

---

---

# In-Building Wireless Fundamentals

by Dominic Villecco, *President & Founder of V-COMM, LLC*

---

---

Often times when watching an exceptionally good college football team, the announcers will say the coach has the team “well-disciplined,” and mention how they “stick to the fundamentals.” It seems fairly intuitive to hear these comments. Maybe the team was off-track previously and the coach pulled them back in. They practice the basics of the game, and these basic fundamental principles help them restore that winning mentality. It seems pretty simple too; just stick to the fundamentals and you’ll keep winning, right? The simple answer to this question is yes, but why does it not always seem to work out that way?

How is it that many times these same players and coaches come full circle when they get to the NFL? Is it the game that’s changed? That answer is no and yes. No, it is the same game as college, give or take a few rules. Yes, these new teams are the best of the best, and the intensity, level of play,

execution is flawless.” Because this is the flagship issue of a new publication dedicated to in-building wireless, it made sense to start with “the fundamentals.” Much like the transition from college to professional football, the wireless game has changed. The systems and their engineers are the best

“  
*Much like the transition from college to professional football, the wireless game has changed.*  
”

caliber of players, level of excitement and amount of money are significantly increased. Regardless, when the teams do well, the announcers will say, “this coach has these players drilled on the fundamentals, their

of the best, and the technology, intensity, level of service, expectations and amount of money has significantly increased. Do they need to stick to the fundamentals? Yes! Have the fundamentals

changed? To some extent, yes, but many of the basic premises remain the same. Just like a successful football team, the proper applications of these fundamentals are key to a successful wireless in-building deployment



(i.e. on budget, on time, meets performance requirements).

### What are the G's and why are they important to me?

When someone refers to 4G LTE, they are referring to the fourth generation of wireless technology available to the public. LTE, or long term evolution, is a characterization by the standards industry to state the obvious; where this technology is supposed to be headed. What does this mean to the everyday wireless customer? How does it impact what I am trying to do today regarding the wireless service in my building? How will it impact the future of wireless service inside my building? These are all good questions! Let's start with the fundamentals. Let's walk through the generations of wireless, and it will become clear.

First generation (1G), or "cellular" as it was known in the late 70s and early 80s,

was the beginning of cell phones as we know them. It was an analog, narrowband service (i.e. one phone call per one radio channel) and the primary expansion goal was coverage. Devices were primarily car phones (large-vehicular mounted, high power devices with external antennas) and the primary time for network congestion coincided with daily rush hours. Subscribers would "catch up" on calls to and from the office while in the car. In-building wireless service was virtually non-existent and since most of the devices were mounted it didn't really matter to most subscribers.

In the late 80s and early 90s, second generation (2G) was introduced. This was a digital network. Calling features were mostly the same as 1G with the exception of texting, which was added for 2G. Devices got smaller, had lower power and quickly transitioned to hand held form. In-building wireless coverage became more of an issue than before, so new in-building systems

were being installed. Most of these systems were in venues with high public traffic. These systems were mostly installed by the wireless carriers and the primary goal was providing coverage where none previously existed. "Ubiquity" was the buzz word at the time as many industry forecasters envisioned customers eventually being able to use their devices everywhere. Wireless network capacity was generally not a concern, as the airwaves were digitized with 2G and these digitized radio channels could now support at least three times the capacity of the previous 1G narrowband channels.

Third generation (3G) came out in the late 90s and early 2000s. It was more data-oriented and promised more features. Blackberry and other similar data devices became popular and utilized 3G technology to provide new and enhanced features to subscribers; features that were not previously contemplated by subscribers.

While the data speeds were certainly faster than anything offered in 2G, they paled in comparison to what is being offered today with 4G. This fundamental difference is important to note because it made 3G a transitional technology and not a break-out technology like 4G. In-building wireless systems became more prevalent, and many large public venues either had in-building systems or were in the process of implementing them. Coverage was still the primary motivation for these in-building systems, similar to the 2G motivation. While Blackberry was certainly one of the primary devices driving 3G, the limitations of 3G technology ultimately became the limitations of the devices. Email and instant messaging were the primary features used in 3G systems until Apple came out with the iPhone.

These new devices developed by Apple Computer were some of the catalysts for fourth generation (4G) technology. This new wireless technology promised subscribers greater and further-expanded features. It promised more than just email, texting, SMS and slow web browsing. It promised fast web browsing, pictures, unlimited applications and, most interestingly, video.

