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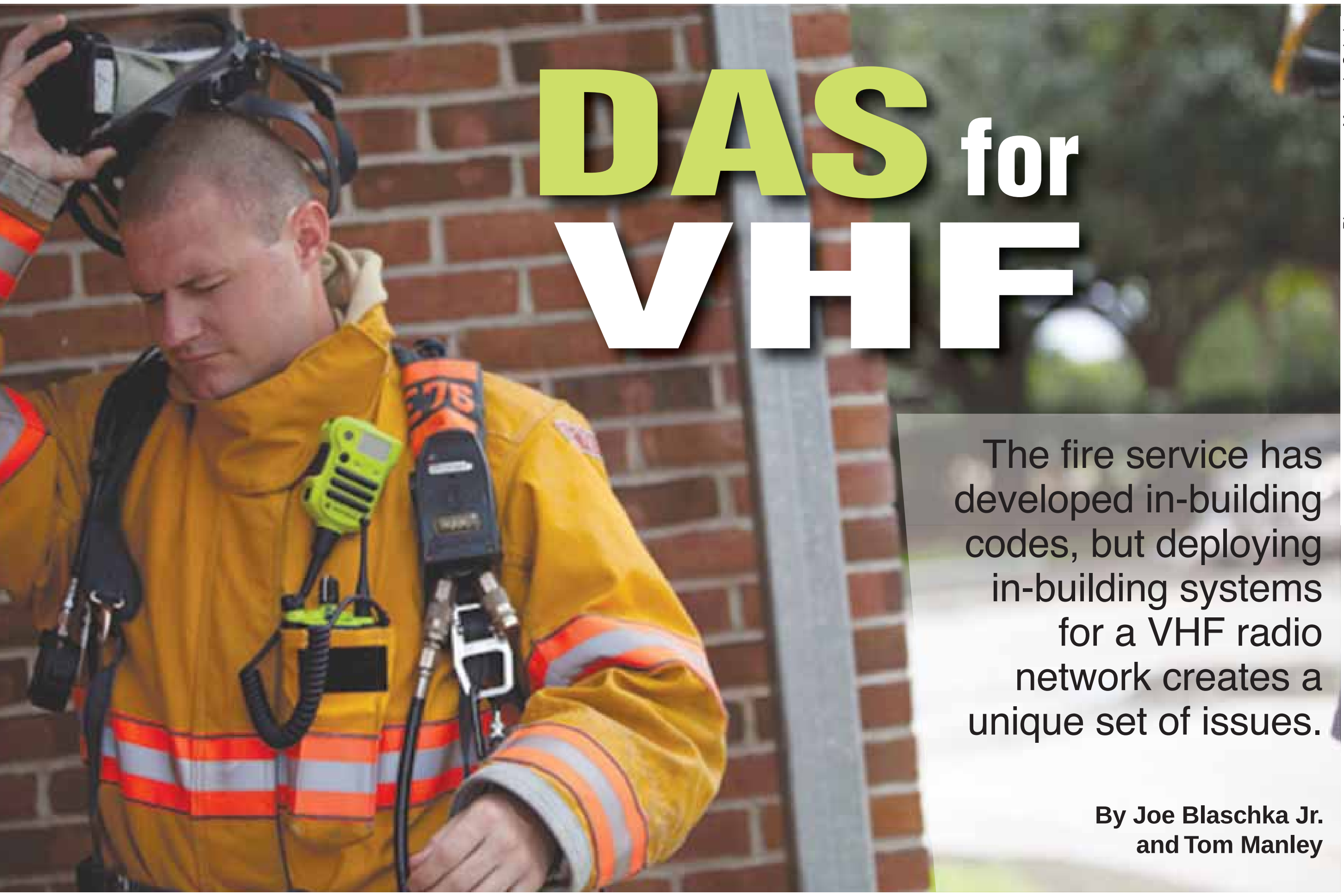

Photo courtesy Motorola Solutions

DAS for VHF

The fire service has developed in-building codes, but deploying in-building systems for a VHF radio network creates a unique set of issues.

By Joe Blaschka Jr. and Tom Manley

In-building coverage seems to be the bane of almost any wireless communications system from cellular to public safety. Operators of 700/800 MHz systems have often been able to ride the coattails of the cellular industry by being included in in-building systems provided for commercial wireless carriers. Often, this was done at little or no cost, because the frequencies and technologies used were usually compatible. Life was good. Unless, of course, you were operating in the UHF or VHF spectrum; then, there was no "free" commercial system to ride on nor were the technical solutions simple. Thank goodness there is not much VHF low band still in use.

