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HORIZONS

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5G Network Architecture
Using Drones

YEAR OF THE CLIMBER

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Three Steps to Safety
Why Andrew King Died

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Christmas Monopole

This month's AGL Tower of the Month, a camouflaged tower in Morganton, North Carolina,



seems unusual because I don't know that I ever previously saw a monopine that supports only municipal antennas and no

antennas from commercial mobile network operators. Maybe there are some others that I just don't know about.

The monopine took the place of a tank that used to be part of the municipal water system. The city took the tank out of service for water purposes but left it standing to support the municipal antennas until the city decided to replace it. That's why (as you may notice) the site is identified as Mountain View Water Tank, but you see no tank in view.

Our selection of a monopine for the center spread image is our way of saying Merry Christmas, and may you have a Happy New Year, too.

Tower Registration, Lights

General Communication settled a matter with the FCC involving its failure to register towers with the agency's Antenna Structure Registration system and for aviation obstruction marking violations. The settlement included a fine that should give anyone pause: \$675,000.

I don't remember a larger fine involving towers that didn't have to do with loss of life, such as a helicopter colliding with a tower that wasn't properly lighted.

The FCC doesn't give violators much of a break when they come forward to report mistakes, as General Communications did.

In early 2014, General Communications told the FCC it discovered registration violations, including towers it recently acquired, and that three towers weren't lighted. There were 118 unregistered towers.

More TV on Cellphones

T-Mobile USA made things a little more interesting in November when it announced it would offer unlimited video streaming services such as Netflix, HBO Go and Sling TV. One of the factors that leads to building more antenna sites is the growth in consumer use of wireless data, and video forms a large portion of the consumer data diet. Leaving out YouTube will limit video choices somewhat and put some sort of a cap on the capacity required of T-Mobile's network to deliver all those flying pictures. Nevertheless, more video on wireless networks is good news for infrastructure providers.

Ernie Jones, 1950-2015

On Oct. 21 in Oklahoma City, Ernest "Ernie" Jones died while working on a TV broadcast tower. Jones was known for his tower engineering prowess and for his devotion to safety for those who work on towers. See page 82.

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Subscription Information

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A sneak peek of the AGL Tower of the Month (found on pg. 52)

AGL Magazine (Above Ground Level) is published 12 times a year by AGL Media Group LLC, P.O. Box 2090, Ashburn, VA 20146-2090, and is mailed free to qualified individuals in the United States of America.

POSTMASTER: Send address change to AGL Media Group Circulation Department, P.O. Box 2090, Ashburn, VA 20146-2090.

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Photo courtesy of Valmont Structures



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And Then It All Changed

I'm having a difficult time getting my head around where things are going in this industry. Fiber routes are highly desired. Traditional tower companies are playing hardball in distributed antenna system (DAS) and small cell markets. Traditional tower growth is off. Carriers are talking about working together. 5G lies ahead. The end of Wi-Fi as we know it is coming. Unlimited data plans are on, then they're off, and then they're on again. What is this world coming to?



Recent discussions from just about every tower company names DAS, fiber and small cells among their opportunities for growth. The opportunities for non-fiber backhaul are disappearing rapidly, particularly in urban areas. Plans for future antenna sites almost always require fiber. Have we reached the end of the traditional tower investment? Absolutely not. We've reached the point at which we are going to find every avenue and solution available to obtain necessary capacity and coverage

Incentive Auction

Keep an eye on the FCC's broadcast television incentive auction as it begins to unfold. There are hints that the big wireless telecommunications carriers may skip it.

If they do, the question becomes whether it's possible that smaller carriers, and hopefully some new carriers, have enough cash for their bids to be

high enough to give TV stations enough incentive to surrender their spectrum. The nice thing about the lower frequencies the auction involves is that they cover a greater area than higher frequencies already in use. Thus, the frequency band is well suited to cover large areas and thus to on-tower deployment. There will be considerable deployments of 600-MHz equipment on your towers and all of the modifications that go with it.

Ernie Jones, 1950–2015

The sad notes in the industry keep coming. With great sorrow, we share the news of the passing of Ernie Jones, P.E. Ernie was an industry veteran who was professional, kind and dedicated to the industry and to safety. J. Sharpe Smith wrote a tribute to Jones that appears on page 82. Ernie specialized in the tall towers. He was legendary.

It was at just such a tower where I met him, early in my career. As a veteran of the broadcast industry myself, I know everything is bigger in broadcasting compared with wireless communications: the transmitters, the antennas, the power levels, the towers and the safety issues. Ernie lost his life on a tall broadcast tower. It's a sobering and tragic end to *AGL Magazine's* year of discussing tower safety.

Connie Durcsak, 1965–2015

Connie Durcsak, CEO of Utilities Telecom Council (UTC), passed away unexpectedly in mid-November. Durcsak was really incredible, personally and professionally. I first had the

opportunity to work with her when she was at PICA, working with its former CEO, Jay Kitchen, and later another former CEO Mike Fitch. It was with Durcsak and Kitchen that the idea of *AGL Magazine* as an industry resource came to life. I had the opportunity to coordinate ideas for articles and industry issues with her, and she wrote a few articles.

We worked closely together on a microwave coordination tool as part of the 2.3-GHz spectrum clearing.

Durcsak moved to UTC, taking over from the retiring (and amazing in his own right) Bill Moroney. Because DAS and other small cell opportunities have such considerable overlap with the utility community, Durcsak reached out to everyone in the wireless space to participate in helping utility folks understand our needs and constraints, and vice versa. Durcsak continued to be a supporter of AGL Media Group, speaking at many of our events. She was always willing to help us find industry leaders to address questions and write articles. She was a great supporter of our community and will be deeply missed. Many a lunch, many a laugh, and a lot of hard work together — we will all miss you, ma'am. Thoughts and condolences to her family.

Wishing everyone a safe and happy holiday, and a very safe new year.



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Rice Tests Wireless Data Delivery Over Active TV Channels

Wi-Fi in active TV channels transmits data over UHF without interfering with TV broadcasts.

By Dr. Edward Knightly

Rice University engineers have demonstrated the first system that allows wireless data transmissions over UHF channels during active TV broadcasts. If the technology were incorporated into next-generation TVs or smart remotes, it could significantly expand the reach of so-called super Wi-Fi networks in urban areas.

Because of the popularity of cable, satellite and Internet TV, the UHF spectrum is one of the most under-used portions of the wireless spectrum in the United States. That's a bitter irony because the demand for mobile data services is expected to grow tenfold in the next five years, and the UHF band is perfectly suited for wireless data.

The UHF spectrum, which ranges from 400 MHz to 700 MHz, is often called the beachfront property of the wireless spectrum. Unlike the higher frequency signals used for existing Wi-Fi hotspots, UHF signals carry for miles and are not blocked by walls or trees. Because of these advantages, wireless data hotspots that use UHF are

often referred to as super Wi-Fi.

In the United States, TV broadcasters have been given preferential access to the UHF spectrum for more than 50 years. If no TV broadcaster has laid claim to a UHF channel, the FCC allows secondary users to transmit wireless data on that channel, provided the transmissions do not interfere with TV broadcasts in any part of the UHF spectrum. The rules governing this secondary access are often referred to as "TV white space" rules in reference to the industry term for used or blank portions of the TV spectrum.

Unfortunately, in the most densely populated areas of the country, where the need for additional wireless data services is the greatest, the amount of available white space is extremely limited. Tests conducted in Houston found one channel open in parts of the city and none in others. This is fairly typical of a large U.S. urban area.

Though most of the UHF band is already taken in U.S. cities, it is largely underused. According to a 2014 report by the TV rating company Nielsen, fewer than 10 percent of U.S.

households rely on over-the-air broadcasts for TV programming.

To demonstrate that wireless service providers could make use of the UHF spectrum without interfering with TV broadcasters, Rice graduate student Xu Zhang and I developed a technology called Wi-Fi in Active TV Channels (WATCH) and received FCC approval to test it at the Rice campus in 2014.

WATCH requires no coordination with or changes to legacy TV transmitters. Instead, TV signals are broadcast as usual and the WATCH system actively monitors whenever a nearby TV is tuned to a channel to avoid interfering with reception. The technology to allow this comes in two parts. One aspect of WATCH monitors TV broadcasts on a channel and uses sophisticated signal-canceling techniques to insert wireless data transmissions into the same channel; that eliminates TV broadcasts from interfering with the super Wi-Fi data signals being sent to computer users.

The other aspect of WATCH is dedicated to making certain that data transmissions do not interfere with TV reception. This part of the

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/ HORIZONS /

technology would require TVs to report when they are being tuned to a UHF channel. In practice, this could be accomplished with either smart TV remotes or next-generation TV sets. In the tests at Rice, Zhang constructed a smart-remote app that reported whenever a test television in the lab was tuned to a UHF channel. When that happened, the WATCH system automatically shifted its data transmissions to another part of the UHF spectrum that wasn't being used.

Our tests showed that WATCH could provide at least six times more wireless data compared with situations where we were limited to only the traditionally available white-space spectrum. With WATCH in use, it took a fraction of a second longer than normal to tune in a UHF TV broadcast on the test television. Although the increment could be measured — it was

less than a 5 percent increase — it was almost imperceptible to the person switching channels.

Zhang's and my report on the research, "WATCH: Wi-Fi in Active TV Channels," won best-paper honors in June at the Association of Computing Machinery's MobiHoc 2015 conference in Hangzhou, China. Technology such as WATCH will become increasingly important as the demand for wireless data services increases and the number of broadcast TV viewers decreases.

For example, the "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014–2019" white paper found that nearly a half-billion mobile devices with data connections had been added to the global supply within the previous year, bringing the global total to 7.4 billion — a bit more than the number of people on Earth, according to the U.S. Census Bureau. Of

the 7.4 billion data-connected devices, Cisco found that more than a quarter were smartphones, which used an estimated 22 times more data than nonsmart devices.

Allowing the UHF spectrum to be inefficiently used makes little sense today and will make even less sense in the future. There are already more people in the United States who require mobile data services than there are people using broadcast-only TV. By showing that these two communities can coexist, we hope to spur innovation and a public debate about how this valuable resource could be used.

The research is supported by the National Science Foundation, Cisco Systems and the Keck Foundation.

Edward Knightly, Ph.D., is a professor and the department chair of electrical and computer engineering at Rice University in Houston.

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5G Networks: A New Architecture for a New Era

The challenge is to develop the 5G network as a single system of systems that integrates and aligns the network's many different parts. Many of the components are already up and running.

By Volker Held

The demands on 5G are stacking up. The technology will be called upon to deliver performance that is orders of magnitude higher than today's networks, including 1-millisecond network latency, more than 10-Gbps peak data rates, 100-Mbps throughput anywhere and 10,000 times more capacity compared with 2010. 5G will also need to support 100 times more devices and have extreme reliability, which is becoming critical as mobile communications are increasingly used for control and safety.

And that's not all. 5G networks will also need to support a great diversity of use cases, delivering ultra-high-definition (UHD) video, steering robots in factories, connecting health care sensors, controlling smart city infrastructure and more. Beyond that, 5G networks will need to cater to unknown use cases of the future.

This flexibility goes hand in hand with reliability. With the flexible integration of different technology components, we will see a step away from best-effort mobile broadband toward truly reliable

communication with the expectation of infinite capacity and coverage.

How can one network technology do all that?

Although it may be straightforward to build a separate system for each of these requirements and use cases, the real challenge is to develop 5G as a single system of systems that integrates and aligns the network's many different parts.

Integrated Service

All network elements will be virtualized and sliced out as one integrated service. An operator will be able to create a virtual instance of an entire network using the underlying infrastructure. If all elements of the network from access, core and OSS to security and analytics are virtualized and can be sliced out as one integrated service, it should be possible for an operator to create an instance of an entire network virtually, relying on whatever underlying infrastructure is available for the defined geography, including fixed, wireless, Wi-Fi, peer-

to-peer, mesh or ad hoc networks. Each network instance or slice could be tailored to the needs of any industry whether media, automotive, health care, logistics, retail, utility or other.

The technology is embodied in business models powered by network performance, network data and network slicing. Nokia Networks has used these principles to create a future 5G architecture that automatically and dynamically adapts radio access and core network resources to meet the needs of different services, traffic variations and network topologies, including transport. Nearly all network functions will be software-defined; cognitive technologies will automatically orchestrate the network; and content and processing will be distributed across the network close to where they are needed.

This Nokia programmable 5G multiservice architecture will open up new revenue opportunities for operators. Connectivity+ business models will offer ultra-broadband services such as HD and UHD video in the home and on the move, as well as virtual

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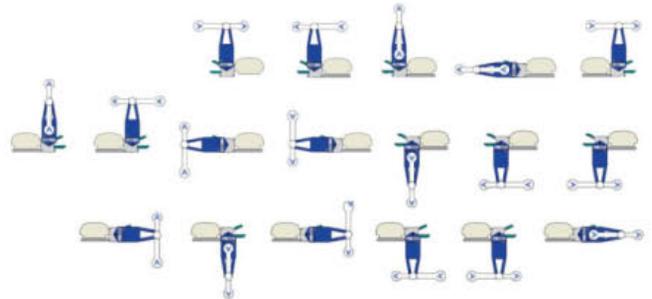
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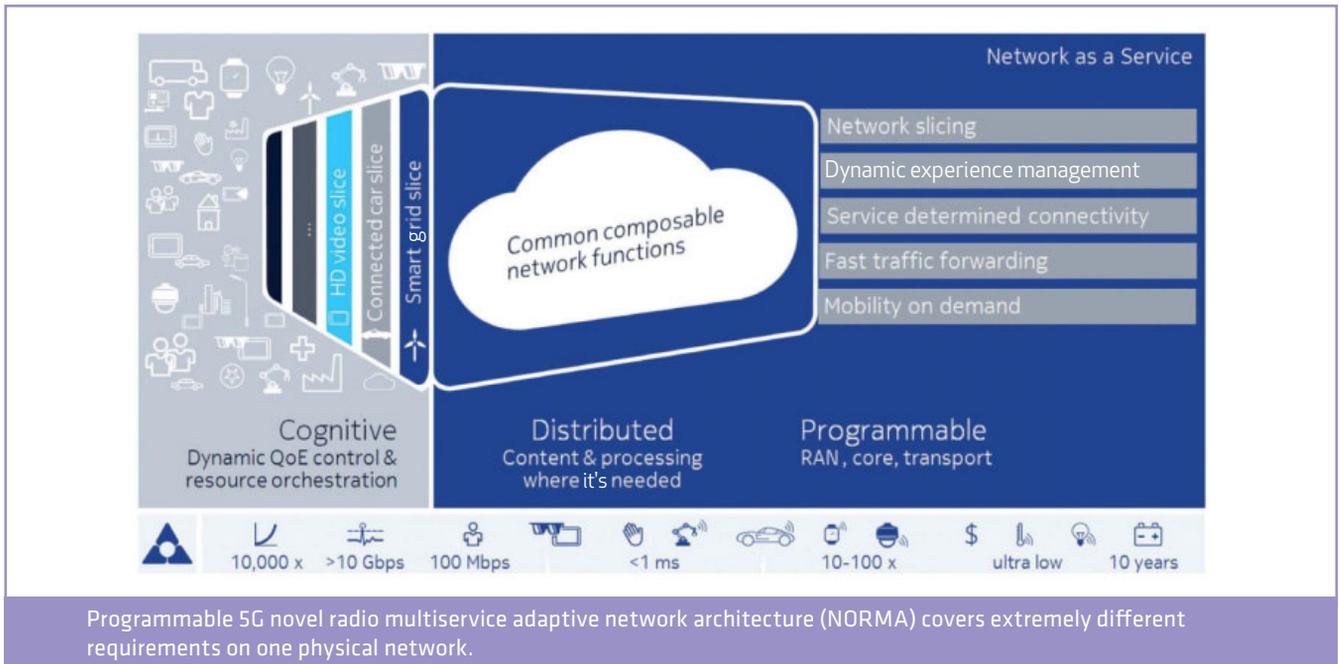


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Another opportunity will come from using the vast amount of transactional and control data from the network to create new services that benefit from contextual real-time and non-real-time data. This information will be valuable for many industries such as augmented reality service providers, municipality traffic control, factory and logistical systems and utilities.

A third revenue model will offer dedicated virtual subnetworks, the network slices, which can be marketed as a “network as a service,” providing the exact functions required by different industries and their diverse use cases. For example, the functionality needed for connecting great numbers of consumer health sensors is completely different from that required to deliver high-quality UHD video to TV sets.

Proving the Architecture

Although 5G standardization has not started yet, Nokia provides a clear concept of what the future 5G architecture needs to be. Many of the components are already up and running. The theory behind programmable 5G multiservice architecture is firmly established, and Nokia is well on the way to proving its capabilities through several proofs of concept.

One example is Nokia’s self-aware software-defined transport network that automatically adapts itself to changing service requirements and the needs of different network slices, application demands and customer experiences. This is achieved by a self-organizing networks (SONs) solution for transport in combination with a multivendor software-defined networking (SDN) fabric control that acts across SDN domains.

Nokia is also introducing programmable application programming interfaces (APIs) to virtual core network elements to adapt core network behavior in run time, unlike today’s

elements that require hours or even days to be reconfigured. As a result, the core network can adapt to dynamically changing needs such as creating new network slices or mobility profiles either immediately or on demand.

Finally, Nokia is at the forefront of 5G development in many areas. It runs several 5G-related industry projects in Europe, leads the 5G-Public Private Partnership project 5G NORMA (5G novel radio multiservice adaptive network architecture) and runs 5G innovation projects with major operators globally. Nokia further collaborates with universities in Europe, the United States and China to make 5G technologies viable and future-proof.

As head of innovation marketing at Nokia Networks, Volker Held focuses on 5G, telco cloud innovation, cognitive networks and the Internet of Things. Prior to this role, he held various senior positions in portfolio management, sales and business consulting at Nokia and Siemens.

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How to Serve Carriers in the New Comm Infra World

It won't be as easy as just building a tower. The convergence of 5G cellular will call for wireless infrastructure providers to become more versatile and offer more services to stay relevant for their carrier customers.

By Don Bishop

Speaking at the Tower & Small Cell Summit in Las Vegas in September, Marc Ganzi, CEO of Digital Bridge Holdings, said the future for wireless infrastructure owners lies in their versatility. They will need to understand how to shift capacity and how to provide multiple types of infrastructure, because those are the kinds of partners the wireless carriers will want.

Ganzi said the past two years have seen the emergence of an asset class called communications infrastructure that investors refer to as comm infra. Previously, Wall Street's focus was on

the tower industry, how carriers were going to build networks and how they were going to buy radio-frequency spectrum. The agent of change has been the consumer.

Consumer Behavior

The concept of how wireless service users consume bandwidth and how they use mobile products has changed during the past five years, largely because of consumers viewing full-motion video and downloading music, large documents and other programs that are content-based. Ganzi said that as a consequence of consumer behav-

ior, RF engineers require more from infrastructure providers.

He said when he started in the business 21 years ago, it was easy to build a telecommunications tower, once the difficult zoning problems were overcome. "If you had a great location, you built a tower. And what do you know? Two and a half years later, four tenants showed up on it," he said.

Today's more complex value proposition forces infrastructure providers to think not only about macrosites, but also about what used to be called microcells in the '90s and that now are called small cells. It forces provid-

ers to think about interconnectivity, backhaul, collocation, the cloud and hosted services.

Five Subsets of Comm Infra

Ganzi said among the five subsets within comm infras are towers, which are macrosites. Also included are distributed network services or systems, which used to be called distributed antenna system (DAS) networks or small cells. He mentioned collocation facilities such as data centers. Another subset is fiber-optic cable service for interconnect, including backhaul, dark fiber and lit fiber. The fifth subset is the cloud or managed services.

“What’s interesting is that after the thunder the tower industry enjoyed for two decades, now other components of this ecosystem are receiving as much attention from the investment community as towers did,” Ganzi said.

In looking for where future dollars would be sent, Ganzi said he asked wireless carriers, and they told him that their needs were complex, including lower infrastructure cost, lower spectrum cost, better radios, better handsets with better battery life, and easier zoning regulations. He said the answers indicated how difficult it is to be a carrier today. And he concluded that tremendous opportunity remains in the macrosite business.

Fundamental Business Model

“The macrotower, the core fundamental tower industry or tower business model, is still intact,” Ganzi said. “It works. A lot of investment is going into it today. Many sites are being built, and thousands of macrosites are being deployed today, including new towers, antenna collocation, water tanks, rooftops and



Marc Ganzi, CEO of Digital Bridge Holdings. Photo by Don Bishop

electrical transmission towers. That part of our industry is very healthy.” He cited 6 to 12 percent organic growth.

“The macrotower is still an incredibly important and vital part of the comm infra ecosystem,” Ganzi said. “In fact, if you look at the market cap of the three public tower companies, one would suggest based on sheer investment and enterprise value that those are three of the most important companies in the ecosystem.”

Small Cells

Including DAS nodes, Ganzi said the small cell part of the wireless infrastructure business has built more than 63,000 nodes since the 1990s. He said

the number is forecast to reach 220,000 nodes in five more years, with a few new forecasts suggesting as many as 350,000 nodes within five years. The numbers represent a compound annual growth rate of 35 percent.

Ganzi said small cells are not as easy to deploy as building an outdoor DAS, or an indoor DAS for that matter. Deploying small cells is more complex because they must be designed to fit within the network architecture. It becomes even more complicated when using new spectrum, as with 5G cellular technology. Not only would 5G be a spectrum-based solution for network capacity problems, 5G would use software to shift capacity in such a way that one transmission or one call can use multiple cell sites at the same time.

To sustain their businesses in future years and with 5G, Ganzi said wireless infrastructure providers could no longer think of themselves as being in the collocation business, the macrotower business or the small cell business. “You’re really in the networking business,” he said. “To be a provider to any of the wireless carriers on the globe, you need to be prepared to build, manage and optimize networks, if you want to survive and make money.”

The Five Subsets of Communications Infrastructure (Comm Infra)

- Towers, which are macrosites
- Distributed network services, also called DAS or small cells
- Collocation facilities, including data centers
- Fiber, meaning interconnect, including backhaul, dark fiber and lit fiber
- The cloud or managed services

VERSATILITY



Convergence

Network architectures are converging, as evidenced by how strategic companies spend their capital. Ganzi gave as an example Crown Castle International's acquisition of Sunesys to complement and extend its DAS footprint to fulfill a customer need.

Another example Ganzi mentioned is Zayo's move into wholesale collocation by buying lattices. "They're now out building small cells," he said. "They probably have a couple of hundred nodes already built and a couple of thousand nodes on the drawing board. They figured out that their existing infrastructure overlays are where their customers want to be. They were bringing dark fiber to towers. They were bringing dark fiber into the urban core. It's a logical progression that they can take that dark fiber, create laterals off of it, hang node

antennas, backhaul it to a collocation room, and guess what? They're in the DAS business, just like that."

Carrier RFPs

For Ganzi, convergence is important because to have relevant conversations with carriers about their requests for proposals (RFPs) means not only talking about bidding on 50 towers, it may also mean bidding on a thousand nodes or 2,000 strands of dark fiber. The RFPs require bidders to demonstrate multiple capabilities for delivering system bandwidth.

The recent history of mergers and acquisitions combined with what carriers are saying indicates to Ganzi that today's infrastructure providers are no longer one-trick ponies. "You have to be able to deliver macrosites, small cells, backhaul, collocation and, to a certain

degree, hosted services," he said.

5G Cellular

Ganzi said that 10 years ago, when 3G spectrum was deployed, the wireless infrastructure industry had a clear mandate, a sense of how many macrosites had to be built. Tower developers raised capital, and the tower industry had a boom from 2002 to 2010.

Then, when 4G came along, the propagation characteristics of 4G spectrum meant network densification and thinking about how to shift capacity to the fringe of the network to deal with connectivity and the broadband crunches seen almost as often during off-peak times as during peak times. "Consumers now use wireless devices throughout the entire day," Ganzi said.

"The progression of infrastructure is more about a story of the consumer driving where infrastructure needs to be built, not the OEMs, not the FCC and not the carriers, with each transition of cellular generation coming in roughly eight-year cycles," Ganzi said. "Analog cellphones were successful because of the allure of being able to make a phone call anywhere. It wasn't so much about the device, and it wasn't so much about the spectrum. It was, 'Hey, I got a phone. Isn't this cool.' That was the allure of 1G cellular."

Ganzi said digital PCS, or 2G cellular, was about providing cellphones to everyone. 3G brought the notion of text and data delivery, and the advent of product that changed the market, the iPhone. And 4G deals with network congestion.

