ABOVE GROUND LEVEL

agl Magazine™

FCC ON THE FUTURE OF WIRELESS

What Wireless Will Bring in Years to Come

HORIZONS

T-Mobile USA's 5G Vision

Tower Companies' View of Small Cells

BUSINESS & MANAGEMENT

Your Company's Future

December 2016 /// Volume 13 /// No. 12

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AGL Magazine (Above Ground Level) is published 12 times a year by AGL Media Group LLC, 44715 Prentice Drive #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, 44715 Prentice Drive #2090, Ashburn, VA 20146-2090.

Changes

With the election of Donald J. Trump to be president of the United States comes change at the FCC. The FCC is directed by five commissioners appointed by the president and confirmed by the U.S. Senate for five-year terms, except when filling an unexpired term. The president designates one of the commissioners to serve as chairman. Only three commissioners may be members of the same political party.

Chairman Tom Wheeler's term expires June 30, 2018. The FCC chairman usually leaves if the party controlling the White House shifts to the opposite party. On Nov. 17, Wheeler stated his intention to resign, but he said he has not decided his departure date. Sooner or later, Trump will appoint a Republican successor and the political majority would change. Trump could designate the new commissioner as chairman, which would be typical, or he could designate a current Republican commissioner as chairman.

Wheeler could exit the chairmanship and remain as a commissioner, but I don't recall a previous chairman doing so.

The FCC has some commissioners who are continuing to serve beyond the expiration of their terms, which the law allows. Their time on the commission may come to an end when the current Congress adjourns at the end of the year. This could leave the commission with vacancies to be filled by the new president's appointees.

The new president has authority to appoint people to fill nearly 1,200 executive-level jobs with Senate approval and another 321 that do not require Senate confirmation. When the FCC might receive his attention is unclear. But sooner or later, the FCC will have a Republican chairman, and a majority of commissioners will be Republican.

Writing Achievement

Congratulations and a big thanks to Michael Mitchell and Andy Singer. With this issue, the two contributors completed a year's worth of giving you business and management information and advice in the pages of *AGL Magazine*. Try writing an article every month yourself. It isn't easy for folks who make a living working other jobs or running businesses of their own to meet writing deadlines, much less every month for a year. It's an achievement worth noting and much appreciated.

Reading Achievement

With this issue, *AGL Magazine* completes 12 years of publishing information for the antenna-siting community. Thank you for reading every issue. Where did you find the time?

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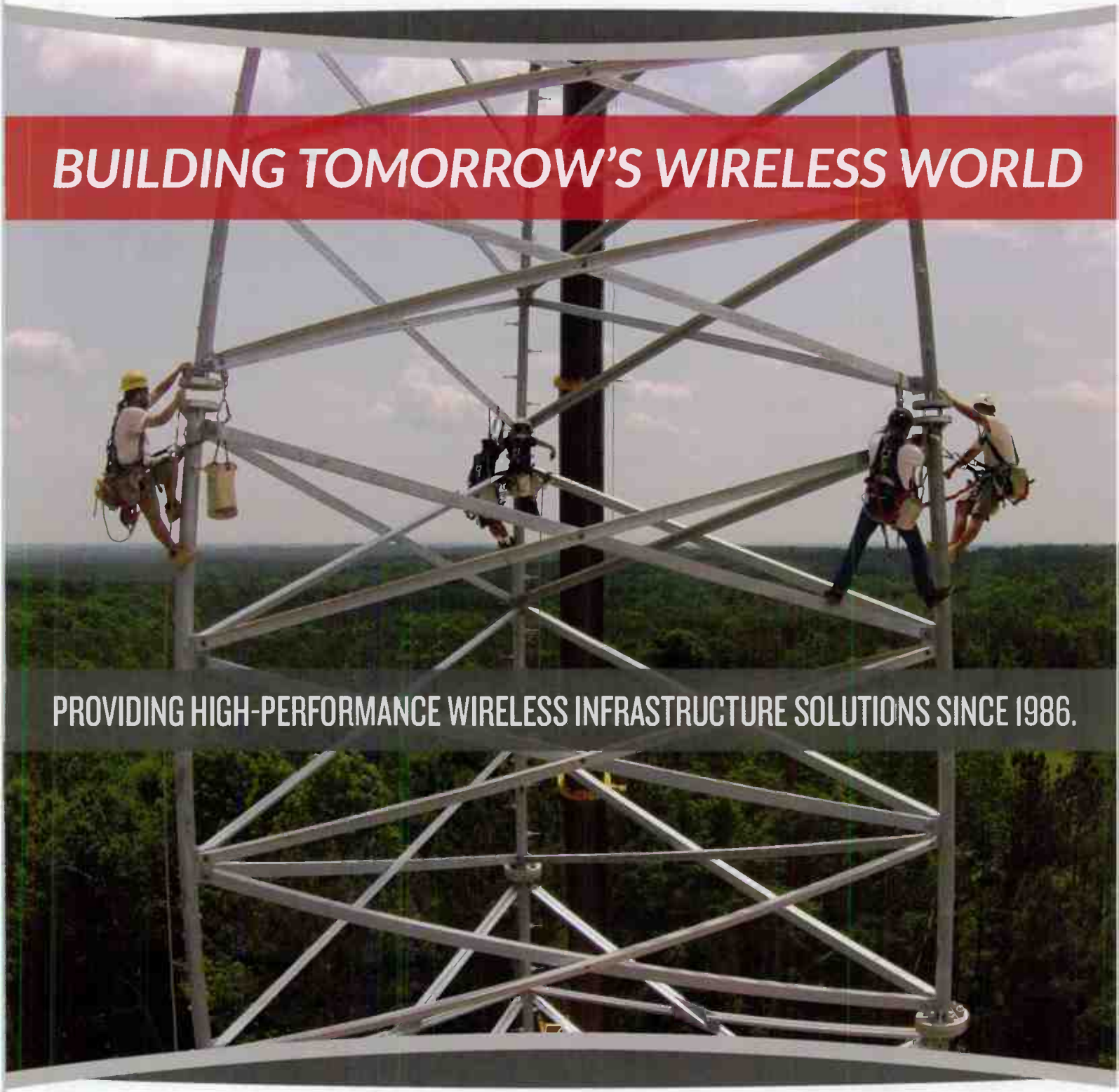

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What to Expect from the New FCC

Jeff Eisenach and Mark Jamison probably will become two new FCC commissioners. How do we know this? Because President-elect Donald Trump named them his transition team to oversee his administration's FCC and telecommunications policy agenda.

Eisenach has a consulting history with Verizon and with the GMSA wireless communications membership organization. He has a Ph.D. in economics from the University of Virginia. Eisenbach previously served in presidential transition teams. It looks to me as though he will become a Trump nominee to the commission or, if not, he will have a hand in selecting commissioners.

Jamison, a professor at the University of Florida, opposes net neutrality, among other policies. He previously worked for three years at Sprint as a lobbyist who focused on landline policy.

If Eisenbach and Jamison are any indication, the folks running the FCC will reflect more territorial attitudes, asserting, "eat what you kill," "build your own network" and "it's all proprietary." Thus, things will change. I would expect to see larger carriers, cable companies and fiber giants investing more in their own fiber as the cost of using a competitor's fiber increases, or as the fear of the increase becomes tangible. This is good news for tower companies that already own a lot of fiber as well as those that will be encouraged to do so. It is also good news for those companies that are positioned to acquire more fiber as trusted allies of the carriers.

What I don't see changing much are well established and fairly well accepted regulatory matters, including the FCC antenna site application shot clock, the National Environmental Policy Act, state historic preservation officer roles and antenna collocation by right. In the next four or more years, high-level changes may come on some larger issues, such as net neutrality, and on smaller issues, such as doing away with set-top cable TV box rentals and other consumer-friendly matters. Just cough up the $7 to $9 a month.

We'll probably see reduced FCC support for rural broadband communications deployment issues, including the Community Connections Grant and the U.S. Department of Agriculture Connect America Fund. Why should the haves have to help out the have-nots? It is a fair question. You chose to live in a rural area, not me. Changes in funding of these kinds of projects will disappoint many. However, core to the antenna siting industry, they are not.

I envision a reduction in the regulatory hurdles carriers face from municipalities as the FCC curbs local authority to question and slow down some projects. I expect the wireless infrastructure business to strengthen, at least to some degree. It could benefit from the incoming president's stated preference for U.S.-based manufacturing and services.

It takes a lot of energy and time to move the D.C. pendulum and make meaningful, important and lasting changes by repealing the laws you don't like and replacing other long-lasting laws. Perhaps the law or regulation should have not existed in the first place. Chances are that a law or regulation was passed in the first place because of a need —perhaps a need different than yours. But still, a need.

I hope that whatever political gyrations are yet to come will spare rules affecting worker safety. Having one wireless carrier buying another is one thing; getting home safely should never be in doubt. Safe and happy holidays to all.

Rich Biby, Publisher
rbiby@aglmediagroup.com

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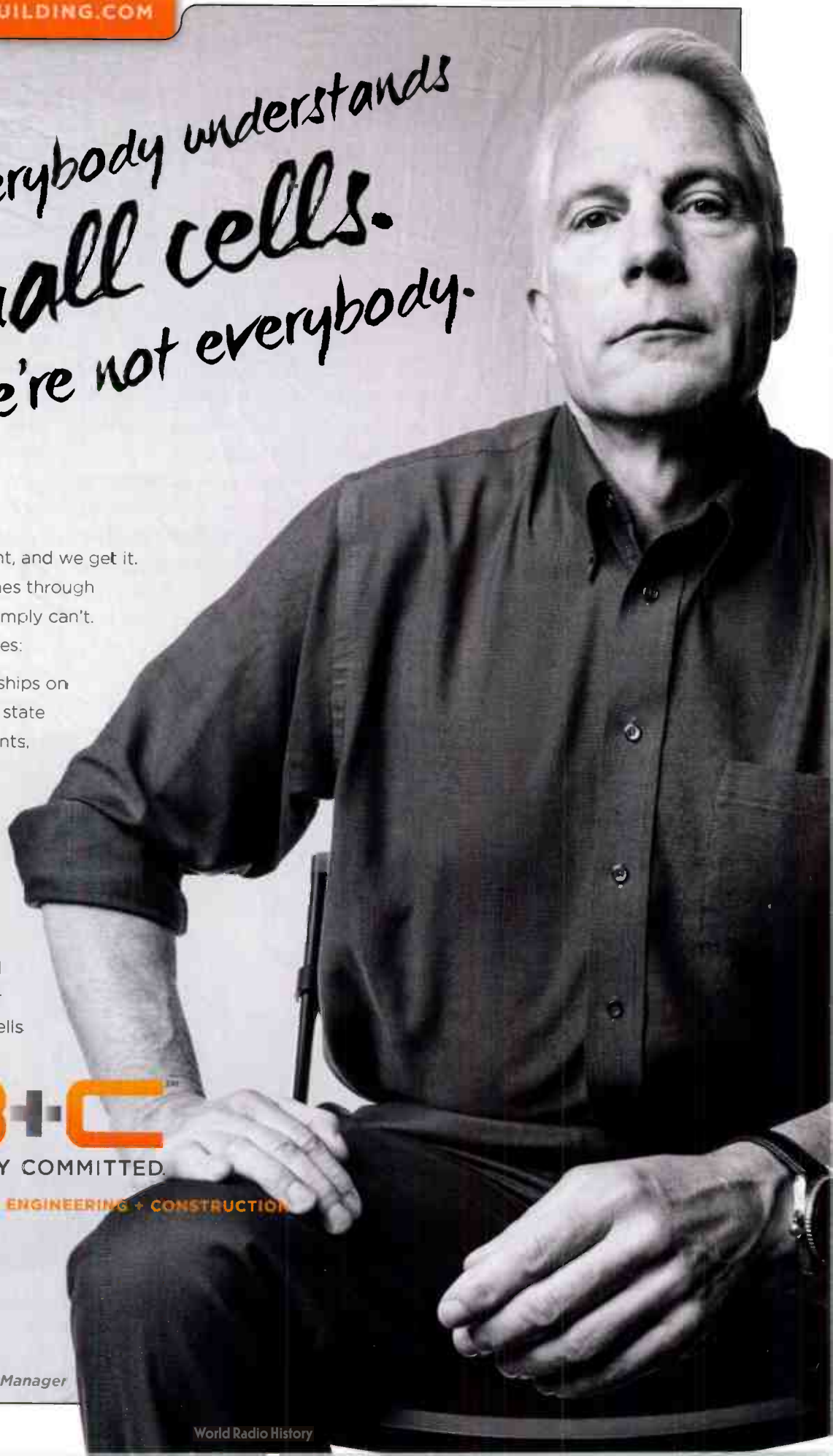

Jimmy Ellis, Project Manager

Municipalities and Mobilitie Have a Meeting of the Minds

By J. Sharpe Smith

Municipalities across the country are making it clear: Having a certificate from the public utilities commission and a desire to deploy a cell site in the public rights of way does not result in the ability to bypass local zoning ordinances.

At a technical meeting in September conducted by the Connecticut Public Utilities Regulatory Authority (PURA) to discuss applications for right of way use that Mobilitie sent to numerous municipalities, the company promised that it would follow the state's local zoning regulations.

The Office of Consumer Counsel requested the meeting after receiving calls from representatives of municipal officials who found Mobilitie's correspondence confusing. The company sent letters indicating that it had selected sites for its 120-foot monopoles in the rights of way in the municipalities' jurisdictions.

Milford, Connecticut, was one of the municipalities that complained Mobilitie's applications for the cell sites raised more questions than they answered. A letter from John W. Knuff, an attorney representing Milford, to Melanie Bachman, the acting executive director of the Connecticut Siting Council, conveyed the city's viewpoint.

"While it is impossible clearly to discern Mobilitie's intent from its letter, two things are quite clear," reads the letter from Knuff. "First, Mobilitie has failed properly to consult with the city, which must be accomplished 90 days prior to any application in accordance with the statute. Second, the letter and attachments fail to satisfy the requirements of a technical report."

In particular, a technical report must include a map of the area of need, existing surrounding facilities, alternate sites under consideration, locations of nearby schools, analysis of potential aesthetic effects, mitigation of aesthetic effects and potential environmental effects.

At the meeting on the proposed utility infrastructure facilities, which was attended by representatives of the Connecticut Conference of Municipalities and Council of Small Towns in Connecticut, Mobilitie's attorney presented the company's plans and gave assurances that the company would abide by all the zoning laws and regulations. Later, Mobilitie communicated that it plans to begin submitting applications by the end of the year.

