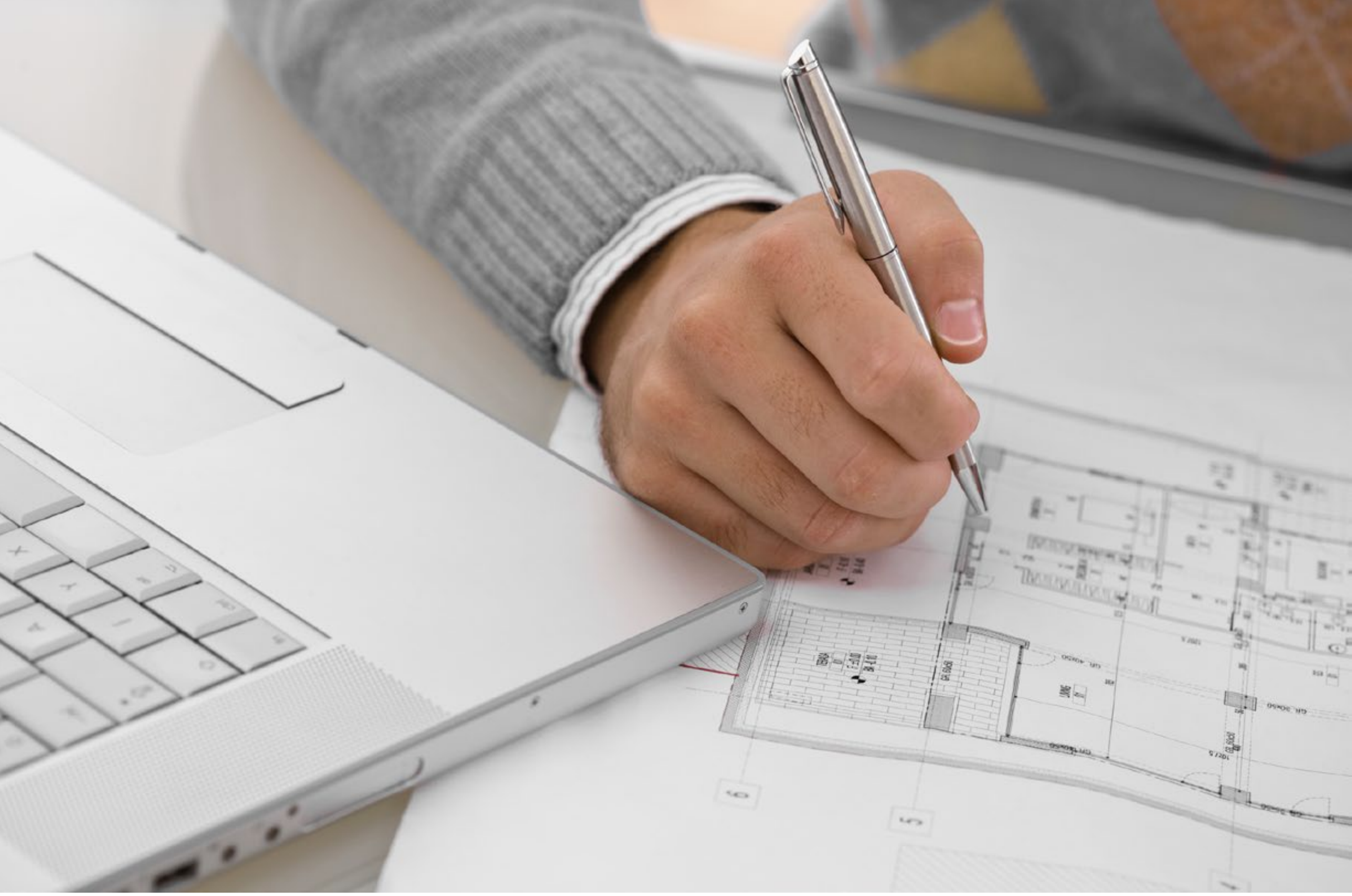
Planning for Mobile Broadband Connectivity at the Architectural Design Phase



Save Time and Money by Including Cellular Connectivity at the Beginning Stages of the Design Process

Planning for Mobile Broadband Connectivity at the Architectural Design Phase

This white paper is meant to be an educational tool and does not reflect Wireless Infrastructure Association policy.