C-RANs

"With 5G, it's going to be a totally different ball game, with C-RANs, for

What Wireless Carriers Say They Need

- Easier zoning regulations
- Lower infrastructure cost
- Spectrum at lower cost
- Better handsets with better battery life
- Better radios

VERSATILITY

example,” Ganzi said. C-RANs are cloud-based radio access networks. “There’s been a lot of talk about whether C-RANs are bad for towers and whether they are good or bad for DAS,” he said. “All of these things are good for the ecosystem, because when you think about how 5G networks are going to be built, you’re going to continue to need the core of the network. And the core of the network is still the macro-site. Make no mistake about it. If you ask any RF engineer at every major carrier, they will tell you the backbone of their network is the macrosite. You’re still going to need small cells, and you’re going to need DAS for indoor venues, stadiums and airports.”

Ganzi said what’s really interesting is the ability to spread capacity out



to the edge of the network. He said the only way to do that is through a fiber-based architecture that connects macrosites, small cells and Wi-Fi with one common radio room, with hosted services as the software piece of the network.

“With 5G, the only way it works is when all five pieces of the ecosystem work together,” Ganzi said. “To stay relevant in the wireless infrastructure business means getting

ready to become versatile enough to provide services to the AT&Ts and Sprints of the world. You have to understand how to shift capacity and how to provide multiple types of infrastructure because those are the kind of partners that carriers are going to want.”

Ganzi said he believes the wireless infrastructure industry to be in good shape, with billions of dollars of investment coming its way.



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Using Unmanned Aircraft Systems (Drones) in Telecommunications

Technological innovation will make the difference in how effectively drones can be used in collecting data for design, post-construction inspections and asset management.

By Paul Wood and Nader Elm

Legal commercial operation of unmanned aircraft systems (UASs) is a recent development. In the latter part of 2014, the Federal Aviation Administration (FAA) granted the first certificate of authorization for commercial operation of a UAS. Since then, hundreds of other applicants have been granted certificates for commercial UAS operation.

The FAA Modernization and Reform Act of 2012 mandated that the FAA develop a road map for integrating UASs into the National Airspace System (NAS). The act directed the Secretary of Transportation to determine if safe UAS operation was possible and to “establish requirements for the safe operation of such aircraft systems in the national airspace system.” To expedite UAS integration into the NAS prior to implementing regulations, the FAA has granted certificates of authorization as an interim measure.

On Feb. 15, 2015, the FAA released a framework of regulations for integrating UASs into the NAS. Key ele-

ments of the framework include flying at a maximum altitude of 500 feet above ground level (AGL), maintaining a visual line of sight between the operator and the UAS, and not flying the UAS above anyone not involved in the UAS operation. UAS operations will be restricted in controlled airspace. An FAA airworthiness certification would not be required for the UAS. Operators must pass a written test every two years and be vetted by the Transportation Security Administration. Once enacted, these regulations will open the door to commercial UAS operation.

Potential UAS Applications

With the opening of the NAS to commercial UAS operation, Black & Veatch recognized the potential for UAS application in wireless telecommunications. In 2014, Black & Veatch organized a task force to investigate potential use cases, including tower audits to identify tower-mounted equipment and its configuration, rooftop and water tank surveys to record equipment layout, and struc-

tural mapping of towers to collect detailed tower and equipment information, including dimension, that is required to perform a structural analysis. The use cases also included site closeout documentation for verification that work performed is in accordance with the defined scope and meets quality expectations, transmitter/receiver antenna line-of-sight verification for microwave backhaul systems, capture of tower spatial data for the developing computer-assisted design models, and asset management for carriers and tower owners.

The benefits of the use cases identified are compelling and include no-climb inspections for safer data collection for tower-mounted equipment, reduced costs because a climbing crew would not be required and on-site time would be reduced, and higher productivity because climbing crews would not need to be diverted from construction activities for tower inspections.

These benefits do not come without a significant investment in a fleet

of UASs and trained pilots, if an entity were to roll out the technology to service a nationwide system of wireless infrastructure.

Black & Veatch Test Flights

In 2015, Black & Veatch purchased a DJI S1000 Plus UAS equipped with a 36-megapixel camera and conducted test flights with the equipment to determine if the use cases could be delivered. Black & Veatch first tested the tower audit use case. Testing is continuing to determine the degree to which other use cases can be achieved.

Test flights were conducted on self-support and monopole towers. The flight pattern in each case progressed up the tower to gather photographs of items of interest, but most of the

effort was spent examining the mounts and equipment on the tower. Black & Veatch made every effort to obtain complete audit details.

It was not possible for the Black & Veatch UAS to hover in the space between the tower and the outer edge of the mounted equipment because of the size of the UAS and the congestion in the space. Photos of equipment had to be taken from a position outside of the mounted equipment, shooting from a location opposite the back side of the equipment.

Results were mixed. Where there were clear views of equipment nameplates, it was possible to obtain photographs of the nameplates that were readable. However, in many cases, nameplates or other critical

information were masked by obstructions. In some cases, sufficient information could be obtained for equipment on each sector, so that a complete composite of the tower-mounted equipment could be developed, assuming that each sector was configured in a similar manner. But this cannot be guaranteed.

It became apparent that handling photographs would be an issue. The full 36-megapixel resolution of the photographs was required for the information to be legible, but this resulted in large files. Field crews typically transmit photographs and data back to Black & Veatch design offices electronically. Although the file sizes for the photographs obtained during the test flights did not



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Detailed information can be captured where an unobstructed view is possible.

preclude electronic transfer, it would make the effort more challenging.

Research Team Collaboration

Black & Veatch is collaborating with a major university in research on UASs equipped to gather dimensional information. The company provided the research team with video and photographs of tower flights, as well as detailed requirements of information required for a structural mapping. Black & Veatch accompanied the team to a self-supported tower site to provide them with first-hand knowledge of the structures and equipment on a wireless telecommunications site. The research team flew a UAS equipped with sensors to gather data to determine the unique nuances of the schema and features of a tower that distinguish it from other kinds of structures.

The tower visit was useful and revealed interesting and unique challenges because of the lattice structure of the tower. Previous development by the team had focused on applications having solid vertical and horizontal planes, such as walls and floors. As a

result, the team found the challenge interesting and is currently evolving its technologies to work with sparse tower-like structures and to control a UAS in close proximity to a tower.

Flying Close to Towers

Pilot error or wind gusts when flying near a tower may not only cause a catastrophic failure of the UAS itself, but could also result in damage to tower equipment. Furthermore, UASs are subject to various draft effects when flying close to other objects. In order to prevent accidents, pilots typically would need to maintain a sufficiently wide berth between the tower, tower-mounted equipment and the UAS. However, obtaining accurate dimensional information and high-resolution imagery requires navigation to within a few feet of the tower.

To enable safe flight in close proximity to the tower and equipment, the research team is developing technologies to allow a UAS to operate semi-autonomously. The technologies currently being researched include applying state estimation principles of control theory to make the UAS

situationally aware so that it understands its position relative to the structure and the ground. The use of obstacle avoidance autonomous control software builds on state estimation to ensure that the UAS intelligently avoids obstacles (structure, ground and trees) despite pilot instructions, allowing the UAS to get as close as possible to points of interest on the tower without the operator having to drive. Using onboard velocity control supplements simplifies operator control so that a semiskilled pilot can operate the UAS.

In order to determine accurate dimensional information, the UAS will require a combination of high-resolution images, precise calibration and accurate state estimation.

The research team's first testing will be conducted at an outdoor test facility developed for this work, followed by on-site testing at a cell tower location. The on-site testing is expected to occur in the fall of 2015.

Future Trends

The applications of UAS for telecom work with the technology currently available are limited. It is the responsibility of Black & Veatch, the carriers, tower owners and other interested parties to identify and communicate telecommunication industry requirements for UAS and other technology to drive development in a direction that will add value for the telecommunications industry.

UASs seem destined to provide significant benefit to telecommunications. Future changes and technologies that may help provide value include modified equipment labeling, radio-frequency identification (RFID)

technology and bar codes. Research and testing on these and other technologies will be required to verify their suitability.

Modified Equipment Labeling

A simple change that could be made is in the labeling of equipment. Historically, information on tower-mounted equipment has been collected by tower climbers. For climbers to have easy access to equipment nameplates, the nameplates needed to be mounted on the equipment so the labels face inward on the tower. Information collection by UAS would be facilitated by equipment tags with sufficiently large lettering, facing outward from the tower

or to one side or the other so a UAS-mounted camera could easily capture an image of a nameplate. This is a simple adjustment that could be made by equipment manufacturers to facilitate UAS data collection.

RFID Technology

RFID technology may also help in identifying and tracking equipment at a cell site. Tags placed on equipment would be read by an RFID tag reader using radio-frequency radiation. The simplest tags allow storage of 12 characters. Tag numbers could be matched in a database to a particular model or type of equipment. All the tagged equipment on a tower could be scanned

using a UAS-mounted RFID reader in a matter of a few minutes. By matching the scanned equipment IDs with the information in the database, a full inventory of the tower-mounted equipment could be obtained. The database could also be integrated with a full asset management system and include more detailed information about each piece of equipment, including location on the tower, installation date and service record.

Currently available RFID readers scan and process any tag within range of the reader, so identification of the location of a device that is in close proximity to other tagged devices would be a challenge. The pattern of



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the reader's transmitted radiation is a function of the antenna, and it may be possible for RFID equipment manufacturers to develop an antenna with a more targeted radiation pattern, making it possible to identify individual devices and locate them with the aid of an onboard camera.

RFID readers that have sufficient power for scanning at distances up to 10 meters typically operate in the 800-MHz to 900-MHz range. This may present a challenge to any system on a site where cellular communication is transmitted in that frequency range or neighboring bands because of

possible saturation of the RFID tags by the base station transmissions.

Bar Codes

Bar codes are commonly used to track inventory around the globe. Tags applied to cell tower equipment, if oriented to make them readable, could be scanned by a UAS equipped with a scanner. Scanners are available with ranges greater than 10 meters. Bar code IDs could be used in a similar manner to the RFID tag numbers. Potential issues include targeting precision for scanning bar codes.

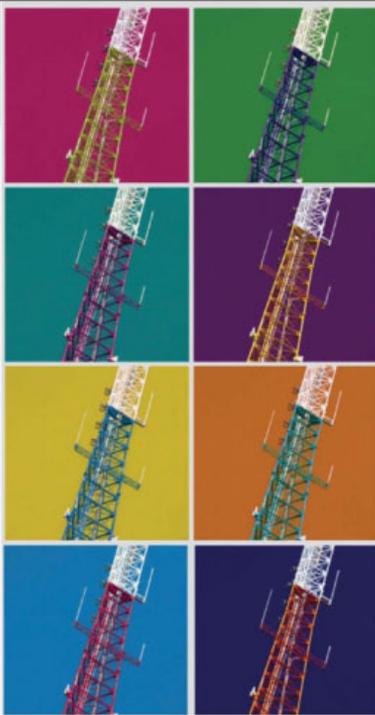
Conclusion

As is apparent from the prevalence of drones in the news and in popular culture, UAS technology is exciting, young and immature. Developing the technology and supporting capabilities are required to provide an offering with a significant value to the wireless telecommunications industry. The competition to be early to market will undoubtedly accelerate development, but may also result in claims beyond what may be fully realized.

Black & Veatch is confident that the technology will ultimately result in tools that will reduce safety risks and prove useful in collecting data for design, post-construction inspections, asset management and other use cases. But the degree to which these use cases can be delivered will depend on efforts on the part of the telecommunications industry to drive the necessary technological innovation.

Paul Wood is chief engineer of the telecommunications business at Black & Veatch. Nader Elm is CEO of Exyn Technologies.

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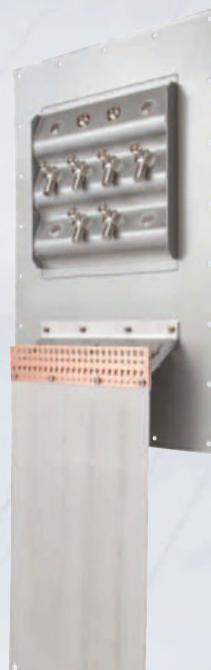
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DAS Takes on the Enterprise

Five years from now, you may not recognize the DAS market because the customers will be different and the system will be much more highly integrated.

By Joe Madden

The distributed antenna system (DAS) has been around for 20 years, and has grown to be a \$1.7 billion market for equipment, mostly to outfit giant buildings such as airports, stadiums and Las Vegas casinos. Mobile operators have always been the main source of funding in this market. In some cases, the mobile operators share costs or a neutral hosting company may finance the DAS network, but in the end it has always been the mobile operator that pays for the equipment.

That's starting to change. During the past year, mobile operators have turned down opportunities for new DAS projects. It seems that big public buildings with more than 1 million square feet are mostly covered by basic DAS networks now, and smaller buildings don't justify the costs for a DAS network (see Figure 1).

Building owners in the 100,000-to-500,000-square-foot range have realized that the mobile operators simply won't invest in any in-building mobile infrastructure, so they're starting to pick up the tab themselves. The enterprise market is now growing much more

rapidly than the mobile operator DAS market.

Change for Flexibility and Cost

To satisfy their new enterprise customers, DAS vendors are redesigning the DAS product. Some DAS vendors have moved toward the use of Cat-5 and Cat-6a cabling because the lower cost of a twisted-pair low-voltage cable can make installation cheaper.

Many DAS vendors are now offering solutions with dynamic operation. So far, most of these implementations do not incorporate LTE-Advanced features for coordination (such as coordination multipoint, or CoMP) between sectors but simply reallocate capacity resources between sectors.

DAS also needs to be flexible in allowing integration of Wi-Fi or other Internet Protocol (IP) traffic over the DAS distribution network. As digital techniques have taken over the DAS market, the Ethernet transport capability has become a necessary feature. DAS networks are sometimes deployed on their own, but during 2015 we see increasing emphasis on joint deployment for

DAS and Wi-Fi 802.11ac upgrades.

The most flexible systems are the broadband systems that don't require a technician to visit the remote antenna unit for every band upgrade. The Zinwave system uses broadband remote antennas, and the ION-E system eliminates the duplexer in the remote antenna for flexible frequency usage.

Embedded Signal Sources

The biggest obstacle to market growth today is the difficult process that a project manager must follow to get a DAS project done. Especially in the emerging enterprise market, multiple people have to make decisions along the line.

- The building owner must decide that he wants a DAS system and is willing to pay for it.
- The building owner hires a system Integrator to step in to specify, buy, install and commission the DAS system.
- A neutral host will sometimes step in to pay for the system and charge rent to the operators.
- Each mobile operator must agree to provide a signal source and maintain

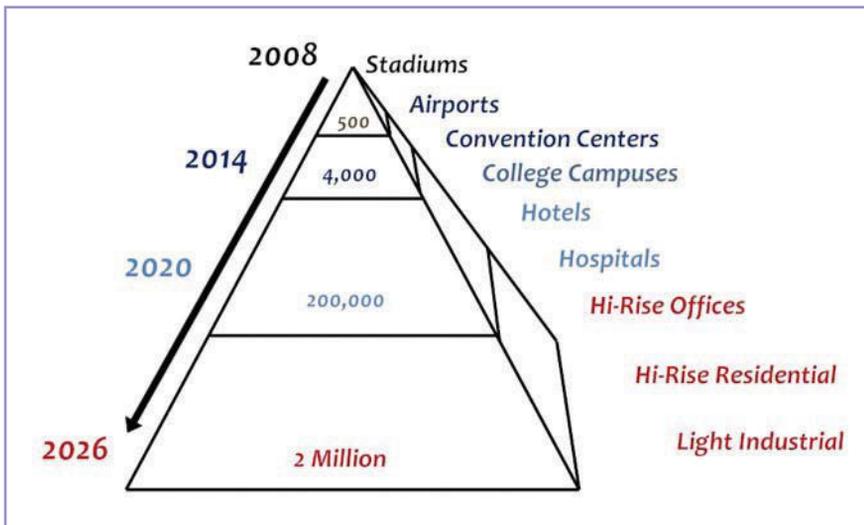


Figure 1. During the past year, mobile operators have turned down opportunities for new DAS projects. It seems that the big public buildings with more than 1 million square feet are mostly covered by basic DAS networks now, and smaller buildings don't justify the costs for a DAS network.

their signal source over time.

- One of the players in this list must set up backhaul for the signal sources.

The physical architecture of the product makes it difficult to break out of this fragmented decision loop. Each signal source will be different, and each operator has its own ideas about how to approach the building. That's always been handled in the past with separate boxes. This was reasonable when RF inputs were the main interface between signal source and DAS. Today, the rise of common public radio interface (CPRI)-based packets and small cells with digital DAS show a new direction, with direct digital input to the DAS network from a baseband processor.

To simplify the business model, a few DAS vendors are looking into direct combination of the small cell signal source and the digital DAS. The acquisitions of Airvana and TE

Connectivity line up with this strategy at Commscope. Airvana has small cell expertise and can provide a digital signal source. TE Connectivity owned key intellectual property involving digital DAS, which will be key to efficiently distributing the signal from multiple digital signal sources.

In short, I see a clear path to DAS products with embedded signal sources that can be deployed independently from mobile operator involvement. That's an important step in the growth of the DAS market overall.

DAS and Wi-Fi, LAA and LWA

Wi-Fi and traditional DAS nodes are quite different in the topology employed. Old-school DAS systems leave the baseband processing in the basement and distribute the RF signals. Wi-Fi baseband processing is located right in the access point with highly integrated semiconductor solutions. Because of this, DAS/Wi-Fi

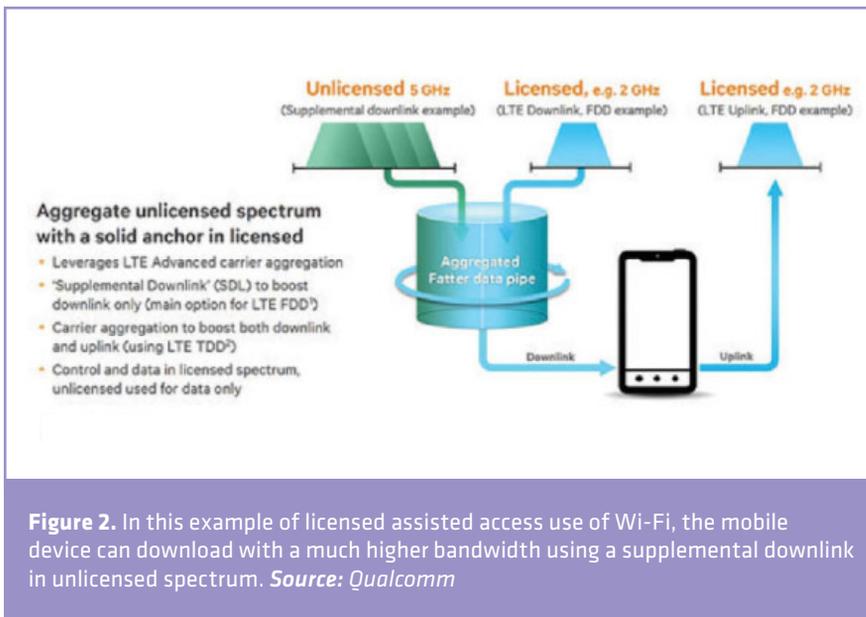
combinations have been awkward over the past 10 years.

Recent development of digital DAS systems allows for IP packets to be transferred via Ethernet cabling from the remote antenna unit to the head end. This simplifies things, allowing the Wi-Fi access point to be easily integrated into the radio access unit (RAU). As an alternative, any vendor's standard Wi-Fi access point can be mounted next to the RAU and simply plugged in via Ethernet port. The DAS has become a backhaul network for Wi-Fi.

How will this all change as mobile operators move toward licensed assisted access (LAA) and LTE + Wi-Fi link aggregation (LWA)? These new standards will change the relationships between licensed and unlicensed modes and will greatly increase the amount of traffic that mobile users offload onto the unlicensed bands.

During the next five years, most small cells will adopt LAA and will include multiple radio bands, including LTE-Unlicensed in the 5-GHz unlicensed band. For a stand-alone, small-cell deployment, the LTE-U transmitter would be simply turned on in connection with the LTE channel in that area for higher throughput. The 5-GHz LTE-U signal will not propagate as far as a 1-2-GHz LTE signal, but it's helpful wherever 5-GHz coverage is available.

Integration of the LAA small cell into a DAS will be preferable for the mobile operator because LAA is the mobile operator's preferred way to control the quality of service for traffic. However, an enterprise with a separate Wi-Fi network is not likely



between the two. The data traffic is tunneled through the Wi-Fi link, whether the Wi-Fi signals are carried over the DAS or separately. Link aggregation is done back at the core network.

In this way, LWA does not interfere with any Wi-Fi implementation inside the building. For a landlord in a multitenant office building, there's no disruption to the Wi-Fi networks installed by the tenants. For a hotel, there's no loss of throughput on the hotel Wi-Fi network. For this reason, we believe that LWA will be the preferred mode in most DAS scenarios.

to allow LTE-U/LAA to be used on the DAS because of interference concerns with their existing Wi-Fi investment. Inside its stadium, hospital or airport, the building owner is quite likely to prohibit LAA.

In other venues, LAA could be welcomed. In a hotel system, it's not hard to imagine the hotel owner or

a neutral host charging a rental fee for the operator to use the private DAS network. Want to use LAA? Pay a higher fee (see Figure 2).

On the other hand, LWA can be more invisible to the DAS. With LWA, the LTE anchor channel can be located far away from the Wi-Fi access point, with light coordination

The Future of DAS

Five years from now, you may not recognize the DAS market because the customers will be different and the system will be much more highly integrated. Mobile Experts has recently published a market study that lays out the future of DAS in a quantitative five-year forecast. Our conclusion: DAS is converging with small cells to create new multi-operator products that will provide in-building coverage and LTE-Advanced performance.

Joe Madden is principal analyst at Mobile Experts where he provides market forecasts for small cell, distributed antenna system and base station markets, with in-depth research down to the nitty gritty details of frequency bands and power levels. He oversees research at Mobile Experts and is responsible for synthesizing the input from other team members. Visit www.mobile-experts.net.



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A Case for Diversification

Employ these tactics to diversify and stay strong during volatile times.

By Allen Powell

I was 15 when my dad taught me how to drive a standard stick shift. I still remember the lurch and sputter of our 1969 Datsun pickup and my frustration as it would stall out, yet again, as I attempted to make it up the small hill of our driveway.

My dad was a patient instructor and, in time, driving a stick shift became second nature to me. My racing teenage mind slowly came to understand that hammering the gas wasn't getting me anywhere. I did much better when I thought of shifting as a series of small, connected steps versus one big rush of energy.

Operating in today's business environment reminds me of those early days in the Datsun. It's surprising to me how many people — most of whom should know better — treat business as one big push of the gas pedal. They toss all their belongings in the backseat and floor it, convinced that momentum and sheer force will see them through any potential setback.

Much like the lessons I took away from learning to drive a stick shift, my strategy at S&N Communications has always been to approach business as a series of connected steps, a

thought-out and measured approach that moves us toward our goals. Many of these steps have relied on diversification. Far from putting all our eggs in one basket, our company's past, present and future success comes from seizing opportunities to offer an increasing selection of services to more customers, both geographically and in more industries.

What follow are three ways S&N and our subsidiary companies have successfully continued to grow, even when segments of our industry were stalled, or in decline.

Diversity Through Acquisition

Over the past several years, we've chosen to align our core business of infrastructure construction with other companies that provide related and complementary services. Through the acquisition of Tower 16, Stake Center Locating, and SCE, we've increased our specialized expertise to include construction management and professional services, utility locating and end-to-end technical and construction solutions to the wireless telecommunications industry.

This cradle-to-grave model of doing business (meaning we provide

all services from underground utility location to tower construction for wireless networks, a one-stop shop sort of approach) has added a new resiliency to our business model and has made the difference in our ability to weather setbacks.

For example, significantly expanding our geographical footprint has meant new opportunities; bids that had previously been closed to us because we didn't have holdings in, say, Utah or Pennsylvania, have opened due to the companies that we've acquired having a history of working in these areas.

In addition, each of the businesses we've acquired has synergies. After an initial introductory period, the full capabilities of team members at each company became apparent. Instead of micromanaging, our approach via these acquisitions has been more hands-off. This has allowed talent to rise to the top. Many team members have cross-trained and have skills that surpass their formal titles or job duties. Working with these team members, versus dictating strategy to them, has allowed us to keep workload queues filled and has allowed the companies to become

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We're building a world of difference. Together.



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natural extensions of S&N.

Diversity of Services

As it says on our website, when it comes to services, if we don't do it, we'd be surprised if someone else does.

Note, however, that the phrasing applies to services in our wheelhouse. The key to successfully diversifying your services is understanding and playing to your core strengths. S&N is not going to suddenly run out and offer financial planning or life-coaching services. Think about how you can expand on what you already do well. Can you add a new vertical, expand a service or offer consulting? Whatever you do to diversify, you have to be able to still provide the expertise for which you're known, so that you don't erode trust in your core capabilities.