Bachman also attended the meeting. "It was necessary to have a meeting where everyone could come to the table to hear Mobilitie make that statement [that it would abide by the rules]," she said. "It alleviated a lot of concerns among the municipalities."

River Street in Milford, Connecticut. *Photo by Robert Kurfehs*

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The Connecticut Siting Council approves free-standing tower siting requests after consulting with municipalities. Jurisdiction belongs to city councils if requests involve attachments to existing structures, such as telecommunications towers or electric line structures. If a request involves an attachment to an electric distribution line structure, PURA decides whether to approve it. Local municipal authorities make the decision when the request is for an attachment to a light pole.

"You can't blanket the state with applications to the municipalities for your deployments in the right of way," Bachman said. "The analysis of jurisdiction [in Connecticut] has to do with the principal use of the existing structure to which they want to attach their equipment.

"We hope that Mobilitie got the message and when they do start submitting formal applications, they will approach it the appropriate way," she added.

Minnesota Right of Way

Municipalities in Minnesota also were distressed by the Mobilitie correspondence, prompting the Minnesota Department of Commerce to send a letter to the company requesting that it stop asserting that it has authority from the Minnesota Public Utilities Commission (PUC) that exempts it from local regulations in the public rights of way.

"The Department has consulted with PUC staff and we are aware of nothing in Minnesota statutes or rules that exempts a PUC-certificated carrier from the requirements of local government units concerning rights of way," the letter reads. "While Mobilitie holds a certificate of authority to provide local niche service, ... this does not give Mobilitie an exemption from the requirements of the local government units."

The Department of Commerce and PUC received numerous complaints from Minnesota municipalities, indicating that representatives of Mobilitie were claiming that Mobilitie is not subject to right of way regulation by the Minnesota municipalities because Mobilitie holds a certificate of authority issued by the Minnesota PUC to provide telecommunications service.

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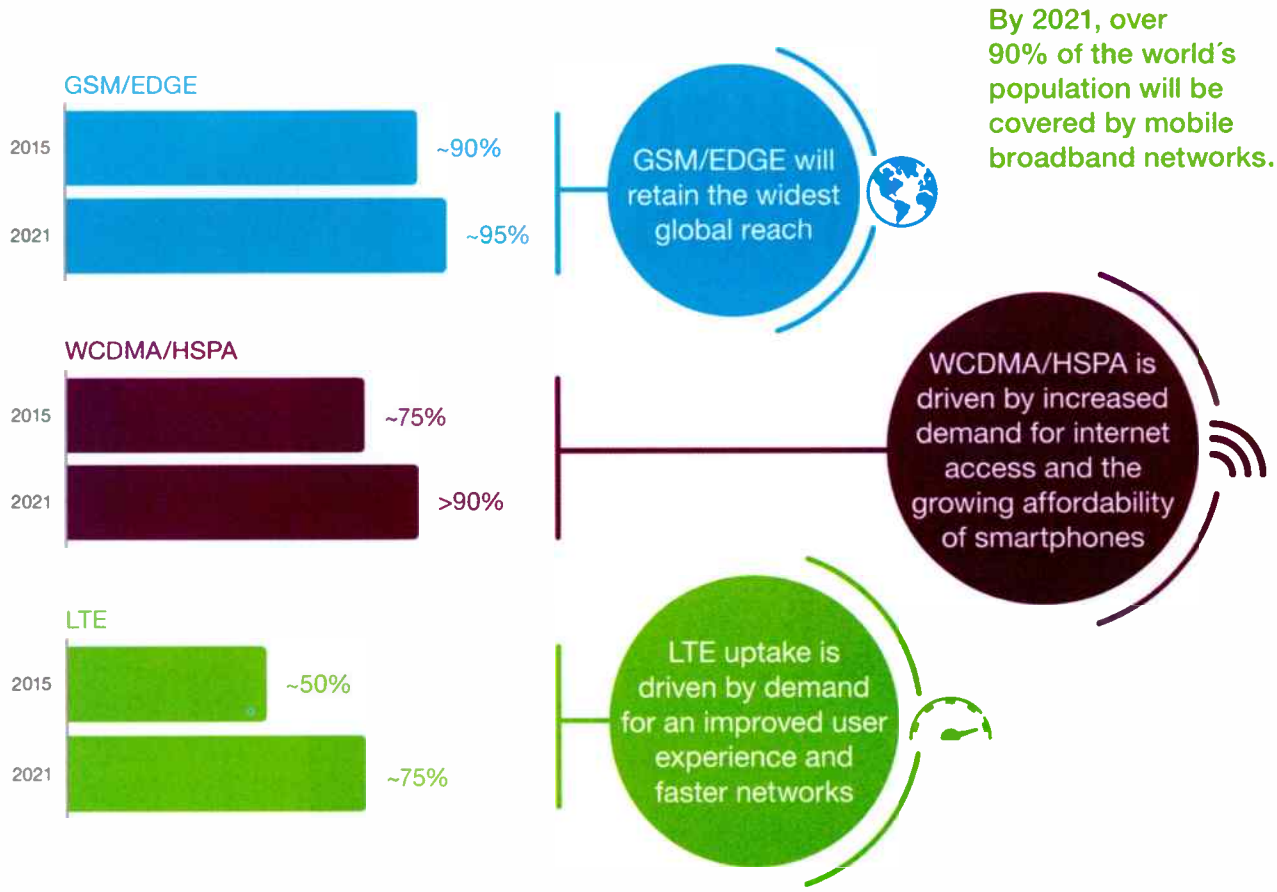
State of the Networks

By Don Bishop

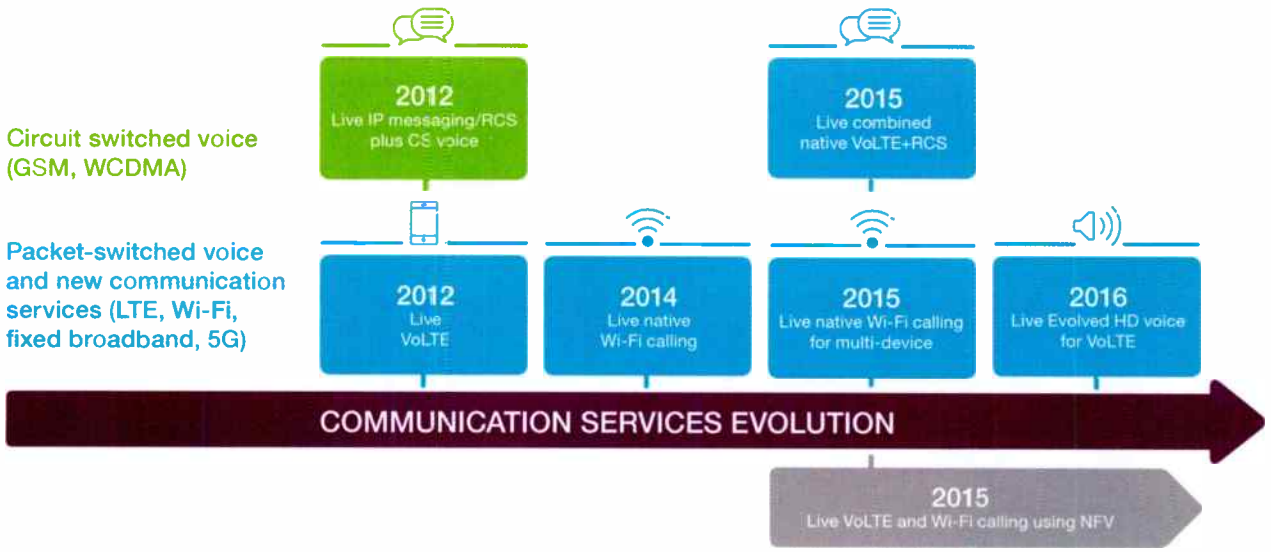
Evolving mobile network capabilities are key to ensuring a high-quality user experience and continual service improvements.

Wideband code-division multiple-access (WCDMA) and its high-speed packet access (HSPA) enhancement are third-generation (3G) wireless technologies that continue to experience significant growth in subscribers and populations worldwide, according to the June 2016 Ericsson Mobility Report. Although the report predicts 3G growth would continue for years to come, it said global statistics mask diverging trends on a regional level.

The report found that, in some regions, there is high growth of WCDMA subscriptions as declining smartphone prices offer an economic entry into mobile broadband. In other regions, there is a growing focus on re-farming WCDMA frequency bands to Long-Term Evolution (LTE) technology, enabled by the ability to fit higher HSPA traffic volumes into smaller frequency allocations. "This is made possible by new radio access



World population coverage by technology. The figures refer to population coverage of each technology. The ability to use the technology is subject to factors such as access to devices and subscriptions. *Source: Ericsson Mobility Report*



network software functionality that enhances smartphone handling and network capacity," the report reads. "Operators are also seeking additional ways to make the network simple to handle and thus increase network operational efficiency."

1 Gbps Downlinks

The demand for enhanced app coverage continues to push LTE data rates to new heights, according to the report. It found that in 2016, a long-anticipated milestone is being passed, with commercial LTE networks supporting downlink peak data speeds of 1 Gbps.

"The 1-Gbps LTE peak data speeds will provide users with significantly faster time-to-content," the report says. "Gigabit speeds will also enhance the usefulness of personal hotspots, as well as making LTE a more attractive alternative to deliver fixed wireless services."

The report identifies one of the barriers to delivering higher LTE data speeds as spectrum. It says new, commercially available LTE capabilities provide greater spectral efficiency and make the delivery of commercial LTE peak data rates of 1 Gbps feasible using 60 MHz of spectrum. The capabilities the report identifies include:

- Three-component carrier aggregation that enables the aggregation of 60 MHz of LTE spectrum
- 256 quadrature amplitude modulation (QAM) that can increase downlink data speeds by 33 percent
- 4x4 multiple-input multiple-output (MIMO) communications, which doubles the number of unique data streams being transmitted to the user's smartphone, thereby enabling up to twice the capacity and data throughput

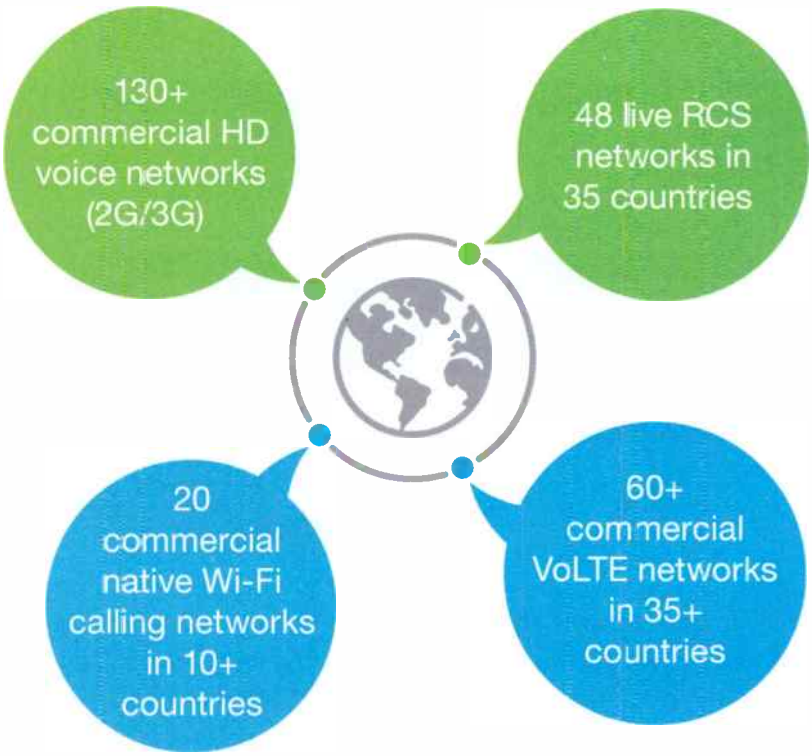
"When used in combination, two aggregated 20-MHz LTE carriers using 4x4 MIMO and 256 QAM aggregated with a single 20-MHz LTE carrier using 2x2 MIMO and 256 QAM can support a LTE peak data rate of 1 Gbps over the downlink," the report reads. "256 QAM is susceptible to interference. However, system interference can be reduced, hence increasing the utilization of 256 QAM in the network."

The report found that the number of commercial LTE-Advanced (LTE-A) carrier aggregation launches continues to increase. It says that operators are evolving their LTE-A networks with Category (Cat) 4, 6, 9, 11 and 16 implementations. Cat 16 devices, which support 1 Gbps data speeds, are expected in the second half of 2016.

"These higher speeds will enhance the user experience both indoors and outdoors," the report reads. "The network speeds mentioned are a theoretical maximum. Typical user speeds will be lower and depend on factors such as device type, user location and network conditions."

Staying Competitive

According to the report, demand for communication services remains strong, despite declining voice and messaging revenue. It refers to the August 2015 Ericsson



ConsumerLab study, "Bringing Families Closer," which shows that text messaging and voice remain the main methods of communication for the majority of families in the United States.

"Communication services based on VoLTE enable operators to offer bundled data and high-quality communication services packages, with telecom-grade high-definition (HD) voice, video communication, multi-device capabilities and more, while enabling simultaneous LTE data services on smartphones," the report reads. "GSM Association standards-based rich communication services enable globally interoperable Internet Protocol messaging and content sharing during calls. This can also be combined with VoLTE natively on smartphones."

LTE and Wi-Fi HD Voice

HD voice improves mobile voice quality, the report explains. It requires device support and new functionality on 2G, 3G and LTE networks. According to the report, an evolved HD voice service — 3rd Generation Partnership Project standardized Enhanced Voice Services (EVS) for VoLTE-enabled networks — further improves the user experience by delivering even higher-quality voice and music within calls (e.g., call announcements or sharing music from a concert during a voice or video call).

EVS also provides a better-quality service than HD voice in challenging LTE radio conditions, together with a more robust service when using Wi-Fi calling.

