managing the service providers.
Financing a DAS
The single carrier and multi-carrier model?

• The carriers may do partial funding of the system design even if it is multi-carrier. It all depends on what you want to commit.

• Carriers will also in key deployments perform a teaming agreement where one carrier will manage the multi-carrier deployment but each carrier will pay a share.

• Carriers make a NPV decision which is # of units x ARPU x term of the contract to offset the cost of the DAS.
What is the typical model for healthcare?

- Hospitals cannot control their customer. Their customers are the physicians, patients, and their families.

- Some carriers will contribute some funds to a customer-owned DAS in exchange for a handset commitment of corporate phones. These individually liable phones are hard to quantify.

- This model often will require all the carriers to participate as well as to provide public safety coverage. This would include ATT, Verizon, Sprint, and public safety coverage in either 800MHz, and/or 700MHz or lower frequencies.
What is the typical model for healthcare?

• Hospitals act somewhat like a landlord with wireless, providing tenants (practitioners) with basic utilities, which now include wireless.

• They are the “owner” of the system.
Design Considerations
Initial Guidelines

• Project investigation and site visit.
• Carrier notification and vendor evaluation.
• Development of the RFI and RFP guidelines.
Hospital Challenges

- Available space for Remotes
  - Install in IDF
  - Install in other more convenient locations
- Fiber availability
  - Test existing fiber prior to install
  - Innerduct or armored fiber acceptable
  - Conduit requirements – existing conduit available
- Infectious control measures
- Accessibility restrictions – ICU, Trauma, Prenatal, etc.
- Lead lined walls (near Radiology)
- Concrete/block walls
- Firewalls – stubs/fire caulk/meet fire code
- Available hours for DAS installation
- Union/Non-union labor
Design Considerations
The Link Budget

- The Link Budget must be met for these systems to operate in a correct manner.
- Link Budget is defined as: Received Power (dBm) = Transmitted Power (dBm) + Gains (dB) - Losses (dB).
- This takes into account all the gains and losses from the transmitter through a medium to the receiver in a telecommunications system.
Propagation Modeling

- Test phones can be used to conduct an initial site survey.
- Propagation modeling for RF coverage is the most popular way of design for in-building systems.
- [www.ibwave.com](http://www.ibwave.com) is the standard in the field.
What are typical designs – active or passive with off air repeater.
What are typical designs – with base station
Different design requirements

- Passive architecture
- Normally used for smaller environments, under 200,000 square feet.
- Above 200K sq. ft. the link budget dictates to use an active based design.
Different designs and requirements

- Fiber-fed DAS Designs.
- More efficient use of the link budget.
- Typical in enterprise healthcare deployments.
What is considered “radiating “leaky” coaxial
Design and cost considerations for the Deployment of a DAS

- Passive versus active based-fiber fed designs.
- Design considerations, automated tools, versus proprietary.
- The amount of single mode fiber used, one strand versus many.
- The number of remote units used (higher composite power), less number of remote units. Less space and less energy costs.
- NEMA4 rated remotes are ideal for public safety deployments.
- Modularity in remote units provides for a cost effective solution.
How to handle campus environments

• Use of single mode fiber to interconnect buildings.

• Also seeing a trend of high power outdoor DAS (or a full cell site transmitting from the outside in with DAS) used to fill in the gaps in coverage.

• Can also use a SONET ring for building to building transport. Using one companies fiber-fed DAS you can achieve distances up to two miles from the head end to the remote unit.

• Could use an indoor and outdoor DAS “fill-in” model.
Components of a Fiber-Fed DAS

- Yagi Antenna and the BDA
Different designs and requirements for BTS/BDA?

- BTS versus BDA, what are repeaters?
- Base Transceiver Station or Bi-Directional Amplifier.
- A BDA is usually used in a healthcare facility.
- Functions to receive signals from the outside cell site, filter, and amplify them.
- BDA “Steals the signal”, BTS provides dedicated capacity.
Components of a Fiber Fed DAS

- The Master Distribution Unit (MDU) and Optical Distribution Unit (ODU) in the MDF.
- Single Mode Fiber Vertical throughout the building.
RF Filtering Explained

Surface Acoustic Wave (SAW) Filters in the BIU and ROU work with Cavity Filters in each ROU to improve RF performance, overcome thermal noise, and prevent frequency intermodulation.
Remote Optical Unit Filtering

In Addition to SAW Filtering, Cavity Filtering is included inside the ROU on each Frequency Band

Filtering Benefits for Carrier
- Independent RF Path Control on Uplink & Downlink
- RF Isolation from interfering frequency bands
- Optimizes RF Amplifier usage for dedicated frequency band
Components of a Fiber Fed DAS

- Remote Units in the IDF to convert all to RF over optical signals to RF.
Components of a Fiber Fed DAS

- Passive coaxial cable infrastructure, splitters, combiners, and antenna elements for distribution on the floor plate.
Installation Pictures

Remote Unit with door open

Bottom view of Remote Unit

Internal Power Supply
Internal Splice Tray

Sealed Fiber Input
Military Grade Power Cable
Water Drip Edge

Single Sector with DMS

Head end equipment
Typically in MDF
Designs and Requirements
(802.11 b/g)

- A DAS was typically designed up to 1900 MHz.
- At 2.4 GHz, data only for 802.11b/g, signal strength of -85dBm is sufficient.
- For VoIP, design requirements are -65dBm, however major concern to take into account are roaming and latency issues of VoIP (under 180 msecs of roam time AP to AP).
- Cisco Systems “non-endorsement” and “non-warranty” support.
Designs and Requirements (802.11a)

- Due to the signal at 5.0 GHz, the link budget requires amplification of the signal. Often is done at the antenna element.

- This requires additional active infrastructure that can fail in the presence of a life critical WLAN.
Designs and Requirements (802.11n)

- Requires multiple antenna infrastructures to support MIMO.
Designs and requirements (WMTS)

- Wireless Medical Telemetry Service requires diversity support.
- WMTS and the design changes do require some sort of regulatory approval.
- Dual infrastructures (coaxial), are required for diversity support.
- Costs could be significant because of the design and cabling infrastructure required.
The future of DAS Support of MIMO

- If a DAS is to support 802.11n and WIMAX, it will need to support MIMO (WIMAX approved for in-building SIMO).
- 4G services over the next few years will deploy 4G services (WIMAX and LTE), using SIMO.
- A DAS must have a clear roadmap to SISO and to be considered 4G or “N” capable.
Q & A

• THANK YOU!
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