Abstract

Building owners, tenants and the people supporting their communications IT requirements demand device connectivity throughout their buildings. Much of the cost of deploying in-building cellular coverage can be defrayed by including plans for cellular connectivity into the process early on in the design stage for new buildings or during planned renovations to an existing building.

Introduction

Smartphones and tablets are changing the way society communicates with each other and accesses content.[1] Forrester Research labels this as "the mobile mind shift – the expectation that a person can get what they want in their immediate context and moments of need."[2] Simply put, people turn to their mobile devices for answers to their questions. As today's employees and tenants continue to embrace this constant connectivity, a strong wireless infrastructure foundation is needed to accommodate these mobile moments. Cellular connectivity is needed to address public-safety concerns as well. Today, 70 percent for continuity of 911 calls take place over the cellular network and 64 percent of calls made to 911 are indoors.[3]

However, mobile broadband connectivity is not often thought about during initial architectural drawings, or early on in the process for designing new buildings. In fact, some other building designs, like low-emission glass and building material choices like aluminum, hinder RF transmission, necessitating the need for in-building connectivity to be brought into the venue. Further, established buildings also may suffer from poor in-building connectivity, resulting in them being less desirable when trying to rent to tenants or enabling employees' productivity. Much of the cost of deploying in-building cellular coverage can be defrayed by including plans for cellular connectivity into the process early on in the design stage for new buildings or during planned renovations to an existing building. It is easier to run necessary fiber, antennas and other equipment when ceilings, floors and walls are exposed. In existing buildings, adding wireless infrastructure should be included during remodeling efforts or as stand-alone service. Designers who think ahead about the venue's cellular and public-safety connectivity needs can plan ahead accordingly to make the process less costly.

This paper aims to examine these parameters:

- In-Building Cellular Coverage Overview
- Stakeholders
- Wireless Carriers
- Public-Safety Communications
- Available In-Building Solutions
- The Ecosystem—Who the players are
- DAS Funding Models
- Other Small Cell Funding Models
- In-Building Design & Installation Considerations
- Conclusion

While this paper addresses the overall market for mobile connectivity, each building is different and each buildout likely has its own nuances.

In-Building Cellular Coverage Overview

The cellular industry got its start in earnest in the 1990s when mobile communications networks were built out to help people communicate on the go, often while driving. Wireless carriers built networks alongside highways, in urban centers and eventually extended them to the suburbs and rural areas. Since then, mobile traffic has moved indoors. Today, 70 percent of 911 calls take placeover the cellular network and 64 percent of calls made to 911 are indoors.[3] That connectivity crosses nearly every industry and segment of society. For example, 87 percent of doctors use a smartphone or tablet in the workplace.[4] About 84 percent of smartphone shoppers use their phones while in a physical store.[5] More than 90 percent of global executives say they access news and business content via their smartphones and tablets.[6] In addition, communications has moved beyond people to what is commonly called "The Internet of Things," or IoT. Cisco predicts 3.1 billion machine-to-machine (M2M) connections to the Internet by 2020.[7] Many of those connections will take place over the cellular network.

A study by Coleman Parkes found that about half (48 percent) of architects worldwide plan and design buildings with dedicated in-building cellular networks in mind. In the United States, the experience is a little better, with 65 percent of architects saying they do consider cellular networks in planning and design. In addition to ensuring a far better customer experience, provisioning indoor wireless networks as buildings are being constructed avoids significant disruption to tenants when systems are added after-the-fact, and saves considerable cost involved in building retrofits, according to Dr. Ispran Kandasamy, global building solutions leader at CommScope, which commissioned the study. [8]

Stakeholders

Stakeholders can be grouped into four main categories:

- Building Owners and Managers
- Tenants, Customers and Visitors
- Wireless Carriers
- Public Safety/First Responders

Building owners and managers have a stake in offering great mobile broadband connectivity because today's consumers are expecting it. Apartment owners and managers should take mind of these statistics: 48.3 percent of Americans live in wireless-only homes, according to the U.S. government agency that tracks these statistics.[9] More than half of all adults aged 18-44 and of children younger than 18 were living in wireless-only households.