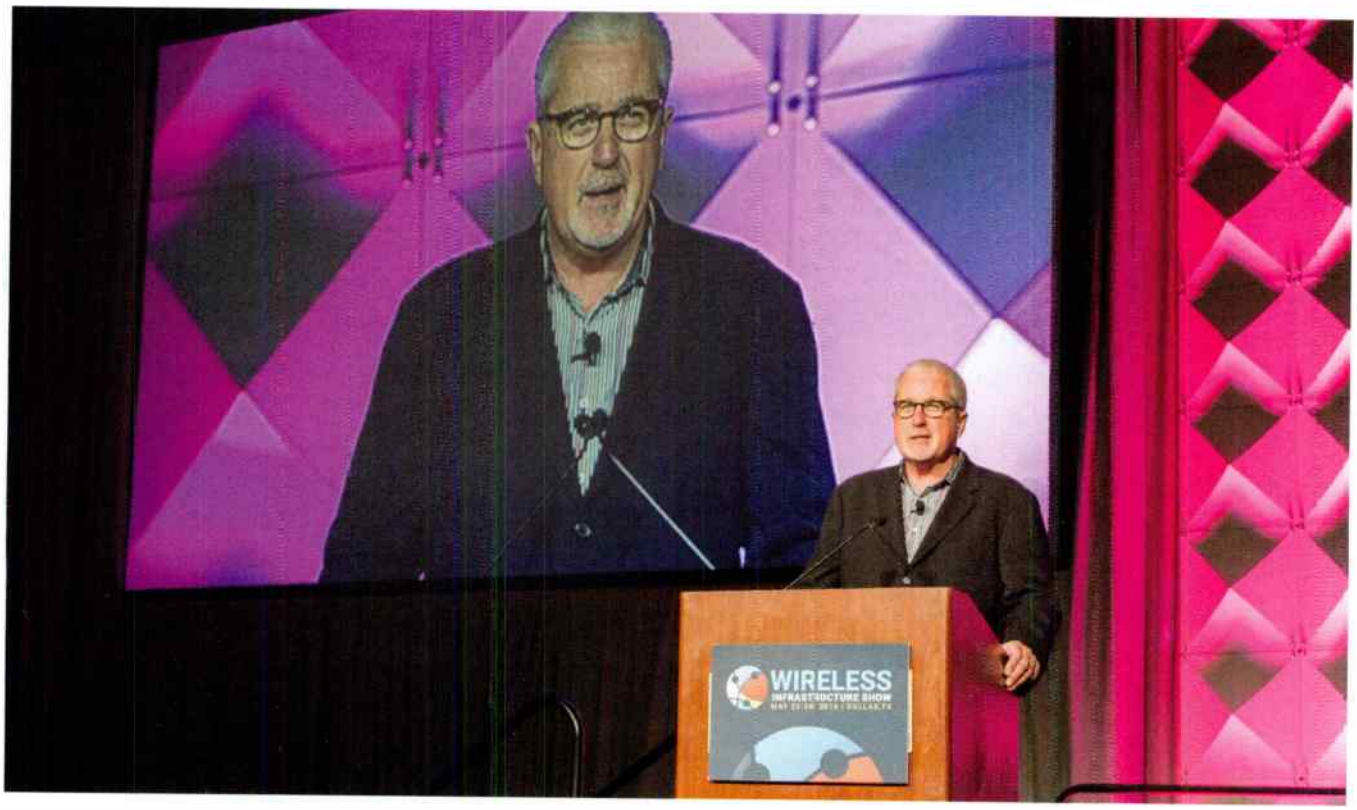
Wi-Fi Calling

The report says that with Wi-Fi calling, operators can extend their voice service indoors so consumers can make calls in their homes over their own Wi-Fi access points, using any internet service provider. It says this benefits users with limited circuit-switched voice or VoLTE indoor coverage and benefits roaming users.

"All major chipset and device vendors now support natively integrated Wi-Fi calling on many smartphone models," the report reads. "Some device and network vendors also support Wi-Fi calling on devices without a subscriber identity module (SIM) card, such as tablets, smartwatches and personal computers. This means the users' personal devices can be located at different Wi-Fi access points across the world, and the smartphone can be on cellular or Wi-Fi access. The users can select to answer and make calls on any of the devices, and then transfer calls between their personal devices."

Network Evolution

The report concludes its description of the state of the networks by saying that the IP multimedia subsystem and evolved packet core enable the packet-switched communication services, which can be run over LTE, Wi-Fi and fixed broadband on any device, as the device ecosystem evolves. "VoLTE and Wi-Fi calling are the first consumer services that have been deployed using network function virtualization in core networks," the report reads. "A 5G-ready core takes network function virtualization one step further by adding the concepts of distributed cloud and network slicing."



Antenna Site Pain Points and How to Fix Them

By Don Bishop

Renting space for antennas on towers isn't as easy as it should be, according to T-Mobile USA executive Dave Mayo. And the process for small cell placement should be industrialized.

Dave Mayo, senior vice president of technology at T-Mobile USA, would like to see tower owners and regulators resolve five categories of difficulty the wireless carrier — or the uncarrier, as the company likes to call itself — faces in doing business with those who own or control sites where it places its mobile network antennas. Mayo referred to the categories as pain points, using a reference T-Mobile uses when it addresses difficulties its customers have in doing business with wireless carriers. The pain points are: liberation of operator access to antenna sites, fees paid to site owners, small cell rights of way, tower equipment loading flexibility and legacy contract terms. Mayo spoke about the pain points in an appearance at the Wireless Infrastructure Show in May.

Pain point No. 1: operator access. Mayo said it is amazing how much time and energy T-Mobile spends attempting to access the antenna sites it rents. Migratory birds nesting on towers are a problem because regulators limit access when they are present. "Can somebody please figure out how to keep the damn birds off the towers?" Mayo asked. "It'd be a great thing, and I think there's innovation required there that would add a lot of value."

Mayo said that, at times, T-Mobile wants to make equipment upgrades at several hundred towers, but it can't when there's a bird's nest and a bird is in the nest. During the past five years, the carrier has conducted network upgrades for LTE and 700-MHz

Pain Points for Antenna Sites

No. 1: Liberate operator access

- Innovation required
  - Migratory birds
- Human and process opportunities
  - Time-consuming structurals
  - Site access impairments
  - Incorrect combinations or wrong keys

No. 2: Fee structures

- Monthly rent
- Tower access fees
- Per equipment loading fees
- Inspection fees
- Escalator fees
- Maintenance fees

No. 3: Small cell rights of way

- Many jurisdictions are in a defensive mode.
- Why repeat the history of macrosite moratoriums and strident local regulations?
- T-Mobile USA is committed to clean, simple solutions and to educating and building relationships with jurisdictions and right of way owners.
- Case in point: *www.howmobileworks.com*

No. 4: Loading flexibility

- Equipment-specific loading is costly and is an administrative nightmare.
- Simplicity is required. Basing loading on sail area and not-to-exceed total weight is the only sensible way to stop the madness.

No. 5: Legacy contract terms

- The outdated nature of many legacy agreements creates opportunities for developers to build models that include:
  - Simplified rate structures
  - Lower escalators
  - Protection from tower consolidation
  - Cash back or a signing bonus to ease operator transitions

band operations. The carrier now is doing work on towers in connection with refarming its 1900-MHz spectrum. "If we can find something to do about the birds, that would eliminate the pain point," he said.

Meanwhile, Mayo said T-Mobile all too often runs into site impairments that prevent site access for one reason or another, such as incorrect lock combinations, the wrong keys and time-consuming structural analysis. "If we can find a way to streamline the process so structural analyses that otherwise could take days don't instead take weeks, that would be a vast improvement," Mayo said.

Pain point No. 2: fee structures. Mayo said one of his team members told him that working with a tower company is like dealing with the bank. "You get nickeled and dimed for fees and everything," the team member said.

Mayo said he recognizes that everyone wants to make a buck, but he believes both the wireless carriers and the tower owners put too much complexity into their businesses because of their fee structures. "I'd like to see us annihilate it and do something different because it's too complicated; it's not sustainable," he said. "It takes a lot of process work for us to make changes to our network. We have to find a way to simplify it and make it easier."

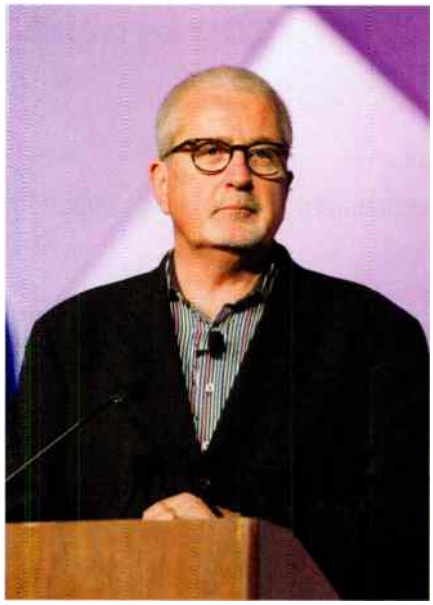
Pain point No. 3: small cell rights of way. Something T-Mobile found is that it needs to have a way to work with municipalities that gives the carrier quick access to public rights of way for small cell placement. "I like to use the word 'industrialize'

in referring to our ability to deploy small cells," Mayo said. "I'm concerned that some site developers are being a little too cavalier in some cases and messing up the relationships with municipalities."

Mayo said he doesn't want T-Mobile to undermine its relationships with municipalities while pursuing small cell placements in rights of way. "We spent a lot of time and energy trying to build relationships with municipalities so that we can find a clean path to deploying things en masse," he said. "Over time, the industry is going to require lots of small cells. The processes we use to build macrosites are not scalable. You can't build the kinds of numbers of small cells that the industry will require with the processes that we have in place to build macrocells."

Recalling when T-Mobile was beginning its LTE deployment, Mayo said he was hoping by now that wireless service providers and their site developers would have figured out small cell deployment and it would be easy. But, he said much work remains to be done to make that happen. "I used the word industrialize," he said. "We have to figure out how to industrialize and make it really, really screamingly easy for operators to add small cells to their networks."

In support of that effort, T-Mobile built a website with a video to try to help educate officials at municipalities as to what the carrier is trying to do with site development. The aim is to help simplify the process work for adding small cells to its network (see *www.howmobileworks.com*).



Dave Mayo, senior vice president of technology at T-Mobile USA, speaking at the Wireless Infrastructure Show.

Pain point No. 4: loading flexibility. Mayo said that when it comes to adding equipment to towers, it's an administrative nightmare not only from a cost perspective, but also from a process perspective. He said loading should be based on sail area, which refers to the wind load, and on a not-to-exceed weight limit. He said what happens today is absolute madness.

"We recently had a situation where we needed to add a tower-mounted amplifier to a site," Mayo said. "It was 3 pounds heavier than the tower-mounted amplifier it replaced. The change cost us a rental increase of $5 a month. It's not the $5 that bothers me, it's the time and the energy that it took two companies to figure out that it was going to cost five bucks. It's just crazy."

On the flipside, Mayo asked, "When have you ever heard of a rent go down when you pull equipment off of the tower? I haven't heard of that. I'd love to hear about it, though."

Pain point No. 5: legacy contract terms. As the cellular industry began, Mayo said, carriers didn't know what would happen with sites they built in the early days. "None of us had any idea the equipment on the sites would be upgraded six to eight times," he said. "My gosh, if we had known then what we know now, we'd have a much different relationship with tower owners. We would have forced ourselves to build a process that was much easier and that took a lot of cost out of both of our businesses. Most importantly, we would have created a process that gave us access and the ability to add capacity and change things out faster."

Mayo said opportunities exist for developers to include simple fiber rate structures, lower escalators, protection from consolidation and even cash back or signing bonuses to ease operator transitions. He said he expects that there will be transitions in the coming years. "We will have to get off of some of those high-cost sites, which creates opportunities," he said.

Competition

In the end, Mayo said, competition solves every problem. "We have to create an ability for competitors to do things faster and cheaper," he said. "I trust that will solve the problem. If it doesn't, we'll just keep whittling away at it. I don't know of any other way. But competition tends to work."

The next Wireless Infrastructure Show is scheduled for May 22–25, 2017, in Orlando, Florida. Photography by Don Bishop.

Tarpon Towers: 200 Towers and Growing

By Mike Harrington

A vested, hands-on, roll-up-your-sleeves management style keeps Tarpon Towers' co-founder and CEO Ron Bizick busy.

Ron Bizick said he's never really done anything else.

"I graduated from the University of Pittsburgh in the summer of 1989, worked briefly for an Iams pet food distributor as a sales manager" — overly qualified for wireless, he laughed — "and then I signed up with SBA Communications' Steve Bernstein in November of that year," Bizick said. "I've been in the cell tower and wireless business ever since. There are countless stories like mine, I would guess. What a great industry. Although I have had many mentors along the way, I can never thank (company founder) Steve Bernstein enough for the chance of a lifetime."

Carrier Investments

Since his days with SBA Communications, Bizick has seen all the ups and downs in the industry, but says the last five or six years have been terrific for private and public tower owners, as the carriers have made significant investments in their 4G and LTE networks.

Today, Bizick and his partners at Tarpon Towers roll up their sleeves and use a hands-on approach to growing the company. Bizick serves as CEO and Bill Freeman is president. However, Bizick said that "titles at Tarpon mean very little to us. Bill and I have four other partners, all of whom are personally invested in Tarpon. By design, we have entrepreneurial, multi-talented, experienced, hardworking partners with their own skin in the game. We all work together to advance Tarpon's interests and, as a result, our own personal interests. It has really worked very well."

Ron Bizick, CEO of Tarpon Towers.

Tarpon's other partners are Gail Buteau, Brett Buggeln, John Armour and Todd Bowman, all of whom previously held senior roles at various public tower companies and, in some cases, at carrier companies.

In 2008, Bizick and Freeman co-founded Florida Tower Partners with their own capital. Subsequently, the Bradenton, Florida-based wireless communications tower company renamed itself Tarpon Towers and brought in two equity partners, ABS Capital Partners and Spire Capital.

Before Tarpon Towers, both men were executives at Global Signal, previously named Pinnacle Towers. Bizick and Freeman joined the executive management team as the company was seeking experienced industry executives to manage its financial and operational turnaround — having just gone through a bankruptcy restructuring — and achieve future growth for the company.

Global Signal Days

"My role at Global Signal was initially chief development officer and, over time, I became COO and continued to manage the acquisitions group jointly with Bill, who was the CFO," Bizick said. "With a team effort by a lot of people, the company grew from about 2,200 towers to more than 11,000 towers through various acquisitions with small and large independent sellers. We also bought the Sprint tower portfolio during that time." Crown Castle bought Global Signal in 2007 for about $5.9 billion.

In November 2014, Tarpon Towers sold the towers it had acquired and built since 2008, and ABS Capital Partners and Spire Capital exited the company. Bizick and Freeman, together

with the four other partners, recapitalized Tarpon Towers (as Tarpon Towers II) with their own money. In early 2015, because of the company's growth, the partners decided to bring in equity partner Redwood Capital, a family office based in Baltimore.

