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Horizons

Wireless Age Renaissance
Wireless Infrastructure Horizon
Tower Growth in 2015

Ten Years of AGL Magazine
Putting the Band Back Together
Johnny Multiple Rides the Waves

December 2014 // Volume 11 // No. 12



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ABOVE GROUND LEVEL

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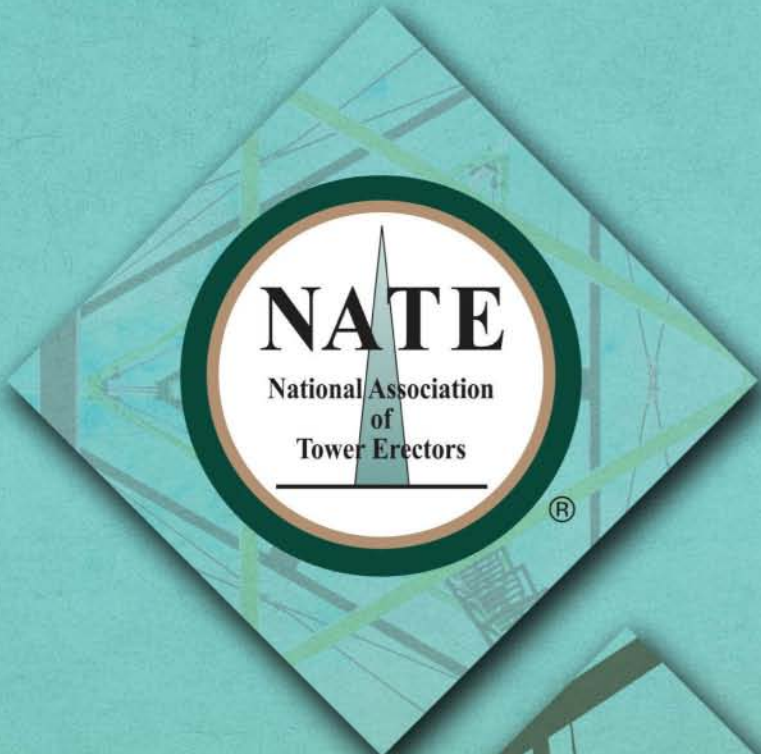


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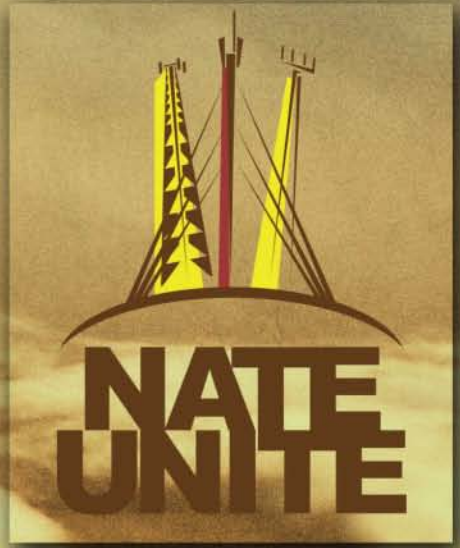


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Cell Towers. Who Wants Them?

No one wants a cell tower. What consumers want is connectivity. Well that, and apps, whether connectivity is needed to make them work or not. What mobile network operators want is minutes of airtime to sell. What's in between consumers and network operators that makes connectivity work, cell towers, no one wants. It's just that they are necessary. If another way, a cheaper way, could be found to make mobile networks work without cell towers, wireless carriers would be pleased to switch. Therein lies the technology risk for cell tower owners. Thus far, the challenges to cell towers have not done much to erode their utility, if not their necessity. Could that change?



Horizons

Each year as December rolls around, *AGL Magazine* publishes its Horizons section that represents forecasts about the wireless infrastructure industry for the coming year and beyond. Most often, the forecasts are rosy. They're reasonably rosy this year, too.

If we've heard anything that reduces enthusiasm at least a little bit, it's the effect of Nextel decommissioning churn, primarily, and additional churn from various wireless carrier consolidations. Added to that is some uncertainty about the extent to which AT&T will continue its high level of

spending on wireless infrastructure in 2015 compared with 2014. Analysts who track this kind of thing much more closely than *AGL Magazine* does can be heard on earnings calls conducted by the publicly traded tower companies, and they express themselves in reports they issue. That's where we picked up the notion that maybe the business of building cell towers and leasing antenna space on them won't keep quite the same pace in 2015 that it did in 2014, and that net gains may be reduced somewhat by churn.