The time spent on smartphone-based entertainment – music, video and games – has doubled in little more than just a year among those ages 18-24 and now averages nearly 40 hours per month, according to ComScore.[10] Likewise, a recent Pew Research Center survey in 2015 found that 86 percent of people ages 18-29 have a smartphone, as do 83 percent of those ages 30-49.[11] Beyond expecting in-building connectivity where they live, people also demand connectivity at work, at play and on the go. A news article in Tech Republic[12] noted that college fans are leaving the stadium at half time if they cannot get connectivity. Professional sports teams have noticed this trend and are adding mobile connectivity at stadiums nationwide.

Healthcare is another industry truly embracing mobility. Indeed, 87 percent of physicians use mobile devices in the workplace. [13]

The Internet of Things is also having an impact on buildings, making buildings smarter and reducing energy consumption. Connectivity will be one of the underlying foundations for that intelligence. In this vision, networks will no longer live in silos but be integrated so IT professionals can look at their HVAC, lighting control systems and security systems holistically, rather than in silos. Further, the data collected from these converged networks will be actionable, so if an alarm sounds, the resolution of that alarm will also be tracked and recorded.

A smart building will need connectivity and mobility as these integrated networks will communicate over Wi-Fi and cellular networks. An IBM internal project on reducing energy consumption across its global real estate used a combination of Wi-Fi and cellular technologies to monitor and control its energy consumption.[13]

Wireless Carriers

Wireless carriers have spent billions of dollars building out their networks, and continue to invest in them to keep up with the increased traffic demands. Indeed, the top four U.S. wireless carriers spent a cumulative $34 billion in 2013 at the height of the LTE buildout to make their networks strong enough to handle today's connectivity demands, according to Recon Analytics Analyst Roger Etner. [14]

Those investments include towers, rooftop antennas, Distributed Antenna Systems (DAS) and small cells in addition to using Wi-Fi technology to offload traffic from the cellular network to Wi-Fi networks. Despite these investments, not every building or venue enjoys mobile coverage and capacity today.

Ultimately, wireless carriers own the RF spectrum that is required to bring cellular connectivity inside a building and so the wireless carriers and building stakeholders must work together to achieve in-building coverage.

Public-Safety Communications

Both the International Code Council's International Fire Code and the National Fire Protection Association have addressed the need for first responders to be able to communicate with each other inside buildings. Among other things, the codes require in-building public-safety radio coverage for new structures that are of a certain size and have sub-grade space, such as parking garages. These codes are evolving, with updates every several years. In general, the codes require certain levels of coverage in mission-critical spaces, battery back-up equipment and other redundancies. The code requirements can vary from jurisdiction to jurisdiction, depending on what sections the Authority Having Jurisdictions (AHJs) have adopted into local laws. [15]
Some examples of applicable codes are listed below:

Review of applicable code requirements related to DAS and Public Safety

1. International Code Council International Fire Code (2012) Section 510 Emergency Responder Radio Coverage
   a) 510.1 Emergency responder radio coverage in new building
   All new buildings shall have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction at the exterior of the building.
   b) 510.2 Emergency responder radio coverage in existing buildings
   Existing buildings shall be provided with approved radio coverage for emergency responders as required in Chapter 11.
2. NFPA 72 (2012) Section 24.5 Two-Way, In-Building Emergency Communications Systems
   a) 24.5.2 Two-Way Radio Communications Enhancement Systems
   b) 24.5.2.22 Amplification Components