"Redwood is perfect for us," Bizick said. "We sought a long-term holder of assets with a cheaper cost of capital than traditional private equity. Additionally, Redwood's ability to commit significant further capital, should it be needed, means we are well funded for the foreseeable future." Bizick indicated that Redwood has already committed $50 million of equity capital to the company and, with debt and management capital, the company has $120 million of total capitalization.

Today, Tarpon Towers has a portfolio of more than 200 towers, including towers under exclusive management agreements and new sites to build under contracts with the carriers. Tarpon also has a backlog of about 100 sites.

Working with Carriers

When Bizick signed on with Steve Bernstein in 1989, SBA was primarily a service business. 1997 marked the year of the first build-to-suit agreement with a carrier. "As far as I know, we were one of the first of two companies to do build-to-suit," Bizick said. "It was exciting. I remember making our pitch to Bellsouth PCS. I went to the airport feeling OK, but not great. Before we boarded our plane, the phone rang and they asked us to come straight back. Jeff Stoops and I shared a high five and SBA was off and running. That was sort of a game-changer for both the carriers and the tower industry."

Other tower companies, including American Tower and Crown Castle International, were acquiring assets. But Bizick said there wasn't a truly programmatic build-to-suit arrangement, nor was there a tower company primarily focused on build-to-suit until 1997. "You can see what has happened since," he said.

> *"Carriers seem to be keenly interested in reducing costs, and one cost that is in the crosshairs is cell tower rent. Bizick said he's not surprised."*

These days, Tarpon Towers works with all four major carriers and with regional carriers. "We build assets based on carriers' needs," Bizick said. "Sometimes that results in towers here and there, and sometimes it results in multiple towers in one certain area."

Bizick said the ideal way to identify tower locations is for a carrier to say: "This is where we'd like a tower." He calls this approach the holy grail of tower siting, and he knows that guessing is not a good strategy. However, he also believes there are those places where, based on years of experiences or relationships in the field, or both, he is fairly certain that

a tower is required. In those instances, Tarpon typically secures a ground lease option at one location or multiple locations in that area and markets the locations to the carriers.

According to Bizick, the tower business, from an operational standpoint, is highly efficient. It has come to rely heavily on the specialized skills of an extensive subcontractor network. He points to each local market where there are site-acquisition companies and zoning experts, attorneys, construction crews and installation crews. "These are all of the various professions you require to acquire, zone, build and ultimately install antennas on a tower," he said.

Bizick maintains that Tarpon is extremely sensitive to what the carriers want and how they want the work to be done. "So, they may mandate — or ask politely [laughs] or maybe not so politely [laughs harder] — they may say they prefer a certain vendor over another and ask would we be willing to work with them," he said. "And 99.9 percent of the time, we say 'OK,' because if they're comfortable with a subcontractor, that makes our job a bit easier. Ultimately, our goal is to make the customer happy and own great assets."

> *"Although Bizick said he believes the cell tower market has a bright future, he doesn't foresee dramatic growth for Tarpon Towers over the next few years."*

Cost Reduction

Carriers seem to be keenly interested in reducing costs, and one cost that is in the crosshairs is cell tower rent. Bizick said he's not surprised. "I think it's an obvious time for carriers to focus on costs, especially as the average revenue per user declines and they fight to keep their customers

and steal those of their competitors," he said. It's pretty easy to take a look back at legacy leases that have been around for more than 20 years and find many that have seen six or seven technology-transition-driven amendments plus annual built-in contracted rent escalations."

Meanwhile, Bizick said he believes the carriers are saying that they need a different kind of deal from now on and that the cell tower owners have benefitted disproportionately from the wireless industry's growth. He said that although one could argue who has benefited and who has the leverage, the carriers or the tower companies, he believes the best outcome is to find a solution for the future. "Legacy sites and past deals between cell-tower companies and the carriers may be difficult to change, if at all or ever," Bizick said. "My personal opinion is that we need a healthy partnership, which means working together and cutting deals that benefit both parties. The old cliché that pigs get fat and hogs get slaughtered is perhaps a way to look at it. We need each other to be successful."

Putting Capital to Work

The biggest concern and challenge for Tarpon Towers involves putting capital to work at attractive returns. Bizick said the business has many people with an enormous amount of capital who are chasing limited opportunities. He said that carriers also are putting increasing downward pressure on rents, escalators, future additional equipment amendments and reserved space requirements on the assets.

"When you put these two factors together, the combination is challenging," Bizick said. "On the acquisitions side, you have an environment in which you have to price deals to perfection to win. And then, the carriers are looking for a great deal to be your second, third or fourth tenant. On the build side, the carriers are asking you to build towers at lower initial anchor tenant rates with financial and operational terms more attractive to the carriers. All the while, your cost capital probably has stayed the same." Bizick said doing business this way is like a high-wire balancing act.

"As a company, we aren't pressured

to invest money for the sake of investing money," Bizick said. "The partners have a significant amount of their own capital invested, so naturally, we act every day like it's our money because it really is, and that makes you approach things differently than if you're working with other people's money. The thought process and decision-making can be different in those two cases."

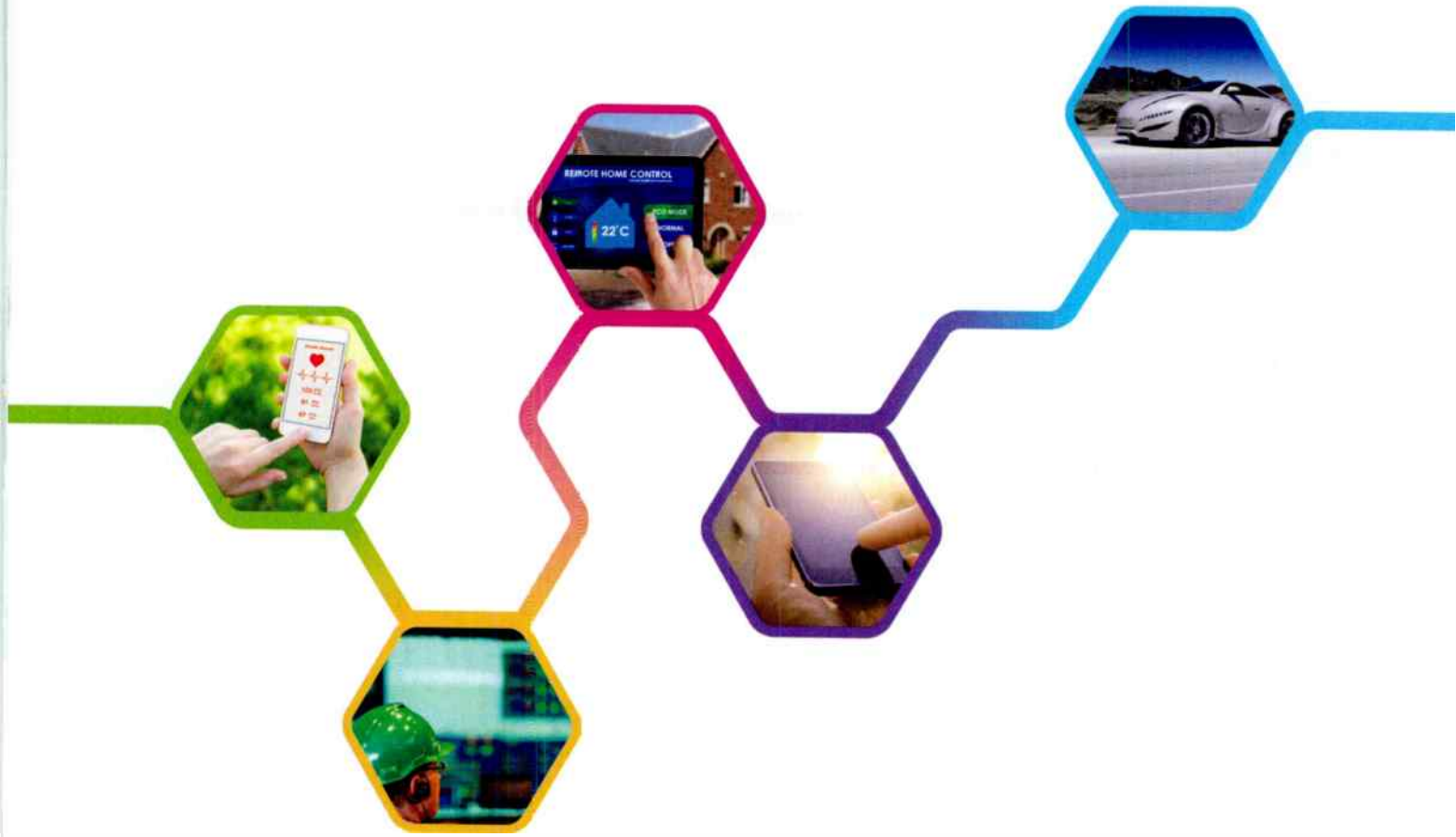
Tarpon Towers' investor, Redwood Capital, thinks the same way. "If it takes a little longer to gain scale, so be it, but we don't want to overpay or invest unwisely, and then if the market has some sort of correction, we're left holding the bag," Bizick said. "You can't bet on the greater fool theory of when and if it's time to exit. The industry has enjoyed a rising tide for almost 10 years now with strong carrier investment and a low interest rate environment. Multiples for private tower deals have increased by seven to, in some cases, 10 clicks during that time. Exiting at high multiples can hide a lot of investment sins."

Although Bizick said he believes the cell tower market has a bright future, he doesn't foresee dramatic growth for Tarpon Towers over the next few years. "I believe business will be slow and steady," he said. "We will be more like the tortoise than the hare for a little while." But he said he also believes that several potential catalysts should spur cell tower growth, notably further investment in AWS 3, FirstNet, the current spectrum auction, the potential deployment of radio-frequency spectrum owned by Dish Network and the mysteries of fifth-generation cellular technology.

Good for the Industry

"Although consolidation tends to be a bad word in the tower world, certain consolidations could be quite good for our industry," Bizick said. "Directionally, 2017 ought to be an interesting year for the industry. If the catalysts I mentioned happen and, even more so, if they happen in some fashion simultaneously, the tortoise will quickly become the hare. Let's all hope for a great race."

Mike Harrington is a freelance writer in Prairie Village, Kansas.



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An FCC View of the Future for Wireless

By Tom Wheeler

Nationwide data roaming, access to 4G LTE, possible federal preemption of siting authority to facilitate 5G access points, security and privacy are among the FCC's upcoming priorities.

Editor's note:
On Sept. 20, FCC Chairman Tom Wheeler addressed a meeting of the Competitive Carriers Association in Seattle. What follows are his remarks, edited for length and style.

At the FCC, we're pursuing an aggressive agenda to seize the opportunities of mobile for rural America. It starts with competition. When competition exists, consumers win. It drives innovation, investment and economic benefits.

Roaming is one of the most effective tools to help fuel wireless competition. To compete, wireless carriers must be able to offer nationwide coverage. Roaming agreements have made it possible for smaller providers — particularly in rural areas — to do business.

Data Roaming Order

The FCC's 2011 data roaming order took a significant step toward preserving roaming for the internet age, but our roaming rules are already due for a fresh look. In the past two years, multiple providers have filed formal complaints and requests for mediation alleging that the data roaming rates offered by larger providers are commercially unreasonable. Because of high rates, we know that some smaller providers have placed usage and speed restrictions on data roaming traffic.

There are two roaming frameworks: a just-and-reasonable standard for voice roaming and a commercially reasonable standard for data roaming. The Competitive Carriers Association has been vocal in calling on the FCC to apply uniform roaming standards across voice and data services. Before the end of the year, I plan to call on my fellow commissioners to adopt a notice of proposed rulemaking on the FCC's data roaming framework. Tackling this issue will allow the FCC to provide greater certainty in the marketplace and promote consumer benefits and competition.

Universal Service Fund

Although nurturing competition is always going to be Option A for maximizing consumer benefits, that is not an option in many parts of the country. Indeed, many rural areas do not have access to robust rural broadband at all. The FCC has an affirmative responsibility to make sure all Americans have access to our nation's critical communications networks. That's where the Universal Service Fund (USF) comes in.

In 2011, the FCC adopted landmark reforms to the USF, reorienting this 20th-century program for providing phone service to support broadband connectivity. One of the big innovations of the revamped USF was to create the Mobility Fund to spur deployment of advanced wireless infrastructure, and replace the old competitive eligible telecommunications carrier support, which the FCC concluded was not well-targeted. The FCC is working to move forward with Phase II of the Mobility Fund by the end of this year.

Keys to the Future

At a high level, here are what I see as the keys to the future of the Mobility Fund. First, we need to identify where there's actually no 4G LTE wireless coverage. There's an old saying that "you can't manage what you can't measure." When it comes to measuring wireless coverage in America, our record, quite frankly, is — like coverage in many rural areas — spotty.

The problem is the way we collected data. For the one-time support distributed under Phase I of the Mobility Fund, we relied on a third party and used the data at the census-block level, which is getting down to a pretty small area. But it wasn't granular enough, particularly for the geographically large census blocks found in rural areas. A census block would get identified as having coverage. But, within that census block, the east side of the area might have service, while the west side has none.

So we're fixing that. Here's how: Twice a year, the FCC requires mobile carriers to submit Form 477, which contains network coverage data. This data allows the FCC to create a sig-

nificantly more detailed picture of actual wireless coverage within the census block. Instead of generalities, we can drill much deeper to see that there's coverage here, but there's not coverage there.

The data confirms what everyone knew from experience — that significant LTE coverage gaps still exist throughout America. Excluding Alaska, 11 percent of the nation's road miles have no 4G LTE coverage at all, including no subsidized coverage. Sixteen percent of all square miles have no LTE coverage or only subsidized coverage. And 1.4 million Americans currently have no access to LTE coverage at all, and 1.7 million live in areas where the only LTE coverage relies on a subsidy.

It's no accident that I've been describing the unserved areas as those without access to 4G LTE. 4G cellular technology is table stakes for wireless connectivity in 2016. As we're gearing up for 5G, we can't consign parts of the country to second-class digital citizenship by settling for 3G service.

Investment Focus

If the first key to the Mobility Fund's future is better measurement, the second is using this new data to make sure our investments are properly focused, and that focus is clear: unserved areas.

I'm part of the broad, bipartisan coalition that supports the Walden Rule, which says we should not use ratepayer funds to support service in an area that is served by an unsubsidized provider. The Walden Rule's namesake, Rep. Greg Walden, represents a rural Congressional district in Oregon, which is larger than Ohio, so this is a person with real-world experience dealing with rural connectivity issues. He's also chairman of the FCC's oversight committee in the House of Representatives and a thoughtful leader in policy development.