Bottom line, if your clients can rely on you for a number of services they need, you become more valuable to them. And the diversification of services allows a greater level of stability and greater sources of income for you.

Want to know what other services you could successfully expand into? Ask your employees and clients. I guarantee you'll get some ideas.

Diversity of Client Base

It's always a good idea to know how much of your business any one or two clients account for. Before we acquired Tower 16, Stake Center Locating and SCE, we had one client that accounted for the majority of our work. Diversifying through acquisitions helped balance our

portfolio so no one client claimed an overwhelming percentage of our total revenue. Does that mean our major client became any less important to us? Absolutely not. However, in our business, no job is unlimited, so keeping diversification in our client base is a must-have for survival.

Even with several major clients on board, your business development team should have its collective nose to the grindstone, scouting out new opportunities. Just recently, we were put on notice that the work for one of our large-scope clients was wrapping up. That would be bad, except for the fact that we're in the process of onboarding several new clients, one of which will become our largest client. These new customers will more than make up for our workload from the exiting client. To a certain extent, this puts us back in the boat of one client making up a disproportionate percentage of our overall business, but as far as problems go, that's a good one to have. And we're already in the process of thinking about how to invest our growth funds from these new clients so that we're in a solid financial position if — or more realistically, when (hopefully many years from now) — the work we've taken on for them comes to a close.

Conclusion

Clients will come and go and work will ebb and flow. That's simply the nature of business. And although there are inherent challenges present in learning how to ride out the lows, opportunities also abound. When one door closes, another

always opens. The real question is: Have you done what's necessary with your business to make sure you're ready to walk through it?

Diversification can help you reinvent your business and grow with new markets and clients. It all goes back to having the knowledge and know-how in place so that when you shift, everything comes together.

Allen Powell is CEO and president of S&N Communications, a provider of wired and wireless utility construction services.

Diversification

Do you need to diversify? Below are a few questions to ponder in order to get your answer.

1. No one client accounts for more than 30 percent of my business. True/False
2. If my biggest client left today, the business could survive for _____ years/months.
3. I'm investing ___ percent of current growth funds in business development.
4. My company has a formalized transition plan in place. True/False
5. Our business development team has more than three likely prospects in the pipeline. True/False



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What Owners Need to Know About Cell Site Decommissioning

Part Four — Be prepared to deal with contingencies — much can be similar among decommissioning projects, but knowing how they can differ lets you take steps to protect yourself from what otherwise could go wrong.

By Don Bishop

Speaking at the Wireless Infrastructure Show in April, Vertical Bridge's CEO Alex Gellman talked about the landlord perspective in connection with decommissioning equipment at telecommunications tower sites and on rooftops used for antenna sites. Vertical Bridge was founded in 2014 and is the largest privately owned tower company in the United States.

"For tower owners, it's just a matter of whether to remove equipment or not," Gellman said. "Sometimes, you don't want the antennas removed from a tower. For building owners, it's a matter of do no harm to the property when you remove antennas. For landlords, what happens if one of the tenants goes away? With Cricket, MetroPCS and Clearwire merging out and with Sprint shutting down the Nextel Communications iDEN network, there has been a bit more of this than everybody wants to talk about. In general, the first thing you need to do as a landlord is to learn

whether a declared lease termination is a valid termination."

Gellman spoke at the session "Decommissioning Aging Cellular Infrastructure" led by Rich Berliner, CEO of Red Wing Electric. Gellman said that when a network operator decides to decommission a thousand or more sites, the operator's first step could be, "Let's just terminate all the leases and see what happens." But he noted that the leases can't necessarily be terminated. The landlord has to review the master lease agreement for proof of the tenant's assertion that it can terminate the lease for the reason it asserts. And most leases do not provide for termination for purely economic reasons or simply because the lessee wants to terminate.

Next is what the lease says about removal and restoration. If someone is going to come to the property to remove equipment, what are they required to do? Gellman said the language in leases varies, so it's important

to learn what the tenant is required to do. "Somebody's going to show up at your property, and they're going to try to do a cookie-cutter job like they do at every other site, and your site may not be cookie-cutter," he said. "Make sure they know what's in your lease and what they are required to do. Don't forget, there are deposits and bonds, and then what's going to happen with your workers and equipment is an important question."

Although Gellman said decommissioning at towers is fairly straightforward, one thing an owner can overlook is that as soon it's known that a carrier is going to decommission a site, the owner should market the rad center (antenna position, called a radiation center) because otherwise possible tenants who might see the site could assume its rented, even though it's available. "We've had circumstances in the past where a carrier has left early because we have a new tenant," Gellman said. "We ask the tenant to put the site at the top

of its list for decommissioning so the space is available as soon as possible for the new tenant. Many times, the new tenant will take down the old equipment to get onto the rad center, so it's a win-win. The carrier's always going to want to remove the radios and the generator. They may not get it back, but they'll remove it. Somebody will remove it. You want them to remove the batteries for sure."

Antennas and Feed Lines

Gellman said that removing the antennas and feed lines should be decided on a case-by-case basis. Because if the tower is otherwise not going to have a tenant on it, it could be a bad idea to remove them. A neighbor might notice and say something about it, or a representative of the town government might notice, and could take the opportunity to point out that no one is using the tower and ask that it be taken down.

"You don't want that," Gellman said. "Sometimes it's better to leave the antenna and feed lines there. And there's a term of art in the industry called 'pay and walk' where the carrier will pay you money to leave the equipment there.



Alex Gellman, CEO, Vertical Bridge.
Photo by Don Bishop

Decommissioning Article Series

September, Part One, Equipment: "How to Decommission Equipment on Cell Towers"

October, Part Two, Technology and Spectrum: "Carrier Mergers and New Spectrum Lead to DAS Upgrades and Decommissioning"

November, Part Three, Software: "Software Aids in Decommissioning Telecommunications Antenna Sites"

December, Part Four, Landlord Perspective: "What Owners Need to Know About Cell Site Decommissioning"

That's another win-win. They'll pay you to leave their antennas and feed lines — not too bad."

As for decommissioning equipment on building rooftops, Gellman said that although every building is different, the key lies in what's going to be left behind. One basic rule is not to penetrate the roof to remove anything. If the roof had been penetrated to install the equipment on a platform, leave the platform. It's too risky to remove it, and the platform may be valuable for somebody else.

For the side of a building, it's important to pay attention when the antennas are being attached in the first place, and to think about small cells coming lower and lower, down to the street level. "What's the building going to look like when these things are gone?" Gellman asked. "You'll have holes in facades and parapets that you have to fill. Whoever comes to do the work probably will be in a hurry, being paid by the piece for it. In that circumstance, they probably will rip it out and go, which is not necessarily what you want."

Pulling Riser Cable

The decommissioning should free up

interior space, but Gellman advises caution for the carrier, the contractor and the property owner. It's important to be careful about pulling cable out of a riser. At a building with the carrier's equipment inside, the antennas on the roof and the connecting cable coming up through the riser, pulling on the cable could cause chaos. Neither the building owner nor the vendor wants to cause chaos by pulling cable and creating Internet or TV outages. Gellman said it's important to consider how much additional riser space is available and how difficult it would be to remove the cable. It could be better to leave it in place.

Finally, from the perspective of the owner of the land beneath a tower that's being decommissioned, why would the owner care? "It makes the most difference if the tower is going to be naked, if that was the only tenant," Gellman said. "If, for example, Sprint Nextel was the only tenant on the tower and now they're gone, the ground payments ultimately are going to be connected to whether there's a tenant on that tower. The landowner could lose the ground rent."

/ FEATURES /

One-tenant Towers

The landowner should pay attention to who's on the tower and who's coming off, and what the terms are. Some ground leases are cancellable, most of them every five years, but some much more frequently than that. The question of whether the landowner would want to take ownership of the tower applies as well for an aggregator or a farmer who leased the land for the tower. Gellman said that if the landowner takes ownership of the tower, then the landowner has to pay the property taxes, take over the FAA and FCC compliance, and maintain the tower. "I would say, buyer beware," Gellman said. "If you're buying the ground lease and there's a tower there with one antenna, if that antenna goes, you bought nothing."

Berliner asked Gellman whether tower owners should have someone on-site to monitor a decommissioning carried out by a tenant or a contractor. "How do you know that the tower just wasn't ripped apart?" he asked.

"It's really a notice to proceed in reverse," Gellman said. You have to make sure you know who the vendor is. We won't necessarily be there all of the time for all of the decommissionings at towers, but we'll visit shortly thereafter. We know who's on our towers at any given time, so we'll know who was there. With most buildings, we'll have someone there."

Berliner asked about any horror stories, and Gellman said there haven't been many because in his view, the wireless infrastructure industry has good vendors who are trained and who know what they're doing. He said he has noticed that decommissionings may not happen as fast as the carriers

might want. "If there are horror stories, they have more to do with someone dropping something onto someone else's antennas," Gellman said. "That happens once in a while. Or they hooked on to somebody's mount and bent it because they were using it as a leverage point. With rooftops, you can have horror stories because if you penetrate the roof and the roof leaks, it's a disaster."

Asked whether he had ever decommissioned the wrong carrier, Gellman said he hadn't seen that happen. "But I once had a carrier decommission and then within a month ask to go back onto the tower. That was pretty interesting."

Status of Decommissioning

Berliner said that it's fairly common knowledge that T-Mobile USA is decommissioning some MetroPCS sites and that some Nextel sites are still being decommissioned. "Clearwire would be a logical situation," he said. "I'm not suggesting that everything is being taken off, but those are the things that I think are happening."

Gellman commented on the status of various large decommissioning projects, saying that the Cricket decommissioning is well along. He said MetroPCS is slower, but it's coming. And he believes Sprint hasn't really stepped up to Clearwire. "The number keeps changing on Clearwire," he said. "Originally, I think they said they were going to decommission 11,000 sites. The last number I heard was 5,000. As the network evolves, the number goes down. It's always true that carriers decommission fewer sites than they announce they're going to decommission in the beginning — always."

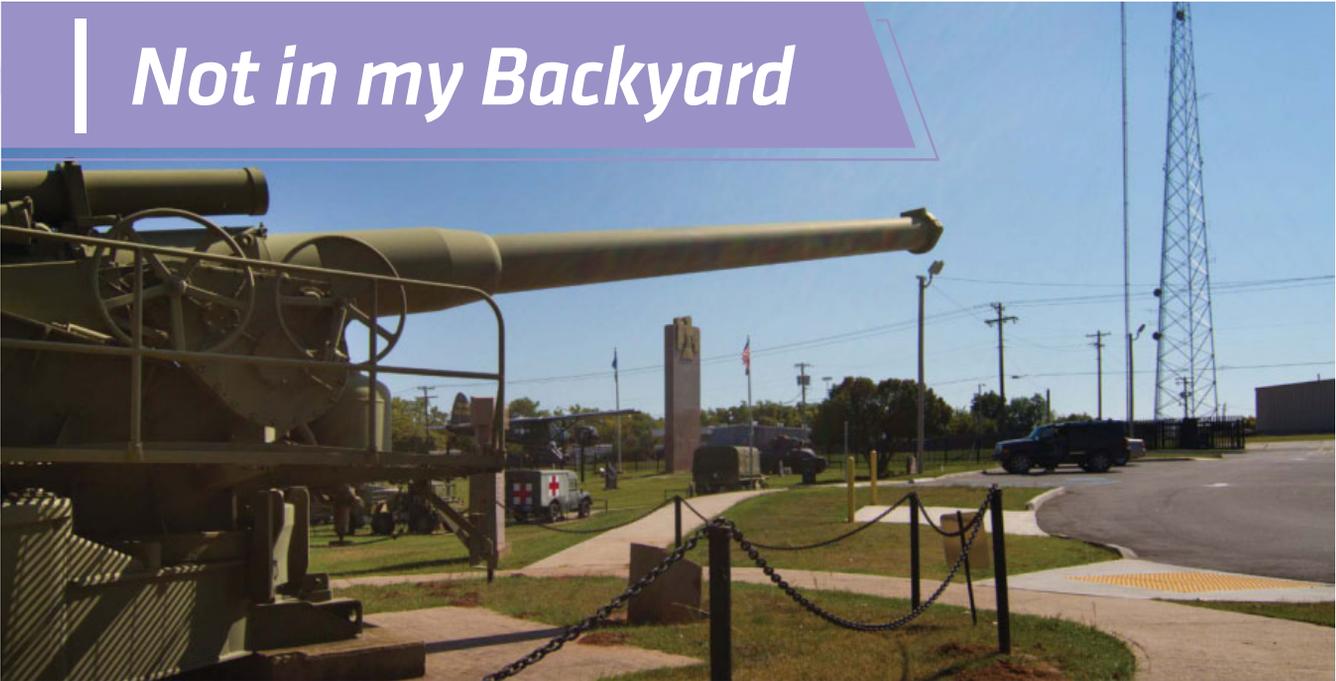
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Not in my Backyard



Not in my backyard. (As seen at the 45th Infantry Division Museum, Oklahoma City.) Photo by Don Bishop

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Rethinking the Distributed Antenna System



An all-digital distributed antenna system, first developed 23 years ago, makes headway after base station manufacturers open up the interface.

By Don Bishop

Phil Wala, senior engineer, Wireless Division of TE Connectivity.
Photo by Don Bishop

DAS

TE Connectivity Wireless Division's senior engineer, Phil Wala, talked about new developments taking place in the field of distributed antenna systems and how they apply to developments taking place within larger wireless networks. Speaking at the Wireless Infrastructure Show in April, he said it's time to start rethinking what a distributed antenna system is.

"We have a baseband unit generating antenna carriers, and a fixed number of antenna carriers go out to a fixed site where we have a remote radio head that turns those antenna carriers into RF," Wala said. "Separately, we have this idea of what a distributed antenna system is, which takes the RF and simulcasts it throughout a building, for example. Twenty-three years ago, we developed a distributed antenna system that was

all digital. To marry these two together, you take the radio head or base station's RF output and put it into a distributed antenna system to distribute it where you want it to go.

"We're going from digital to analog, and then in our system going from analog back to digital out to the remote where we turn it back into analog. So from day one, our vision was: Why can't we just take our digital distributed antenna system and connect it directly to the digital baseband unit? The problem was that the base station manufacturers were reluctant to open up that interface. That is now changing."

Wala said that some base station manufacturers realize the benefit in being able to connect digitally directly to a distributed antenna system. Thus, TE Connectivity is deploying for the first time a distributed antenna system that is a direct

common public radio interface. The result is an all-digital distribution network that can feed a distributed antenna system. The distributed antenna system takes the place of an individual remote radio head.

"It doesn't eliminate the need for remote radio heads," Wala said. "If you only need one site, you use a remote radio head. If you need to take that sector and deploy it throughout a building, you can use a distributed antenna system instead of a remote radio head."

He said that for makers of distributed antenna systems that did not like the previous requirement to duplicate RF equipment, the new development is exciting in itself. In addition, it means something for the next generation of systems that include network function virtualization. With network function virtualization, the system takes all of the baseband

processing capability and places it into the cloud, sometimes called the “cloud radio access network.”

“All your network operation, your generation of carriers, everything takes place in the cloud where you’re able to pool resources to great economic benefit,” Wala said. “And now all you need is some way to get those channels that you’ve generated out to the place where you want to turn them into RF. The digital distributed antenna system is that network. What we used to think of as just a DAS, a means of simulcasting RF, now we can see that evolving in the next generation to what becomes multicarrier, multiband, multiprotocol and multi-operator. You can have multiple wireless service operators sharing this system at a neutral-host application. And everything is digital out to the remotes.”

The operator then has the ability to tailor the coverage area. Each channel, each radio protocol, each operator can have different simulcast groupings depending on where the capacity needs to go. Where there is a concentrated need for capacity, it is possible to shrink the coverage area to one or two of the nodes. Where the capacity need is light, one sector could cover a large area. All of the processing takes place back in the cloud.

The distributed antenna system becomes really just a fronthaul network to get your RF where you want it to be. And everything else — all the processing, all the carrier aggregation, all the MIMO processing — everything else takes place in the cloud. “We talk about the savings from network function virtualization, and we’re starting to see where things are headed,” Wala said.

LTE-Advanced features carrier aggregation with joint transmission reception, requiring a lot of coordination between transmitting and reception nodes. With an all-digital distributed antenna system, instead of achieving the coordination with backhaul, everything takes place at

the central location, within the cloud. It minimizes latency times. And because the RF distribution network is broadband, upgrades to technology, changes to protocols and new generation of radio access protocol all take place in the cloud, and the network stays the same.

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The Faster and Smarter Way to Address Critical Infrastructure Business Challenges

An improved way of searching and analyzing vertical assets boosts the speed and accuracy of site selection while helping users get a handle on the explosion of telecom intelligence.

By Bryan Darr

Tower professionals require more precise information to make profitable decisions, but mining the Internet to get accurate comprehensive intel has become a grueling task. When seeking opportunities for collocation, leasing, buying and selling, they must contend with a complex infrastructure ecosystem. At the same time, information about vertical assets needs to be easier to analyze, while also being accurate and reliable.

On the Web, several available resources attempt to provide an inventory of infrastructure assets. Some simply collect and reformat federal databases, while others include search features that may be limited and the returned data is often obsolete.

Another option is navigating through regulatory databases yourself. This presents its own set of challenges because regulatory data-

bases have vastly different formats. For example, assets less than 200 feet tall or those located too far from an airport are usually not required to be registered.

Scores of companies provide listings on their websites. However, many have not updated them in years. Asset

“When considering a new build, in-depth intelligence on the surrounding ecosystem can make the difference between owning a mule or a thoroughbred.”

owners, managers and leasing agents sometimes offer the same asset in their disparate marketing lists, each with their own site ID and often differing on the tower description.

The hard truth is that none of these options deliver the intel needed to

make smart business decisions.

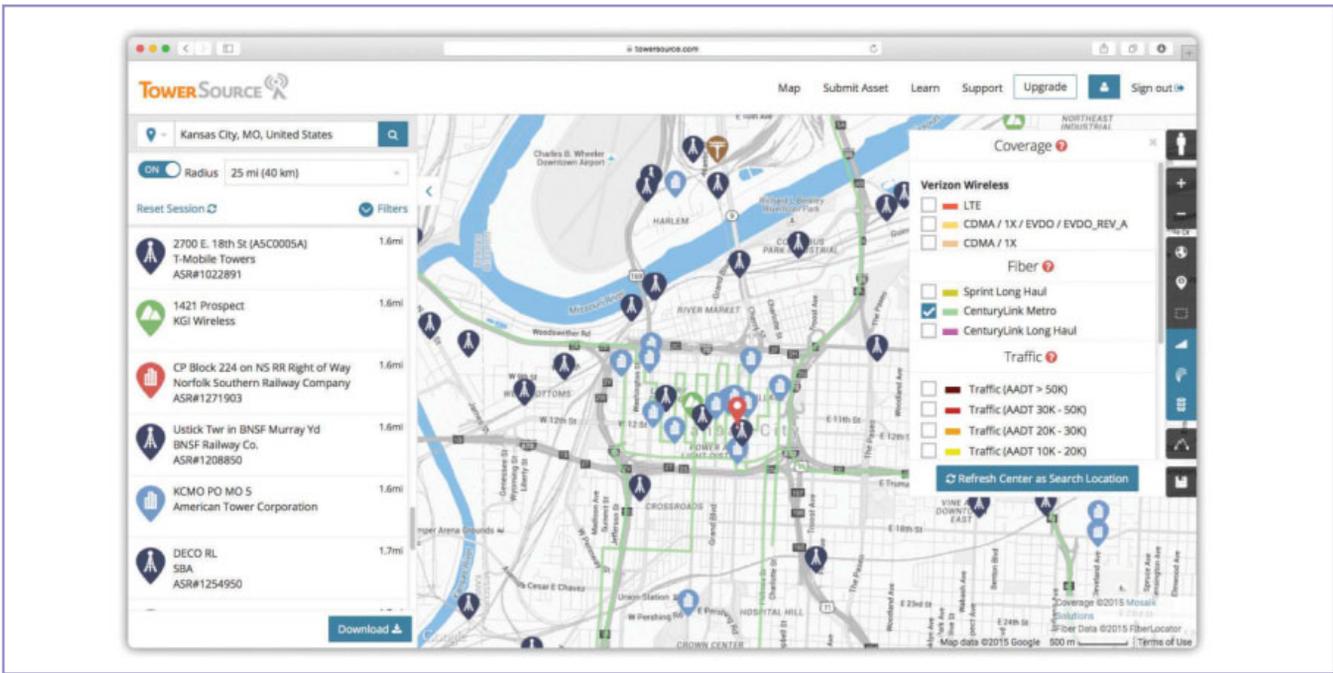
Search and Analyze

To fill this industry gap, Mosaik Solutions reintroduced the TowerSource database earlier this year, providing tower pros with a faster, smarter way to collect quality intel using a richer and more immersive interactive user interface.

The data found in the reintroduced database includes assets reported directly by tower owners and site managers in addition to federal databases. Companies in many sectors outside of telecom own and operate tower assets that are equally considered prime real estate for tower professionals. These entities include radio and TV broadcasters, utilities, railroads and public safety agencies.

Details such as location, operator, manager, asset type (e.g., monopole, guyed tower, rooftop, water tank,

VERTICAL ASSETS



A computer monitor display shows some of the data sets that the rebuilt database includes.

DAS, raw land), height and elevation are essential in determining if the site is worthy of investigation for collocation, acquisition or a new build. This data becomes even more compelling when filtered for additional datasets such as wireless coverage by mobile network operator, technology deployment or nearby fiber routes.

Speed and Accuracy

Rebuilding the database has relied in part on an extensive user experience survey, one-on-one interviews with select clients and a deep market research campaign. These are some of the concerns the rebuilding sought to address:

Industry consolidation and age have taken their toll on data integrity. In the days when mobile operators owned the majority of their towers, they were protective

of their locations, considering many sites to be a competitive advantage. Many carriers have now sold large portions of their tower inventories because it makes financial sense to do so. Leasing has proven to be less expensive than owning, and it has freed up much needed funds for expanding and deepening their radio networks. As these assets have changed hands, some multiple times, federal records have become confusing, and many have not been maintained properly. Sometimes, multiple players have an interest in a site; thus, more than one may market it, leading to a confusion of ownership or responsibility. To ensure accuracy on TowerSource, a team of dedicated market researchers maintains the data on a daily basis, making it a curated vertical asset database.

Location, location, location,

and that's still not enough. Site selection is about expanding a network or plugging holes in it. The problem used to be thought of as expanding coverage, but increasingly, it is about boosting capacity. If you are trying to collocate on an existing site, you need details on all the assets in the search area along with general specifications such as location, height, type and ownership. When considering a new build, in-depth intelligence on the surrounding ecosystem can make the difference between owning a mule or a thoroughbred. If, for example, two other operators also have a weak network in the same area, the opportunity to maximize the value of a new site increases dramatically. Either way, you will need to know what backhaul options you may have or which zoning body you may face, among other variables. The rebuilt database provides

more information in one interface than has ever before been available to the infrastructure industry.

Your searches are safe with us. Mosaik Solutions is not a broker. We don't buy or lease site locations and we don't operate or manage a network.

Collaboration. The service lets you save your work and favorite specific sites, and it lets you easily share information with others on your team. Soon, the service will make it possible to upload files to provide direct comparisons with other data sets already in the system. It remains your proprietary data until you are ready to share it with the rest of the industry.

Faster time to market.

As many new network access points might be added to the cellular networks during the next five years as the industry built in its first 30 years. The mobile network operators don't have the time or budgets for protracted site acquisitions because their customers, as well as regulators, will not have the patience for it. The rebuilt database can be used to speed deployment time by providing faster access to the information needed to filter down to the best options for site placement.

Telecom Intelligence

Every industry relies on comprehensive information to make use of corporate strategies for market growth, customer retention and demographic targeting. Tower data is used for the same purposes and can be stated as one core objective: to make better and smarter business decisions.

As data demand continues its exponential growth, the wireless industry will continue to depend upon the infrastructure providers to help them meet consumer demand. Towers and macrocell structures are now being joined by other solutions to meet the need for network densification. Heterogeneous networks are burgeoning and will continue to do so, and the new database offers the level of granularity and precision needed to accommodate this intelligence as it becomes available. There are already many distributed antenna system

“As data demand continues its exponential growth, the wireless industry will continue to depend upon the infrastructure providers to help them meet consumer demand.”

and small cell deployments tracked within the site. Thousands of buildings, properties, signs, utility structures and other nontraditional assets can be filtered by category. The road map for TowerSource is to continue to include much more of this data as the site develops.

Getting Started

Many more features and data sets are on the way. User feedback has already helped us to prioritize enhancements. An agile development approach allows new capabilities to be rapidly pushed into the interface once they have been tested.

The database tracks more than 1,000 mobile operators globally, each representing multiple network deployments. Vertical assets within the United States number in the hundreds of thousands. The goal is to make the database as comprehensive as possible.