4G technology hit the streets in the late 2000's and delivered true ubiquity, which had been envisioned by industry analysts for many years. Due to the constant expansion of wireless networks over the years and the new 4G LTE technology (which still has future upgrades planned for increased data capability and network capacity), coverage is no longer the primary driving factor when deploying in-building wireless networks. The new buzz word is "capacity." Why, as a building owner or developer, is this important? Because it drives 100% of the decision-making process for the deployment of a new or expanded in-building wireless network; it is the fundamental that needs to be taken into account for a successful in-building deployment. In fact, all of the in-building systems that were deployed during the 2G and 3G era have either been upgraded or are in sore need of one. Having five bars of service ("coverage") displayed on your device does no good if the connection does not get through ("capacity"). It is analogous to picking up a desk phone and getting dial-tone, but consistently getting "all circuits busy". It is very frustrating to the subscriber, which now also translates into frustration for building and venue owners.

## Need to Know Fundamentals for In-Building Wireless Systems

### *1. The wireless carriers are licensed by the FCC to provide wireless service*

The Federal Communications Commission (FCC) has jurisdiction over the broadcast and re-broadcast of wireless frequencies throughout the US and its territories. Licenses are granted to certain qualified companies for this purpose. In this context, this includes the four nationwide wireless companies, AT&T, Verizon, T-Mobile and Sprint, as well as regional players like US Cellular. This is a very important fundamental issue because only these companies are permitted by law to transmit these licensed channels. Additionally, in-building systems that transmit or re-broadcast these channels, do so under the authority of the wireless carrier licenses.

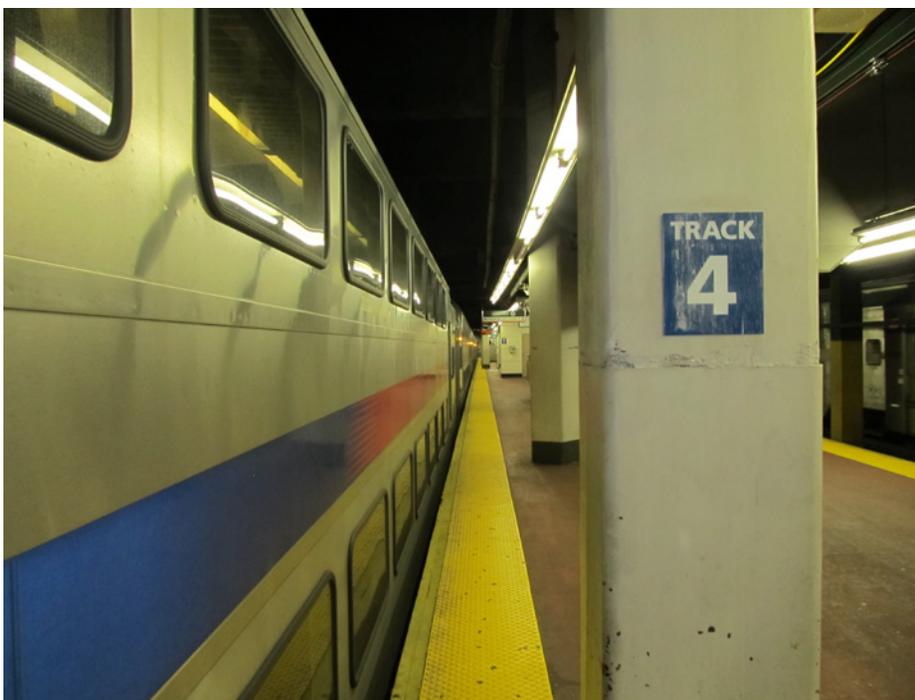
Recently, we have seen some in-building deployment companies design and implement wireless systems for building owners only to find out a carrier, or carriers, have a problem with the system because it causes interference (or even capacity issues) to the larger network. If the parties (i.e. building owner and wireless carrier) are not able to come to an agreement on how to modify

the system to alleviate whatever problems it is causing, the carrier can file a complaint with the FCC and the in-building system will be shut down. The bigger problem with a system shut down is the cost to modify the system after the fact to make it work within the carrier's FCC license. Since many of these systems are installed in the ceiling and behind finished walls, this can become increasingly expensive, and very disruptive to tenants.

