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Specialists in Public Safety Communications Since 1979

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VHF DAS Systems

—Tom Manley

With the enactment of IFC 510 in 2009, fire codes are being updated with suggested jurisdictional guidelines regarding emergency responder radio coverage. A few of the important IFC 510 suggested requirements are:

- All new buildings should have approved radio coverage for emergency responders within the building.
- Radio signal strength requirements must be met in 95 percent of all areas on each floor of the building.
- All existing buildings should have radio coverage throughout the building and are required to retrofit the building with radio coverage if the existing wired system is not able to be repaired or is being replaced, or per a timeline as identified by the jurisdiction.

Aside from these guidelines, implementing DAS is not a one-size-fits-all proposition, especially in the VHF spectrum. Specific codes are set by state, county, and city requirements and jurisdictions in many cases are discovering that it is an evolutionary process requiring all of the players to contribute to the local solution.

The Public Safety (PS) RF spectrum covers a wide range of frequencies from Low Band near 25 MHz through 800 MHz. And then there is Broadband coming around 4.9 GHz. Many of these bands are logically laid out, which helps in the application of bi-directional amplifiers (BDAs) typically used in a distributed antenna system (DAS). To a large degree, in mostly larger urban areas, the orderly 700 and 800 MHz spectrum (after re-banding, anyway) lends itself well to a BDA with widely spaced uplink (UL) and downlink (DL) channels, which mitigates problems with filtering and potential oscillation in the BDA system.

Not so with the old and grizzled VHF spectrum. This spectrum grew up in the early days of land mobile radio communications. The band primarily supported simplex communications. As time progressed, duplexed repeater-based operation grew but the management of the spectrum was haphazard with frequencies getting little coordination. Frequencies for repeater uplink and downlink are often interleaved and some frequencies are tucked very close together. This was great for filter manufacturers.

Radio waves have always had some difficulty penetrating buildings, perhaps more so with the use of newer materials like low-emissivity glazing, and that situation is now being addressed in building codes. Although VHF has been supplanted by 700/800 MHz systems in many cases, a significant number of jurisdictions still make use of VHF for PS (in general) and Fire (in particular). With the new codes, fire marshals, planning departments, and building owners of both new and existing buildings are beginning to wrestle with the realities of implementing DAS in the VHF spectrum. Part of that reality is the difficult positioning of relevant frequencies as noted above. Another is the traditional practice of simplex communication on the fireground.

Remember that DAS systems are built around BDAs, meaning that UL and DL RF traffic share the same antenna and coax system, and the amplifiers are simultaneously amplifying both directions on that same antenna's system. It is not possible to amplify a simplex frequency in this manner. Attempts are sometimes made to physically split the UL and DL infrastructure. While this may be possible on paper, it introduces a number of opportunities for "Murphy" to set up residence. The likely result of a miscalculation or inadvertent change in the system that compromises the engineered isolation is that the system will oscillate and potentially disrupt communication over a wide area.

Building owners are increasingly being required to provide DAS in new structures. Depending on the jurisdiction and how codes are being written and enforced, existing structures may become subject to the requirements as well having an unexpected, and unwelcomed, impact to remodeling expenses. DAS to support

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Industry News ...

VHF DAS Systems

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cellular telephone service in a building is a fairly well understood issue with a number of manufacturers providing equipment that can host a number of providers in different frequency bands over the same head-end and antenna infrastructure. The ability to include VHF in the mix is not as well supported in this way, however. A building owner can easily find that two independent DAS systems become necessary.

Another factor is that a PS DAS, VHF or not, imposes additional requirements on the system. The electronic equipment must be housed in a NEMA 4 enclosure so that it can survive fire suppression and it must have standby power available to support 12- or 24-hour operation in the case of utility failure.