Phase-out Period

Although the idea of non-duplication is clearly a settled policy principle, it raises very real challenges. Every USF dollar used to support duplicative service is a dollar that is not available to bring service to the more than 550,000 miles of unserved roads where somebody might have an accident and need to contact 911. That just won't do. Nevertheless, we recognize that there has been reliance on these subsidies for the provision of duplicated service. We can't just go cold turkey, but we need a responsible phase-out period.

> *"Roaming is one of the most effective tools to help fuel wireless competition."*

That's why the third big challenge for the Mobility Fund is going to be phasing out support in a way that is fair to those who have been receiving universal service funding in duplicative situations. But the FCC's mandate is to support service where there is none, and diverting dollars from that purpose is not in the long-term public interest.

Tomorrow's Mobile Networks

So far, I've been talking mainly about expanding the availability of today's mobile broadband networks. Now let's talk about tomorrow's mobile networks. Let's talk about 5G.

Where today's wired and wireless networks force customers to choose either high speed and capacity or mobility, 5G promises gigabit mobile connections at any location. The limitations of speed, capacity and latency are about to become history, and these changes will define our future.

Fiber-fast wireless connectivity will deliver that long-sought goal of competitive high-speed internet access for rural consumers. C-Spire, for example, successfully tested 5G fixed wireless service in its home state of Mississippi, reaching speeds of 2 gigabits per second.

Whether it's 5G or the ubiquitous delivery of 4G into unserved areas, there are three keys for what the commission must do.

Spectrum for Competitors

The first is ensuring ample availability of spectrum to a range of competitors. On that front, the FCC has opened the door to the spectrum trifecta. We've targeted low-band, mid-band and high-band airwaves that make available unprecedented amounts of spectrum. After years of work, we are finally in the midst of the historic incentive auction to make available greenfield low-band spectrum. We've created a market in the Incentive Auction that makes available a significant amount of prime beachfront spectrum in the 600-MHz band. And we created the first-ever market-based spectrum reserve to provide competitive carriers and new

entrants with an opportunity to obtain a portion of this valuable resource.

The first stage of the auction closed when the cost to clear 126 megahertz of broadcast spectrum exceeded the bid prices of the carriers. We resumed bidding in the reverse auction to determine the cost to clear a reduced amount — 114 megahertz — of spectrum. Following the close of Stage 2 of the reverse auction, we'll again turn to the forward auction to determine if the spectrum is worth that cost to you.

The Incentive Auction, however, is just a part of the spectrum trifecta. The commission's record-setting AWS-3 auction and creation of the new Citizens Broadband Radio Service in the 3.5 GHz band are landmarks in using new sharing tools to open up more mid-band spectrum in multiple forms, whether exclusive, shared access or unlicensed. Such sharing will only become more important, which is why we are pushing aggressively to make the Spectrum Access System a reality for 3.5GHz and beyond.

This summer the FCC approved an order making the United States the first country in the world to open up high-band spectrum for 5G networks and applications. And in order to give this industry the opportunity to lead the world in 5G, we did it in record time — only nine months from proposal to final decision.

Competitive Infrastructure

The second key component of the commission's strategy is fostering competitive provision of infrastructure, specifically backhaul. Regardless of the spectrum allocation, 5G will require a lot more cells, particularly at the higher frequencies. These small cell sites will need to be connected, so we'll need a lot more backhaul.

But backhaul isn't just about 5G. If there is going to be universal wireless coverage, there needs to be fair access to backhaul. In many areas, competition in the supply of backhaul remains limited, and that can translate into higher costs for wireless networks, higher prices for consumers, and an adverse impact on competition. Backhaul accounts for about one-third of cell site operating costs.

Before the end of this year, I will present the FCC with a reform proposal that will tackle this issue and encourage innovation and investment in what we now call business data services, while ensuring that lack of competition in some places cannot be used to hold back wireless coverage.

Notably, reform is supported by the nation's leading wireless carriers, save one.

And the issue of an expanded number of cell sites brings us to the third challenge: siting. Estimates are that 5G will require a 10 times growth in cell sites, and potentially significantly more. That's hundreds of thousands of new antennas. That's hundreds of thousands of siting decisions. That raises a key question: How can we work with siting authorities to allow the plethora of antennas that will be required quickly and at a reasonable cost?

One thing we must do is to tell the story of what 5G is — and not just in terms of technology, but as deliverables that mean something to real people. We will be unsuccessful in dealing with NIMBYism and the recalcitrance of local authorities if all we talk about is engineering. We have to help leaders at the local level — and all levels for that matter — understand that 5G will make the internet of things (IoT) real. But even talking about IoT is too obtuse.

Let's talk about the benefits of smart-city energy grids, safer transportation networks and new opportunities to improve health care. Let's paint the picture of how 5G will unleash immersive education and entertainment industries and how 5G will unlock new ways for local employers to grow, whether it's a small specialty shop or a large factory, creating new jobs and improving services for the community.

It is also necessary to explain that the nature of 5G technology doesn't just mean more antenna sites, it also means that without such sites, the benefits of 5G may be sharply diminished. In the pre-5G world, fending off sites from the immediate neighborhood didn't necessarily mean sacrificing the advantages of obtaining service from a distant cell site. With the anticipated 5G architecture, that would appear to be less feasible, perhaps much less feasible.

Furthermore, the nature of the technology makes the review and approval by community siting authorities and the associated costs and fees all the more critical. There are just over 200,000 cell towers in the United States, but there may be millions of small cell sites in the 5G future. If siting for a small cell takes as long and costs as much as siting for a cell tower, few communities will ever have the benefits of 5G.

Make no mistake, localities play a vital role in the siting process, and they have important and legitimate rights, but those rights don't extend to blocking a national communications

pathway. Given the importance of ubiquitous expansion of 4G and the rollout of 5G to our economic future, it's not reasonable for localities to view cell site deployment as a potential new revenue stream, which is something we've seen. It's not reasonable for cities to franchise their siting to a third party, who acts as a gatekeeper.

For our part, the FCC is united in its commitment to cutting red tape and facilitating siting. We've streamlined our environmental and historic preservation rules, and tightened our shot clock for siting application reviews.

And there's a bipartisan commitment to do more as warranted. Both my Republican colleagues, for instance, have recently agreed that where states or localities are imposing fees or not being fair and reasonable for access to local rights of way, the FCC should preempt them. We shouldn't be afraid to use all of our authority under the Communications Act to address unreasonable local barriers.

Security

A couple of other important issues warrant mentioning. Our wireless networks must be secure. The FCC has been engaged with industry professionals to make sure cybersecurity is addressed, including during the design phase for the entire 5G ecosystem, including devices.

Privacy is another important topic. Digital networks create big data, so it's imperative that carriers have privacy policies that enable customers to understand and control how their personal information about their digital activity is being used.

The bottom line is that there is a road map to chart both our path to ubiquitous wireless LTE and to our 5G future. Now is the time to make it happen. Now is the time to update our data roaming rules to promote and preserve wireless competition in rural America. Now is the time to move forward with the next phase of the Mobility Fund to ensure that every American can access high-speed wireless connectivity. Now is the time to come together to build the mobile future.

Tom Wheeler is chairman of the Federal Communications Commission.

T-Mobile USA's Vision for 5G Cellular Technology

By Neville Ray

Carriers are mired in their telecom utility legacy, tangled in outdated tech and landlines, and buried under layer upon layer of bureaucratic BS and Old Economy thinking. Maybe with one exception.

Over the past year, just about everybody talking about the future of wireless has been talking about one thing: 5G cellular technology. On behalf of T-Mobile, I've been pretty quiet on the subject while the standards are still being defined and, by my estimate — and that of every credible expert — true wireless 5G is still years away. Broad deployment should be here toward the end of the decade.

Still, that fact hasn't stopped the carriers from making ridiculous promises to deliver 5G in 2017 and then having to run away from those promises. Watching all this nonsense, I've been amazed by the carriers' complete lack of vision for 5G's potential as well as their naiveté about how we'll all get to 5G.

A Real Vision for 5G

The carriers' vision for 5G's potential is mind-numbingly limited. We are talking about amazing technology here, and they can't see beyond their own self-interest. AT&T wants to "connect your world" by connecting your microwave and everything else in your life — including your bank account — to AT&T. Verizon's grand vision is that you can cancel your fixed broadband and watch Netflix at home with wireless Verizon broadband. Double yawn.

How disappointing. So little imagination from these supposed network leaders.

Transforming Mobile Internet

Sure, broadband and the internet of things (IoT) are exciting opportunities, and we will play there, too. But, 5G is not only about connected cities or refrigerators or wireless replacements to your perfectly good home broadband. 5G is about the absolutely amazing things we can do with mobile technology from virtually anywhere. Our vision for 5G goes so much further than this. We see 5G

AGL TOWER OF THE MONTH

ABOVE GROUND LEVEL
agl
DECEMBER 2016

SITE NAME
STATE LINE ROAD

HEIGHT
100 FEET

OWNER
AT&T MOBILITY

MANUFACTURER
SABRE TOWERS & POLES

YEAR CONSTRUCTED
2012

LOCATION
KANSAS CITY, MISSOURI

Photography by Don Bishop

Small Cells? No Thanks

By Don Bishop

For the most part, SBA Communications can do without small cells. The company has some. It's just that it finds the small cell business is not as good as its tower and macro business.

One of the five largest tower companies, SBA Communications, has had limited involvement with small cells since it divested its ownership stake in ExteNet Systems. Its chief financial officer, Brendan Cavanagh, said SBA has a small group focused on developing small cell or distributed antenna system (DAS) installations associated with properties for which SBA already owns some rights. This includes the company's towers and more than 5,000 buildings and other properties for which SBA has management rights. He said exclusivity is the key, and SBA focuses attention on assets for which it has some exclusivity.

Importance of Small Cells

"We're not one to say that small cells aren't real or that they're not a critical part of what the carriers are doing," Cavanagh said. "They absolutely are. The question is whether there's a good place for an independent infrastructure provider to play a role in the build out of small cells and DAS. I think there is, but it's not nearly as good as the existing tower and macro business."

Cavanagh said it's a matter of choosing where to deploy capital and resources. As an exclusive asset, towers help SBA to sustain pricing and to obtain worthwhile returns on its investment. On the other hand, the small cell business has less exclusivity and therefore more competition. He said small cell developers sell projects with their responses to requests for proposals (RFPs). He said that, in itself, shows competition and pricing influence the small cell business. In Cavanagh's view, competing for small cell projects works especially well for companies that own fiber-optic networks because owning fiber helps them obtain a more acceptable return on small cells.

Leveraged Capital Appreciation

"In our case, we still look at ourselves as a leveraged capital appreciation story, and the best way to drive value there is to continue to focus on the macrosites," Cavanagh said. "Even if that means focusing on our own macrosites through stock buybacks, we see the returns as better."

Cavanagh conceded that whether

Jeffrey A. Stoops, CEO, SBA Communications.

Brendan Cavanagh, CFO, SBA Communications.

completely transforming the mobile internet and delivering amazing breakthroughs.

With incredibly low latency, very high bandwidth and sensors capable of decade-long battery life, 5G networks are set to enable one of the biggest tech transformations in history.

We see a 5G future where every major tech trend that sparks our imaginations — mobile virtual reality, augmented reality, artificial intelligence and more — will all be made better and available on the go because of 5G. Just as 4G spawned the mobile-first internet and gave rise to applications and devices that have literally changed the way the world communicates, 5G will unlock apps and solutions we can't even imagine right now.

At T-Mobile, we will put 5G to work for people, as we always have with new technologies. And, true wireless 5G on our network has the potential to change things radically, accelerating long-term trends, creating immersive experiences and increasing mobile productivity and entertainment for everyone. When we talk about 5G, we need to really focus on the exciting areas 5G will revolutionize:

How will higher speed, massive capacity, lower latencies and increased battery life change the way we live our lives?

How will personal communication evolve with augmented reality and virtual reality that works great on the go?

Will we consume new content and communicate with new and compelling device formats?

What will happen with media and content — will it become truly mobile and follow you?

Will we create richer flows of data from ourselves for mobile health, personal security and more?

These are the kinds of questions we're exploring.

Building Toward 5G

The carriers present 5G as some kind of research project that will emerge fully formed from the lab at some point in the future. That's utter BS. 5G is something we are building now. At T-Mobile, each and every new technology we roll out is building toward the future — toward 5G. Great 5G wireless will be anchored in and will live alongside an amazingly advanced LTE network. And that is exactly where we're focused. And, what a rock solid, ass-kicking foundation for 5G we are building at the Un-carrier.

We've built our network and our entire network team to advance faster than the carriers. T-Mobile is a mobile internet company, and our network is moving faster onto the same IP tech that runs the internet, which means our network advances at internet speed.

That's how we went from zero to covering nearly 312 million people with T-Mobile LTE in just about three years, all while remaining America's fastest 4G LTE network, according to OpenSignal, Ookla and the FCC. That's why nearly every meaningful network technology over the last three plus years has been available to Un-carrier customers first. And that's why we continue to lead with the nation's densest network and, most recently, three-carrier aggregation, 4x4 multiple-input multiple-output (MIMO) communications and 265-quadrature-amplitude modulation (QAM).

Meanwhile, the carriers are mired in their telecom utility legacy, tangled in outdated tech and landlines, and buried under layer upon layer of bureaucratic BS and Old Economy thinking.

And, of course, we're already doing all the same basic things for 5G they are. (We just spend our time doing. They spend their time talking about doing.) We're already working with standards bodies, with the FCC on spectrum, with Deutsche Telekom to tap into its global expertise and with Nokia, Ericsson and Samsung on early trials. Some of those early trial results are impressive. We've already demonstrated speeds up 12 Gbps with latency under 2 milliseconds, 8x8 MIMO and four simultaneous 4K video streams.

No doubt about it: 5G will be amazing. And, we are all working with the same tools to get there. But, here's the thing: It's not about the tools. It's about how you use them. What's going to set 5G networks apart is how we put that amazing technology to work for our customers. That is what's always set the Un-carrier apart.

When the carriers look at 5G, they see another opportunity to line their pockets. We look at 5G and see another opportunity to unleash customers. So, we'll keep going faster, growing faster and advancing faster into the future. As T-Mobile CEO John Legere always says, "We won't stop."

Neville Ray is CTO of T-Mobile USA.

the small cell business is enough of a moneymaker is a matter of opinion, and he said it could take years to find out for certain. "But we're not against it," he said. "We just don't think it's as good as what we have."