### *2. Capacity is the driving motivation of wireless carriers; coverage is the motivation of building owners.*

As noted above in the 4G discussion, the greatest challenge facing wireless carriers is keeping up with subscriber demand (i.e. capacity). Wireless carriers have consistently seen usage increases of more than 100% year over year; in some cases 250-300%. It is impossible to double and triple the size ("capacity") of these networks annually, therefore the carriers have taken focused steps to address high-traffic venues. If your building or venue has little or no coverage, instantaneously adding this venue to the larger wireless network without any consideration for a capacity increase only exacerbates the problems faced by carriers and, ultimately, by subscribers. The end result could be five bars and no service.

During a recent site walk in a multi-use building under construction, we found the in-building system designer and building owner determined they would merely supply the signal source of their in-building network by rebroadcasting the outdoor signal. Intuitively, this makes sense; fundamentally, it does not. To do this, a bi-directional amplifier (BDA) is the commonly-used device for in-building systems when macro network capacity is not a concern. Simply put, these amplification devices pick up off-air signals and rebroadcast them indoors. BDAs were commonly deployed in 2G and 3G in-building systems, when capacity was not a concern. They are a cost-effective means of rebroadcasting the outdoor signal indoors. However, this method only works



if the outdoor macro network has the excess capacity to support the load of the new venue. In major cities, especially in the northeast, this is definitely not the case. The owner of the previously mentioned building planned to allow carriers free access to the new in-building network.

So why should the carriers complain? When this new system goes live, it will drag down the capacity of nearby outdoor sites, and the five-bars-and-no-service problem now extends beyond the venue and throughout the neighborhood. The carriers' recourse: file complaints at the FCC with get the in-building system shut down. The building owner's problem: modify the system at a substantial cost, or have no service inside the building. Further, in this case, the area designated to house the in-building equipment had just enough space to house the system as-designed. Now, a new area would have to be chosen.

Extensions from the previous equipment closet to the new space would be required, and this additional cost was never envisioned by the designer and/or owner. The building owner's problem is likely resolvable, but not without great cost overruns and pain. Had the system designer taken the capacity fundamentals into consideration from the get-go, these problems would be nonexistent. Because the building owner did this on his own, the cost is his responsibility. The carriers have no skin in the game, thus no technical input is offered. Stick to the fundamentals and you will make it to the championship; stray far away and you have a losing season!

### 3. Design your system with the future in mind.

The FCC, the federal agency that has jurisdiction over these wireless systems, is in the middle of a spectrum auction where new "channels" will be made available to the wireless industry. These channels will operate in a frequency band not currently utilized by the wireless carriers. The channels are expected to begin implementation within the next five years.

What does this mean for building owners? It means the carriers will come



back to them requesting system modifications, more power, more cooling and more space. What can building owners do to "future proof" their systems being installed now? The answer is simple.

First, reserve space, cooling capacity and power in your head end (i.e. main equipment distribution room; usually one or more IDF's) for technology enhancements. Also, allow easy access to antennas, which are either mounted on the ceiling or wall, so "swap-outs" are a non-issue in the future. The good news is most, if not all, fiber optic and coaxial cables will support any new bands. This means any installation behind finished walls will not be disrupted.

Lastly, make sure any splitters, couplers or other hardware that provide a junction for the cables are easily accessible, as this equipment will likely be swapped out when new technology comes along. New technologies will require upgrades of many components. As long as these components are easily accessible, the upgrades will be relatively painless.

We have seen many systems where the components are contained behind beautifully finished walls and facades, for obvious aesthetic reasons, but an upgrade requires opening and refinishing these beautiful areas. Certainly not impossible, but usually not contemplated by the building owner.

### Conclusion

Stick to the fundamentals and you'll have a winning season! Understand the technology

requirements upfront, design your system to include these fundamentals. Recognize, as the building owner, you do not possess the FCC license to broadcast frequencies, therefore you cannot to call all the shots. However, the carriers have this ongoing capacity problem, which is not only not going away, but rather increasing.

With this in mind, they are typically more willing to work with you than you might expect, as the correct solution to your problem is also the correct solution to their problem. Keep the future in mind and reserve space for it. This will prevent future heartburn.

Finally, taking the smart approach upfront may seem like it costs more, but you'll pay a lot less in both the short and long run! Not only will this be a winning season, but you will have sustainable winning seasons to come. ¶

---

*Dominic Vilecco is the president and founder of V-COMM, LLC, a telecommunications engineering firm located in the northeast that specializes in wireless system performance, design and implementation. Mr. Vilecco is a 36-year veteran of the wireless industry, recognized as an expert at the FCC and currently Vice President on the Board of Trustees for the New Jersey Wireless Association. Visit [www.vcomm-eng.com](http://www.vcomm-eng.com) for more information.*