Available In-Building Solutions

In-building solutions are generally categorized in the following:
Distributed Antenna Systems: A DAS distributes RF signals from a central point to antennas located throughout the facility to provide ubiquitous coverage and capacity. They are primarily used in large buildings, stadiums, public spaces, airports and outdoor environments. DAS networks can accommodate a large number of people and a variety of frequency bands and technologies. They can be designed to house all wireless carriers, which is often referred to as a neutral-host design. A DAS also can scale so new carriers or frequencies can be added to the system after it has been deployed. They require upfront capital costs and can cost anywhere from $2 per square foot to $6 per square foot. [16]

Repeaters and Bi-Directional Amplifiers (BDAs) boost the cellular signal by rebroadcasting it inside the building from an existing cell site. They are coverage-only solutions. Operators must approve BDA deployments as they can interfere with the macrocellular network. Depending on the services in the area, multiple BDAs might be needed to cover the area adequately.

Small Cells are an umbrella term given to microcells, metrocells, picocells and Enterprise Radio Access Networks (E-RAN). These are operator-controlled, low-powered radio access nodes, including those that operate in licensed spectrum and unlicensed carrier-grade Wi-Fi spectrum. Traditional small cells are typically low-power radio access points designed to increase coverage and capacity within a short range and can handle a limited number of users; they generally have a range from 10 meters to several hundred meters. An E-RAN can scale to cover very large venues and thousands of data sessions. Small cells are generally indoor, premise-based deployments that go beyond a home-office environment. They are primarily coverage-driven, with a need for high reliability, although they can be deployed to aid capacity requirements as well. Residential homes and very small businesses can purchase femtocells — a wireless access point that improves cellular reception inside a home or office building — to augment cellular coverage.

Wi-Fi Communications

Wi-Fi connectivity is prevalent throughout the United States on a wide variety of devices and in a plethora of venues. People install wireless routers in their homes so they can remain connected to the Internet wirelessly. In a business setting, an enterprise IT team usually deploys Wi-Fi access rather than the venue owner. Often, a business will deploy two types of Wi-Fi: a closed-loop enterprise connection for employees that needs encryption, and an open Internet connection that faces out to customers.

Unlike commercial cellular technology, Wi-Fi uses unlicensed radio spectrum in the 2.4 GHz and 5 GHz bands. Wi-Fi can ride on top of the wired element of a DAS. However, the caveat is that the Wi-Fi RF coverage range from a shared antenna is smaller than cellular services due to its higher frequencies, so the antennas need to be closer to provide seamless Wi-Fi coverage. This translates into more antennas and reduced voice power levels to minimize the overlap.

To date, Wi-Fi connections have mostly been data-centric. Voice over Wi-Fi is offered by some wireless carriers. Wi-Fi services typically do not have the same quality of service standards of commercial cellular networks and can suffer quality if too many users are talking on the Wi-Fi network.

While small venues with limited numbers of people may be able to get by with a Wi-Fi-only solution, mid-sized and larger venues likely will need a combination of cellular and Wi-Fi connectivity to offer their customers robust mobile broadband connectivity.

The Ecosystem

The ecosystem for deploying DAS and other small cells starts with the customer, driving the demand for in-building coverage, and the wireless carrier, which owns the wireless spectrum, sets the design standard and provides the RF source. However, there are a number of other parties that touch the system and are involved in the process of deploying wireless broadband.
Original Equipment Manufacturers (OEMs) make the products that are installed in the buildings. Each OEM has its own product line and often provides training specific to their product line. In addition, OEMs can do in-house engineering as well as support engineering. Third-party neutral-host providers build and manage DAS networks under long-term contracts with end-user customers. They seek to get all carriers on the system and often can provide the necessary funding for the project. Distributors supply the inventory for the project, and can be involved in large IT projects that go beyond the telecom portion of the buildout, supplying products like audio/visual, lighting or security cameras. Low-voltage contractors install the cable infrastructure. RF signals are sensitive to interference so it is critical that the connectivity buildout be integrated with the larger macrocellular network, so as not to interfere with it. As such, it is important to have an RF engineer design the DAS or small-cell buildout. Architectural and Engineering firms permit and design the physical installation to support integration of the DAS or small cell to support the building architecture. DAS integrators interface with all of the rest of the ecosystem to ensure successful deployment, including the design, buildout and management of the DAS.