The SBA executive said that he has heard some imply that if a wireless infrastructure provider doesn't provide certain specific types of solutions to the carriers, it could in some way affect the existing solutions it provides. "If we provide macrosites and we don't provide a particular fiber or small cell solution, some say that would affect our macrosite business, and I would take the position that it would not," Cavanagh said. "In fact, that other business could not leverage my existing macro business, and it comes down to the exclusive nature of the macro business."

Cavanagh said that doesn't mean a wireless infrastructure company couldn't do well in the small cell business or that it wouldn't be worthwhile to try to provide other solutions to its customers. "That's absolutely worthwhile," he said. "To the extent we can all do it, we should. But we should also be making the decision based on profitability to our company and to our shareholders, and you don't need to have one to have the other. They don't have to go together. They can be apart."

Non-urban, Highway Portfolio

SBA's CEO, Jeffrey A. Stoops, said that the nature of the company's portfolio of towers influences its decisions about small cells. Small cells mostly are deployed where the population is dense, such as in urban areas. "Our portfolio is primarily a non-urban residential and highway portfolio," he said.

> *"The question is whether there's a good place for an independent infrastructure provider to play a role in the build out of small cells and DAS."*

Compared with the radio frequencies used for cellular communications today, 5G cellular technology includes the use of higher frequencies, such as 28 GHz. Stoops said that outside of urban markets, network operators won't achieve satisfactory radio-wave propagation in the 28-GHz band.

Towers as Aggregation Points

"You are not going to have 5G out along the highway corridors that run only on 28 GHz," Stoops said. "It will not be economically feasible. Our towers will continue to be extremely important, more so as fiber hubs as aggregation points for backhaul. We are optimistic about where all that takes us, and we do not believe that systems and networks that run on 28 GHz, or even some higher frequencies that they have talked about, are going to replace or even dilute the macro networks that represent the bulk of our portfolio."

Brendan Cavanagh, CFO of SBA Communications, spoke at the Wireless Investors Conference, part of the Wireless Infrastructure Show, in May. The next Wireless Infrastructure Show is scheduled for May 22–25, 2017, in Orlando, Florida. Jeffrey A. Stoops, CEO of SBA Communications, spoke during a company earnings call in July. Photography by Don Bishop.

Small Cells? Maybe Later

By Don Bishop

The balance that American Tower strikes between macrosites and small cells has much to do with the better return on investment it can obtain with foreign investing.

American Tower owns 40,000 towers in the United States. It owns 300 in-building distributed antenna system (DAS) networks in places such as Las Vegas casinos and Class A shopping malls, among other inside venues. It owns another 30 outdoor DAS networks that cover areas where zoning for towers is difficult to obtain.

The company's senior vice president and CFO, Rodney Smith, said wireless carriers need towers, DAS and small cells to solve their mobile network problems. He said American Tower believes the carriers spend about 5 percent of their capital on small cell and DAS deployments, generally in urban centers where permits for macrosites are difficult to obtain. "But we do see the carriers choose macrosites whenever they have the chance," Smith said. "If you can get a macrosite zoned and built, they will go on that before they'll build an outdoor DAS network." American Tower has been constructing new in-building networks and leasing to additional tenants on its older networks.

Smith said he believes wireless carriers will grow their investments in small cells by at least 5 percent and maybe by as much as 10 percent during the next four or five years. "That would mean if they're spending about $30 billion dollars altogether, they will be spending about $3 billion of that on small cells," he said. "That's not a huge drag away from macrosites, which the carriers will

Rodney Smith, senior vice president and CFO, American Tower. *Photo by Don Bishop*

continue to need to use in the long term and outside of urban centers. But they will also need the DAS networks in other places."

Smith compared in-building DAS with outdoor DAS, saying that in-building systems are where American Tower has chosen to spend most of its capital allocated to DAS. "When we invest capital, we look at the returns that we can get, and we've done really well with our in-building deployment," he said. "We generally see those networks lease to an average of two carriers, or a little more, similar to the way we see towers lease. On outdoor DAS networks that we've had for as long as five or six years, the average is 1.2 or 1.3 carriers per system. They don't lease up quite the same way."

American Tower also obtains lower margins on its outdoor DAS networks compared with its in-building systems. Smith said the margin for indoor networks is about 70 percent, compared with 50 percent for outdoor DAS. The outdoor networks are more complex and they have a heavy operating expense (opex). Smith said they are capital-intensive, too, resulting in a mid-single-digit return on invested capital. "That's primarily because we don't see the clear path to lease to second tenants because every time you put a new node in, you're running new laterals, you're running fiber, you're splicing your investing and you're increasing your investment," he said. "In the indoor space, we see returns that are similar to the tower space when they get in the double digits." As a result, American Tower invests more in in-building systems, although Smith said outdoor DAS definitely is needed.

"We also have the whole globe available to us to invest in macro towers," Smith said. "One of the reasons we are somewhat choosy about what we invest in in the United States is because we can invest in India, Mexico, Brazil, Germany, South Africa, Nigeria and other countries in Africa. We see better risk-adjusted returns from macro towers in those markets. For us, the ability to invest internationally is key. When you ask, 'Why isn't American Tower investing in outdoor DAS,' it's because we believe we can achieve better returns in different spaces in the United States and outside of the United States."

Rodney Smith spoke at the Wireless Investors Conference, part of the Wireless Infrastructure Show, in May. The next Wireless Infrastructure Show is scheduled for May 22–25, 2017, in Orlando, Florida.

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Small Cells? Yes Please

By Don Bishop

For three companies with roots in the tower business, small cells offer an alternative too good to pass up. Their fiber-optic networks offer small cell collocation opportunities that resemble antenna collocation opportunities on towers.

Crown Castle International, InSite Wireless Group and Digital Bridge Holdings share an appetite for small cells.

For Crown Castle, small cells represent assets placed on a collocatable asset, which is the fiber-optic network that delivers traffic from a mobile wireless network at a local point. "Whether that's a distributed antenna system (DAS) node, a small cell, a femtocell or a picocell doesn't necessarily matter to us, as long as there's a fiber on which we can collocate," said Dan Schlager, senior vice president of corporate finance at Crown Castle.

Schlager said Crown Castle wants to make the fiber-optic network profitable. To do so, the company seeks to participate in the densification of the radio-frequency (RF) spectrum the mobile networks deploy and, in doing so, become a partner to its wireless carrier customers. "We firmly believe that fiber is the asset that we're going to collocate on, and what we really try to push on," he said.

In a view expressed by Jay A. Brown, Crown Castle's president and CEO, because small cells are deployed closer to the end user and in a denser array, such as on traffic lights or telephone poles, they represent the natural progression of network densification required to provide continuous consistent high-capacity and low-latency connectivity. With small cells, the company's initial investment relates primarily to the build out of the fiber-optic cable network. "We believe our fiber footprint of 17,000 miles in top mature markets combined with the capabilities that we have acquired and developed over time give us time to market and economic advantages that should allow us to capture a significant share of this large opportunity," Brown said.

> *"In the small cell business, we're drinking through a fire hose. We have 2,000 nodes in construction. We have a leasing backlog that's worth close to $60 million in annual recurring rent. There's more than we know what to do with."*
>
> *– Marc Ganzi*

For 2016, Crown Castle is expecting $170 million in organic revenue growth, with $115 million from towers and $55 million from small cells. Brown said the company sees its investment in small cells as representing an opportunity to grow the dividend it pays shareholders.

"Looking beyond 2016, we believe we are in a multiple-year cycle of network upgrades and enhancements, as carriers focused on meeting significantly increasing demand for wireless connectivity, which we believe will benefit both our tower and small cell businesses," Brown said.

InSite Wireless started in the DAS business 16 years ago. The company built a system in the Moscone Center in San Francisco that has since undergone nearly six generations of upgrades for densification. InSite Wireless focuses on indoor DAS, always providing fiber access to the sites.

"The leasing on DAS is phenomenal," said Lance Cawley, CFO and co-founder of InSite Wireless. He said the company built a DAS that covers the Massachusetts Bay Transportation Authority (MBTA) subway in Boston that serves AT&T Mobility, Verizon

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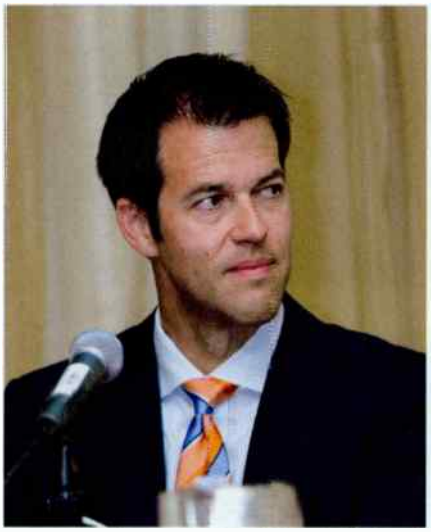

Jay A. Brown, president and CEO, Crown Castle International.

Marc Ganzi, chief executive officer, Digital Bridge Holdings.

Dan Schlager, senior vice president of corporate finance, Crown Castle International.

Lance Cawley, chief financial officer and co-founder, InSite Wireless Group.

Wireless, T-Mobile USA and Sprint. In addition, Comcast provides Wi-Fi service. InSite Wireless has started some underground wireless service for Verizon in the Los Angeles County Metropolitan Transportation Authority (Metro).

"DAS is a wonderful, yet difficult, business," Cawley said. "Unlike towers, which are just a simple real estate leasing business involving many forms and a documented information flow handled by run of the mill staff, in DAS, it requires somebody at all levels of legal, engineering, RF and finance. These are $20 million, $30 million and $40 million build outs that take many years to complete. It involves a lobbyist and attorneys. It's complicated, but we have phenomenal results in our DAS business. I think of the small cell business as an extension of the DAS business. A small cell has a base transceiver station (BTS) built in, whereas DAS has a centralized BTS pack."

Cawley said InSite Wireless is indifferent to which solution it provides. "We provide whatever is cost-effective for the carrier to meet its capacity demands," he said. "We love the macro tower business. It's the majority of our business. We believe you should be in all these lines of business to meet the carriers' growth and capacity requirements."

At Digital Bridge Holdings, CEO Marc Ganzi said mature small cell networks experience lease amendment activity much like the tower business does. And business is good. "In the small cell business, we're drinking through a fire hose," Ganzi said. "We have 2,000 nodes in construction. We've got a leasing backlog that's worth close to $60 million in annual recurring rent. There's more than we know what to do with. It's that size of an opportunity. That's good, because as some of the macro tower business has slowed, we've seen the small cell business accelerate dramatically."

Dan Schlager, Lance Cawley and Marc Ganzi spoke at the Wireless Investors Conference, part of the Wireless Infrastructure Show, in May. The next Wireless Infrastructure Show is scheduled for May 22–25, 2017, in Orlando, Florida. Jay A. Brown spoke during an earnings call in July. Photography by Don Bishop.

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What Wireless Will Bring in Years to Come

By Michael Mitchell

The heavy influence of mobile network operators was felt in the Wireless Recession of 2015-2016, with all wireless carriers but Verizon cutting back. 5G cellular network plans hold promise for future growth.

I don't know about you, but I'm happy to see 2016 fall away in my rearview mirror. How does one really capture what most small business owners went through in the last 12 to 24 months? In short, we were in a wireless recession, not nearly as bad as the Great Recession of the late 2000s and early 2010s, but it was pretty bad.

What makes the 2015-2016 Wireless Recession different from the rest? We know that, unlike the other recent recessions, the 2015-2016 recession was pretty selective and didn't affect everyone. For example, the auto industry was less affected, thanks in part to low fuel prices coupled with low interest rates. And if your business was an approved Verizon vendor, your wireless business was less affected.

Wall Street saw growth, but was it really growth or was it something else? Often, Wall Street is smoke and mirrors. I believe those modern-day thieves simply came up with yet another scam to make money. In this case, they probably borrowed cheap money to buy back their own stock so their balance sheets showed increased margins, but did they really grow their businesses? In most cases, probably not. I'm betting that at some point when interest rates rise and those companies begin paying back those cheap-money loans — *ka-boom*. Wall Street should never be taken as an indication of economic health.

Some small businesses were busy. Verizon did a nice build out, but the other carriers basically did nothing in comparison. Although my company wasn't involved, we saw a lot of activity installing backhaul, but, again, most of that was for Verizon. We were involved with pockets of activity, one with a rural carrier and others based on special events. In the second and third quarters of 2016, we saw some things start to heat up: T-Mobile kicked off a few things and Sprint held a weird reverse auction for micro-mini sites. All in all, most wireless businesses will have a good fourth quarter.

> *"Human minds can think up some amazing designs and applications, but consumer products could take years to design and manufacture."*

But again, why did wireless die in 2015 and the first part of 2016, and what does this mean for the future? Here are several reasons:

- Companies didn't have plans in place.
- Companies didn't have money to invest in their networks.
- Carriers focused on rate-plan, buy-out programs that killed their incomes.
- Carriers are way out in front and are planning for 5G.

History teaches us that all markets eventually stabilize and then rebound, generally becoming a little more valuable than they were before a financial crisis. You cannot cut your way to profitability, and, at some point, company executives become tired of not making money. The only good thing about Wall Street is the pressure it exerts to grow. We saw this happen in the second week of September when all four major carriers' stock prices rose, some by as much as 34 percent.

History will probably be kind to FCC Chairman Tom Wheeler regarding his direction toward 5G cellular technology. If you haven't seen the speech he made at the National Press Club posted on YouTube and on the FCC website, you should. I'm sure everyone is excited because 5G should bring the next big build out of wireless infrastructure for all those who are prepared. But when will it start?

Most of the 5G build out will be directed toward user devices, as will

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the carrier build outs. Human minds can think up some amazing devices and applications, but consumer products could take years to design and manufacture. Until the Big 4 have a consumer product to serve with their networks, it'll be a little while longer until we see them go into full-throttle build mode.

Nevertheless, we can predict how the network will look. Antenna positions will be lowered dramatically, and antenna site placement will be much more dense. We are already seeing signs of the future with distributed antenna system (DAS) networks and small cells, but they are expensive. Some experts say every carrier is going to need hundreds of sites to cover small urban populations. If that is the case, then DAS networks and small cells will be much too expensive to maintain, let alone build. How will all this play out? It's too soon to tell.