After a user shared their need for quicker microwave evaluations, we added an elevation profile function that gives an instant topographic cutaway of any line drawn on the map. Those types of demands and user experience are what motivate us to make an already powerful infrastructure search site even better.

Marketing Assets

All users may search on any reported asset without charge. Paying users have access to additional features, search functions and data sets. Reporting assets is free. Once the entry has been validated by the research staff, the asset is searchable within

the database. You can also provide bulk site lists. Site photos can be added to each asset, and paying users can choose whether to make the photos public or keep them proprietary.

Users include professionals from the telecom, broadcasting, public safety, utilities, transportation and regulatory sectors. They are both providing asset information to add revenue potential to their portfolios and seeking new opportunities to deploy or expand their networks.

Bryan Darr is the founder and CEO of Mosaik Solutions. Visit www.towersource.com.



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How to Analyze Antenna Mounts to Avoid Costly Consequences

Performing a complete mount analysis based on a full mount mapping helps tower owners avoid placing heavy loads associated with LTE equipment where they could cause injuries or fatalities and costly damage. Analysis allows recommending improvements where necessary.

By **Michell Miller, P.E.**, and **Ismaias Recinos, E.I.**

With LTE technology and data consumption the reasons behind the wireless communications industry's growth, antenna mounts are beginning to resemble the proverbial camel loaded with straw. Innovations in technology and corresponding equipment upgrades associated with LTE technology are like additional straws placed on older mounts. It's only a matter of time until the load exceeds capacity, at which point the consequences can be devastating. Fortunately, there is a way to accurately determine capacity and avoid placing the last straw on a mount: a complete structural mount analysis, conducted by a qualified architectural and engineering (A/E) firm.

Overburdened, Aging Mounts

Most of the mounts now in the field are older models designed primar-

ily for wind loads and to support previous technologies with smaller, lighter and more symmetrically placed equipment than what is typical with newer LTE components. These older mounts were not designed for the larger dead loads from new equipment such as remote radio units (RRUs), nor were they designed to withstand heavy ice loading as required by the TIA-222-G and ASCE7-05 standards.

Human error during installation, such as improper mount orientation or inadequate connection to the tower, also poses risks, as does overall deterioration of the mount structure caused by long-term exposure to the elements. Few mounts are regularly checked for corrosion, material degradation, connection failure or other deficiencies that may occur over their lifetime. Furthermore, mounts that are overburdened with LTE equipment may

be inadequate to bear the additional loads induced by tower climbers while servicing equipment. Although manufacturers have begun designing mounts to handle the increased loads of LTE equipment, most existing mounts are not being replaced because replacement is typically preceded by a failing structural analysis.

Although TIA-222 standards do not currently require a rigorous mount analysis prior to new equipment installation, it would be in the carriers' best interest to hire a qualified A/E firm to provide a certified mount analysis. Failure to do so puts a carrier at risk of consequences ranging from the inconvenient (loss of coverage caused by a change in the azimuth or tilt of an antenna) to the devastating (full tower collapse or loss of life caused by a mount falling and striking the structure or someone on the ground).

Full Mount Mapping

A comprehensive mapping should include:

- Measurements and dimensions of all structural components taken with a tape measure and digital caliper when applicable
- Elevations taken with tape or laser
- Details of connection to the tower
- Existing loading information (including model numbers and/or dimensions and locations of antennas and TMEs)
- Multiple photos of the mount from the ground and tower
- Multiple photos of all measurements

The deliverable should include:

- A compiled report with computer-aided design sketches
- Pertinent photos
- A list of deficiencies (if any) found on the mount

Full Mount Mapping

Only an analysis based on a hands-on mount mapping can provide the peace of mind that comes from knowing mounts are free of structural deficiencies and adequate for the proposed equipment. Some vendors cut corners by substituting a ground mapping for a hands-on mapping, resulting in assumptions made regarding sizes of structural components based on what might appear to be an equivalent mount model in a manufacturer's catalog. Others might not perform a field mapping at all, instead basing their analysis solely on front wind load comparisons between current loading and design loads specified by manufacturers. Relying solely on front wind load comparisons is troubling because it fails to take into account any added dead loads for which the mount was not designed. These types of shortcuts are inadequate, and in some

cases negligent, and must be avoided.

A full mapping involves climbing the tower and measuring all dimensions and structural component sizes of the mount to be analyzed. Detailed structural information on the existing mount is gathered, eliminating the need to make assumptions about its specifications. Existing loading can be visually confirmed and defects may be spotted, such as bent or rusted structural components, faulty connections and missing or additional structural components. The mapping can also detect the incorrect installation of an orientation-dependent mount.

One client's experience illustrates the importance of undertaking a full mapping. The client's antennas were located behind a shroud, preventing an accurate visual assessment from the ground. Because the addition of the proposed equipment caused no increase in wind area and only a

minimal increase in weight, at first glance it would appear that a structural letter may have been sufficient. However, a full hands-on mapping revealed a critical defect in the mount. The mount's top rail had a gap of more than three feet in one corner, leaving it and the surrounding equipment unsupported in that area. Upon analysis, the mount was found to be significantly overstressed because of the cantilever effect of the top rail. This dangerous condition was only uncovered because a full mapping was performed.

Analysis and Recommendations

Only a rigorous analysis based on a hands-on mapping can provide assurance regarding the structural capacity of the mount. Top-tier vendors now use 3-D finite element modeling software, such as RAM Elements, STAAD.Pro, RISA-3D or an equivalent program to create a virtual model



With this lightweight t-frame mount, the proposed loading consisted of only remote radio units. The mount failed at >200 percent when analyzed. A bolt-on prefabricated modification was proposed to reduce mount stress rating to <100 percent.



This lightweight t-frame mount is loaded with LTE equipment. It failed at >200 percent when analyzed for the existing loading. A full mount replacement was recommended.

based on the mount geometry and loading configuration specified in the mapping report. Forces from appurtenances are calculated based on the governing TIA-222 standard and applied in the model using load cases based on site-specific wind and ice conditions derived from TIA-222 and ASCE7, along with supplemental load cases to account for man-live loads. The stresses induced by the loading in the mount are then checked against American Institute of Steel Construction (AISC) requirements using load resistance factor design (LRFD) or allowable stress design (ASD) checks, depending on the governing TIA-222 standard.

All failing models should be thoroughly reviewed and checked to see if a conditional passing analysis can be issued. Often, mount failure can be eliminated by shifting proposed loading or by adding and relocating tie-backs for sector mounts. A course of action that's less desirable because of its high cost would be to relocate existing antennas. If a mount is still overstressed after preliminary attempts to eliminate failure, the carrier is issued a failing analysis along with a quote for modification design.

Proposed modifications should focus on finding the quickest and most cost-effective solution. The first avenue to explore is off-the-shelf, bolt-on solutions from reputable tower hardware distributors. This approach reduces the expense and time spent waiting because there is no need for independent third-party fabrication, and most kits are readily available from regional distributors. If an off-the-

ANTENNA MOUNTS

shelf, bolt-on solution is not feasible, the vendor can issue modification drawings for a customized bolt-on solution. Welded solutions are not advisable because of the high cost and the risk of fire.

Inching Toward Mount Analyses

Proposed changes in industry regulations suggest movement toward requiring some level of mount analysis. The TR-14 committee has proposed the inclusion of specifications for new mount designs in the TIA-222-H standard. This would allow a carrier to quickly determine if the mount is sufficient for its loading. However, the comparison would only be applicable when

loading is symmetrical and certain wind speed and ice requirements are met. Otherwise, a full structural analysis would be required.

Although these changes in TIA-222 may be on the horizon, and although progress is being made in the design and sale of LTE-capable mounts, neither of these advances precludes the need for an independent, site- and loading-specific mount analysis, given that the vast majority of mounts currently in use are not designed for the heavy loads associated with LTE equipment and escalated ice conditions required by TIA-222-G. Mount failures can have costly and even fatal consequences. Examining all mounts according to

the standards outlined in this article greatly reduces these risks. Only with proactive steps — a full mapping and comprehensive mount analysis — can a carrier ensure its mounts are safe and sufficient for their desired load configuration.

Michell Miller, P.E., is a structural engineer, and Ismaias Recinos, E.I., is a structural designer at SSOE Group (www.ssoe.com), a global engineering, procurement and construction management firm. Both have experience working on towers, mounts, rooftop sites and other specialty structures throughout the United States. Miller's email address is mlmiller@ssoe.com. Recinos' email address is irecinos@ssoe.com.

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LTE-U Helps Wireless Carriers to Use Unlicensed 5-GHz Frequencies in Small Cells

Delivering video, serving the Internet of Things and supporting an increasing number of user devices pushes network operators beyond the boundaries of their licensed frequencies.

By Don Bishop

LTE-U technology operates in unlicensed spectrum at 5 GHz to deliver higher performance for operators and a better user experience. LTE-U, which stands for Long Term Evolution-Unlicensed, can be deployed commercially with Release 10 from the 3rd Generation Partnership Project (3GPP), a collaboration among groups of telecommunications membership organizations. Speaking at the Wireless Infrastructure Show in April, Prakash Sangam, director of technical marketing at Qualcomm,

explained that Release 10 includes features that allow LTE-U to coexist with Wi-Fi local area network service in the 5-GHz band in the United States, Korea, India and China. Europe and Japan have specific regulatory requirements for maintaining channel occupancy called listen before talk (LBT). LTE-U deployment in Europe and Japan awaits a new 3GPP standard, Release 13, known as license-assisted access (LAA).

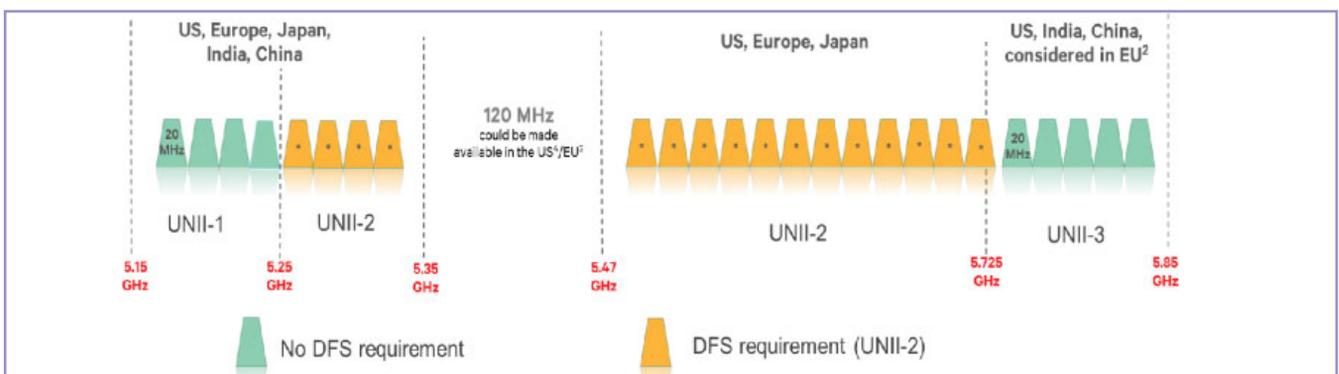
Sangam said LTE-U offers an excellent opportunity for wireless network

operators to use unlicensed radio-frequency spectrum. "A lot of thinking has gone into making sure that LTE-U peacefully and fairly coexists with Wi-Fi," he said. "Using the 3GPP standards, we demonstrated the performance of Wi-Fi, LTE-U and coexistent Wi-Fi at multiple forums including at Mobile World Congress and public demonstrations."

LTE-U Forum

Qualcomm is a founding partner of the LTE-U Forum, which was formed in 2014 by Verizon in cooperation with

TECHNOLOGY



This lightweight t-frame mount is loaded with LTE equipment. It failed at >200 percent when analyzed for the existing loading. A full mount replacement was recommended.



Prakash Sangam, Qualcomm director of technical marketing: "Using the 3GPP standards, we demonstrated the performance of Wi-Fi, LTE-U and coexistent Wi-Fi."
Photo by Don Bishop



Jeffrey Thompson, Towerstream's CEO: "If you sat here five years ago and said Verizon and T-Mobile are going to use unlicensed spectrum, no one would have believed you."
Photo by Don Bishop



Ahmad Armand, T-Mobile USA staff vice president, said if interference between LTE-U and Wi-Fi were to become a problem in a given location, it's easy to turn off the license-assisted access. *Photo by Don Bishop*



Marc Patterson, Boingo Wireless vice president of product management, said carrier Wi-Fi is the most promising technology. *Photo by Don Bishop*



John Gordon, Devicescape Software's chief technology officer: "Amenity Wi-Fi is going to be far and away the largest use of the unlicensed spectrum."
Photo by Don Bishop



Surya Bommakanti, Ericsson vice president and head of its mobile broadband engagement practice: "It's natural for those who are using licensed spectrum today to look into unlicensed spectrum." *Photo by Don Bishop*

Alcatel-Lucent, Ericsson, Samsung and Qualcomm. Sangam said the LTE-U Forum released Wi-Fi performance and coexistence specifications and that Qualcomm's technology complies with them. "Coexistence goes beyond meeting the minimum requirement," he said. "It goes into making sure we adhere to all of the regulatory requirements, standards and specifications. We also expect stringent compliance testing before

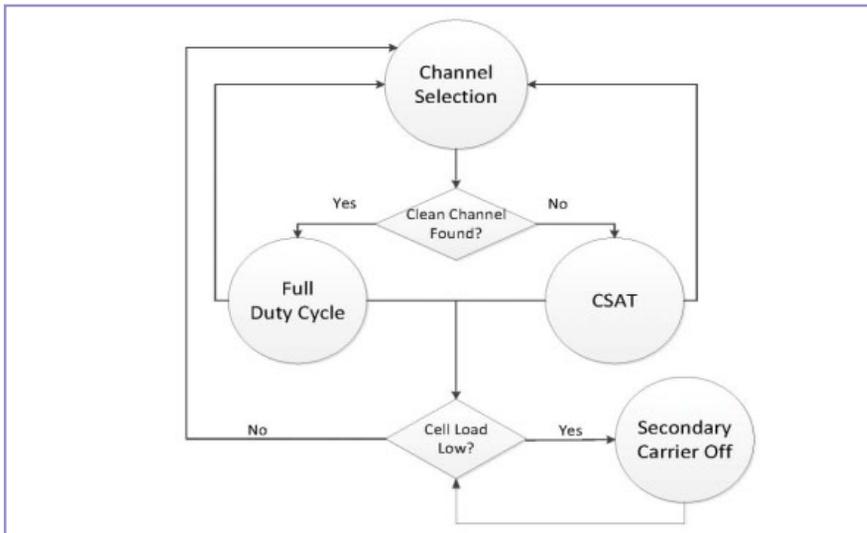
LTE-U is commercialized."

Surya Bommakanti, vice president and head of the mobile broadband engagement practice at Ericsson, said the fixed Internet has used Wi-Fi increasingly as an access mechanism. Ericsson uses microwave products for backhaul and increasingly in potential fronthaul solutions in licensed and unlicensed spectrum. "It's natural for those who are using licensed spectrum today to look

into unlicensed spectrum," he said. "They have different performance characteristics and different regulatory needs."

Amenity Wi-Fi

John Gordon, chief technology officer at Devicescape Software, said his company is interested in what's called amenity Wi-Fi used in retail places. "With LTE carrier Wi-Fi, carriers can work out which one they want to deploy or deploy



A coexistence algorithm flow chart for LTE-Unclicensed in areas of the world without listen-before-talk requirements. CSAT stands for carrier sensing and adaptive transmission. Source: Qualcomm

both,” he said. “But amenity Wi-Fi is going to be far and away the largest use of the unlicensed spectrum. They’re going to be in all the small bars, restaurants, cafes and shops, and some larger ones that will keep putting in Wi-Fi because Wi-Fi is what their customers have on their devices today and what will deliver the most to them in the future.”

Promise of Efficiency

Marc Patterson, vice president of product management at Boingo Wireless, said his company deals in all sorts of Wi-Fi implementations, distributed antenna system (DAS) networks and small cells. He said carrier Wi-Fi is the most promising technology because of its potential bandwidth per session and the flexibility that unlicensed spectrum provides. Meanwhile, he said LTE-U holds some promise for efficiency.

Availability

Ahmad Armand, staff vice president with T-Mobile USA, said his company is a heavy user of Wi-Fi

that will, at some point, deploy LTE-U or LAA when it becomes available. With license-assisted access, T-Mobile will use the 5-GHz Wi-Fi band in conjunction with the licensed band, not by itself. LAA augments licensed LTE service, speeding the downlink as it uses unlicensed frequencies opportunistically. He said LTE with LAA won’t rely on unlicensed spectrum all the time, instead using it if it’s available when the cell site needs it. Otherwise, the unlicensed spectrum won’t be used, and T-Mobile instead will rely on the licensed band.

The handset uplink requires the best available reliability. “You’re not going to use the 5-GHz spectrum at least for the immediate future deployments that uplink, which need reliability to have the handset be able to communicate with the base station,” Armand said. “That makes the link performance for the 5-GHz band on license-assisted access much better than Wi-Fi, with

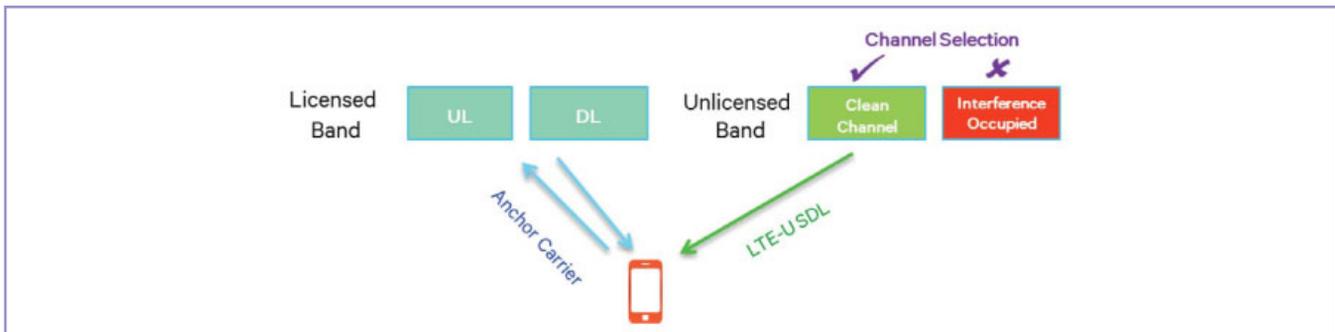
more coverage at 5 GHz than what you would have on Wi-Fi. Therefore, you can use it with either outdoor or indoor small cells and have more coverage, just as you would expect from the small cells.”

Jeffrey Thompson, CEO of Towerstream, said the only part of wireless telecommunications that’s harmonized on every device is Wi-Fi, and no devices yet have LTE-U. He said that in the short term, nothing will replace Wi-Fi. Towerstream supplies Wi-Fi to carriers.

“If you sat here five years ago and said Verizon and T-Mobile are going to use unlicensed spectrum, no one would have believed you,” Thompson said. “It’s a huge turn, but there’s so much spectrum, it must be used to solve all of the problems. It really is a gold mine, if you think about how much a 10-megahertz channel sold for in New York City — billions of dollars.”

Thompson said when carriers start to embed license-assisted access, tower locations are perfect for LTE-U. Towerstream had to build its consumer Wi-Fi locations at the right height to optimize downlink power, about 25 feet at most of its locations. “So we’re right there, at that 25-foot point on most of our locations with backhaul already. It uses rooftops for carrier Wi-Fi. If a wireless carrier wants to put up an extra sector, we would love to have that on our rooftops and then use LTE-U on the downlinks,” Thompson said. “It’s a lot less expensive than buying a 10-megahertz channel for the downlink for \$3 billion.”

Gordon said LTE-U has undergone testing to ensure that it won’t



Channel selection for LTE-U supplemental downlink transmission. Source: Qualcomm

harm 5-GHz Wi-Fi performance. “There’s enough spectrum and it covers small enough areas,” he said. “Wi-Fi is highly local. If someone inside of a store attempts to connect with a Wi-Fi access point that’s outside, it doesn’t work. If you’re not in your house, you have to struggle to get on Wi-Fi if the access point is indoors. So as long as the LTE-U system behaves similarly and the power is similarly low, I don’t see any problems. Wi-Fi and LTE-U are going to coexist quite nicely.”

Patterson said that although tests of Wi-Fi and LTE-U coexistence in controlled, laboratory environments demonstrate functionality and lack of conflict between LTE-U and Wi-Fi networks, venues are concerned about the physical demands associated with delivering carrier Wi-Fi — how much power and what other elements would they need to support the infrastructure. He said venues say they don’t want to have to install more cables, nor do they want to have to deal with a lot more headend equipment or having to use more of their real estate to satisfy changes in technology.

Interference Concern

LTE-U may use more power, and

some say it could possibly overpower Wi-Fi access points. Some cellular handsets already use Wi-Fi, and there is concern that communicating with those handsets and with other Wi-Fi devices might be adversely affected. Armand said T-Mobile is a heavy user of Wi-Fi, and the company wouldn’t deploy small cells with LTE-U that would interfere with handsets already in use. If T-Mobile has LTE-U or LAA available next year, and if the company decides to deploy it, not all of its devices would be capable of using it. He said it would take many years before all the consumer devices have been recycled. T-Mobile’s use of LTE-U and LAA is based on its small cell strategy. “Once we do small cells, then we may have the small cells enabled with LAA,” he said.

Bommakanti said Ericsson is committed to fair sharing. “As we bring in LTE-U, we’re going to be at least as good a neighbor to a Wi-Fi system as another Wi-Fi system would be,” he said.

Armand said the LTE Forum is working with 3GPP and the Wi-Fi Alliance, although at 3GPP, the focus is on its own standard, to make coexistence or fair sharing take place. He said if interference between LTE-U and Wi-Fi were to

become a problem in a given location, it’s easy to turn off the license-assisted access. The small cell involved would not be completely relying on LTE-U because it already would be using frequencies in the licensed band. “The worst case is that the network turns off LAA, the use of unlicensed band,” Armand said. “That’s the ultimate solution that the network operator has available.”

Patterson said classes of wireless telecommunications service, even in Wi-Fi, are emerging. He said he expects carrier Wi-Fi will provide a variety of Wi-Fi options to many types of users. Robust networks will be able to partition and to prioritize traffic based on applications and users. “We see this happening today with the carriers,” he said. “We’re conducting carrier-offload trials. Important questions are how to deal with downlink and capacity allocation on Wi-Fi and maintain complimentary or amenity-based Wi-Fi service at a level that users expect from free Wi-Fi.”

Future for the Standard

Standardizing LAA will take 3GPP two or three years, according to Bommakanti. The focus is on getting the

(continued on page 54)



SITE NAME

MOUNTAIN VIEW WATER TANK

HEIGHT

150 FEET TO TOP OF STEEL
160 FEET TO TOP OF BRANCHES

USERS

PUBLIC SAFETY DEPARTMENT
PUBLIC WORKS DEPARTMENT
ELECTRIC DEPARTMENT
WATER RESOURCES DEPARTMENT
COMPAS CABLE

TOWER TYPE

MONOPINE

OWNER

CITY OF MORGANTON

MANUFACTURER

LARSON CAMOUFLAGE
VALMONT

YEAR CONSTRUCTED

2014

LOCATION

MORGANTON, NORTH CAROLINA



ABOVE GROUND LEVEL
agl

DECEMBER 2015

AGL TOWER OF THE MONTH

/ FEATURES /

(continued from page 51)

downlink-based technology out to market, although the standards group has a study item for the uplink slated for later this year. At present, network operators use the licensed band for the uplink and for control. It's possible that some user applications would need extra bandwidth on the uplink. Gordon said such applications are coming, and for current examples he cited consumers who use Meerkat and Periscope live video streaming. "They're still a minority of users," Gordon said. "Some users will want faster uplinks for video, but there are going to be far more people consuming video than producing it." LTE-U plays into the nature of how

Boingo Wireless designs and builds Wi-Fi networks, according to Patterson. "In public venues, Wi-Fi no longer is an amenity," he said. "Some venues use our Wi-Fi networks for their own operations, including asset tracking. You would be surprised at the number of airports using Wi-Fi to track passengers' baggage. The variety of applications emerging from LTE-U affects our transition from providing amenity Wi-Fi service to providing managed services because of the huge number of devices, applications and operational processes that are becoming wireless-enabled."

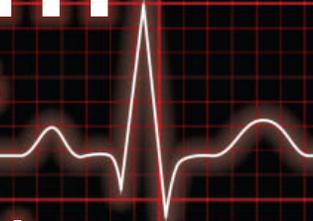
Internet of Things

When it comes to the Internet of Things, Armand said that the multi-

tude of devices that planners anticipate will use the IoT would not require much network capacity, even considered in total. The amount of data they will transmit on the uplink will be in the bytes or kilobytes range. In one small cell, there is a limit to the number of IoT devices that would fit into the physical space. Compared with video, the amount of IoT data will be small. Therefore, Armand said, the problem with the uplink for IoT involves the control signaling.