And, finally, new FCC regulations have come into play for Class B amplifiers as of November 2014. Class B amplifiers are non-channelized units that are likely to find use in the VHF spectrum (note that there are channelized, Class A amplifiers available as well). Class B units amplify a wider bandwidth of the spectrum that can have implications for interference due to passing unintended frequencies and generally increasing the noise experienced by the intended radios. Consequently, the FCC is requiring registration of any Class B systems, existing or new, with a substantial fine for non-compliance.

VHF brings some unique issues to PS DAS implementations. The first cut at codes to address this need in a given jurisdiction may not take into account the difficulties imposed by the VHF frequency non-plan. Codes may also not account for the special requirements of fireground, simplex communications. Both of these issues will call for a meeting of minds by fire marshals, planning departments, building owners, emergency communications organizations, and firefighters.

"I Feel the Need ... the Need for Speed"—Top Gun

—R. Scott Peabody, P.E.

According to the WiFi Alliance, a worldwide network of companies manufacturing WiFi devices, the total shipments of WiFi devices surpassed 10 billion per month in January 2015—*10 billion devices per month* 1 year ago! No other wireless technology comes close to the ubiquity of WiFi. For comparison the total number of smartphone users is projected at 6.1 billion by 2020.

WiFi or its technical name 802.11 has evolved from its humble beginnings to a powerful, flexible, and inexpensive enabler of modern living. In 1997 the Institute of Electrical and Electronics Engineers (IEEE) released the first Wireless Local Area Network (WLAN) standard and called it IEEE 802.11. With speeds up to 2 million bits per second (considered glacial by today's capabilities), a large number of amendments have been proposed and adopted to the baseline standard. Here are the most important amendments:

802.11a (2000): "WiFi A"—the first amendment to standard was developed to use 5 Gigahertz (GHz) unlicensed frequencies. The amendment proposed a very efficient use of the airwave called Orthogonal Frequency Division Multiplexing (OFDM) so it took a bit longer to get out of the starting blocks than 802.11b but it offered up to 54 Mbps.

802.11b (2000): "WiFi B"—started at a similar time with WiFi A, it jumped to an early lead worldwide adoption. It was designed for the 2.4 GHz frequencies with a speed up to 11 million bits per second (Mbps). For the first time, wireless LAN speeds approached the 10 mbps of its wired Ethernet cousin and the world responded by buying millions of WiFi devices for the first time in history.

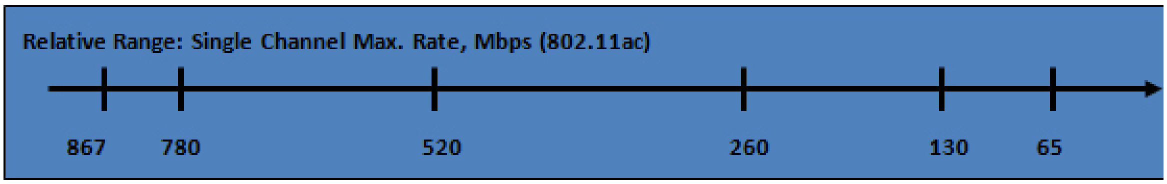
802.11g (2003): "WiFi G"—developed to match the 54 mbps rate of WiFi A, G implemented the OFDM efficiency with the longer range advantage of the 2.4 GHz compared to 5 GHz. Today over 80 percent of WiFi runs over 2.4 GHz.

802.11n (2007): "WiFi N"—converged the A and G amendments into a single amendment and dramatically improved transfer rates up to a theoretical maximum of 600 Mbps although 150 mbps with a single antenna is the most common experience. N operates in either the 2.4 or 5 GHz unlicensed frequency bands with ability to bond multiple channels through different antennas. Although not immediately recognized by most users, N also contained the seeds for future enhancements to break the one gigabit per second (Gbps) speed barrier.