In the meantime, some small internet-of-things (IoT) carriers are trying to build out, but will they be able to compete when the Big 4 decide to enter the race? The more competition, the better, but being first to create a market is usually a good position to be in. The entire IoT marketplace potential is so vast, trying to predict this future is too difficult, although I'm sure the IoT will make our lives much easier and faster.

Andy Hester

In September 2015, the wireless industry lost a good soul. Raymond "Andy" Hester, or as I called him, "RayRay." Hester started his career in the Marine Corps, where he learned electronics and communications. He started in the two-way radio industry, and then went on to paging, LoJack and EMF Telecom. RayRay worked for us for six years and made lasting impressions on his coworkers and me. I miss you every day, RayRay.

Michael Mitchell is president and CEO of EMF Telecom, a construction company with headquarters in Nashville, Tennessee. Mitchell has run a small to medium-sized company for the past 11 years and has more than 20 years of managerial experience with large wireless companies. His email address is mmitchell@emftelecom.com.

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Seven Ways to Envision Your Company's Future

By Andy Singer

If you're a business owner or a senior executive, providing foresight is one of the most important aspects of what you do for your organization. Spend enough time to envision your company's future and make it a continuous process.

One of the greatest challenges of leadership is determining what your organization's future will be. Envisioning what the organization should look like and where you should focus to get there is not always easy to determine. Your wager can have a significant effect on the future value of your company and the satisfaction of your stakeholders. To be successful, we have to understand how to develop and execute long-term, value-creating strategies. Developing foresight is necessary, although not always easy or obvious. Here are seven ways to envision your company's future:

1. Start with what you know: The first place to start is gathering and organizing what you do know. This may sound obvious, but often I walk into organizations that do not have this information organized. Another common challenge is that a senior executive gives the order to develop a strategic plan. The plan is then frantically assembled in four weeks, but with strategic planning you generally get out what you put in. A better method is to spend time every week of the year gathering, organizing and updating the key required information. The executive in charge of your strategic plan should be someone with significant product management and marketing experience. "Amateur hour" in this area will be costly to your organization in the long run and possibly sooner.

2. SWOT: Once you have enough information organized, your team should perform a SWOT (strengths, weaknesses, opportunities, threats) analysis. This is a classic tool used by product mangers to better understand product lines and markets. Often, keys about your best future strategies can be found by understanding how your market will change in these areas and what trends are expected. Then determine how you can innovate and transform your organization to make use of those changes. Be sure you take an honest assessment when you perform your SWOT analysis. Getting this correct and accurately seeing trends can allow you to be ready well before your competitors.

> *"Ensure that you understand how your organization will be different in the future. Many businesses merely react to changes in their markets."*

3. Know what you don't know: One of the most common errors I have seen in the process of envisioning an organization's future has to be the failure to understand there are things you don't know. Making assumptions can lead to significant errors in judgment, which will be costly to the outcome of your strategy. Know what you don't know.

4. Identify problems and risks: I enjoy investing, and one of the key areas I focus on prior to making an investment is to understand the potential problems and risks. As you may have, too, I learned how important this is the hard way. Always ask what might go wrong and understand how your organization can plan or react to those scenarios. You should also think about what problems your customers and your customers' customers will face going forward. Finding creative solutions to those challenges can allow you to develop unique and strong future solutions for your market.

5. Understand your differentiators: Successful businesses have a unique solution, offering or service that their competition cannot easily provide. This is the basis of differentiation and the path to greater profits. Ensure that you understand how your organization will be different in the future. Many businesses merely react

to changes in their markets. The most profitable and successful businesses create the market demand. With the technology we have available today, even a small company can transform the market and be a disruptor.

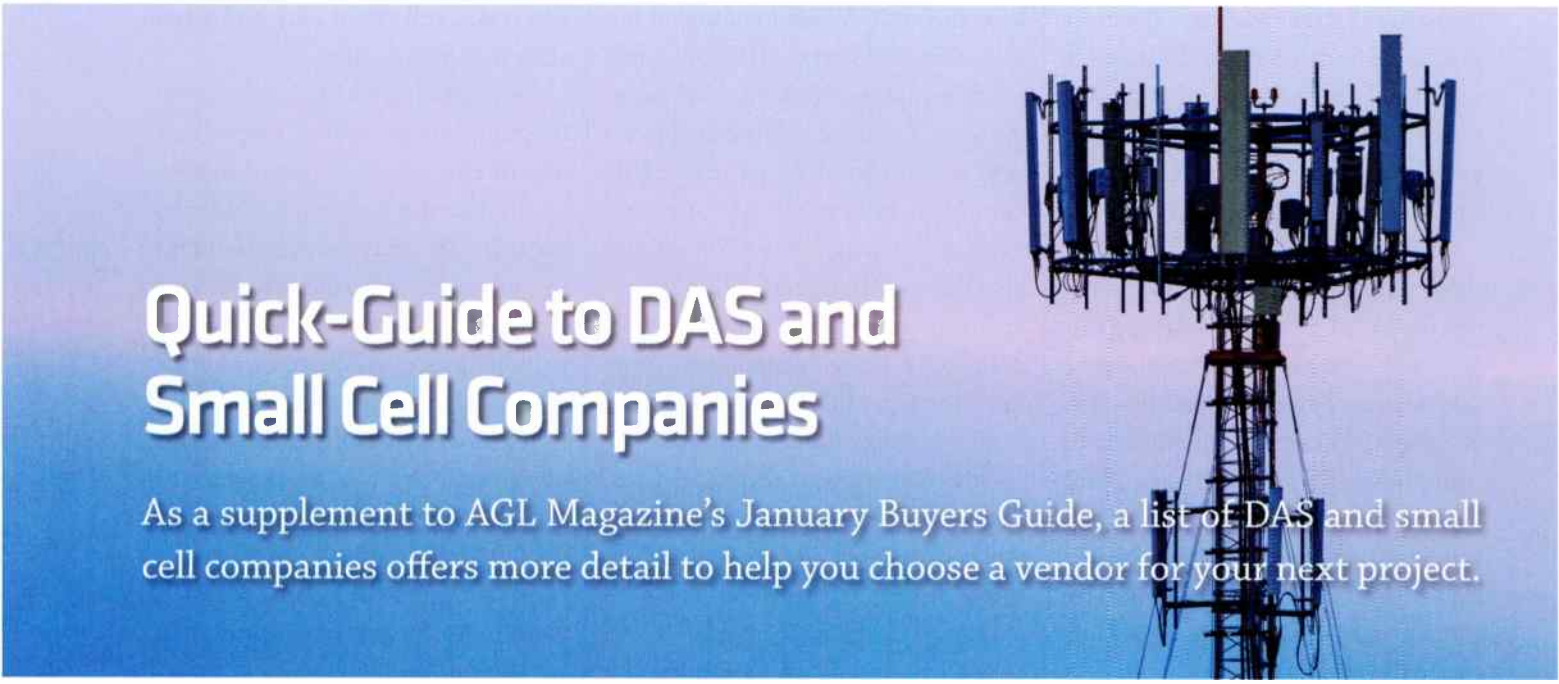
6. Plan to be transformative: Being transformative means to change, not just a little, into something different. Whenever I have taken over a business, we became transformative. We transformed the business into something different. Strive to be an organization that somehow provides value to the end users. No one asked Apple for an iPod, but Steve Jobs was transformative and Apple was wildly successful as a result.

7. Envision your future: Having foresight and considering the points mentioned will allow you to envision the future of your organization. By envisioning your future and communicating these plans to your team, you will be significantly ahead of most of your competitors. Keep in mind, a vision and strategic plan is not just a set of numbers. I was working with a company once and asked the vice president of sales and marketing about its strategic plan. He said he had one, and I said I would love to see it. What he showed me was a spreadsheet with sales and profit numbers. That is not a strategic plan. You need a detailed plan on how you are going to get there. This should include goals, actions, due dates and responsibilities. You should also be sure that part of this future vision includes what skills or types of people you need your team to grow into. Then, get help from the outside to develop your human capital.

You also need to consider if the future will require any changes in your corporate culture. A culture is like a strong gravitational force — extremely hard to overcome. It will take work and often help from the outside. Any culture shift will require a charismatic and experienced team made up of both internal and external representatives. Don't minimize the challenge in changing cultures — most executives fail doing so. Even though what you are doing may be good for the company, possibly saving it, we are all human, and change is tough. When we get stressed, most of us want to go back to the familiar. This will include your managers and your employees. Don't forget, people respond better when you tell them why and when they feel ownership.

Yes, planning for the future is challenging, but providing foresight is one of the most important aspects of what senior executives do for an organization. Ensure you are spending enough time to envision your company's future and make it a continuous process. Foresight requires analytical and creative thinking, and it requires experience. Ultimately, obtaining help from an experienced outside expert can greatly increase your odds of success. Although we cannot predict the future precisely, we can envision scenarios and plan for the future. Remember, failing to plan is planning to fail. Plan for your organization's future and inspire your team to greatness.

Andy Singer is president of Singer Executive Development. The company offers training courses in executive management, product management and microwave systems. An electrical engineer with an MBA, Singer is a former president of RadioWaves. He writes "Down to Business," a syndicated newspaper column. His email address is andy.singer@singerexecutivedevelopment.com.



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.

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Clearwater, FL 33760
Customer Service
800.419.5100
customerservice@eupen.us
www.eupen.us
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3030 Warrenville Road
Lisle, IL 60532
Tony Eigen
630.505.3800
general@extenetsystems.com
www.extenetsystems.com
DAS or small cell system service owned or operated: operator-owned (neutral host), facility-owned, carrier-owned, public safety
System products, components or accessories: DAS, small cell, Wi-Fi, backhaul, C-RAN, LTE Packet Core, fiber transport
Services: site analysis; financing; permitting; system design, engineering, installation, management, monitoring and maintenance; carrier coordination; RF analysis; concealment solutions, turnkey solutions

ExteNet Systems designs, builds, owns and operates outdoor and indoor distributed networks for use by carriers, municipalities and property owners. ExteNet delivers tailored infrastructure solutions using proven technologies such as small cells, DAS, Wi-Fi, C-RAN and other networking components. —*adv.*

FDH Velocitel

1033 Skokie Blvd., Suite 320
Northbrook, IL 60062
Terri Beck
949.933.5707
terri.beck@fdhvelocitel.com
www.fdhvelocitel.com
Services: site analysis, permitting, system design, system engineering, system installation, RF analysis, concealment solutions

HMI Services

3525 Whitehall Park Drive
Suite 150
Charlotte, NC 28273
Thomas Jones
800.256.5500
marketing@hmiservices.com
www.hmiservices.com
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Huber+Suhner

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Suite H
Charlotte, NC 28273
Dick Schmidt (wireless)
704.790.7236 office
630.816.4021 mobile
dick.schmidt@hubersuhner.com
Larry Conway (DAS)
214.425.9428 mobile
larry.conway@hubersuhner.com
www.hubersuhner.com
System products, components or accessories: DAS, small cell, Wi-Fi, backhaul
Services: system design

Huber+Suhner manufactures systems and components for optical and electrical connectivity. H+S offers expertise in radio-frequency, fiber-optic and low-frequency solutions, providing the backbone for DAS and small cell systems for customers worldwide. —*adv.*

Kathrein

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Richardson, TX 75082
Danette Hovland
214.238.8800
info@kathrein.com
www.kathreinusa.com
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Service: concealment solutions

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. —*adv.*

See ad on Page 35.

Larson Camouflage
1501 S. Euclid Ave.
Tucson, AZ 85713
Mark Schmidt
520.294.3900
schmidt@larsoncamo.com
www.larsoncamo.com
System products, components or accessories: DAS, small cell, Wi-Fi
Services: concealment solutions; concealment engineering, design and custom fabrication

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, financing, permitting

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San Diego, CA 92130
Tom Leddo
858.799.7850
info@md7.com
www.md7.com
Services: site analysis, permitting

MobileNet Services
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Irvine, CA 92618
Mark Chapman
949.951.1444
kohr@mobilenetservices.net
www.mobilenet.net
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System product, component or accessory: backhaul
Services: site analysis; system design, engineering, installation, management, monitoring and maintenance; carrier coordination; RF analysis and acceptance testing; DAS commissioning and system verification (AT&T 5 step); public safety design and testing; iBwave design; Wi-Fi design, testing and installation.

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Founded in 1984, NB+C is a leading wireless site development firm comprised of three divisions: Site Development, Engineering Services and Construction, and Technical Services. We are staffed with over 400 professionals who are totally committed to client service and project results. *—adv.*

See ad on Page 7.

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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 macrosites, DAS or small cell antenna venues. *—adv.*

Phazar

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Mo Bhuyan
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sales@phazar.com
www.phazar.com
System products, components or accessories: DAS, small cell, Wi-Fi
Service: concealment solutions

Phillips Lytle LLP

Phillips Lytle

One Canalside, 125 Main St.
Buffalo, NY 14203
Douglas W. Dimitroff
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ddimitroff@phillipslytle.com
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Services: all legal and regulatory matters related to small cell infrastructure.