"The network needs to be able to handle many control signals," Armand said. "The reliability of the uplink could be important with the use of some devices. It's not really the amount of data that you need to support."

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YEAR OF THE CLIMBER

YEAR OF THE CLIMBER

By Don Bishop

AGL Magazine brings to a close the Year of the Climber coverage of tower worker safety, which included 48 articles and other items published about safety in 2015. What seems clear is that there is no shortage of information, opinions and recommendations about preventing illness and injuries, including fatal injuries, involving workers whose tasks bring them to telecommunications antenna sites, especially workers who climb towers.

The coverage has included a combination of hope and heartbreak as articles have covered efforts to improve safety along with details about workers who lost their lives because of injuries that happened because they fell from towers.

Knowledge of safety protocols, use of personal protective equipment and experience working on towers isn't always enough, as evidenced by an accident on a tower in October that took the life of Ernest "Ernie" Jones, P.E., a foremost safety expert (see page 82).

During the year, the U.S. Occupational Health and Safety Administration requested information to assist it in determining what steps, if any, it can take to prevent injuries and fatalities during tower work. Some who responded said they would like to see OSHA become more involved, and some said they would prefer that standards-setting and membership organizations take the lead.

In 2016, many of the efforts that began this year and the year before will come to fruition. Perhaps that combination of those efforts will result in a year that will be free of fatalities associated with tower work, if not free of most injuries.



Stemming Tower Climber Accidents Requires Heavier Regulation

Until OSHA gets some teeth and really regulates the industry, nothing will improve.

By the *AGL Magazine* staff

Earlier this year, the Occupational Safety and Health Administration issued a request for information (RFI) about communications tower safety. Rick Jones, president of Sky Jack Communications, is among the respondents. Edited for length and style, the following information includes Jones' generalized response to OSHA's questions and includes his opinions.

Definition of a Tower Hand:

A tower hand is an individual who, prior to employment, possesses a basic electromechanical aptitude and basic construction skills. Through extensive training, generally lasting several years in a position similar to an apprentice, a tower hand learns to recognize hazards, to install equipment, to perform maintenance and repairs and sometimes erections, and to safely climb antenna structures to the work station daily.

Definition of a Qualified Tower Company Owner:

A qualified tower company owner should be a previous tower hand who, through extensive training, worked his way up through the ranks of a tower hand until he learned his craft and would be considered a journeyman in his particular area of expertise in performing work on antenna structures and towers. Such an owner is one who possesses the knowledge and has an entrepreneurial spirit to start his own business.

Tower Climbers

I would think that at least 60 to 70 percent of the respondents would be considered unqualified to answer any of OSHA's questions, one reason being lack of experience as evidenced by providing canned answers. I recognized the names of several respondents from work-wanted listings on job boards where their names appear on a regular basis. There has to be a reason that they can't hold a job.

I recognized many of the names of the other 30 to 40 percent and held their responses in high regard; they made valid points.

The majority (the 60 to 70 percent of the tower climbers with less than a few years' experience) believe that they are risking their lives every day they work. They drill that belief into their families and friends, tormenting their loved ones with fear of whether they are coming home from their jobs, all the while acting like fools taking ridiculous pictures and posting them on social media. In business employment, no one should ever risk his life for anything, and if he believes he is, he is in the wrong line of work.

Training and Certification

The most concerning thing about training and certification is that OSHA has absolutely no teeth in training requirements, other than that employees must be trained in fall protection. This issue only comes up in the event of an accident. The problem starts there.

Many employers send an employee to become train the trainer certified. In many instances, whether through ignorance or arrogance, trainers run these guys through their training program, first to see if they are afraid of heights, then training them how to use their personal protective equipment.

This type of training is endorsed by the carriers, turfing contractors, general contractors, especially the tower owners, and even some of the training companies. I personally called one of the largest and best known training companies questioning them about these practices, and the way these train the trainer programs work is very misleading. I personally feel like this practice should be abolished to make this a safer industry. I have seen men working as foremen, crew leaders or construction managers with the bare minimum of training. There are numerous reputable third-party training companies, and then there are ones who are bad actors. Everyone on the job-site needs to be trained to a standardized program, and the training must be equally acceptable to any client. Hopefully, the TIRAP program will level the playing field. It is hard to police the training companies when you can't get any OSHA support.

Suitability for Work

If the person performing the interview were to evaluate the prospective employee during the interview process, you could weed out some based on morbid obesity or being extremely frail. Most new hires should have at least some type of previous construction experience

before applying in this field. Many new hires are brought in from staffing companies or recruiters, and those companies get paid by the head. There is a lot to be said about evaluating a prospective employee's mental and physical condition without breaking any discrimination laws. When you have a workforce made up of ex-pizza delivery guys, restaurant workers and sales clerks, none of these trades have the basic foundation to qualify as climbers.

Hazards and Incidents

Training is at the forefront of accident prevention. When you send new employees to a training program and you expect them to learn tower climbing, proper use of personal protective equipment, RF awareness, first aid and CPR, and you cram all this information into one or two weeks, then there is no way you can expect to have a qualified employee unless they have previously worked in the tower business.

Most new hires have no idea how to recognize a hazard, and if all the crew is certified as authorized climbers, one must assume that the entire crew has the same knowledge. The tower owners, turfing contractors and carriers are skirting the issue of competence. This is gross negligence on their part. They know the rules, but they go along with the status quo. Just check out the requirements to work on their sites.

For example, the use of carabiners has become more prolific within the industry. There are all different types with different ratings. In many cases, they are put into service in situations where they are obviously

the wrong tool for the job. A carabiner may be rated for 22kN, but what is the safe working load?

All tower climbers should be thoroughly trained in rigging, knots, hitches and sling angles prior to ever being allowed on the tower. What about capstans or catheads? Frequently, they are being overloaded beyond their intended capacity, as are the aluminum blocks that are commonly used. Improper training on a capstan hoist is another big issue. Many companies have the new guy operate the cathead when it should only be operated by someone deemed competent.

Contracting and Work Oversight

General contractors have no business building sites. Their only concern is to get the site completed as fast as possible. This most often creates a multi-employer work environment. You can have a tower crew working aloft, electricians on the ground, and civil crews pouring generator and cabinet pads, and it is a recipe for disaster.

The general contractors rarely care about safety. Most of the time general contractors are underfunded and can't pay their subcontractors until 90 days after the site is accepted. Typically, they drag out the job by finding punch list items in the work performed that was not on the scope of work to begin with. This requires the subs to make additional trips to take care of the problem in question.

I have personally seen general contractors want the tower crew to stop erecting the tower while a civil crew comes in to spread gravel. All work aloft should be completed

prior to or after all the ground work is completed. In many circumstances, the tower owner or turfing contractor rarely even comes out to the jobsite, depending on the scope of work being performed, such as a major modification or extending the height of the tower.

Economic Issues

My company, Sky Jack Communications, employs one full-time crew, four crewmen, plus me, the competent person, and one office administrative person. We have been in business since 1988. I have a pool of crew that I can choose from, depending on the type of project we are working on. All employees are W-2 employed direct. We have two double-drum man-rated hoists, two rubber-track front-end loaders, four gin poles and three warehouses with rigging equipment up to 20 tons. All of my employees are certified through third-party companies, and we undergo training on virtually every job.

We generally do projects that are difficult and that most companies would not touch. We work in foreign countries where the safety requirements are much more stringent than in the United States. It's expensive to operate the way we do, and by no means am I a fat cat desk jockey. I am at the jobsite every day. I make sure my men come home safe at the end of the day. I learned the old school way.

Tower Design

One of the biggest issues of tower design involves the structural engineers designing modifications and the retrofitting on towers. You

can take six engineers with each having the exact same software, and you will get six different types of modifications. They each have their own pros and cons. The new ANSI standard requires engineers to calculate the loads applied to towers during these procedures. There are only a couple of engineers that I know that will do this, and they charge a fortune.

Elevators on towers are not practical. Even very few of the newer tall broadcast towers have elevators anymore. We have man-rated hoists, and if we need it, we have it at our disposal.

A davit head with a climbing extension would be practical. However, for the 190-foot towers, they would then have to be marked, lighted and registered. Who would pay for that?

Another one of the biggest issues with tower design involves the different types of safety climb cables used and the lack of inspection. A safety climb cable grab is designed as a cam-actuated device with teeth designed to grab the cable in the event of a fall. These cable grabs are heat-treated in the manufacturing process and technically designed to grab a 3/8-inch 6x19 galvanized aircraft cable. Many safety climb companies instead use a 3/8-inch 1x7 EHS cable, which is often too hard for the safety climb cable grab to bite, resulting in falls.

Regulatory/Nonregulatory Approaches

If OSHA wants to substantially reduce the number of fatalities and injuries on tower sites, the first thing that needs to happen is to license the

owners of tower companies, just like electricians, plumbers and HVAC companies. It would take a skills-based testing program instead of the non-test specialty contractor's license that most states issue.

Electricians are generally the worst. They know absolutely nothing about communications towers, but they hear about the big money that's paid out. The next thing you know, they hire some green crew cheap, and their entire knowledge base is determined by the lack of knowledge of their green crew. They buddy up with the general contractor or turfing vendor, let them know they are now in the tower business, have their employees covered under low-voltage installers, and the next thing you know, one guy falls off and dies. I see electricians, landscapers and anyone else who may work on tower sites become overnight tower companies. The good old boy system runs deep within the telecom industry.

Another group OSHA has failed to address is the broadcasters. These guys fly under the radar when it comes to tower work. More often than not, they hire totally untrained companies to do their work, whoever they can get cheapest. You would not believe some of the things I've seen happening on these towers. Even the largest companies out there get by on the cheap. Municipalities are just as bad. They hire people with absolutely no training at all.

Until OSHA gets some teeth and really regulates the industry, nothing will improve. I'm sure that this response will anger many of you out there, but if the shoe fits, then wear it.

Three Steps to Improve Tower Worker Safety

For NTCH, it's about OSHA taking concrete steps to remediate factors contributing to the tower industry accidents. Edited for length and style, the following information comes from the NTCH comment in the OSHA proceeding about tower worker safety.

Submitted by Donald J. Evans

NTCH is an active participant in the communications tower construction industry. It has supported the cause of tower worker safety through financial and other support for tower workers injured in the course of their work. It has long advocated for systemic reform of the tower construction safety regime. NTCH believes that several concrete steps can be taken to dramatically improve worker safety. NTCH informally communicated some of its proposals to OSHA staff last year, and it applauds OSHA's effort to now move forward toward specific measures that will prevent injuries and save lives.

There are three basic problems with the safety situation of tower workers: The telecom carriers who are the ultimate beneficiaries of tower construction have no stake in tower worker safety, tower workers tend to be short-term employees or contractors who do not develop the depth of experience needed to ensure safety, and there is no economic infrastructure that incentivizes

everyone involved to prioritize worker safety. There are several steps that can ameliorate these conditions.

Improve crew safety through training and certification. For too long, tower construction has included work crews of the "two guys in a truck" ilk. These are men who may have some familiarity with tower construction, but work cheap, have little to no support infrastructure and, most particularly, lack the training in basic tower safety measures that will prevent most accidents. NTCH believes that thorough training is so fundamental to tower construction safety that personnel should not even be allowed to climb a tower without certification of completion of a recognized course of training in tower safety. More than simple skills are required if someone is to be trusted with putting his or her own life (and sometimes that of his or her coworkers) at risk. It is absolutely essential, therefore, that anyone climbing a tower demonstrate that they have satisfactorily completed an intensive

course of study in tower construction and safety including field demonstrations and hands-on practice of not less than 50 credit hours. This prerequisite would apply to employees of tower construction companies, but anyone engaging outside contractors would also have to verify compliance with this requirement.

NTCH has offered to partner with PCIA in furthering relationships with educational institutions that have formal training programs in tower construction and safety. The more schools that have such programs — and the more widely available are scholarships or other forms of financial aid — the more people will take advantage of such opportunities. Tower erection companies can help by providing financial support for such programs at smaller rural schools, lending expertise to the training programs, offering scholarship programs of their own, and providing on-the-job training once the students have been certified.

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workers, NTCH recommends a work rule whereby any tower climbing crew would have to include at least one worker with at least five years of experience in tower climbing. In our experience, longevity in the field is the single most important factor in respecting safety precautions. They say there are old tower climbers and there are bold tower climbers, but there no old, bold tower climbers. The experienced climber carries the authority and the wisdom to ensure that newer climbers do not scoff at or discount the importance of safety measures.

Making climbing a career. Another symptom of the “two guys and a truck” syndrome is that tower climbing is not seen as a long-term career. This is because wage scales do not generally present an attractive career opportunity. This necessarily leads to the reality that tower climbers do not become true professionals in the field. They might do it for a summer or a couple of years until more remunerative work comes along. But in the meantime, they never develop the expertise and knowledge base that contributes to real tower safety.

The model employment paradigm here is the elevator industry. That industry is stringently regulated in most states, requiring meaningful and thorough training. Because the entry requirements are relatively high, those who enter the field tend to make a career of it. They can make a good living wage and have economic incentives to stick with the field and expand upon the expertise they develop on the job. Regulations ensure that nonqualified people are not working on elevators. Elevator

repair jobs are also heavily unionized, which serves to make these positions career-oriented rather than a temporary stepping stone to something else.

The combination of strict training standards, higher wages, unionization, and state or federal certification requirements would all help to weed out fly-by-night tower operations and instead make this a respected profession where skill, knowledge and experience are financially rewarded.

Carrier liability. The third essential leg of this tower safety program involves financially incentivizing the carriers that place their antennas on the towers constructed by others to have a stake in construction safety. The current industry practice is for the cellphone companies to lease tower space from enterprises that construct the towers for them and with their cooperation. The radio equipment installation is also handled by third-party contractors. This permits the cell companies to have towers where they want them without having to go through the process of finding, building, owning and managing the tower sites or installing their own equipment. It also creates a liability gap between the people most involved in tower construction and equipment installation and the companies and workers who actually handle the construction and installation.

Because the companies that construct and lease the towers depend on the cellphone companies for their ultimate revenue, the liability gap between carriers and workers could be bridged by imposing liability upon lessees of space on towers for worker injuries incurred in violation of the

safety standards that OSHA ultimately adopts. The carriers would have the financial clout to insist in their contracts with the tower owners or the antenna hangers that all applicable OSHA regulations have been followed and perhaps even include additional safety inspections and safety precautions beyond what OSHA demands. This will only happen if the cellcos have something to lose by the continuation of slipshod safety measures. If they can be found vicariously liable, they will take strong steps to ensure that all appropriate safety measures have been implemented.

An added benefit is that if a safety lapse does occur, there will be a deep-pocketed entity standing behind the safety obligation that will have the wherewithal to pay for the damage suffered.

Conclusion

NTCH believes that it is high time that OSHA take concrete steps to examine and remediate the factors that contribute to the increasing number of tower industry accidents. Although training and education are important factors, OSHA should also address the industry structures that contribute to a culture of unprofessionalism and an absence of responsibility upstream for tower worker safety. We urge OSHA to act and stand ready to assist in any regard.

As its attorney, Donald J. Evans represents NTCH. He is with Fletcher, Heald & Hildreth, Arlington, Virginia. Evans submitted this information to OSHA from NTCH in response to OSHA's request for information about tower worker safety.

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The OSHA Files – Why Andrew King Died

Guidelines in use in 1995 are not the same as today's, but this fatality could have been avoided by adhering to the guidelines in use at that time.

By Dr. Bridgette Hester

The following information, installment three in the OSHA files series, explores what happened to Andrew King in the spring of 1995. My hope is that you will find the information in this series useful as a learning tool for tower crews to help to identify the failures in the safety process involved in fatal accidents and encourage crew members to ask questions about what they can do to make their workplace safer.

Much of the information comes from the file OSHA sent me in response to a Freedom of Information Act request. OSHA redacted some of the file contents. Other information (such as surviving family) was obtained with a search I conducted. The following are my words unless indicated by the citation (OSHA, 1995).

Summary of Events

According to the citation notations in the file, it appears that on or about April 26, 1995, King was attached to the load line and rode the gin pole attached to the pill that

served as a personnel platform when the line failed. "The cable broke and Mr. King fell with the gin pole until striking a star mount on the way down, then he free fell the rest of the approximately 400 feet." (OSHA, 1995).

The Incident

This report consisted of the citations. The report had no narratives, no redacted interviews and no comments from the investigator; thus, this explanation pieces together what happened based upon the narrative of each violation.

Specific information on why the citations and violation notices were issued (OSHA, 1995):

- Not using protective helmets.
- Mr. King's positioning device was cracked, worn and corroded.
- At the site, the pill was used to hoist employees and tower sections up the tower under construction.
- A failure to maintain inspection records for the two DP winches (model C200AAIRA), an Allied gin pole, wire rope, snatch blocks and

related equipment.

- The jute line cable had corrosion in several areas and failed under load.
- The employer's visual, undocumented inspection of the equipment was inadequate in that it failed to reveal the corroded C edition of the wire rope and corroding and pulling out of strands from wire rope clips at the end of the jump line.
- Manufacturer's information indicated that twin DP model C200AAIRA winches are not to be used in hoisting personnel.
- The hoist rope was wrapped around the load, and the load was not attached to the hook by means of slings or other approved devices. The gin pole was attached to the jump line by the following means: A clevis was attached to an eye splice without a thimble, the splice was fabricated with improperly applied wire rope clips at the end of the jump line, and the jump line was used as a choker wrapped around

- the girt pole's latticework.
- U-bolt clips did not have the U-bolt on the dead end or short end, and the saddle on the live or long end of the rope. Spacing and number of all types of clips were not in accordance with the clip manufacturer's recommendations. Put another way: An eye splice was fabricated at the end of the jump line with staggered clips, which were not applied with sufficient length of turn back to prevent the dead end of the rope from pulling through the clip.
- Synthetic fiber slings were used to lift materials and personnel and were not inspected daily.
- Mr. King was using a safety harness

equipped with a back positioning device attached to the harp's D-ring with two nonlocking snap hooks (nonlocking attachments used on the same D-ring may inadvertently disengage one another).

- Cup and cone breaks on the ¼-inch jump line, which failed, indicate the cable was pulled to destruction, which means it was either not moving freely on the snatch blocks (sheaves) or the gin pole hung up, causing the winch to pull apart the cable.

Inspector's Commentary

The inspector made some valid points in the citation comments, including observing cup and cone, chisel and

other varieties of breaks at the three failure points. If two workers had the task of keeping the gin pole from hanging up, it isn't really clear how King could have controlled the gin pole's movement because "he was tied off to the gin pole without the use of a lanyard." King had used a carabineer attached directly to the D-ring on the front of the safety harness, and then to the gin pole, which would leave him no ability to move laterally to steady the gin pole.

If he had been inside of the tower, he could have controlled the gin pole until it passed. The inspector concluded that it was likely that the gin pole hung up, causing the hoist to pull the cable



Photo by Jade Albert

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/ YEAR OF THE CLIMBER /

to destruction, thereby shock-loading the cable every time this occurred. Workers said they felt no hanging up, although they said this was a common problem.

Author's Commentary

Given what is in the citation descriptions, we know that King had been riding a gin pole that was not rated by the manufacturer to hoist personnel. We can also tell that the worksite had safety issues

throughout, including lack of basic safety equipment such as hard hats. The site had poor rigging. The splice was constructed using wire rope that had been corroded. Slings, wire and other materials were not inspected.

As for the gin pole not being controlled, they might have positioned slings above and below King, not on the gin pole as observed by the inspector. Had this been done, it might have been more likely that they could

have kept the gin pole from swinging or catching on the tower legs.

One company partner stated to the inspector that he “was aware that employees are not to ride the headache ball of a crane,” and that he was aware that King had been riding on the gin pole. The company partner stated that King had been told “repeatedly not to tie off to it.” The fact is that even if he had not been tied off to the gin pole, King still would have fallen

The OSHA Files

Andrew King: April 26, 1995



Pertinent Information:

Inspection Number:	361131295
Date of Incident:	April 26, 1995, 8:54 a.m.
Location:	CR 32 and Highway 365 Brenham, TX 77833
Gender:	Male
Age:	41
Family:	The author contacted King's family and received no response. If you know the family or could provide further information, please email the author.
Cause of Death:	“Fall/Other” (OSHA, 1995)
Toxicology:	Not indicated
Training:	Unknown; no certifications provided in file
Time on Job:	Not noted in file
Company Years in Business:	Established in 1979 (according to research)
Total Number Employees:	12 (according to research)
Reported to OSHA:	April 26, 1995
Others Injured:	N/A
Height of Tower:	420-foot tower under erection (OSHA, 1995)
Height at Fall:	Approximately 400 feet
Tower:	Guyed
Tower Condition:	Nothing was noted in the file
Operation:	Tower erection
Free Climbing Reported?	No
Case Closed-	
Last Closing Conference:	July 26, 1995

SAFETY

Citation:

Citation 1 Item 1 Type of Violation: Serious **Proposed Penalty: \$1,050**
 29 CFR 1926.20(b)(1): The employer did not initiate and maintain such programs as may be necessary to comply with this part.

Citation 1 Item 2a Type of Violation: Serious **Proposed Penalty: \$750**
 29 CFR 1926.95(c): All personal protective equipment was not of safe design and construction for the work to be performed.

Citation 1 Item 2b Type of Violation: Serious
 29 CFR 1926.100(a): Employees were not protected by protective helmets while working in areas where there was a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock and burns.

Citation 1 Item 3 Type of Violation: Serious **Proposed Penalty: \$1,500**
 29 CFR 1926.251(a)(4): Special custom design lifting accessories for material handling were not marked to indicate the safe working loads and were not proof-tested prior to use to 125 percent of their rated load(s).

Citation 1 Item 4a Type of Violation: Serious **Proposed Penalty: \$1,500**
 29 CFR 1926.550(a)(6): Employer did not maintain record of the dates and result of inspections for hoisting machines or equipment.

Citation 1 Item 4b Type of Violation: Serious
 29 CFR 1926.550(a)(7)(ii): Wire ropes were not taken out of service when as much as one-third the original diameter of outside individual wires was worn out or when rope was damaged resulting in distortion of the rope structure.

Citation 1 Item 4c Type of Violation: Serious/with alternative: Section 5(a)(1) of the Occupational Safety and Health Act of 1970:
 29 CFR 1926.550(e): All derricks in use did not meet the applicable requirements for design, construction, installation, inspection, testing, maintenance, and operation as prescribed in American National Standards Institute B30.6-1969, Safety Code for Derricks.

Citation 1 Item 5a Type of Violation: Serious / with alternative: Section 5(a)(1) of the Occupational Safety and Health Act of 1970 **Proposed Penalty: \$1,500**
 29 CFR 1926.550(a)(19): All employees were not kept clear of loads about to be lifted and of suspended loads.

Citation 1 Item 5b Type of Violation: Serious
 29 CFR 1926.550(g)(2): A crane or derrick was used to hoist employees on a personnel platform.

Citation 1 Item 5c Type of Violation: Serious
 29 CFR 1926.553(a)(4): All base-mounted drum hoists in use did not meet the applicable requirements for design, construction, installation, testing, inspection, maintenance, and operations, as prescribed by the manufacturer.

Citation 1 Item 6a Type of Violation: Serious **Proposed Penalty: \$1,500**
 29 CFR 1926.1051(b): The employer did not provide and install all stairway and ladder fall-protection systems required by Subpart X and which complied with the other pertinent requirements of Subpart X before employees began the work that necessitated the installation and use of stairways, ladders, and their respective fall-protection systems.

Citation 1 Item 6b Type of Violation: Serious
 29 CFR 1926.1053(a)(19): The total length of a climb on a fixed ladder equaled or exceeded 24 feet (7.3 m) and the fixed ladder was not equipped with: (i) ladder safety devices; or (ii) self-retracting lifelines, and rest platforms at intervals less than 150 feet (45.7 m) or (iii) a cage or well, and multiple ladder sections, each ladder section less than 50 feet (15.2 m) in length.

Citation 2 Item 1 Type of Violation: Other **Proposed Penalty: \$0**
 29 CFR 1926.251(a)(6): Each day before being used the sling and all fastenings and attachments were not inspected for damage or defects by a competent person designated by the employer.

TOTAL FINES PROPOSED: \$7,800

TOTAL FINES PAID: \$2,625

**The citation was reclassified as "Other" and reduced to \$750 as a result of an informal settlement hearing (settlement paperwork not released).*

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because he was riding on it when it fell. The gin pole was being hoisted on the jump line.