802.11ac (2013): "WiFi AC"—called "WiGig" in some circles, AC introduced two waves of device availability due to the difficulties in implementing its enhancements. Wave 1 devices using a single antenna could reach speeds up to 433 Mbps. Beginning in 2015 AC Wave 2 devices began initial shipments and today they are available to consumers and businesses alike in smartphones, tablets, and wireless routers. Wave 2 devices can reach speeds of 867 Mbps with a single antenna. The theoretical maximum for AC Wave 2 using 4 antennas is a whopping 3.5 Gbps.

Results Will Vary

Product marketing is not forthcoming to the speed limitations of WiFi. Fundamentally the transfer rate is limited by range—the distance between the wireless router and the device—due to signal processing algorithms in the radios. As the number of wireless transmission errors increases, the WiFi radios adapt to improve the communications at a slower rate.



The other performance limiter is the router and network connection capabilities. To keep up with gigabit transfers speeds, today's routers need a lot processing power, which can be expensive. After the router there is a network connection. A gigabit connection to a personal computer or smartphone doesn't matter much when the Internet connection is a hundred times slower at 10 megabits per second. While monthly Internet Service Provider rates for 100 Mbps and higher are coming down due to increased fiber availability, these high-speed data connections are still not available in all areas at any price.

Future WiFi Amendments

802.11ah: "AH" or "HaLow" is designed for low power with long range in the 900 MHz frequency band. HaLow has the benefits of penetrating through walls and obstructions, which makes it ideal for smart building applications to control lighting, heating ventilation air conditioning (HVAC), and smart security systems. Unfortunately there is no global agreement on the 900 MHz frequencies to use reducing the market size for manufacturers requiring economies of scale for profitability. The good news is smart building applications can use 2.4 GHz until AH emerges in the market place.

802.11af: "AF" nicknamed "White-Fi" got its nickname from the vacated television radio spectrum from the digital TV conversion. This vacated spectrum called white space is between 54 MHz and 790 MHz. White-Fi is targeting long-range applications with speeds comparable to today's fourth generation (4G) cellular systems. To mitigate interference between operators, the Federal Communications Commission (FCC) requires spectrum sharing rather than licensed or unlicensed authorizations so each white space device must obtain permission to transmit from a geolocation database (GDB). Similar to HaLow, White-Fi has a limited market because TV channels in North America do not match allocations in other countries.

802.11ad: "AD" has been designed for very high speeds at very short distances using 60 GHz frequencies. To understand these speeds consider the width of the data channel in the early 802.11 standard as a single lane of highway traffic. AC would be equivalent to eight lanes. Continuing this analogy, AD is equivalent to over 100 lanes and it can support up to three of these highways opening up applications like wireless hard drives performing as well as a local disk or streaming video directly to large high definition video screens without cables. All this speed comes at the cost of range. The range of AD is typically a single room as compared with range of a home for N and AC as 60 GHz has difficulty penetrating walls. AD components are relatively expensive to manufacture but devices are available today. Similar to AH and White-Fi, there is no global agreement on the 60 GHz frequency limited the market potential for manufacturers.

WiFi is Here to Stay

Mobile network operators, both domestically and internationally, have begun planning for their next generation—so called 5G systems—to be available by 2020. The Next Generation Mobile Network (NGMN) alliance "recommends that LTE/LTE-Advanced (4G) and WiFi, as well as their evolution, are to be supported by 5G network designs." We all have a need for speed.

Can You Find the Problem Here?

The first person to email me (j.blaschka@adcomm911.com) with the correct answer gets a $10 Starbucks card.

THE LAST BYTE

—Joe P. Blaschka, Jr., P.E.

"FUD" Fear, Uncertanity, and Doubt is often created when there is a new technology right around the corner. FirstNet seems to be creating FUD based on the perception that the system will be the end all for public safety communications. So, elected officials are reluctant to commit money to new radio systems. Regardless of what the FirstNet may say on their website, many elected officials and others view FirstNet as this great system that will cost them virtually nothing.

Haven't we learned there is no free lunch? Oh, I forgot, it is an election year. I guess not.

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