Phillips Lytle is a corporate and commercial law firm with a dedicated telecommunications industry team that has extensive expertise with heterogeneous networks. Our attorneys have represented wireless service providers, neutral-host DAS providers, tower companies, property owners and fiber providers in transactions touching all parts of the small cell ecosystem. *—adv.*

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Kelly Batstone
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kelly.batstone@molex.com
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System products, components or accessories: backhaul
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Southern California Edison offers 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 switched Ethernet to dedicated wavelengths, SONET and dark fiber. *—adv.*

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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. *—adv.*

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Ad Council

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Product Showcase – DAS and Small Cell Products

Site Power Monitor

DuraComm's HE1U series high-efficiency rackmount DC power supply is designed to provide maximum power in a small package. These switching power supplies are designed to provide regulated voltage and low noise for use with wireless communication equipment. Built into a sturdy 1-RU high and 13-inch deep chassis, the HE1U is available in many power, voltage and feature combinations. This series is available at 300-watt, 750-watt and 1500-watt power levels with a choice of 12-, 24- or 48-volt DC output. Optional built-in features include battery backup, trickle charging, smart charging, low-voltage disconnect, and remote monitoring and control. The remote monitoring and control feature can be added to any of the HE1U platforms. It provides Ethernet-connected monitoring, control and notification of alarm conditions.

www.duracomm.com

Antenna

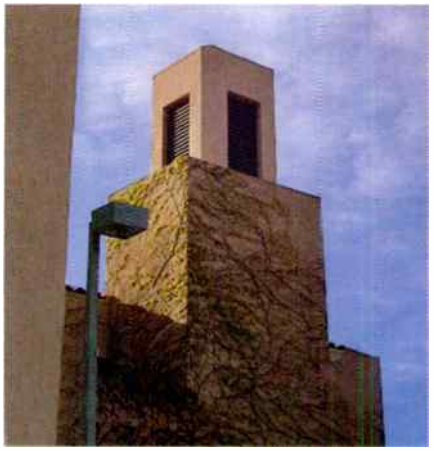
The Sencity Rondo omnidirectional antenna from **Huber+Suhner** is suitable for indoor DAS systems. Its VSWR of 1.5:1 across all cellular frequency bands maximizes system performance and allows for lower power levels. A PIM specification of –155 dBc (decibels relative to the carrier) makes the antenna useful in carrier-neutral systems and systems where interference is a concern. The antenna can be mounted above, through and under drop ceilings using the custom mounting bracket. The Rondo antenna is available now in both MIMO and SISO configurations with various connector interfaces.

www.hubersuhner.com

Mid-power Remote

Now supporting five-band MIMO in a single chassis, **BTI Wireless**' new mid-power (2-watt and 5-watt) remote solves the challenges high-capacity venues face — i.e., the outside signal not penetrating the building or the signal being taxed beyond its limits by a heavy concentration of people using their devices at the same time. This newly enhanced remote features BTI's high-performance amplifiers along with a space-saving design, allowing the user to customize the frequency band and power levels while deploying fewer chassis.

www.btiwireless.com



Custom Concealment Enclosures

Designed to meet the growing demand for small cells and DAS, **Peabody's Telecom Division**, also known as the Cell Site Disguise Guys, will custom-design DAS and small cell concealment enclosures so that, as the demand for increased communication rises, the sites will blend in seamlessly with the architecture and environment, indoor and outdoor. The company designs and fabricates a wide range of concealments, from RF-friendly faux wall sconces, framed wall décor, and creative sporting signage to fancy wall boxes, stop signs, and lamp posts. The company's concealments aim to allow superior cell reception without visual pollution.

www.cellsitedisguiseguys.com

Aesthetic Custom Concealments

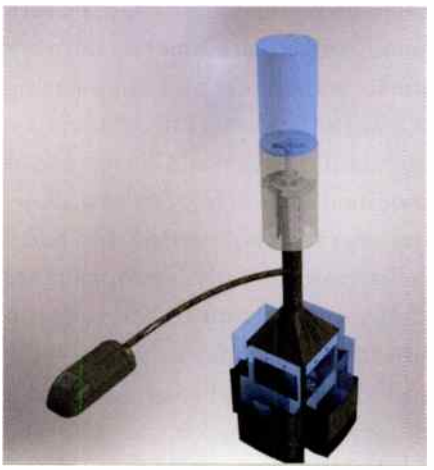
Stealth Concealment offers a myriad of custom concealments, from DAS concealments that keep fans cheering to concealed small cells that keep Washington, D.C., online. Because communities and cities have a growing need for cell coverage, Stealth Concealment is expanding its ability to design and manufacture cell sites that look aesthetically pleasing. RF-transparent poles are designed to hide the antennas, day or night. The company offers a variety of concealment products, including rooftop, tower, steeple, small cell, silo and tree-and-pole concealments, as well as various custom cell-tower concealments.

www.stealthconcealment.com

Common Public Radio Interface Panels

Radio Frequency Systems' (RFS) common public radio interface (CPRI) panels facilitate the connection between the macro network and small cells. By enabling fiber connectivity to be tested between optical baseband units (BBUs) and remote radio heads (RRHs), CPRI panels — considered essential for network densification to evolve from 4G to 5G and enable IoT and SON — allow cell operations and system performance engineers to ensure the best performance without having to disconnect the fiber-optic system or disrupt service. RFS' CPRI panel enables easy RF-over-CPRI testing at the bottom of the tower, reducing the need for tower climbs, thus minimizing the maintenance cost and the overall operating expense for customers. The CPRI panel can be bundled with RFS' fiber-optic jumpers (available in several length options), providing an end-to-end solution that includes Hybriflex fiber-to-the-antenna DC and F/O solutions.

www.rfsworld.com



Small Cell Solutions

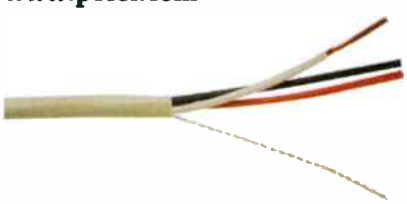
The Titan product line from **Distributed Wireless Group** offers a small cell solution delivery with maximum flexibility on both antenna and radio manufacturer integration. Titan products are available in solo, dual, triple and quad configurations. Titan products are intended to stylishly secure and address both growth and serviceability with strategically hinged access panels. The antenna component allows for a multitude of antennas for deployment consideration. Either an omni-directional or a tri-sector panel solution can be managed effectively. Mechanical adjustment in both the vertical and horizontal plane is available and will vary depending on the desired solution. The antenna radome is made up of two-piece high-grade ASB material panels that allow for ease of access for antenna maintenance functions.

www.distributed-wireless.com

Engineering and Testing Tools

SeeHawk Engage is the name of **PCTel's** family of UE-based mobile network performance test and engineering tools. The SeeHawk Engage tools use standard commercial UEs instead of modified custom test devices, allowing operators to see DAS and small cell networks exactly as customers see them. In addition to the flagship product, the SeeHawk Engage family includes SeeHawk Engage+, SeeHawk Studio and SeeHawk Engage Lite. The SeeHawk Engage full-featured Android-based tool works for walk testing using a single smartphone or tablet. The SeeHawk Engage+ tool allows engineers to deploy multiple UEs and manage them from a single Android device.

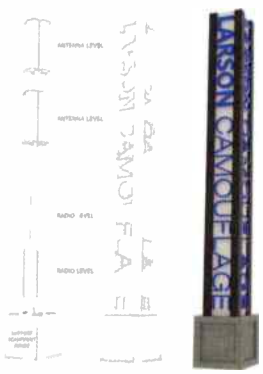
www.pctel.com



Line Power Cable

The **Electro-Wire** team provides DAS, small cell and passive optical network line power cable for centralized power distribution. Electro Wire's line power cable is available in plenum, riser and LSZH outdoor-rated constructions. These products are UL-listed for CL2 and CL3 applications and are available from 20-gauge thru 12-gauge sizes with as many as 30 conductors. These products are approved for use with Alpha Technologies' line-powering solutions and VoltServer's digital electricity solutions. They may be used with GE's Power Express products. Power and fiber composites are also available from 18 gauge to 12 gauge, with as many as 12 fibers, in plenum, riser and outdoor-rated constructions.

www.genuinecable.com



Small Cell and DAS Structure

The **Larson Camouflage** Larson Pillar structure is designed for versatility and for use as a multicarrier small cell and DAS structure. The structure can conceal equipment and provide effective signage, advertising or messaging, which can be crucial to jurisdictional approval. The scalable design provides a footprint and concealed volume intended to appease carriers and jurisdictions alike. The Larson Pillar structure can be implemented with exterior lighting or internal lighting to allow for illuminated signage all within an RF-friendly package. The product is suitable for university campuses, outdoor malls, stadiums and event venues that require multiple nodes. Larson offers custom design and fit for customer equipment in any small cell location.

www.larsoncamo.com

Antennas

Antenna Products offers Phazar DAS and small-cell antenna solutions for wireless service, WiMAX, Wi-Fi and broadband internet system suppliers to increase network capacity via densification. Phazar antennas, as used by wireless carriers, including Verizon Wireless, AT&T Mobility, Sprint and T-Mobile USA, are available in single-, dual-, tri- and quad-band configurations, and in combinations of 700-MHz, cellular/SMR, AWS, PCS and WCS frequencies. These DAS antennas are built to mount on street lights, utility poles and monopoles.

www.phazar.com

DAS and Small Cell Designing and Building Services

Centerline Solutions offers everything related to designing and building of DAS and small cell installations. The company's projects are designed,

managed and integrated using in-house resources to ensure quality and safety. Centerline offers turnkey services with simple sales and design guidance to eliminate technical intimidation. The company says that, unlike other network integrators, it balances the technical and business aspects of DAS and small cell projects, offering custom-fit solutions.
www.centerlinesolutions.com

Infrastructure Solutions

HMI Services (HMI), a Henkels & McCoy Group company, provides comprehensive infrastructure solutions to help customers advance their project approaches and requirements. Working with carriers, utilities, enterprises and all levels of government, HMI delivers services for the planning, design, construction and installation of wireline and wireless communications networks. HMI's wireless team designs, deploys and provides ongoing support for custom solutions using multiple technologies including distributed antenna systems (DAS), small cell and Wi-Fi.
www.henkels.com

Plenum-rated Coaxial Cable

Eupen Cable's new ½-inch plenum-rated coaxial cable for in-building applications is available in a blue or white jacket. The EC4-50 PL is a ½-inch ultra-low-loss plenum-rated air-dielectric coaxial cable. It is plenum-rated and designed for in-building DAS installations. The EC4-50 PL cable is manufactured and tested to Eupen's standard and, in conjunction with Eupen high-quality RF connectors, is virtually PIM-free.
www.eupen.us

Safety Monitor

FlashRad from **RSI** is a safety broadband exposure monitoring system that preforms continuous measurements of electromagnetic field (EMF) levels. It detects short, radar-like pulsed signals emitted from various sources outside of a building. When predetermined EMF levels are exceeded, the FlashRad monitor sounds, flashes a warning and sends a signal to the surveillance PC for action.
www.rsicorp.com

RF Distribution Platform

Dali Matrix is an all-digital, software reconfigurable and modular RF distribution platform that allows mobile operators to maximize the use of their existing capital investment and resources while providing them with a seamless migration path to a software-driven virtualized RAN. Made by **Dali Wireless**, the platform is a two-tier, modular architecture that consists of the universal base station interface tray, which serves as the active point of interface and the host, as well as a series of low, medium and high remote units. This modular platform allows mobile operators and system integrators to effortlessly update, upgrade and expand their networks in a plug-and-play approach, providing flexibility to accommodate multiple operators, technologies, base station vendors and frequency bands.
www.daliwireless.com

Small Cell Power Supply

Alpha offers the Cellect 600 power supply for powering outdoor small cell sites. A compact, lightweight, AC/DC power supply, the Cellect 600 delivers 600 watts of output power and more than 10 minutes of battery backup. It is made to withstand a majority of interruptions in the AC grid. The unit is equipped with a universal mounting bracket, making it easy for a single technician to install it on telecom poles, on light poles or on the sides of buildings. The Cellect 600 power supply offers advanced monitoring and control, including SNMP, but requires no field maintenance, enabling a "set it and forget it" deployment.
www.alpha.ca/das

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***C2, C3 & C4 indicate cover pages**

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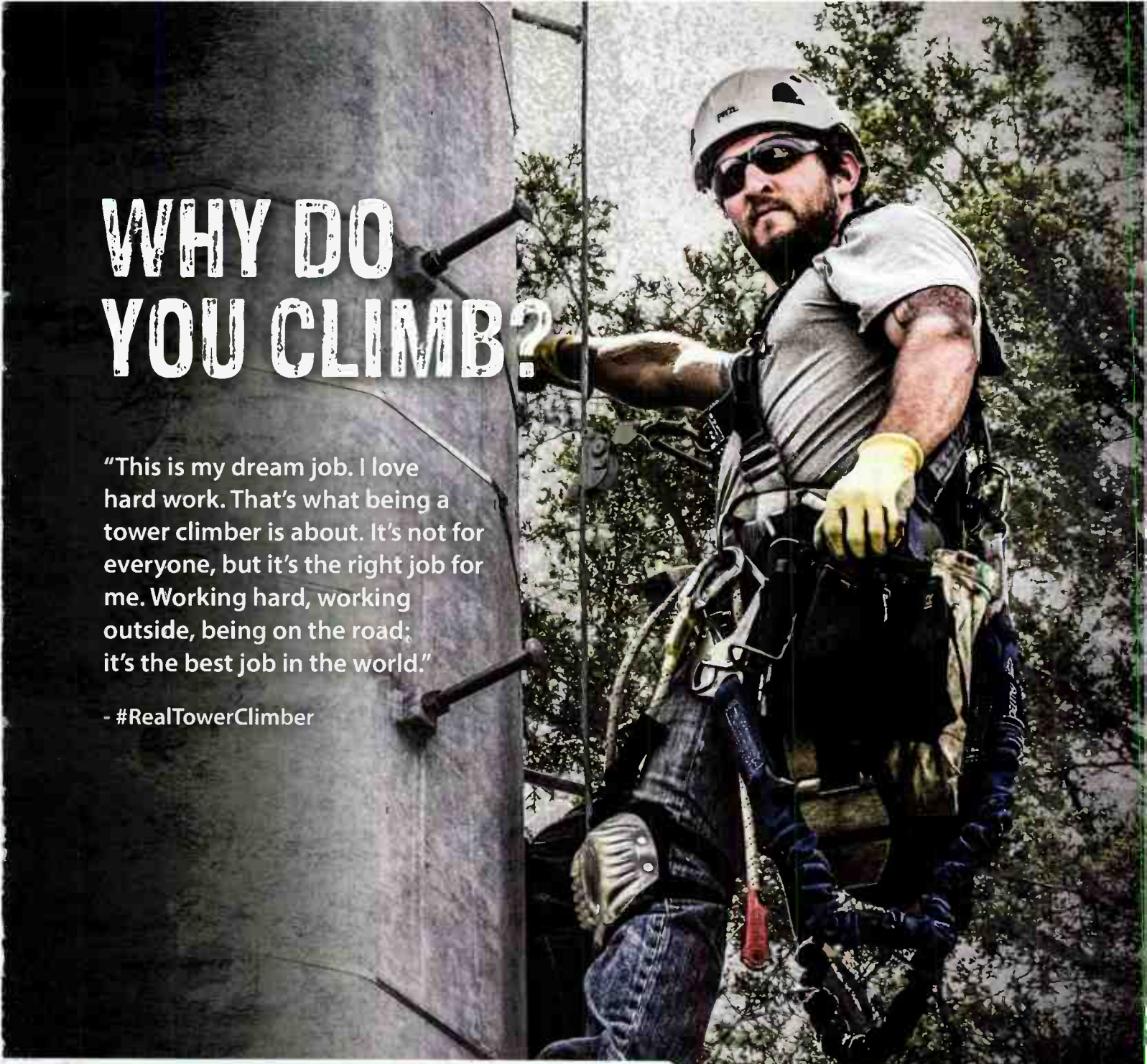

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