When reading the report, comments from the company partners draw attention. One partner commented about having told King not to engage in certain activities that were unsafe (e.g., riding the line or the headache ball). I do not understand why someone would retain an employee who he had to tell repeatedly not to engage in a certain activity. Furthermore, the company owner stated that "he had a feeling that if an accident ever happened, it would be when jumping the gin pole." (OSHA, 1995) I find these statements disconcerting.

These comments tell me that it is unlikely that King was told repeatedly to do or not do anything. If he was in fact told this, the enforcement of safe work practices was apparently nonexistent so long as the job was accomplished. The person in charge of the site (the foreman or site boss) wasn't actively supervising, otherwise, the job should have been stopped and actions corrected before the job moved forward. A climber has to take personal responsibility, but a foreman also has responsibilities. A foreman has to stop the job if employees aren't following instructions. Employees should be terminated if they can't follow workplace safety guidelines. The foreman

should have complete control of the site and the ability to stop the job and ensure workers are acting in a safe manner. My understanding is that ground workers, tower technicians and top hands are supposed to be under the authority of the foreman.

These comments tell me that the employees didn't recognize the foreman or the company partners' leadership. Anyone who requires repeated admonishment is not a responsible employee who should be working on a crew. Such a person also lacks respect for authority, as evidenced by the blatant disregard for the rules.

One page in the report illustrates my points. It says that the

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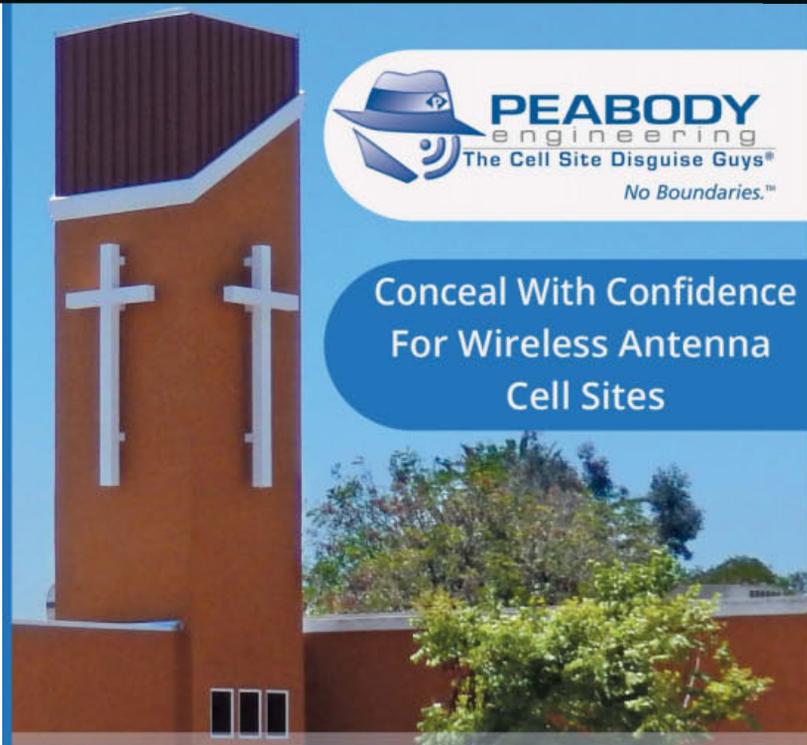
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company had a written health and safety program, but it received a rating of “nonexistent” in communicating expectations to employees or enforcing the health and safety expectations, and a rating of “inadequate” for its safety-training program. The program was provided to the OSHA construction health and safety officer by a company partner “who stated he used the manual for safety meeting subjects. However, the other company partner said he was unaware of the company having written safety programs. He was the wire rope inspector for the company and said he inspected the equipment about three weeks before the accident.” It seems obvious that if one company partner is aware of a written program and the other is not, then there are some problems with communication at the management level.

The report also said the company had not had a prior accident, but the points raised in this section support the idea that communication, adherence to the safety guidelines and creating a safe work environment can save lives. Guidelines in use in 1995 are not the same as today’s, but this fatality could have been avoided by adhering to the guidelines in use at the time.

Bridgette Hester, Ph.D., is a family and workplace strategist. She is the founder and president of the Hubble Foundation, which is dedicated to promoting the safety of tower workers, site crews and all workers at heights. Her email address is bridgette@hubblefoundation.org.



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SAFETY

What AT&T Told OSHA about Tower Worker Safety

For AT&T, it's about careful adherence to its safety plan and participation in safety-related organizations. Edited for length and style, the following information comes from the AT&T comment in the OSHA proceeding about tower worker safety.

By the *AGL Magazine* staff

The following information comes from the AT&T comment in the OSHA proceeding about tower worker safety. In a June 15 letter to OSHA that accompanied the comment, Art Pregler, AT&T's national cell site program director, said that through its participation in working groups, committees, board membership and leadership positions, AT&T supports industry organizations with broad knowledge and specialists focused on particular issues of tower design, construction and climbing.

"We adhere to the core principle reflected in the historic AT&T Creed, that no job is so important and urgent that time cannot be taken to do the job safely," the letter reads. "In our response, we are incorporating input from AT&T's own small, elite team of climbers and their management team who have compiled a superlative safety record while performing the highest quality of work."

Pregler said that AT&T believes the industry is best situated to respond, and is continuing to respond, in a manner reflecting a shared desire to see all tower work conducted in a safe manner according to uniform industry standards reflecting best practices. "We are proud to participate in the work directed to improvement of safety industry-wide being led by the National Association of Tower Erectors (NATE), National Wireless Safety Alliance (NWSA), Telecommunications Industry Registered Apprenticeship Program (TIRAP), PCIA – The Wireless Infrastructure Association, and others," the letter reads. "We believe the effectiveness of industry leaders and organizations in this work is reflected in the continuing reduction in occupational fatality accidents among tower climbers even as total jobs increase, which may reflect the longest period without a fatality since 2003."

Among the best practices AT&T

references and supports are NATE's Tower Climber Fall Protection Training Standard (Fourth Ed., Rev. 2015); TIA 222 Code H; the NWSA tower worker certification program; the TIRAP Department of Labor-credentialed telecom apprenticeship program; and the forthcoming A10.48 Standard, Criteria for Safety Practice with the Construction, Demolition, Modification and Maintenance of Communication Structures, which is in draft for submission for review by the American National Standards Institute (ANSI).

"We anticipate in combination with these and other efforts, the A10.48 Standard will, when finalized through the work of the American Society of Safety Engineers (ASSE), represent the best thinking and most comprehensive treatment of safety related to communications structures," the letter reads.

What follows are OSHA's questions and AT&T's answers, edited for length and style.

Questions for Tower Climbers

OSHA: As a tower climber, what are the most significant hazards that you encounter on the job? What circumstances or conditions create or contribute to these hazards?

AT&T: The hazards under the diverse conditions that may exist for any particular job on a particular tower site vary, but the array of hazards and means to mitigate those hazards to complete work safely are generally known and effectively and comprehensively addressed in the NATE Tower Climber Fall Protection Training Standard (Fourth Ed., Rev. 2015), TIA 222 Code H, the NWSA tower worker certification program and Telecommunications Industry Registered Apprenticeship Program (TI-RAP), among others.

Potential hazards identified by AT&T climbers and management are consistent with those generally recognized by industry organizations engaged in addressing hazard identification, mitigation and safety training. When finalized, the forthcoming A10.48 Standard, Criteria for Safety Practice with the Construction, Demolition, Modification and Maintenance of Communication Structures, currently being drafted by the American Society of Safety Engineers, will further address hazards and safe work practices. AT&T supports ongoing work in the industry to make training to these standards and uniform certification by all tower industry workers the norm, and expectation, to be employed to do work in the communications tower industry. AT&T leadership currently chairs the TIRAP

Quality Committee and will serve on the National Wireless Safety Alliance (NWSA) board of governors. AT&T actively participates in the drafting committee for TIA 222 Code H.

OSHA: What steps do you take, at this time, to complete your work safely? What safety-related work practices do you think should be in place?

AT&T: AT&T requires formal tower safety training and certification through a professional expert vendor, currently a 24-month certification. AT&T climbers conduct safety meetings and work site evaluations, discuss hazards, solutions and responses to any and all hazardous scenarios. AT&T climbers conduct monthly and before-use inspections

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TOWER WORKER SAFETY

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of all equipment and tools, and remove or destroy any faulty equipment. A constant emphasis is placed on training. Supervisors enforce training to AT&T safety standards.

OSHA: What safety rules and work practices are provided to you, and who provides you with that information?

AT&T: AT&T climbers receive training that includes a tower climbing safety course and substantial training in general safety and health courses. AT&T has in place policies that meet or exceed applicable OSHA, ANSI and Z359 standards. Standards are set by experienced antenna technicians and management. Importantly, tower climbing safety and rescue classes are required every year. AT&T requires inspection of all personal protective equipment (PPE), personal fall-arrest system (PFAS), occupational protective equipment (OPE) and safety ropes before every use and monthly. Practices are reviewed by AT&T environment, health and safety staff, subject matter experts and management together with

climbers for updating and change based on standards organization and agency recommendations.

OSHA: Who assigns and oversees your work? Who provides your training and checks your equipment? When at a jobsite, to whom would you report a potential safety issue?

AT&T: AT&T chain of command assigns and oversees work completion, quality and adherence to standards. Crew leaders oversee work completion. All equipment is inspected by trained, competent personnel. All potential safety issues are reported to everyone on-site, up the chain of command and to any appropriate engineering departments.

OSHA: What specific steps do you think employers can take to make tower work safer?

AT&T: AT&T management, crew leaders and climbers believe the company adheres to best practices in providing a safe work environment for its climbers. AT&T is proud that its climbers have not suffered a single

fatality accident in the course of work on towers.

OSHA: How, and to what extent, does the design or configuration of towers, and equipment installed on towers, affect your ability to complete your work safely?

AT&T: AT&T climbers have a record demonstrating they are capable of negotiating all such hazards safely in accordance with their training and experience, but when it is practical to design, construct and maintain towers and equipment on towers to avoid such hazards altogether, it is desirable to do so. Design and configuration of appurtenances and equipment on structures can improve or eliminate work locations presenting hazards.

Where possible, climbers prefer ladders to step bolts and installation of crow's nests on light masts where reasonable. Equipment may be installed in or impinging on climbing paths, representing a hazard that must be negotiated. Improperly installed waveguides and cabling represent hazards that must be negotiated by climbers.

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Training and Certification

OSHA: Tower hands/climbers, please describe the training and certification required for your job. Employers, please describe the types of training and certification you require for your employees.

AT&T: AT&T technicians are required to complete initial training from an expert vendor and complete refresher training every 24 months.

OSHA: What commercial training programs are currently available? What are the topics covered by the programs? Are the programs adequate to prepare employees to work safely on communications towers?

AT&T: AT&T uses ComTrain for tower training, including climbing and rescue techniques. All aspects of safe climbing and rescue are covered. Vendors should be consulted for specific reference to topics and content of courses.

OSHA: Is there a need for a standardized, industrywide training or certification program?

AT&T: Yes.

OSHA: From your perspective given your role in the contracting chain, what does a tower climber need to know to do his or her job safely?

AT&T: Generally, climbers must receive tower climbing certification; know how to preplan for deployment; be trained in proper condition and use of all necessary equipment, processes

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for equipment inspection, site assessment and job planning, hazard recognition and mitigation; be trained in rescue techniques; and have knowledge of installation of parabolic microwave and cell antennas. Specifically, climbers should be trained to and certified for practices and methods covered through expert vendors and adherence to standards previously mentioned.

OSHA: How do employers evaluate employees to ensure that they have been adequately trained, especially when employees receive their training or certification elsewhere? How do companies determine if employees are proficient in the topics covered by the training or if re-training is necessary? Do employers offer site-specific training that addresses specific types of towers and equipment?

AT&T: Use of reputable vendors generally accepted as industry leaders ensures both adequate training for the subjects covered and validation of demonstrated competencies through observation and testing necessary to attain program completion. AT&T assesses its vendors for training purposes based on referrals, credentialing and reputation within the subject matter area. Employees are assessed through testing following course completion, continuous observation and assessment by leads and supervision, regular competency checks and follow-up in instances of deviation from established rules and safe practices. It is a requirement for AT&T climbers to receive training on those types of structures, and conditions, they are required to climb.

Suitability for Work

OSHA: Are employees directly engaged in tower work assessed for physical fitness? If so, how? Are physical fitness requirements and assessments addressed in contracting agreements?

AT&T: AT&T employees receive assessments of fitness for work. Our climbers are Class A motor vehicle drivers, which means they have to complete physicals every two years. Most tower climbing harness manufacturers have limits on weight, including the tools the climber is wearing. Demonstrated ability to perform the physical tasks necessary to climb is a qualification for work.

OSHA: What physical limitations should employers be aware of when assigning an employee communications tower work? What hazards might be associated with such limitations, and how could those hazards be mitigated?

AT&T: Generally, climbers must demonstrate the physical strength and conditioning to ascend and descend using the required means, and to be capable of performing work at elevation including rescue operations, carrying, lifting and manipulating tools and equipment without fatigue, which may impair the capability to complete work safely.

Hazards and Incidents

OSHA: Falls are currently the leading cause of fatalities among communications tower workers. OSHA

believes that many falls result from the improper use of fall protection equipment or the failure to use any fall protection equipment at all. Are employers providing appropriate fall protection equipment to employees? Is it maintained and replaced when necessary?

AT&T: Employees are required to check their climbing equipment when received and before each climb. They are to check for wear, and replacements are given if the inspection identifies issues.

OSHA: What factors contribute to employees failing to use fall protection while climbing or working?

AT&T: AT&T prohibits free-climbing and enforces a 100 percent tie-off rule. Attitude, awareness and other factors that may contribute to failure to use fall protection are best addressed through training, consistent observation of safe work practices and attention to provision of proper equipment.

OSHA: Are there situations in which conventional fall protection (safety nets or personal fall arrest systems) is infeasible? What alternatives can employees use for fall protection in those situations?

AT&T: AT&T is not aware of such situations and does not believe circumstances exist in which tower workers are justified in free-climbing without appropriate fall protection.

OSHA: What are the ways in which fall protection systems or anchorage



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points on communications towers can fail? How can these failures be prevented?

AT&T: Rope systems are subject to abrasion, improper anchorage and shock loading. Steel cable systems' possible failures can be from a lack of maintenance, improper installation or manufacturer defect. AT&T inspects rope systems prior to installation and requires that rope does not lie across any unprotected locations that could cause abrasions. Steel cable systems must be inspected for defects and proof-tested prior to utilization.

OSHA: Should OSHA require built-in fall protection measures on new towers? Existing towers? Would such a requirement enhance worker safety?

AT&T: AT&T does not believe such measures are necessary to appreciably enhance safety. 3/8-inch safety cable is already mandated, and tower structures provide fully adequate tie-off points. The issue is more often a matter of education on proper tie-off.

OSHA: When new equipment is added to communications towers, the additional loading of the tower has the potential to overload or destabilize the structure. Older towers may need additional reinforcements to maintain their structural integrity as new equipment is added to them. Communications tower collapses have resulted in numerous fatalities in the past two years. Which contractual party bears responsibility for ensuring that any structural work on the tower – such as modification or

demolition – is done safely from a structural perspective? What steps are employers currently taking to prevent collapses?

AT&T: AT&T has taken the following steps to mitigate risk. Structural subject matter experts are assigned by geographic or other market area to ensure compliance with codes and best practices. Failed structural analyses go through a disinterested third-party review to ensure code compliance. Quarterly training is provided to AT&T and its vendors on code compliance. Any collapse is subject to a rigorous forensics study to ascertain root cause.

OSHA: Much research has been done on the health effects of overexposure to radio frequencies. General health effects reviews have found that high levels of exposure to radio frequencies may result in burns. In addition, the link between exposure to radio frequencies and cancer, reproductive diseases and neurological effects has not been thoroughly explored. What methods are employers using to protect workers from overexposure to radio frequency?

AT&T: Administration control methods for cellular tower climbers should include RF safety awareness training, use of personal RF monitors and implementing RF energy control procedures when working in proximity to active antennas where RF levels may exceed the Federal Communications Commission (FCC) occupational or controlled exposure limit.

OSHA: Is there a need for employers

to institute comprehensive radio frequency monitoring programs on communications tower worksites? What would a good program look like?

AT&T: AT&T does not believe it necessary, based on current RF safety levels defined, to protect against established adverse effects to human health. Employer programs should rely on industry groups such as the IEEE International Committee on Electromagnetic Safety for defining the need for direct or indirect RF monitoring if practical.

OSHA: OSHA believes that fatigue can affect communications tower workers in several ways. Climbing a communications tower is physically demanding, and OSHA is concerned that fatigue due to exertion can be hazardous for tower workers. Accelerated work timelines can also result in tower workers working very long hours. And OSHA understands that communications tower workers may travel long distances to reach remote worksites, which can result in workers being fatigued before they even begin work.

AT&T: Workers must be physically and technically qualified to perform required tasks without experiencing fatigue at levels impairing safety. Proper training results in technical skills being executed effectively with less exertion, lower stress and generally reduces fatigue. AT&T contractors use workers within a defined geographic proximity of work locations to reduce travel times and associated potential for fatigue.

Contracting and Work Oversight

OSHA: Describe your role in the contract chain and the key safety-related provisions typically included in your contracts. How do contracting parties oversee or enforce those provisions? What are the consequences if a party fails to fulfill those contractual requirements?

AT&T: AT&T is a carrier within the contracting chain and has several safety-related provisions in supplier agreements:

1. All turf vendors are required by contract to maintain comprehensive safety programs, including training, inspections and audits. Contracts require OSHA compliance.
2. AT&T turf contracts require all employee, contractor and subcontractor tower technicians to be trained by NATE-recognized training providers. All training providers must meet or exceed NATE's Tower Climber Fall Protection Training Standard.
3. AT&T turf contracts require all tower technicians to have an OSHA-defined competent climber certification, over and above an authorized climber certification. Competent climber certification training for new tower workers is required as soon as they are eligible for such training. Contracts will require all tower technicians to have a valid NWSA professional certification as soon as this certification becomes available from NWSA.
4. AT&T turf contracts will mandate and drive adoption of safety design

provisions (e.g., OEM manufactured tower tie-off points) defined by the NATE Manufacturing & Engineering Solutions Working Group's Structures Subcommittee, as soon as these safety design provisions become available from NATE.

5. Vendors (primes and subs) cannot work on our projects while they

are listed on OSHA's Severe Violator Enforcement Program (SVEP) vendor list.

AT&T oversees and enforces these provisions through:

1. A network of operational field managers, contract managers,



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- Output: Visual output displays trends and status



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TOWER WORKER SAFETY

safety managers, auditors and subject matter experts.

2. A dedicated tower safety manager. This nationally recognized tower safety expert has the authority to shut down any AT&T project and AT&T contractor, at any time, for any safety-related reason.
3. Random audits performed by independent third-party auditors of AT&T tower construction projects, including tower safety inspections. Any failed safety item automatically fails the overall audit, triggering collection of liquidated damages. A failure to meet a 90 percent pass rate annually on a market-level basis is a breach of contract and grounds for termination.
4. Comprehensive semiannual safety program reviews. AT&T meets semi-annually with vendor executives to review safety programs. Safety is a primary consideration and a metric for evaluating vendor performance and opportunity for work.

The consequences for failing to comply with contractual requirements are:

1. Liquidated damages.
2. Probation. Vendors can be placed on probation, pending remedy of breaches of safety terms.
3. Loss of future work. AT&T can stop issuing additional work to vendors that fail to comply with contractual safety requirements.
4. Termination. AT&T can terminate its relationship with vendors that fail to comply with contractual safety requirements.

OSHA: What characteristics of past

safety performance does your company use in selecting potential contractors and subcontractors? What safety-related criteria does your company use in this selection process?

AT&T: AT&T only selects vendors with financial ability and stability to ensure tower technicians are supplied with high-quality safety training and safety equipment, comprehensive screening, first-rate vehicles, superior compensation and benefits, and to ensure vendors can carry the cost of tower technicians during slow work periods. With regard to safety-related vendor selection criteria, AT&T screens vendors to ensure they do not have a history of safety violations or appear on OSHA's SVEP vendor list.

OSHA: Are safety-related factors considered in determining whether to remove a contractor or subcontractor from an ongoing project or from future selection processes? If so, what specific factors are considered?

AT&T: Yes. Safety is weighted as our highest priority metric over all other performance metrics, including cost, schedule and quality. The following specific factors are considered when evaluating vendor safety performance:

1. Percentage of safety audits to projects worked (high % = good)
2. Percentage of safety incidents to projects worked (high % = bad)
3. Percentage of tower crew schedules expedited beyond standard durations (high % = bad)
4. Percentage of safety training

type, breadth and frequency (high % = good)

5. National Council on Compensation Insurance (NCCI) experience modification rate (EMR) (high EMR = bad)

OSHA: What are the ways in which the multileveled contracting environment (i.e., where entities such as the carrier, tower owner, turfing vendor, subcontractor and contractors hired by the subcontractor all have some role in the project) affects employee safety at communications tower worksites?

AT&T: As a carrier, AT&T hires turf vendors that specialize in communications tower construction as their core competency. Construction safety experts, our turf vendors, directly manage safety and daily construction activities at worksites. We encourage our turf vendors to self-perform and minimize the amount of subcontracting they perform. Only 4 percent of our capital tower work is subcontracted beyond one contracting layer (turf vendor sub-to-sub). Virtually none of our tower maintenance work is subcontracted beyond one contracting layer.

OSHA: What practices might companies in the contracting chain adopt to encourage communication and coordination among employers at tower work sites? What obstacles stand in the way of communication and coordination between different parties in the contracting chain?

AT&T: AT&T publishes national standards that guide all work performed

at our tower sites, regardless of the vendor level within the contracting chain. We also actively participate in industry initiatives, such as the NATE Wireless Industry Safety Task Force, that guide and promote communication and coordination between all contracting chain parties.

Economic Issues

OSHA: What types of equipment are used in tower work, and how often is this equipment repaired or replaced?

AT&T: AT&T inspects equipment for defects and continuing serviceability and replaces equipment as needed.

OSHA: The agency seeks information from all employers in the contracting chain about the extent to which employees directly engaged in tower work are covered by workers' compensation or an employer liability insurance policy.

AT&T: AT&T engages vendors with the scale and financial resources to provide wages, benefits and work conditions that attract and retain high performers and produce conditions leading to attitudes conducive to safe, high-quality work.

Tower Design

OSHA: Can towers be designed and built with elevators for lifting personnel or materials? Can towers be built with booms or davits aloft to aid in hoisting materials?

AT&T: Large towers currently have

elevators, but most AT&T towers do not support the additional required weight. AT&T does hoist with rated gin poles, and the allowable weight is never to be exceeded. Violation results in a crew's removal from site.

OSHA: How would elevators or davits affect productivity and efficiency, e.g., the amount of time spent on the tower? How would elevators or davits address or cause any safety hazards at the site? For example, would elevators or davits address hazards related to employee fatigue?

AT&T: Not all towers support elevators. AT&T recommends use of climb pause protocols and supervised crew hoists to address issues of potential fatigue.

Regulatory/Non-Regulatory Approaches

OSHA: What would be the advantages and disadvantages of an OSHA standard that covers both construction and maintenance activities on communication towers?

AT&T: Although similar and identical issues may arise and be subject to overlapping and redundant provisions in standards, the possibility of confusion in application, interpretation and guidance is sufficient to warrant separate treatment.

OSHA: Should an OSHA standard be limited to work performed on communications towers, or should it also cover towers used for other purposes?

AT&T: Structures are sufficiently

diverse, together with the respective means to access those structures and their joint uses, that an OSHA standard, if any, is better directed to communications towers, which tend to be of specific type, specification and use.

OSHA: If OSHA does not initiate a dedicated rulemaking for work on communications towers, what other types of regulatory actions might be necessary and appropriate?

AT&T: It is AT&T's position that the safety considerations attending communications towers are best, most efficiently and most effectively addressed by private industry and industry organizations including NATE, NWSA, TIRAP, TIA, PTIA, among others. A dedicated rulemaking and other regulatory action may impede and delay the voluntary response by industry underway due to the need to account for the uncertainty of regulatory outcomes. Diversion of resources now directed to promulgation, adoption and implementation of industry standards to respond to regulatory activity, including hearings, studies and workshops, would be counterproductive.

OSHA: What non-regulatory approaches could OSHA take to address hazards faced by employees working on communications towers?

AT&T: OSHA's promotion of education, awareness, and best practices developed and in process of being developed by subject matter experts within the tower industry has been, and is, constructive and productive.



Ernie Jones onstage at the National Association of Tower Erectors convention in 2013.
Photo by Don Bishop

Industry Mourns Loss of Tower Climber Safety Titan

The tragedy that took Ernie Jones' life occurred while he was working on a tower. His expertise in civil and mechanical engineering led to a career in the telecommunications tower industry.