In essence, all of these stakeholders in the project interact with subject matter experts throughout the ecosystem and various stakeholders can perform several of the tasks involved, depending on the project.

DAS Funding Models

Perhaps the biggest question that must be answered in deciding on an in-building solution is who will pay for the system. Wireless carriers might be interested in paying for in-building coverage and capacity at key facilities that are important to them, but beyond those world-class properties, funding models change.

DAS deployments can be financed in a number of ways. There are three basic ownership models, each with their own financial nuances:

In a carrier-owned DAS, the carrier pays for the equipment and installation costs, as well as maintenance and upgrades associated with the network. In this scenario, the individual carrier may charge other wireless service providers a recurring fee if they want to attach to the DAS. Building owners and managers also may pay for a DAS. In this scenario, it is important to work with a competent systems integrator to oversee the project and get wireless carriers to connect the system into their networks. In this situation, the building owner likely will be responsible for continued maintenance and upgrades.

A third-party, neutral-host provider may bear some or all of the upfront costs of the DAS as well as any maintenance and upgrade costs.

Funding other Small-Cell Solutions

As it stands today, venue owners must first work with wireless carriers to ensure the carriers are willing to bring coverage to the building. Wireless carriers may be flexible regarding funding but also may require other parties to pay for the solution. Business models are still developing regarding small-cell funding. Enterprises and third-party providers may be asked to contribute capital.

Residential homes and very small businesses can purchase femtocells—a wireless access point that improves cellular reception inside a home or office building – to augment their commercial cellular coverage. These solutions typically support only a single wireless carrier and do not support handoffs to the macrocellular network.

In-Building Design & Installation Considerations

Beyond budget, other things to keep in mind when choosing an in-building solution are:

- Fiber availability throughout the building
- Cabling pathways
- Physical space to house equipment
- Building aesthetics
- Ensuring the equipment being deployed has been approved by carriers
- Power requirements
- Determining who will maintain the system
- Size of the Building
- Traffic in the Building – Density of population and traffic patterns

The installation of these systems within buildings and other venues can present a number of challenges. While each venue is unique, they generally have common design, approval and construction issues. While small-cell installations may take up less space than a DAS, the general principles apply to any in-building installation. Upfront preparation, thoughtful design and continued project support can save significant installation time, improve design efficiency and reduce costs even in the most difficult project environments. The following list of considerations should be part of the initial design process and followed during construction of the system.

- Depending on size of the building(s)/venue and the number of wireless carriers connecting to the DAS, having a common equipment space for the head-end equipment is critical and often difficult to find. When an available space is reviewed, it should consider a number of design aspects. Locating equipment in existing IT rooms and closets can be an option. However, the building IT department will need to review and understand future space and resource requirements for both the building IT and DAS equipment. Often these spaces end up on mechanical, basement or parking levels, which can pose a number of environmental issues. The design in these areas should be reviewed carefully to mitigate issues like moisture and dust.
- HVAC is critical for DAS equipment spaces. Existing cooling capacity should be assessed for both the initial and anticipated future growth of the system. Dedicated IT cooling is required year round so standard building cooling or small residential type applications should be reviewed carefully for this application. HVAC systems that are designed specifically for IT applications and that are scalable are strongly recommended. Duct work and raised floor applications required for proper air circulation should be coordinated with the cabling design to minimize pathway conflicts.

- Power for the DAS head-end is an important consideration. Capacity of the existing power distribution system should be analyzed. Neutral-host DAS power designs should include considerations for the additional requirements of future carriers. If the building is supplying the power, metering and interconnection for smart-building monitoring will need to be coordinated with building management. Utility metering will require coordination with the local power provider and can be a long lead item that can delay system activation. Utilizing building back-up power or installing a back-up generator to harden the system are also design considerations.

