In-Building Wireless Systems

Rapidly growing demand for cellular data inside large buildings makes distributed antenna systems increasingly necessary. Fortunately, technology advances have made such systems more affordable than they once were.

By Eric Fichtner / *Symphony Technology Solutions Inc.*

Some people are surprised to learn that distributed antenna systems (DAS) have been deployed in commercial buildings for almost 20 years. Early systems were designed for airports, stadiums, convention centers and other places where large crowds gathered, but DAS is needed today in a variety of smaller spaces. A number of large neutral host companies, such as American Tower, Crown Castle, Boingo and Extenet, have built profitable business models on deploying DAS. These companies, which serve as liaisons between venue owners and wireless service providers (WSPs), attempt to generate as much participation on each DAS as possible. But because the priorities of the WSPs are as different as are their budgets across vertical markets, many neutral host and carrier-owned DAS have less than full participation from the four major cellular carriers.

In today's bring-your-own-device world, perhaps the first question for a property owner in implementing any in-building cellular enhancement system – whether DAS or simple booster technology – is this: Does it offer access to all the major players? Formerly, in corporate environments, a carrier obtained a contract to provide cell phone service to all users and agreed to implement a one-carrier DAS in return. Today's consumer, whether an employee, a resident or a guest, wants *choice*. This sharp turnabout is occurring in all market verticals but perhaps most vigorously in buildings that house numerous non-employees. These buildings include hotels, apartments and condos, higher education campuses and, perhaps surprisingly, medical centers.

IS IN-BUILDING CELLULAR ENHANCEMENT NEEDED?

Do you, as a building owner, gain enough competitive, and therefore revenue, advantage to justify the cost of a DAS or booster? To answer that question, consider interference, capacity and demand.

First, building construction technologies increasingly create radio frequency (RF) *interference* that limits the signal strength within a building. Triple-pane, low-emissivity glass, for example, has a 40 dB impact on RF signal strength. That means the signal inside the building is only 1/10,000 as strong as the signal outside the building. Honestly.

Building iron, hurricane shutters, other buildings, even furnishings can significantly impact the signal strength within a building, creating dead zones or even an entirely "dark" building. With or without triple-pane glass, there is routinely a 30–50 dB drop in signal strength, making a fine cell experience outside the building excruciating inside.

The second factor in considering whether to supplement the macro network with an in-building wireless system involves *capacity*. Even if guests can walk through a high-rise hotel at 5 a.m. and obtain excellent cell signals everywhere, they may well encounter the

circle of death when the building is fully occupied and active. The macro network wasn't built to handle all those people occupying the same dot on a map. Thus, excellent cell *coverage* (signal strength) does not always translate into excellent cell performance, due to the lack of *capacity*.

The third factor is the increasing user demand for more bandwidth for broader and deeper internet experiences. Users are like a pack of ravenous wolves when it comes to expecting HD, 3D, VR and high information content on cell devices. Nearly everyone assumes carriers will just take care of increasing demand. But carriers have stated it will be impossible for their macro networks to accommodate the increasing bandwidth demand.

As a hypothetical, Verizon asked how many additional cell towers it would take, if that were the only means utilized, to cover U.S. usage demands. The answer? Three million. There are only 300,000 cell towers today. Does anyone believe the citizens of the United States will accept increasing the number of cell towers tenfold?

Verizon's plan to meet the demand includes a few more towers, a lot of technology advancements and, for the vast majority of that increased demand, "in-building wireless systems" (IBTUF 10 Conference general session, January, 2016).

Yes, Verizon expects building owners to install systems to "densify" its network. So do AT&T, T-Mobile and Sprint. They won't thank you; in fact, they've historically made it difficult and expensive to install systems. But they expect it nonetheless. And they won't pay for it in most cases.

CARRIER-FUNDED DAS

Carriers *do* still pay for DAS. The builder of a stadium, an arena, a large mall, a massive hotel and conference center, a Wynn-like casino or a major medical complex may be able to attract a benevolent carrier or a neutral host company funded by carriers. Carriers do not have the capital budget to fund every building – and even if they do, they do not intend to pay for the DAS for your 300,000-square-foot building.

The ROI models the carriers use in determining to pay for DAS require enough foot traffic to justify their investments. They measure foot traffic in the thousands, not hundreds, when they generate their payback models. Even then, they often still fight to make a DAS single carrier, if not forever then at least for long enough to recoup their investments.

There are exceptions. I've seen a few cases in recent years in which a carrier agreed to cover DAS costs for a smaller facility – a recent corporate headquarters, for example, that was only 550,000 square feet. However, that carrier is angling for a 4,000-line mobility contract and wants access to the corporation's many other facilities and mobility contracts – and it won't foot the DAS bill for the remaining buildings.

DAS OR BOOSTER?

If a building owner will have to foot the bill for enhancing cell coverage, why not just put in a booster and some antennas instead of a full-blown DAS?