By J. Sharpe Smith

Ernie Jones, P.E., 64, a tower specialist with Consolidated Engineering, died Oct. 21 in an elevator accident while inspecting the 1,500-foot KOCO TV broadcast tower in Oklahoma City.

Jones had a productive career during which he designed and oversaw the construction of 3,000 towers, including monopoles, self-supporting lattice towers and guyed towers from 240 feet to 2,000 feet in height.

He also developed software that is used for the structural design of telecom towers. But he is known primarily for his work in the area of climber safety.

To David Davies, engineering consultant at Consolidated Engineering, the structural firm in Lynville, Indiana, that Jones founded, Jones was like a brother. They met at the age of 14, and their lives have been intertwined

in the 52 years since.

"The tower industry is tenfold safer today because of the life of Ernie Jones," Davies said. "He was a wonderful guy. He was a quiet, soft-spoken gentleman. His only flaw was not being able to say no when people asked for help."

Jones was a member of the National Association of Tower Erectors, where he wrote safety resources for tower climbers.

“He was an accomplished individual and was universally respected in the wireless and the broadcast industry,” said Todd Schlekeway, NATE executive director. “People of his expertise in our industry are few and far between. Ernie was one of the most prominent structural engineers in the United States, and his contributions to NATE and the entire industry had an indelible effect on safety.”

Tragedy on Top of the Tower

Ironically, the tragedy that took Jones’ life occurred as he was working on a tower. The incident came at the end of the day after the crew had been released. Jones decided to go back up to the top of the tower to retrieve some missing information for a structural analysis, where he tied off with his back lanyard. Jones remained attached to the tower after he got back in the elevator, and when it began descending, he was pressed to the ceiling of the elevator and asphyxiated.

A Passion for Safety

Jones’ passion for worker safety led him to develop best practices of gin pole use and rigging safety through use of engineering data. He served on the TR14.7 Committee of the Telecommunications Industry Association and Electronics Industry Association for nearly 30 years.

“He was a driving force in the development of the TIA-1019 Gin Pole Standard, leading the re-

search and technical developments it represented. He continued this work broadening the 1019 Standard to create TIA-1019-A, which included safety, standardized construction nomenclature, established standard rigging plans and so much more,” wrote John Erichsen, TR14 chairman.

Jones worked tirelessly with multiple organizations within the tower industry to create standards that would improve safety. Jones,

NATE Executive Director Todd Schlekeway

“*He was an accomplished individual, universally respected in the wireless and the broadcast industry. People of his expertise in our industry are few and far between.*”

FDH/Velocitel vice presidents Don Doty and Pat Moore, and Gordon Lyman, president of SafetyLMS, were proactive in forming a gin pole summit with NATE members in 2012, which would be used to develop the training parameters in the A10.48 standard. Jones worked with NATE representatives and the TIA TR14 committee to improve 1019 to create ASSE 10.48 and the soon to be published TIA 322, which will eventually replace TIA-1019-A, according to Erichsen.

Jones’ contributions to the

TR14 committee research incorporated strength theory into the American National Standard for Steel Antenna Towers and Antenna Supporting Structures (ANSI/TIA/EIA-222). “It is quite a useful resource for workers. So much so that several large companies require their installers use that standard,” Davies said. “They developed a rigging plan concept that is revolutionary in the tower installation business.”

Together with Lyman, Jones wrote NATE’s “Training Guidelines for Working on Communication and Similar Structures with a Gin Pole and Associated Equipment.”

“This safety resource was developed to provide minimum guidelines for worker training required for gin pole use for work relating to the installation, alteration and maintenance of communications structures,” Schlekeway said. *The Gin Pole and Associated*

Equipment Guideline Book is available to NATE members and to nonmembers.

In Remembrance

To honor Jones’ contributions to the tower industry and his life, the TIA TR14 committee will include a dedication to him in TIA322 when it is published in 2016. NATE also plans to recognize his contributions to the association and to climber safety at a later date. Jones is survived by his wife Kathy Jones, daughters Karalyn, Megan and Angel, and son Andy.

Quick-Guide to DAS and Small Cell Companies

As a supplement to *AGL Magazine's* January Buyers Guide, a list of DAS and small cell companies offers more detail to help you choose a vendor for your next project. Where shown, logos and company descriptions were provided by and paid for by each company.

BUYERS GUIDE

Advanced RF Technologies

3116 W. Vanowen St.
Burbank, CA 91505
818.840.8131
sales@adrfttech.com
www.adrfttech.com

DAS or small cell system services owned or operated: operator-owned (neutral host), facility-owned, carrier-owned, public safety
System products, components or accessories: DAS
Services: site analysis, system design, system engineering, system installation, system management,

system monitoring, system maintenance, carrier coordination



advantage engineers

Advantage Engineers

7070 Samuel Morse Drive
Columbia, MD 21046
Tracy Bender
443.367.0003
tbender@advantageengineers.com
www.advantageengineers.com

Services: site analysis, system design, system engineering, system installation, carrier coordination, concealment solutions

Company description: Advantage Engineers provides innovative solutions for complex telecommunications engineering challenges. We specialize in wireless site design for cellular, microwave, public safety radio, DAS and small cell for in building and wide area applications. Comprised of more than 200 professionals and 7 offices, we serve government and private clients throughout the United States.



AFL

170 Ridgeview Center Drive
Duncan, SC 29334
Brian Wheeler
678.772.6627

brian.wheeler@aflglobalcolm.com
www.aflglobal.com

System products, components or accessories: DAS, small cell, Wi-Fi

Services: site analysis, permitting system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis

Company description: AFL designs, installs, maintains and monitors indoor and outdoor DAS, small cell and Wi-Fi systems, delivering quality network connections that keep your network running at optimum capacity. With in-house project teams, RF engineering plus decades of experience, network issues are resolved quickly and on time by AFL-certified technicians.

See ad on page 55

Airwavz

3040 N. Alexander St.
Charlotte, NC 28205
Scott Weiland
919.740.3582
scott.weiland@airwavz.com
www.airwavz.com

DAS or small cell system service owned or operated: operator-owned (neutral host)

Services: site analysis, financing, permitting, system design, system engineering, system installation,

system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions



Alpha Technologies

7700 Riverfront Gate
Burnaby, BC V5C 1C4
Canada

Tony Wilson
800.667.8473
sales@alpha.ca
www.alpha.ca/das

DAS or small cell system services owned or operated: operator-owned (neutral host), facility-owned, carrier-owned, public safety

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul, powering solutions

Services: site analysis, system design, system engineering, system installation, system monitoring, system maintenance

Company description: Alpha is the leader in powering wireless networks, from macrocells to DAS to small cells. Our industry leadership has seen us deploy solutions for the largest carriers in the most visible and high-priority venues; from high-end communities to convention centers to world-renowned sports venues. Visit us at www.alpha.ca/das.

Antenna Products

101 SE 25th Ave.
Mineral Wells, TX 76067
Phil Park
940.325.3301
info@antennaproducts.com

www.antennaproducts.com

System products, components or accessories: DAS, small cell, Wi-Fi

Services: concealment solutions; DAS and small cell antenna design, engineering, manufacturing and installation

Anritsu

1155 E. Collins Blvd, Suite 100
Richardson, TX 75081
Rob Robinson
1.800.267.4878
rob.robinson@anritsu.com

www.anritsu.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Company description: With 120 years of global communications technology leadership, Anritsu is a preferred test/measurement solutions provider for telecom, wireless and optical industries, serving R&D, manufacturing, fiber test and network operations.



AW Solutions

300 Crown Oak Centre Drive
Longwood, FL 32750
James Partridge
407.260.0231 ext. 101
james.partridge@awsolutionsinc.com
www.awsolutionsinc.com

Services: site analysis, permitting, system design, system engineering, system installation, system maintenance, carrier coordination, RF analysis, concealment solutions, site

acquisition/leasing services, site audits, make-ready, pole audits/loading

Company description: AW Solutions, licensed throughout the United States, Canada and the Caribbean, provides turnkey deployment services for iDAS, oDAS, small cell, macro and fiber ISP/OSP infrastructure. Services include project management, audits, acquisition, zoning, leasing, engineering design/structurals/pole loading, permitting, make-ready, construction/installation, testing, warehousing/logistics.

B+T Group

1717 S. Boulder Ave., Suite 300
Tulsa, OK 74119
Leigh Anne Self
918.587.4630
laself@btgrp.com
www.btgrp.com

Services: site analysis, permitting, system design, system engineering, system installation, carrier coordination, RF analysis

Black & Veatch

6800 W 115th St., Suite 2292
Overland Park, KS 66211
Kristi Klohs
913.458.6271
klohskm@bv.com
www.bv.com

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

See ad on page 31



Black Box Network Services

1000 Park Drive
Lawrence, PA 15055
Robert Beaudrie
972.201.2552
bob.beaudrie@blackbox.com
www.blackbox.com

DAS or small cell system services

owned or operated: operator-owned (neutral host), facility-owned, carrier-owned, public safety

System products, components

or accessories: DAS, small cell, Wi-Fi, backhaul

Services: site analysis, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

Company description: Black Box Network Services enables mission-critical, in-building wireless for enterprise organizations in health care and hospitality, as well as government and Fortune 500. Mission-critical wireless delivers all key wireless services, including 3G/4G, fire/life/safety, 802.11 and medical telemetry, with engineered coverage and capacity to ensure all wireless devices stay connected with optimal service levels.



BTI Wireless

6185 Phyllis Drive, Unit D
Cypress, CA 90630
714.230.8333
sales@btwireless.com
www.btiwireless.com

System products, components or

accessories: DAS, small cell

Company description: BTI wireless, a global wireless innovation company, designs and manufactures its in-building and outdoor distributed antenna systems (DAS), small cells and public safety communications solutions with flexible, scalable and modular architecture to maximize current coverage requirements while future-proofing the wireless infrastructures of commercial, sports/entertainment, health care, hospitality and education facilities worldwide.

Charles Industries

5600 Apollo Drive
Rolling Meadows, IL 60142
Dominic Imbrogno
847.806.6300
mktserv@charlesindustries.com
www.charlesindustries.com

System products, components or

accessories: DAS, small cell, backhaul

Company description: Charles Industries manufactures "Innovative Enclosed Solutions" including indoor/outdoor cabinets, building terminals, pedestals and below grade enclosures for wireless, fiber, copper, CATV and utility applications.



C Squared Systems

66 Dartmouth Drive

Auburn, NH 03032

Scott Pollister

978.204.7268

scott.pollister@csquaredsystems.com

www.csquaredsystems.com

DAS or small cell system services owned or operated: operator-

owned (neutral host), facility-owned, carrier-owned, public safety

System products, components or accessories: DAS, small cell, Wi-Fi

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, SiteGate – a network security appliance product, SitePortal – a remote network monitoring and management solution

Company description: C Squared Systems is a consulting source and software developer founded in 1999 for communication professionals and organizations seeking to establish, manage and expand communication networks. We provide remote monitoring through our leading software SitePortal, in-building wireless solutions, DAS integration and RF solutions for a wide variety of industries.

Clearfield

7050 Winnetka Ave. N

Minneapolis, MN 55428

Jennifer Childs

763.476.6866

jchilds@cldf.net

www.seeclearfield.com

System products, components or

accessories: DAS, small cell, backhaul, fiber management and delivery

Products: wall boxes, panels and MPO pushable fiber and microduct

Service: system design

Cobham Wireless

15950 N. Dallas Parkway, Suite 400

Dallas, TX 75248

Matthew Thompson

972.361.8038

matthew.thompson@cobham.com

www.cobham.com/wireless

DAS or small cell system services owned or operated: operator-

owned (neutral host), facility-owned, carrier-owned, public safety

System product, component or accessory: DAS

Services: system design, system engineering, system installation, system management, system monitoring, system maintenance



Comba Telecom

235 Charcot Ave.

San Jose, CA 95131

Kevin Geary

866.802.7961 ext. 3

Sales.nam@comba-telecom.com

www.combausa.com

DAS or small cell system services owned or operated: facility-owned,

carrier-owned, public safety

System products, components or accessories: DAS, small cell, backhaul

Services: system design, system engineering, system management, system maintenance, RF analysis

Company description: Comba Telecom, headquartered in San Jose, California, is a subsidiary of Comba Telecom

Systems Holdings, the leading supplier of RF communications equipment and have been serving the North America market for over 10 years. Collaborating with certified system integrators, we've served many customers, including Ford, Cleveland Clinic and Kohler.

Communications Technology Services

33 Locke Drive

Marlborough, MA 01752

Kate Sheehy

817.291.1371

ksheehy@cts1.com

www.cts1.com

Services: site analysis, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions, design and deploy I-DAS and O-DAS, turn-key wireless solutions

Connectivity Wireless Solutions

2707 Main St., Suite 1

Duluth, GA 30096

Bryce Bregan

605.321.6555

bbregan@connectivitywireless.com

DAS or small cell system services owned or operated: operator-

owned (neutral host), facility-owned, carrier-owned, public safety

System product, component or accessory: DAS

Services: site analysis, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

Dali Wireless

535 Middlefield Road, Suite 280
Menlo Park, CA 94025
Lance Craft
855.250.5082
info@daliwireless.com
www.daliwireless.com

DAS or small cell system services

owned or operated: operator-owned (neutral host), facility-owned, carrier-owned, public safety

System product, component or accessory: DAS

Services: site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions



DAS Advisers

67 W. Boulder St.
Colorado Springs, CO 80903
Deborah Crowley
303.549.5075
Deborah@charter94.com
www.dasadvisers.com

DAS or small cell system services

owned or operated: operator-owned (neutral host), facility-owned, carrier-owned

System products, components or accessories: DAS, small cell, Wi-Fi

Services: Consulting services to facility owners for site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis,

concealment solutions

Company description: DAS Advisers is an independent consulting team experienced in wireless technology, installation, and contract negotiation. We assist clients in understanding the factors affecting their connectivity challenges and in identifying their best strategy and technology solution. We have experience in DAS and small cell system design and deployment, testing, and commissioning.



DuraComm

6655 Troost Ave.
Kansas City, MO 64131
Joe White
816.472.5544
sales@duracomm.com
www.duracomm.com

DAS or small cell system service

owned or operated: operator-owned (neutral host)

System products, components or accessories: DAS, small cell, backhaul

Company description: DuraComm is a complete source of ultra-reliable AC-to-DC switch mode power supplies, DC-to-DC power converters, battery management and charging systems, DC power distribution equipment and complementary accessories.

EDX Wireless

1400 Executive Parkway #430
Eugene, OR 97401
Bob Akins
541.345.0019
bob.akers@edx.com
www.edx.com

System products, components or

accessories: DAS, small cell, Wi-Fi, backhaul

Services: system design, RF analysis



Electric Conduit Construction

816 Hicks Drive
Elburn, IL 60119
Mike Purpura
630.936.3282
mdpurpura@electricconduitconstruction.com
www.electricconduitconstruction.com

Services: site analysis, permitting, system installation, system maintenance, RF analysis, concealment solutions, complete permitting, construction testing, backhaul and power installation, directional drilling and site restoration, antenna site modification, light pole removal and installation

Company description: Electric Conduit Construction offers complete permit, site preparation, construction, testing and commissioning services for small cell installations. We specialize in dense urban sites. We will upgrade or install new street furniture to accommodate small cell antennas. Your site will be optimized by our attention to testing and tuning.

See ad on page 68

EMR

17431 N. 25th Ave.
Phoenix, AZ 85023
Alan Leffler
623.581.2875
alan@emrcorp.com
www.emrcorp.com

System products, components or

accessories: adapters, DAS design, BDAs, UDAs, splitters, dividers, line taps, indoor antennas, in-building DAS hardware – VHF, UHF, 700/800/900 MHz



ExteNet Systems

3030 Warrenville Road, Suite 340
Lisle, IL 60532

Sean Page

630.505.3817

spage@extenetsystems.com

www.extenetsystems.com

DAS or small cell system service owned or operated: operator-owned (neutral host)

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Services: site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions, distributed Evolved Packet Core (EPC)

Company description: ExteNet Systems designs, builds, owns and operates distributed networks for use by wireless carriers and venues in key markets. Using distributed antenna systems (DAS), remote radio heads (RRH), small cells, Wi-Fi and software-defined network (SDN)-based Evolved Packet Core (EPC), ExteNet deploys solutions to enhance wireless service and network performance inside and out.

FDH Velocitel

1033 Skokie Blvd., Suite 320
Northbrook, IL 60062

Ken Czosnowski

224.757.0001

kenneth.czosnowski@fdhvelocitel.com

www.fdhvelocitel.com

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

Fullerton Engineering

9600 W. Bryn Mawr Ave., Suite 200
Rosemont, IL 60018

Frank DiVito

224.585.4430

starthere@fullertonengineering.com

www.fullertonengineering.com

Services: site analysis, permitting, system design, system engineering, system monitoring, RF analysis, concealment solutions



Huber+Suhner

8530 Steele Crook Place Drive
Suite H

Charlotte, NC 28273

Dick Schmidt

704.790.7236 office

630.816.4021 mobile

dick.schmidt@hubersuhner.com

www.hubersuhner.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Services: site analysis, system design, system engineering, system installation, system maintenance

Company description: The

Huber+Suhner group supplies components and systems for electrical and optical connectivity. The company's specialists have detailed knowledge of practical applications. Huber+Suhner offers expertise in radio frequency, fiber optics, and low frequency, providing innovation in in-building (iDAS and small cell) and FttA/PttA acrosite needs of customers worldwide. Visit our website www.wirelessinfrastructure.com.

See ads on pages 19, 21 and 23

iBwave Solutions

7075 Robert Joncas Place
Suite 95

Montreal, Quebec H4M 2Z2
Canada

Amna Chrishty

514.397.0606

amna.chrishty@ibwave.com

www.ibwave.com

System products, components or accessories: DAS, small cell, Wi-Fi
Services: site analysis, system design, system engineering, system installation, system management, RF analysis

Infinigy Solutions

2255 Sewell Mill Road, Suite 130
Marietta, GA 30062

Joe Dean

770.883.3007

jdean@infinigy.com

www.infinigy.com

Services: site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions



InSite Wireless Group

1199 N. Fairfax St., Suite 700
Alexandria, VA 22314

Todd Weller

703.535.3009

info@insitewireless.com

www.insitewireless.com

DAS or small cell system services owned or operated: operator-owned (neutral host), facility-owned

System products, components or accessories: DAS, small cell, Wi-Fi

Services: site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions, tower site development and construction

Company description: InSite develops, owns, and operates wireless infrastructure facilities — DAS and towers — across the United States, Puerto Rico, U.S. Virgin Islands and Canada. InSite's DAS division has developed 20+ projects across the United States — convention centers, casinos, airports, sports stadiums and transit systems including the Boston MBTA Subway and Los Angeles County Metro.



JMA Wireless

7645 Henry Clay Blvd.

Liverpool, NY 13031

Sean Griffin

315.431.7116

sgriffin@jmwireless.com

www.jmwireless.com

System products, components or accessories: DAS, small cell

Services: financing, system design, system engineering, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

Company description: JMA Wireless is the leading global innovator in mobile wireless connectivity solutions that ensure infrastructure reliability, streamline service operations and maximize wireless performance. Employing powerful, patented innovations, their solutions portfolio is proven to lower the cost of operations while ensuring lifetime quality levels in equipment and unrivaled performance for coverage and high-speed mobile data.

John Burns Construction

17601 Southwest Highway

Orland Park, IL 60467

Bill O'Malley

708.326.3500

womalley@jbcco.com

www.jbcco.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Services: permitting, system design, system engineering, system installation, system management, system maintenance, DAS and small cell tower construction, antenna installation, RF equipment installation and integration, site modification, tower climbing, trenching and boring

KATHREIN

Kathrein

Greenway Plaza II

2400 Lakeside Blvd., Suite 650

Richardson, TX 75082

Danette Hovland

214.238.8800

info@kathrein.com

www.kathreinusa.com

System products, components or accessories: DAS, small cell

Service: concealment solutions

Company description: Kathrein is an innovation and technology leader in today's connected world. Kathrein solutions enable people to globally communicate, access information and use media at home or on the road. Kathrein is a hidden champion and family-owned enterprise that has been working on the technologies of tomorrow since 1919.

See ad on page 33

KGP Logistics

600 New Century Parkway

New Century, KS 66031

Kristen Kohler

800.755.1950

kkohler@kgptel.com

www.kgplogistics.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Lawrence Behr Associates

3400 Tupper Drive

Greenville, NC 27858

Mike Britner

252.757.0279

mike.britner@lbagroup.com

www.lbagroup.com

Services: site analysis, system installation

The Lyle Company

3140 Gold Camp Drive #30
 Rancho Cordova, CA 95670
 Matt Johnson
 916.804.7528
mjohnson@lyleco.com
www.lyleco.com

Services: site analysis, permitting



Md7

10590 W. Ocean Air, Suite 300
 San Diego, CA 92130
 Linda Vargas
 858.964.2284
lvargas@md7.com
www.md7.com

Services: site analysis, permitting, site acquisition – leasing and permitting

Company description: Md7 is a real estate and site acquisition/development company serving the wireless infrastructure industry. Our LiveTrack software, streamlined process and highly trained team members enable cell sites to get on the air faster and at lower costs.

Mercury Communications

1710 Larkin Williams Road
 Fenton, MO 63026
 Jeff Fischer
 314.581.0760
jfischer@mercurycom.net
www.mercurycom.net

DAS or small cell system services owned or operated: operator-owned (neutral host), facility-owned, carrier-owned

System product, component or

accessory: small cell

Services: permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions, turnkey DAS projects, construction

MP Antenna

147 Eady Court
 Elyria, OH 44035
 Adam Duskocil
 440.387.5968
sales@mpantenna.com
www.mpantenna.com

System products, components or accessories: DAS, small cell, Wi-Fi



NB+C

6095 Marshalee Drive, Suite 300
 Elkridge, MO 21075
 Jeff Ebihara
 616.218.9444
jebihara@bcllc.com
www.networkbuilding.com

Services: permitting, system design, system engineering, system installation

Company description: Founded in 1984, NB+C is a leading wireless site development firm comprised of three business units: site development, engineering services and construction, and technical services. We are staffed with over 300 professionals who are totally committed to client service and project results.

See ad on page 9



P. Marshall and Associates

1000 Holcomb Woods Parkway

Suite 210

Roswell, GA 30076

Greg Hazlehurst

678.280.2325

ghazlehurst@pmass.com

www.pmass.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Services: site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

Company description: PM&A is a multidisciplinary engineering firm with expertise in wireless technology. Whether our clients are in need of enterprise or ROW site acquisition, RF engineering, small cell deployment solutions, OSP, or carrier integration for DAS, we have an experienced team in house to handle the challenges. We deliver awesomeness.

Parallel Infrastructure

4601 Touchton Road East
 Building 300, Suite 3200
 Jacksonville, FL 32246

Ed Myers

914.565.4129

ed@parallelinfrastructure.com

www.parallelinfrastructure.com

PCTEL RF Solutions

20410 Observation Drive, Suite 200
 Germantown, MD 20876

Joe Hill

813.528.5558

Joe.hill@pctel.com

www.rfsolutions.pctel.com

DAS or small cell system services owned or operated: operator-owned (neutral host), facility-owned,

DEPARTMENTS

carrier-owned, public safety
System products, components or accessories: DAS, small cell, Wi-Fi
Services: site analysis, system design, system engineering, RF analysis



Peabody RFTC Concealment

13435 Estelle St.
 Corona, CA 92879
 Mark Peabody
 888.511.6828
sales@cellsitedisguiseguys.com
www.cellsitedisguiseguys.com

System products, components or accessories: DAS, small cell, Wi-Fi
Services: site analysis, system design, system engineering, concealment solutions

Company description: Peabody has been manufacturing RFTC telecom concealment systems since 1997. We are approved vendors with all major carriers and have vast experience working with A&E firms, site acquisition and contractors. Our creative design, engineering and fabrication team can develop a high-quality, prefabricated concealment solution for your macro-sites, DAS or small cell antenna venues.

See ad on page 69

PierCon Solutions

63 Beaverbrook Road, Suite 201
 Lincoln Park, NJ 07035
 Rich Conroy
 973.628.9330 ext. 207
rich.conroy@piercon.net
www.piercon.net

System products, components or accessories: DAS, Wi-Fi, backhaul
Services: RF engineering, system inte-

gration and implementation. Also rooftop management of Marriott International properties, site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis

Radio Frequency Systems

200 Pond View Drive
 Meriden, CT 06540
 Suzanne Kasai
 203.537.2741
suzanne.kaas@rfsworld.com
www.rfsworld.com

System products, components or accessories: DAS, small cell, backhaul
Services: system design, system engineering

Redwing Electric

15 Daniel Road
 Fairfield, NJ 07004
 Maria Morris
 973.276.0056
mmorris@redwingelectric.com
www.rwellc.com

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis



Sabre Industries, Inc.