However, a few years ago, the fire service, concerned about critical communications for firefighters inside buildings, started working with the building code standards bodies to incorporate critical communications requirements in building, fire and electrical codes. Through that process, standards were developed and incorporated into existing building codes. These standards are a combination of performance-based and specific requirements. They are also band agnostic so they apply to all frequency bands. This has created some significant issues for those using VHF and UHF frequencies.

The codes apply to building design and code compliance, not specifically to a radio system operator. However, at the lower frequencies, especially VHF, the technical solutions may be costly, and in some cases, result in more harm than good.

Codes and Spectrum

The primary code involved is the 2009 International Fire Code (IFC) 510 and subsequent revisions. Fire codes are being updated with suggested jurisdictional guidelines regarding emergency responder radio coverage. The IFC codes are often adopted by local municipalities, counties and states, usually with some local changes, essentially giving the codes the force of law. How well a local jurisdiction may actually enforce the codes is another matter often based on staff availability, knowledge of the codes and interest. The new in-building requirements are starting to get more visibility because of fire departments pushing the issue.

A few of the important IFC 510 requirements are:

- All new buildings should have approved radio coverage for emergency responders within the building.
- 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 building owners 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 a distributed antenna system (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 many jurisdictions are discovering that it is an evolutionary process that requires all players to contribute to the local solution.

The public-safety 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 the bi-directional amplifiers (BDAs) typically used in a DAS. In mostly large urban areas, the orderly 700 and 800 MHz spectrum (after rebanding) lends itself well to a BDA with widely spaced uplink (UL) and downlink (DL) channels, mitigating problems with filtering and potential oscillation in the BDA system.

Photo courtesy Adcomm Engineering

A bidirectional amplifier (BDA) is used in a DAS deployment.

Specific VHF Challenges

Logical and orderly spectrum is not found with the old and grizzled VHF frequencies. This spectrum grew up in the early days of LMR communications and primarily supported simplex communications. As time progressed, duplexed repeater-based operation increased, but the management of the spectrum was haphazard with frequencies getting little coordination. Frequencies for repeater UL and DL were often interleaved and some frequencies were tucked close together. This was great for filter manufacturers. Additionally, VHF antennas are much bigger than typical antennas and are not hidden as well.

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 majority of jurisdictions still make use of VHF for public safety 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 communications on the fireground.

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 communications across a wide area.

In addition, VHF site noise is often high and is compounded when inside buildings. Computers, electronic lighting, medical equipment and many other things generate

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noise that often masks VHF signals. This same noise can also be amplified by the DAS system and broadcasted to communications around the outside of the building and the nearby receiver site, raising the noise floor of the site and resulting in loss of communications across a wide area. This is a case where more amplification is not better and may have wide-ranging effects.

Building owners are increasingly being required to provide DAS in new structures. Depending on the jurisdiction and how codes are written and enforced, existing structures may become subject to the requirements as well, leading to unexpected and unwelcome remodeling expenses. DAS to support 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, however. A building owner can easily find that two independent DAS systems become necessary.

Photo courtesy Adcomm Engineering

A typical VHF antenna often used in VHF DAS systems

are nonchannelized 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 because of passing unintended frequencies and generally increasing the noise experienced by the intended radios. Consequently, the FCC now requires registration of any Class B systems, existing or new, with a substantial fine for noncompliance.

VHF brings some unique issues to public-safety DAS implementations.

The ability to include VHF in the mix with commercial systems is not as well supported, and a building owner can easily find that two independent DAS systems become necessary.

Another factor is that a public-safety DAS, VHF or not, imposes additional requirements on the system. The electronic equipment must be housed in a National Electrical Manufacturers Association (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.

Finally, new FCC regulations for Class B amplifiers came into play in November 2014. Class B amplifiers

The first attempt at codes to address this need in a given jurisdiction may not take into account the difficulties imposed by the VHF frequency nonplan. Codes may also not account for the special requirements of fireground, simplex communications. Both of these issues call for a meeting of minds among fire marshals, planning departments, building owners, emergency communications organizations and firefighters.

In the past, it was easy for public-safety entities and building code agencies to work independently on this issue. Now, it takes close coordination between all of the players so the systems can be implemented in a manner that does not degrade critical public-safety communications outside the building and allows the building owner to operate and maintain the system.

In some cases, the local public-safety entity may come to the conclusion that implementing a voting receiver in the building will resolve the talk-in issue. In others, it may take a decision by the local fire department as to which channel it will agree to use in the building, because it may not be technically possible to implement all channels. There are many different solutions to this problem. The solution must involve resources from the local public-safety communications agency, fire and law-enforcement personnel, code-enforcement personnel and the building owner to come to a reasonable solution. ■

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