- Fire protection for the head-end and maintenance of existing fire wall assemblies is another important design consideration. For spaces with existing sprinkler systems, new walls or rooms within the space may require modifications for additional sprinkler heads. For critical system infrastructure or larger DAS systems, a pre-action sprinkler system may be a consideration to reduce the chance of accidental discharge. Clean agent gas systems like the FM-200 fire suppressant agent also can be used to minimize damage to the electrical equipment should fire suppression be required. Early warning notification air sampling systems also can be employed to minimize notification and response time to a smoke or fire situation. Fire stopping of cabling and utility penetrations throughout the building is also an important consideration. All wall/floor penetrations should be sealed to maintain the existing wall rating. This is especially critical in hospital environments, where wall fire ratings are critical to the venue's evacuation plan. For penetrations where future cabling is anticipated, penetration products are available that are re-sealable and speed up future cabling installations. It should be noted that cabling should never be routed through egress hallways or stairwells unless it is related to the function of that egress as allowed by the building code. Cabling that passes through plenum spaces is required to be plenum rated to meet low-smoke, low-flame spread requirements.

- The design requirements for accessory equipment cabinets should not be overlooked. Depending on the system manufacturer and system configuration, remote cabinets that are required for conversion from fiber to coaxial cabling will need to be located throughout the building. Locations for these remotes are often in IT or mechanical rooms, where space may be limited, so performing initial walks of potential remote locations should be performed during the design phase. Considerations for power and back-up batteries should be reviewed and included as part of the design.

Once a design is completed, the construction activities and sequence should be reviewed with the building owner, system designer, architect/engineer and system installer. Work hours, restricted access points, tenant space restrictions, union requirements, preferred specialty vendors, etc., are all critical points for discussion. Coring and fire stopping of vertical and horizontal pathways for RF cabling and power are critical. Scanning of floor and wall penetrations often will be required and review of pathways is key to identifying areas that require cutting and patching because they do not have accessible ceilings. Working in an unoccupied space can eliminate many of these issues, but often installations must be done in occupied tenant spaces.

Antenna locations and aesthetics should be reviewed and approved by the building owner and tenants. Providing a mock-up and standard mounting details can reduce antenna/cabling relocation after construction begins. Detailed color-coded floor plans with equipment locations, vertical and horizontal riser locations and antenna locations can be a useful tool to display the entire system design and can significantly reduce change orders from installers that can arise from undefined system requirements and unclear scopes of work.

Conclusion

The demand for mobile connectivity inside venues has shifted from an amenity to a feature that consumers expect and codes require. As such, building for robust connectivity is a given for building owners and managers. Thoughtful design projects and enhancements will include mobile broadband connectivity plans in projects at an early stage, when deployments can be done cost-effectively. When retrofitting a building for mobile connectivity, future connectivity requirements should be given thought, as mobile data consumption shows no sign of tapering off.

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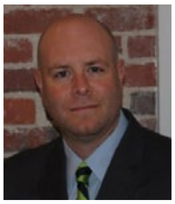

Ben Revette, PE, NCEES, is a senior associate and director of Dewberry's New England telecommunications engineering practice with more than 15 years' experience in the industry. He has provided professional engineering consulting on a variety of telecommunications facilities and Distributed Antenna System (DAS) networks throughout New England for large-scale transportation systems, professional sports and event venues, and universities. These including major installations in Boston's Central Artery Tunnel, Fenway Park, TD Garden, Boston Subway System, Hynes Convention Center, Prudential Tower, Boston College, Harvard University, Yale University and many more. He also serves on the board of directors for the New England Wireless Association (NEWA).

