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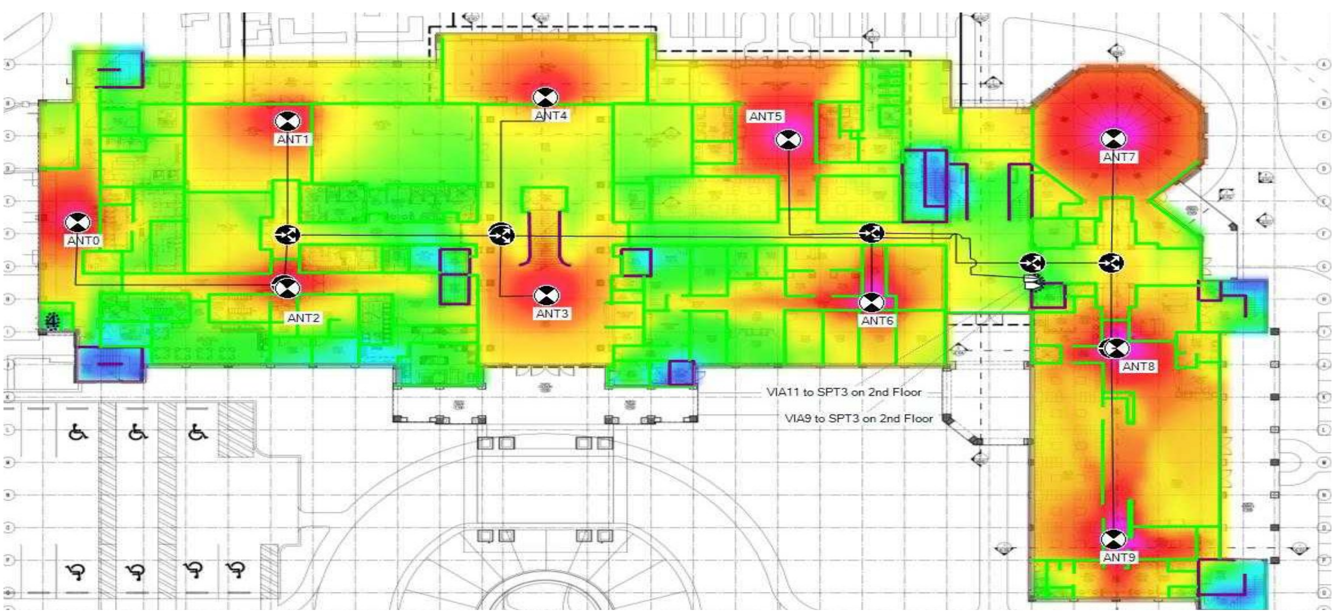
InLogis News

Whole House / Office Professional Cell Phone / Public Safety / DAS Signal Boosters **July 2016**

Predictive Indoor Signal Strength Modeling

When designing Cell Phone Booster DAS and Public Safety Radio signal enhancement systems it's important to properly model and predict the coverage and signal strength in all areas of the structure to verify that the system will meet customers' expectations and local Fire Codes. We use several proprietary software applications to accomplish this modeling. The trick is to properly account for losses caused by walls, metal cabinets, shelving, furniture, desks, room dividers, doors, air conditioning ducts, drop ceilings and humans in the environment. These losses can vary dramatically as a function of the frequency bands the system is covering. We also need to account for multipath effects, signal diffraction around objects and changes in RF signal polarity as the transmissions are reflected by objects in their paths. Besides losses in the environment, cable and splitter losses must be accounted for as a function of the cable lengths and the frequencies involved. Needless to say this is a complex task and requires attention to many details including a good understanding of the outdoor signal levels provided by the local cell sites. The figure below shows a 'heat map' of RF signal strength overlaid on a floor plan of a building. We can work with pdf drawings or CAD formats but it is imperative that a site survey be performed as part of the design process to provide good input data for the model.



Predictive Modeling Produces Heat Maps Showing Signal Strength on Floor Plan

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NARROW BAND BI-DIRECTIONAL AMPLIFIER

WIDE BAND BI-DIRECTIONAL AMPLIFIER

Wide Band vs Narrow Band Systems

The most economical booster systems use wide band bi-directional amplifiers (BDAs). These types of amplifiers (called Class B by the FCC) simultaneously amplify the large blocks of frequencies that are utilized by all of the carriers for their services. Hence one amplifier will typically support AT&T, Verizon, Sprint and T-Mobile). The problem with this approach is that if one of the carrier's signals is much stronger than the others, it will 'steal' a large percentage of the amplifier's power from the others and the redistributed signals inside the building will be disproportionally allocated among each of the carriers. So the actual signal radio frequency (RF) environment outside of the building must be analyzed carefully before class B amplifiers can be use.