Boosters are best suited to smaller environments – generally facilities of less than 50,000 square feet. The FCC has approved the use of these boosters, and as long as a contractor properly *registers these booster installations on the owner's behalf with all four carriers*, the cell environment should improve with relatively little cost and no risk.

The disadvantages of boosters explain why they're so low in cost. A booster is akin to a massive fire hose of cell signal sprayed throughout a building. There is no intelligent distribution, no constant measuring of cell activity and adjustment of signal strength and quality between multiple active remote nodes. A DAS is more like a very smart sprinkler system with valves and meters that deliver the precise amount of water to the exact areas needing it.

To overcome the passive signal distribution of boosters, contractors often attempt to install multiple boosters in larger buildings. This makes the situation worse. Multiple, unintelligent boosters create oscillation – standing RF waves that cause massive noise to flow back into the macro network. To a cell carrier, it sounds like a microphone stuck in front of a speaker. The carriers will find that system, and they will shut it down. Because they paid billions for the spectrum, they have the right to do so and can have the FCC levy fines on the building owner (not the contractor) in the amount of tens of thousands of dollars per day.

If a booster system has been registered with the carriers, they cordially instruct the building owner to shut it down, generally without threatening fines, if they detect any backflow of noise into the macro network. However, if they find a rogue, unregistered, noisy booster or boosters, all bets are off. Depending upon the trouble a rogue system causes, they might decide to make an example of the owner.

Finally, boosters do not accommodate RF source inputs from carriers across broadband landlines. In other words, they cannot increase *capacity*, only *coverage*. They can only take what signal is in the air and amplify it. They increase coverage (along with some noise), but they don't do anything to increase the density of the cellular capacity.

The lack of additional capacity may be OK for a while, but sooner or later, owners will want to upgrade to intelligent, capacity-increasing systems.

DAS OPTIONS AND COSTS

Five years ago, all-in DAS costs averaged $3–4/foot – sometimes more, depending upon what requirements the carriers imposed. It's asking a lot of any building owner to swallow that kind of cost, even for a putative fourth utility. Two significant changes in the interim made the costs much more palatable.

First, all the traditional DAS OEMs and a spate of new ones are bringing new, enterprise-centric products to market. These new products do not have the sophisticated features needed in complex RF environments such as stadiums. But those additional features are completely unnecessary in enterprise

environments that may have only hundreds of users in a simple, stacked building RF environment. Corning MobileAccess and CommScope, the two major DAS industry OEMs, have released new products recently to address the need for a lower-cost, enterprise-grade solution. In fact, CommScope's system is termed Ion-E – E for enterprise. Along with them are products from SOLiD, ADRF, JMA and scores of others.

Even better cost savings can be had with some of the nontraditional DAS OEMs making their mark with increasing wins. Examples include Zinwave and Whoop Wireless. These new OEMS employ nontraditional approaches to providing an intelligent DAS, such as two-stage gain, modular design and a flash-upgradable 5G road map.

The second important advancement in reducing costs has been due to the carriers themselves. For prior DAS implementations, carriers routinely required full base terminal station buildouts, typically costing $100,000 or more per carrier per sector, but they now offer small-cell devices that increase capacity at a cost of only a few thousand dollars. These small cells have vastly lower real estate, power and cooling needs. An entire DAS headend, with all the carrier small cells, can often fit inside one 19-inch rack.

NOW WHAT?

What is an owner to do in this fluid environment, in which the only constant is insatiable consumer bandwidth demand? Symphony's recommendation depends on building size and construction.

1. **New construction, more than 500 occupants at peak:** Swallow your medicine and plan for a DAS. Thank your personal deity that costs have dropped dramatically. Make sure you engage a quality technology partner who knows you've read this article and expect all-in costs to be less than $2/foot and closer to $1/foot.
2. **New construction, fewer than 500 occupants or less than 150,000 square feet:** Engage a quality technology partner to prepare a preliminary design to identify antenna and equipment locations and pay the cabling contractor to install the cable during construction. The cost will be quite low – at most in the tens of thousands of dollars total. After the building opens, test for cell quality and strength. If they are good, thank that same personal deity and wait to install the DAS (which has been cabled already so you'll have no construction mess in public areas) whenever demand demonstrates that you need it. Or, if the signal is not so great, install that DAS that you've already had designed and for which you've gotten all the construction mess resolved.
3. **Existing construction, more than 50,000 square feet:** If it ain't broke, don't fix it. But if you have problems, engage a quality technology partner who will address coverage, signal quality and capacity issues instead of just offering an immediate coverage bandage. In other word, put in a DAS that works now and has a smooth technology road map to 5G. Don't cheat yourself or, worse, incur potential fines, with a low-cost booster.
4. **Existing construction, less than 50,000 square feet:** Install a high-quality booster to address coverage needs, and wait and see what DAS or small-cell technologies emerge in the future to address the capacity needs you'll have later. ❖

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