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Allen Dixon is a 25-year veteran of the telecom industry. During his career, Allen has held positions of increasing responsibility ranging from field engineer, marketing, and product line management to his current role as an account executive with HMI Technical Solutions. He is a strong advocate of the role of standards in telecom and has participated in the ATM Forum, Fibre Channel, IEEE, and TIA. He is currently the chair of the HetNet Forum, a membership body within the Wireless Infrastructure Association. Allen is a 1985 graduate of the University of Florida and a U.S. Navy veteran.

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Joe Mullin oversees all DAS projects for InSite. He has more than 25 years of experience designing and deploying wireless networks, including expertise developing specialized in-building coverage solutions for medical, industrial, and entertainment venues throughout the U.S. Previously, Mr. Mullin was Vice President of Engineering for Arch Wireless, where he was responsible for network design, facility management, and regulatory compliance. Mr. Mullin also has developed and marketed wireless network products with Glenayre Electronics and Harris RF Communications. He managed construction projects for the U.S. Army Corps of Engineers in the U.S. and Europe. Mr. Mullin holds a B.S. in Civil Engineering from Worcester Polytechnic Institute and an MBA from Boston University. He is a Registered Professional Engineer and is a member of the IEEE and the Radio Club of America.

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Patrick Lau is director of business development, Distributed Coverage & Capacity Solutions, in the North America region for CommScope. In this position, Patrick is responsible for coordinating sales opportunities between engineering, project management and sales teams and qualifying new in-building opportunities with wireless operators and enterprise customers. Patrick has 18 years of experience in the RF telecommunications field. Prior to joining CommScope, Patrick worked in various engineering and business development roles for Allen Telecom, Allgon and Andrew Corporation. Patrick earned Bachelor of Science and Master of Science degrees in Electrical Engineering from the University of Akron (Ohio).

Contributors

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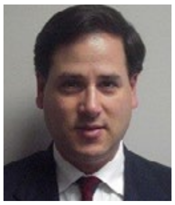

Eric Abbott is the Director of Product Management and Strategy at ExteNet Systems, Inc. Mr. Abbott is a visionary professional with 15+ years of progressive experience delivering market relevant solutions in healthcare, IT services, and telecommunications. His professional experience includes Fortune 500 and entrepreneurial companies focused on technology solutions in business and healthcare. He is also Adjunct Faculty at Northwestern University, teaching Consumer eHealth in the Medical Health Informatics Graduate Program. Eric holds Masters of Science degrees in Medical Health Informatics, Business Administration, and Engineering, and is a graduate of Northwestern University, Lake Forest Graduate School of Management, University of Illinois at Urbana-Champaign, and University of Toronto. He is also a licensed Professional Engineer.

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Kevin Vierling serves as Director of Product Management at SOLiD, a leading manufacturer of Distributed Antenna Systems (DAS) and supplier to the carrier and enterprise markets. Kevin has over 10 years' experience in RF engineering, software and product development, systems integration, and IT and telecom networks. At SOLiD, he leads the company's overall product strategy on DAS, optical, and small-cell product lines, and is responsible for identifying growth opportunities in the wireless and backhaul sectors. SOLiD currently has over 200,000 RF units installed worldwide increasing coverage and capacity for corporate campuses, universities, stadiums, arenas, and underground transportation systems including the New York City subway. Prior to joining SOLiD, Kevin served as VP of Engineering at Intenna Systems, a turnkey provider and systems integrator for indoor and outdoor DAS. He is a graduate of Drexel University, where he earned a Bachelor of Science in Information Science and Technology.

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Seri Yoon joined ADRF in 2015 as a Director of Marketing, with responsibility for marketing programs, brand management, and public relations. In addition to the go-to-market strategy efforts, she also manages and oversees corporate sponsorships, events, social media campaigns, media relations, marketing training and more. She has more than 14 years of marketing experience in the telecommunications industry. Prior to joining ADRF she was a Marketing Manager at Commscope and TE Connectivity. Seri holds bachelor's degree from Carnegie Mellon University. In her spare time, she enjoys travel, outdoor activities, and home renovation projects.

Footnotes

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