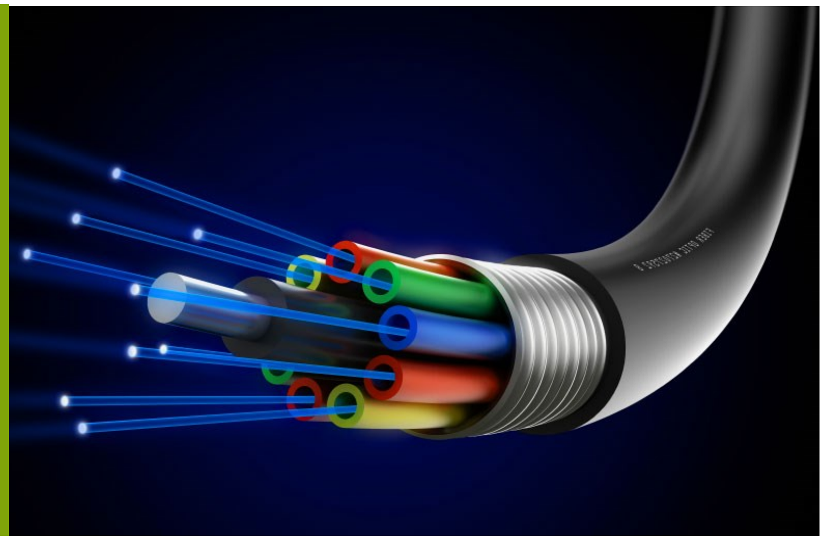
Narrow band BDA's (called Class A by the FCC) use filters to isolate the signals of each carrier. Typically a separate BDA is required for each carrier, so the cost and hardware complexity is much higher but the system will work properly in any RF environment. Unlike the broadband booster systems, Class A systems are configured with individual signal level adjustments for each carrier. For example, if the outdoor signal levels of Verizon are much stronger than AT&T, they each can be individually amplified or reduced so the indoor signal strength of both are the same. This is much harder to achieve with the lower cost broad-band systems.

Wide band systems are less costly to implement but won't work in every RF enviroment

The other problem with wide band systems is that in many locations (typically urban) the adjacent frequency bands to the cellular bands are also heavily utilized and are jam packed with strong signals that in some cases can be as strong or stronger than the cellular signals. These adjacent undesired signals can sometimes 'punch' through the filters in the booster amps and steal power from the desired signals.

We have deployed many successful systems using both types of bi-directional amplifiers but each design requires very careful analysis, good site surveys and extensive knowledge of the local RF environment.

Fiber Optic Cables Enable Installations that would be impossible with Coax



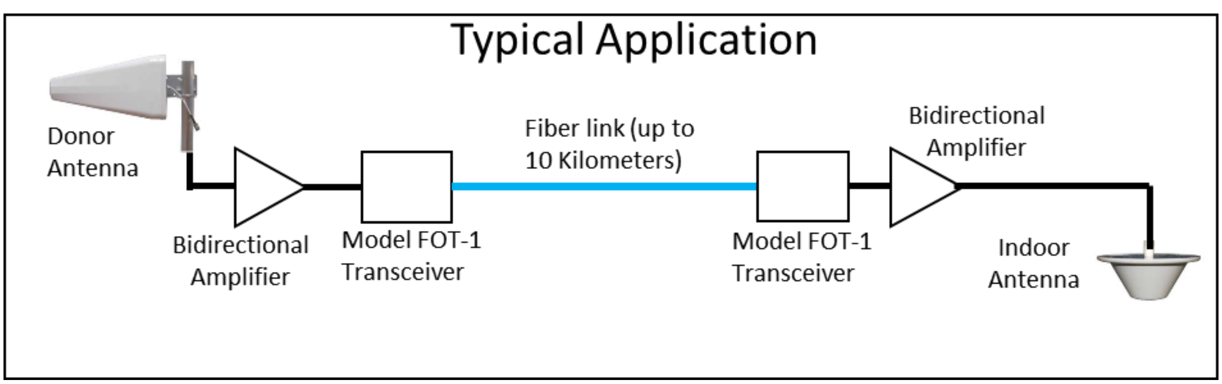
Fiber DAS vs Coax DAS

Classic Distributed Antenna Systems (DAS) use coaxial cables of various lengths and diameter to interconnect all of the amplifiers, antennas and signal splitters. However long runs of coaxial cable can be expensive to install and can create problems with high signal losses if the cable lengths are over a few hundred feet. For installations in larger buildings and campuses frequently fiber optic cables are used to interface between the bi-directional amplifiers which are distributed throughout the venue close to the indoor antennas they drive. These types of systems are commonly referred to as 'Fiber DAS'. This technology enables installations that would be impossible to implement with coax.

Besides being very easy to install, fiber optic cables can be more economical than typical coax. For example, ½" low-loss coax can run $1.50 per foot vs fiber that runs as low as $0.17 per foot. The low cable and installation cost can sometimes easily offset the cost of the active transceivers (such as our FOT-1) that are required at each end of the cable performing the optical to RF conversions. A typical fiber link can transmit up to 10 km with little or no loss.

Model FOT-1

This transceiver coverts RF signals to optical transmissions. By using Wave Division Multiplexing (WDM) it allows simultaneous transmission of uplink and downlink signals on a single fiber optic strand.



NEMA-4 Enclosures are required by the Fire Codes to house sensitive electronics that are part of In-Building Public Safety Radio Booster Systems

NEMA-4 Enclosures

All of the Fire Codes for In-Building Public Safety Radio signal enhancement systems require the use of NEMA-4 rated enclosures to house and protect the electronics.

NEMA-4 rated enclosures are specially constructed for either indoor or outdoor use to provide protection against falling dirt, rain, sleet, snow, windblown dust, splashing water and hose-directed water. The unit will be undamaged by the external formation of ice on the enclosure.

A NEMA-4 enclosure must pass a test where water from a fire hose is directed at it from all different angles at a flow rate of 65 gallons per minute for 5 minutes. The inside of the enclosure must be completely dry to pass the test. There is also a NEMA-4X enclosure that provides additional protection against corrosion.

Many of the bi-directional amplifiers for these systems are designed in NEMA-4 rated housings that protect the interior electronics, but almost none of the 'code required' battery backup and UPS secondary emergency power units are available in NEMA rated housing. Hence they need to be installed inside the appropriate enclosure. Care must be taken to insure all of the connectors and cable penetrations are well sealed with moisture blocking and gasket materials.

For enclosures housing batteries, outgassing from the batteries must be accommodated with a 'breather' semipermeable valve such as the Hoffman model APCDABS. The enclosure must be painted 'fire engine' red and have a sign on it that identifies the contents.