2205 Westinghouse Blvd., Ste. 103
 Raleigh, NC 27604
 Bryan Kearse
 217.954.8885
bkearse@sabreindustries.com
www.sabreindustries.com

System product, component or accessory: DAS, Small Cell, Wi-Fi, backhaul

Services: site analysis, financing, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, rf analysis, concealment solutions

Company description: Sabre Industries is a full service, turnkey provider of products and services to the small cell and DAS community. We design and manufacture small cell and DAS infrastructure that includes stealth poles, NEMA 3 and 4 cabinets, ground furniture, shrouds, and other related components. In addition to manufacturing, Sabre deploys and commissions small cell and DAS solutions. Our services include RF design, leasing, zoning, permitting, construction, integration and benchmarking.

SAF North America

3250 Quentin St., Unit 128
 Aurora, CO 80011
 Peter Arnold
 720.502.0724
salesna@saftehnika.com
www.saftehnika.com

System product, component or accessory: backhaul
Service: RF analysis



SCE Carrier Solutions

4900 Rivergrade Road, 2B-1
 Irwindale, CA 91706
 Brian Ryan
 626.543.8752
carriers@sce.com
www.edisoncarrierdolutions.com
 DAS or small cell system service owned or operated: carrier-owned

BUYERS GUIDE

System product, component or accessory: backhaul

Services: site analysis, system design, system engineering, system installation, system management, system monitoring, system maintenance

Company description: At SCE Carrier Solutions, we offer an extensive portfolio of towers, land and streetlights available for cell site deployment backhauled over our wholly owned 5,000+ route miles diverse fiber-optic network. We offer a variety of services ranging from 50 Mbps to Gigabit Ethernet, Ethernet over SONET, and dark fiber.

SMBH

1166 Dublin Road, Suite 200
Columbus, OH 43215
Tom Callahan
614.481.9800
contact@smbhtelecom.com
www.smbhtelecom.com

Services: site analysis, concealment solutions



SOLID

617 N. Mary Ave.
Sunnyvale, CA 94085
Dave Tuttle
571.436.6590
David.tuttle@solid.com
www.solid.com

System products, components or accessories: DAS, Wi-Fi

Services: system monitoring, optical transport

Company description: SOLiD is a global manufacturer of RF amplifiers, RF radio and optical transport solutions engineered to solve the challenges of cellular coverage and

capacity and public safety communications. Our solutions are deployed within hospitals, sports and entertainment venues, campus and corporate buildings, and airports and metropolitan subways. SOLiD — battle-tested, flexible and always up to the challenge.



SSC

9900 W. 109th St., Suite 300
Overland Park, KS 66210
David Saab
913.438.7700
dsaab@ssc.us.com
www.ssc.us.com

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions

Company description: SSC provides an entire spectrum of DAS and small cell services throughout the United States, delivering consistent DAS and small cell deployment outcomes to maximize customer results. We use the right resources to execute the right plan at the right time. No more, no less.

See ad on page 72

Stealth Concealment Solutions

3034-A Ashley Phosphate Road
North Charleston, SC 29418
Cindy Wishart
800.755.0689
meganrehm@stealthsite.com
www.stealthconcealment.com

System products, components or accessories: DAS, small cell

Service: concealment solutions

Superior Essex

6120 Powers Ferry Road NW
Atlanta, GA 30339
Ken Braziel
770.657.6000
Ken.braziel@spsx.com
<http://ce.superioressex.com>

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul



Talley

12976 Sandoval St.
Santa Fe Springs, CA 90670
Pat Flynn
800.949.7079
sales@talleycom.com
www.talleycom.com

System products, components or accessories: DAS, small cell, backhaul

Services: site analysis, financing, system design, system management, carrier coordination, RF analysis, concealment solutions

Company description: Talley is a leading distributor of wireless communications infrastructure and mobile products. With over 30 years in the industry and over 300 of the top manufacturers including the latest in DAS and small cell, we offer a complete solution service across 10 facilities in the United States.



Practical Solutions, Exceptional Service

Tectonic Engineering & Surveying Consultants

70 Pleasant Hill Road
P.O. Box 37

/ DEPARTMENTS /

Mountainville, NY 10953
800.829.6531
rpkkummerle@tectonicengineering.com
www.tectonicengineering.com

Services: site analysis, permitting, system design, system engineering, system management, carrier coordination, concealment solutions

Company description: Tectonic Engineering & Surveying Consultants provides site acquisition/real estate services, A/E professional services and program management. Tectonic's nationwide staff of 500 provides site acquisition services including site identification, due diligence, leasing, zoning and planning analysis, zoning and planning permitting, title cure resolution, building permit application, construction management and A/E coordination.

Tessco Technologies

11126 McCormick Road
Hunt Valley, MD 21031
Lisa Robey
410.229.1255
robey@tessco.com
www.tessco.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Services: financing, system design, concealment solutions

Times Microwave Systems

358 Hall Ave.
Wallingford, CT 06942
Lou Caruso
203.949.8400
lou.caruso@timesmicrowave.com
www.timesmicrowave.com

System products, components or accessories: DAS, small cell, Wi-Fi

Services: system design, system engineering

See ad on page 25

Tower Innovations

P.O. Box 249
Oldsmar, FL 34677
Bruce McIntyre
813.818.8766
bruce@towerinnovations.com
www.towerinnovations.com

System product, component or accessory: DAS

Services: site analysis, permitting, system design, system engineering, system installation



Valmont Structures

1545 Pidco Drive
Plymouth, IN 46564
Sean Gallagher
503.589.6616
Sean.gallagher@valmont.com
www.valmont-towers.com

System products, components or accessories: DAS, small cell

Service: concealment solutions.

Company description: Valmont Structures is a leading supplier of towers and monopoles for macrosites. Additionally, Valmont is the global leader in the supply of steel, aluminum and composite street light poles, poles that can be readily converted into DAS/small cell sites.

See ad on page 71

Vertex Consulting

2961-A Hunter Mill Road, Suite 640
Oakton, VA 22124
Greg Weiner

571.233.0141
Greg.weiner@vertexconsulting.com
www.vertexconsulting.com

Service: financing



Westell Technologies

670 N. Commercial St.
Manchester, NH 03101
877.844.4274
info@westell.com
www.westell.com

System product, component or accessory: DAS

Service: system monitoring

Company description: Westell Technologies, headquartered in Aurora, Illinois, is a leading provider of in-building wireless, intelligent site management, cell site optimization and outside plant solutions. Westell's comprehensive line of ClearLink in-building wireless solutions ensures wireless coverage and capacity required to optimize the customer experience while improving network performance.

Western Unity Telecom

5032 Salem/Dallas Highway
Salem, OR 97304
Kevin Raddatz
503.587.0101
kevin@westernutilitytelecom.com
www.westernutilitytelecom.com

System products, components or accessories: DAS, small cell, Wi-Fi, backhaul

Services: site analysis, concealment solutions, DAS and small cell pole structure and mount design



Tower Family
FOUNDATION



Providing Support by Standing Together

“The Nevada Wireless Association supports the efforts of the Tower Family Foundation and has made them a recipient in our annual charity golf tournament. Best of luck to the Foundation as you continue to grow and help those in need!”

Chris Wener

Nevada Wireless Association President

“As a climber with 17 years of experience, I've seen firsthand the hurt and the pain caused by the loss of a fallen friend and fellow tower climber. I am grateful and humbled to know there is an organization that has resources to assist tower climbers and their families during times of need.”

John Gates

Tower Climber from ATS

“I want to thank everyone involved for making this happen! Synergy Concepts will be donating to the Tower Family Foundation and encourages other companies in the industry to donate as well.”

Russ Chittenden

Vice President of Synergy Concepts, Inc.

TOWER INDUSTRY FAMILY SUPPORT CHARITABLE FOUNDATION

www.towerfamilyfoundation.org

Product Showcase – DAS and Small Cell Products



Outdoor Enclosure

The MiniFort cabinet from **American Products** is a versatile outdoor equipment cabinet that can be mounted on a pole, a wall or the ground. It features 19-inch adjustable rack rails and stainless-steel hardware and is available in three standard sizes from 9 rack units to 24 rack units. The cabinet can also be equipped with heating and cooling options. The cabinet's flexible design makes it suitable for DAS, small cell, power supply or backhaul applications. The enclosure measures 20 inches high by 24 inches wide by 18 inches deep. It weighs 35 pounds.

www.amprod.us

Software App for Monitoring

The SitePortal Web-based software application engineered by **C2 Systems** remotely monitors and man-



ages multivendor environments. The customizable application is designed to log performance data for trend analysis and to view notifications, system parameters and reports with the ability to troubleshoot devices, add notes and upload documentation directly from any computer or mobile device. The application is a robust network management tool used by network operators and facility managers.

www.csquaredsystems.com

Monitoring System

The FlashRad safety wideband exposure monitoring system from **RSI** performs continuous measurements of electromagnetic field levels. It detects all pulsed signals, including short-pulsed radar emitted from various sources outside a building. When predetermined EMF levels at antenna sites are exceeded, the sys-



tem monitors sounds and flashes a warning in its immediate surroundings while sending a signal to the surveillance PC for action. Users can document levels to prove compliance and system safety in public areas. The system has an alarm and warning light and can also notify someone via text if RF levels exceed a defined RF level.

www.rsicorporation.com



Mobile, Low-profile Cell Towers

Peak Industries offers low-profile, mobile cell towers mounted on trailers, from towers on wheels (TOWs) to cells on wheels (COWs) to cells on light trucks (COLTs). Compact

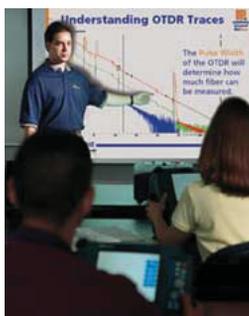
design and small footprints make these mobile towers discreet and versatile. The new Park Garage model has a travel height of 72 inches with a 60-foot mast. All masts have 2,500-pound lifting force and are engineered for 90 mph wind and ½-inch radial ice. Peak Industries has masts ranging from 50 feet to 150 feet and can build to suit.

www.peakindustriesinc.com

Turnkey Field Services

B+T Group, founded in 2000 and licensed in all 50 states with nine regional offices, is a development and field services firm. The company employs a Site360 tool for as-built documentation and asset management to create all site plans. Site360 uses advanced photogrammetry technology to provide highly accurate site information in one visit. In complex and crowded head-end rooms, the tool removes the need for manually measuring and documenting each component. CAD designers are given 360-degree views with centimeter accuracy. The Site360 tool allows B+T Group to provide accurate construction drawings.

www.btgrp.com

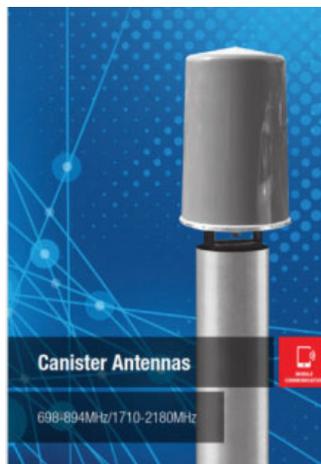


DAS Certification Training

Anritsu offers certification training products including line sweep training,

passive intermodulation (PIM) training, fiber optics and optical time-domain reflectometer training, and RF and microwave interference analysis training. The company offers two new certification courses focused on the unique challenges faced in DAS installation and troubleshooting. One class focuses on passive DAS, while the other course focuses on active DAS. These are three-day instructor-led training courses providing students with theoretical background as well as practical hands-on skills needed to properly test and troubleshoot DAS. Anritsu offers test and measurement solutions to help operators ensure optimum DAS and small-cell performance. Solutions are available for RF cable testing, optical cable testing, RF signal testing and optical transport testing.

www.anritsu.com



Small Cell Antennas

Kathrein creates solutions for mobile operators and third-party owners to provide the much-needed coverage and crucial capacity in a small, concealed, powerful form factor. The solutions are designed to meet the data demands of mobile networks,

which continue to increase while zoning restrictions and site acquisition costs have made traditional macrocell site deployment difficult in dense, urban environments. Kathrein's small cell antenna has been widely deployed for sites that must not only comply with local zoning and installation restrictions, but must accommodate situations where ground leases are impractical.

www.kathreinusa.com



AC/DC Power Supply for Small Cells

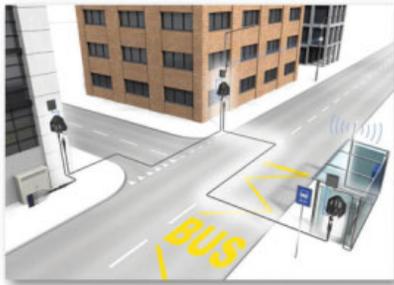
Alpha Technologies has designed the Collect 600 system to solve the multiple challenges in powering outdoor small cells. The Collect 600 is a compact, lightweight, AC/DC power supply that delivers 600 watts of output power and more than 10 minutes of battery backup to withstand the vast majority of interruptions in the AC grid. The unit is equipped with a universal mounting bracket, making it easy to install by a single technician on telecom poles, light poles or on the sides of buildings. Collect offers advanced monitoring and control, including simple network management protocol, and requires no field maintenance.

www.alpha.ca/das

Coaxial Cable

The Sucoform 141 CU CMP from **Huber+Suhner** is a plenum-rated

DEPARTMENTS



wideband coaxial cable for in-building applications designed to work up at frequencies as high as 6 GHz and to support wireless in-building applications. The cable maintains compatibility with existing connectors and is therefore easily configurable to the assembly of the user's choice. Its tin-soaked copper braid outer conductor is designed to provide installation flexibility and form stability. The cable also has passive intermodulation (PIM) stability and effective shielding. Its small bending radius allows space-saving routing and packaging. Compatible with existing low-PIM soldered connectors, the cable is available as factory-made assemblies with 100 percent tested return loss, attenuation and PIM.

www.hubersuhner.com



Small Cell Engineering

The use of mobile light detection and ranging (Lidar) technology has provided a boost in **P. Marshall & Associates'** pursuit of small cell and outside plant engineering. The company provides design engineering and turnkey construction of antenna systems by using comprehensive

and engineering-grade data generated by the latest mobile Lidar sensors. The technology provides a precise digital 3-D point cloud for extracting infrastructure (in CADD or GiS) in the office. This provides design engineers with site data they need more quickly than would otherwise be possible and requires little or no risk of having to revisit the project site. Tweaks, changes or checks in the engineering alignments can be done in the office from the same point cloud, making the resulting business process faster, safer and more comprehensive than traditional manual field collection provides.

www.pmass.com



Small Cell Monopole

Sabre Industries' 14-inch Smart-Stack monopole is one in a series of small cell monopoles designed for deployments that require aesthetically pleasing structures, where a potential rip and replace or new pole is desired. The units are designed to be passively or actively cooled, depending on configuration, so that they meet or exceed necessary OEM environmental requirements for heat rejection and equipment spacing. Using maximum containment on concealment with a minimum footprint, they are easy to install and can be painted to match any color. The monopole is designed to

be a sleek, modular radio and power-integrated pole that blends into the most challenging urban and suburban landscapes.

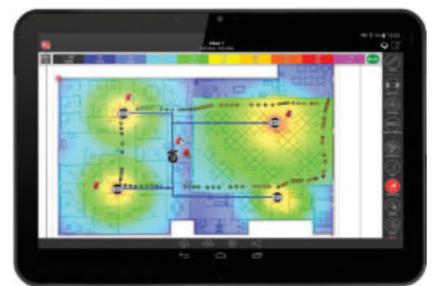
www.sabreindustries.com



DAS and Small Cell Poles

Western Utility Telecom offers innovative DAS and small cell pole structures and mounts to accommodate strict jurisdictions that demand unique, aesthetically pleasing antenna supporting poles and mounts that blend with the surrounding environment.

www.westernutilitytelecom.com



Wireless App

The **iBwave** Mobile in-building wireless application keeps users connected with peers and projects while on the road. The app allows sales

PRODUCT SHOWCASE

teams, RF engineers, IT technicians, installers, building owners and maintenance personnel to access iBwave design projects, take building notes and create small cell designs with a smartphone or tablet. The application comes with a subscription to iBwave Cloud, which allows anyone in the user's organization to safely store and share project information from the same repository, regardless of their location. The app is available in two versions. The iBwave Mobile Note allows users to access iBwave Design files from mobile devices with equipment location, specifications and cable routes. The iBwave Mobile Planner, which includes the capabilities of iBwave Mobile Note, reduces user small cell and Wi-Fi engineering work by half.

www.ibwave.com

Signal Routing Network Platform

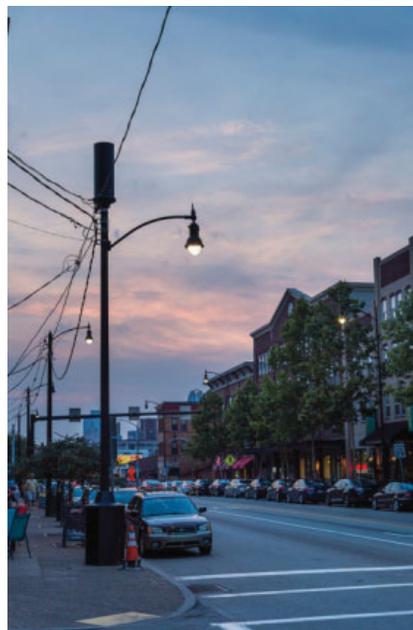
Dali Wireless designs and manufactures an integrated concept in RF signal routing that brings intelligence to every element of the system. The Dali Matrix next-generation platform enables mobile operators to satisfy exponential mobile data traffic growth while being flexible and scalable enough to allow mobile operators to seamlessly migrate to a software-driven, virtualized radio access network. The modular platform allows mobile operators to upgrade networks in a plug-and-play approach as their networks evolve. It supports a throughput of 10 gigabytes over a single optical fiber, enabling full support of 2x2, 4x4 or even higher multiple-input, multiple-output (MIMO) communications architecture.

www.daliwireless.com

Aesthetic Cell Sites

Stealth Concealment designs and manufactures aesthetically pleasing cell sites such as light pole concealments in Pittsburgh. The company created five 30-foot designs installed in the city. The RF-transparent poles hide the antennas.

www.stealthconcealment.com



Regulatory Screening Product

Caldwell Compliance's small cell and DAS regulatory screening product is designed to fit with site development and turnkey solutions to save costs and time. Company experts use the product to assess node locations and equipment specifications against available FCC exclusions from NEPA/NHPA. By using the screening product early in the site development process, problem locations from the standpoint of regulatory compliance can be addressed early, and the product advises on specifications for alternate node location selection or design changes that can provide exclusions from NEPA/NHPA review.

www.caldwellcompliance.com



SeeHawk® Touch™ with SeeGull® IBflex™

Network Testing Scanner

Designed for the complex in-building environment, **PCTEL's** SeeGull IBflex scanner increases the ease and efficiency of indoor wireless network testing. The scanner's field-upgradeable software configuration supports all major cellular technologies, plus Wi-Fi and bands from 570 MHz to 3.8 GHz. The scanner's hot-swap battery system can reduce total testing time and unwanted interruptions. The scanner connects wirelessly via Bluetooth to SeeHawk Touch, PCTEL's software tool, to visualize and analyze data collected by the scanner. SeeHawk Touch software is integrated with iBwave Mobile Planner and Note to increase testing efficiency.

www.pctel.com



MIMO Remote

The 5-watt single-package quad-band, multiple-input and multiple-output (MIMO) communications remote from **BTI Wireless** is designed for low total cost of ownership without compromising performance. BTI's mBSC product line is designed

/ DEPARTMENTS /

to deliver on size, price, performance and efficiency. Designed for meeting the most stringent demands for both in-building solutions and outdoor applications, the products' modular architecture aids in future-proofing infrastructure.

www.btiwireless.com



Faux Concrete Light Pole Tower

Larson Camouflage's faux concrete light pole tower uses real rock aggregate over a steel monopole to replicate the look of a real concrete pole. The faux concrete tower provides enough room to route eight runs of coaxial cable plus remote down-tilt cables in poles with top diameters of as little as 4-1/2 inches. Faux concrete towers can be provided in various shapes, including round and octagonal, and can be made with custom bell-shaped bottoms to match nearby existing structures. Towers can include custom decorative light arm attachments and can be provided with everything necessary for turnkey installation, including anchor bolts and light bulbs.

www.larsoncamo.com



Low-PIM Jumpers

Times Microwave Systems' TFT low passive intermodulation (PIM) jumpers for DAS installations are ultra-flexible and meet the requirements of UL 910 for plenum applications. The TFT jumpers are suitable for in-building jumpers and interconnect up to 6 GHz. TFT jumpers work for installations in tight spaces where maximum flexibility is needed. The jumpers for DAS are 100 percent tested for static and dynamic PIM and verified to provide stable PIM performance prior to shipment. Each TFT cable has a permanent label showing the actual PIM test data, actual insertion loss and VSWR. The plenum cables are UL-listed and printed with the UL file number.

www.timesmicrowave.com

Platform Streamlines HetNet Deployments

A **JMA Wireless** line of products forms a platform called Fuze that combines new connectivity and mounting with other options designed to reduce deployment costs for in-building wireless, outdoor distributed antenna system and power-over-Ethernet networking solutions. The platform streamlines mounting and streamlines cabling to powering equipment, covering cellular and Wi-Fi in one installation. It optimizes connectivity from head-end locations to remote sites. It integrates fiber

distribution, powered Ethernet and different mounting and electrical power options into one. The platform includes digital electricity units that can be used to power Teko DAS remote units for either indoor or outdoor use. Digital electricity uses a managed stream of pulses to deliver energy over different gauges of wire pairs. This allows installers to use wire, such as in-building CAT5 pairs, to deliver power to an intermediate distribution frame closet. It also allows outdoor deployments to use composite cable (fiber and copper in one sheath) to consolidate everything onto a single pull of cable.

www.jmawireless.com

Structural Engineering

SMBH, a structural engineering firm, provides creative engineering solutions for the building and telecommunications industries. The firm has experience analyzing distribution poles, rooftops, antenna mount designs and light poles for DAS and small cell projects. SMBH is licensed in the lower 48 states and the District of Columbia.

www.smbhtelecom.com

Consultant Service

DAS Advisers is an independent team experienced in wireless technology, installation and contract negotiation. They assist property owners in understanding what affects wireless coverage and capacity and then guides them in identifying suitable technology and strategy. The company has experience in site acquisition, indoor and outdoor DAS and small cell system design and deployment, final testing and commissioning. Negotiation with wireless carriers and vendors is a key component of its service. Past clients have included

PRODUCT SHOWCASE

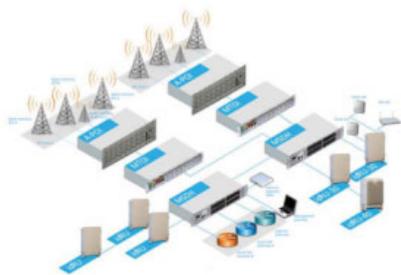
hospitals, universities and airports.

www.dasadvisers.com

Construction Service

John Burns Construction provides telecommunications construction. It has experience working in large cities installing DAS and small cell equipment onto traffic and lighting poles and indoor installations. The company replaces foundations and poles. It trenches fiber and power to DAS sites. The company provides DAS and cell tower construction, antenna installation, RF equipment installation and integration, site modification, tower climbing, trenching and boring.

www.jbconstructionco.com



DAS with Dynamic Allocation

idDAS (intelligent digital DAS) from **Cobham** provides mobile operators with a way of handling the challenges and current limitations of in-building coverage systems. It allows mobile operators to dynamically allocate capacity around a range of facilities to ensure high-bandwidth coverage is available when it is required, without needing to hardwire coverage into the whole site.

For example, many large buildings have multiple uses, including hotels, conference centers, offices, residential apartments and shopping areas. Using idDAS, capacity can be allocated by mobile operators or facilities managers to different parts of the facility as

and when it is needed. During the day, maximum capacity can be allocated to the offices and the hotel, while in the evening extra capacity could be rerouted from the offices to the shopping center and residential apartments where demand has increased.

By pooling and optimizing capacity for maximum utilization, substantial opex cost savings can be achieved. idDAS can be used for either single or multi-operator deployments because it allows each individual operator flexibility and control over the allocation of wireless services within a building.

www.cobham.com



Small Cell Composite Structures

CompSites International offers turnkey solutions and supplies custom-fabricated, durable, environmentally friendly and cost-effective small cell composite structures. The lightweight poles meet FCC TIA/EIA-222-G standards and have a nonconductive, noncorrosive finish. The poles are designed for direct burial or pedestal mount installations. Custom aesthetic designs for single- or multiple-user small cell configurations combine engineering expertise with high-quality manufacturing practices and meet zoning requirements. The company offers quick deployment and temporary site solutions with ballast-mount composite pole kits.

www.retelservices.com

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PRODUCT SHOWCASE

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