Cell Tower Growth Estimates

Jonathan Atkin and Brian Hyun of RBC Capital Markets point to projections from wireless carriers themselves when they estimate less cell tower growth next year (see page 36).

Meanwhile, Marc Ganzi, who heads Digital Bridge, a company with \$500 million in financing to invest in towers, points to the data tsunami and research from others plus research he commissioned as he forecasts 90,000 new tower builds and collocations during the next five years (see page 40). He discounts the technology risk to cell towers.

Please enjoy the ninth presentation of Horizons in this, our 10th anniversary issue.


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Looking Back

I'm excited to see some signs of change in the industry, particularly a number of safety initiatives and a much greater awareness of the need to improve safety. I hope we've

all dropped the blame game and are moving toward recognizing the need for safety, regulated or not. For too long, too many factions existed that pointed

fingers at one another and said, "If the carriers required safety, contractors would have to be more safe," or, "If I provided all of the safety training and equipment, I could not be competitive, and I would be out of business." It looks as though we're all moving past these old, unproductive, back-and-forth arguments, and we're agreeing to create training standards, develop certifications and make sure everyone goes home at the end of the day. Alive.

We've been covering safety, and we'll continue to cover many of the safety activities in more detail next year. We'll do everything we can to encourage these fantastic initiatives.

I'll Never Forget

Looking back on a great year, we're really happy with our regional conference series. We're planning to shake things up for next year with new topics and a new focus. We do that every year, and we're in the really fun part of next year already: planning. The AGL Media Group team has been fortunate enough to work with some fantastic organizations this year, including PCIA, many of the state wire-

less associations and NATE. I still can't believe I climbed a tower, even if it was with a basket on a crane next to me (how wimpy), but what an appreciation I have after that experience. My thanks to those who made it possible: John Paul Jones of Safety LMS; David Anthony of Shenandoah Tower Services; Todd Schlekeway of NATE; PCIA and the OSHA folks who participated. I'll always remember it.

The Road Ahead

Looking forward is pretty exciting, but not all of the future seems to have a positive twist. I'm excited by the AWS 3 spectrum auctions. The total auction amounts already are high, and I'm writing this about four days into the auctions. That means there is plenty of desire to ensure the ability to deploy future networks. Many companies are spending heavily for spectrum, and most likely it will be quite a few years before the deployment of that spectrum begins.

I loved the comments from longtime AGL Media Group friend Jennifer Fritzsche of Wells Fargo Securities, who, at a dinner with some partners of Media Venture Partners, was discussing how there would be few tower companies' assets left to acquire after Verizon Communications' anticipated sale of its towers. That is a sure indicator of a mature market. Someone will roll up the few mom-and-pops that are left or will convince the few remaining communications and broadcast companies to sell their vertical assets and remain focused on communications. But there isn't that much left to acquire. So, back to development we go. Yah.

All of Those Towers

Most of the tower sites I've run into lately, either through my own interest as a consulting engineer or as an observer of all things vertical, are getting to be maxed out. There are some limits to how much you can put on one tower or rooftop. While radiation centers continue to be driven downward in the urban areas, there is still active development pushing coverage into less-urban areas. But there isn't much development yet in especially rural areas. There seems to be a middle beltway area around most urban centers that is seeing newer development of medium-sized towers.

All indicators are still quite positive — but different. Tower companies are embracing new business areas, and small cells and microsites are proliferating. Backhaul is becoming easier to find in urban and not-so-urban areas, enabling all of our small-cell dreams. Tower acquisition is becoming more difficult because there isn't much left to buy, and tower development is openly embraced in some areas and still vehemently opposed in others. The stock market appears to be realizing that there isn't infinite growth in carriers or in the siting industry. Things are maturing, but still, crazy opportunities are out there. It's all still quite positive — but different.



Rich Biby, Publisher

rbiby@aglmediagroup.com



Towers That Mean Business

The art and science of tower management

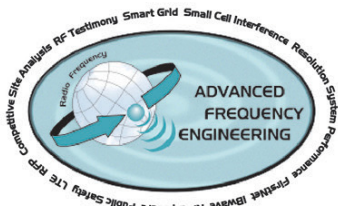


**SUBcarrier
COMMUNICATIONS**

**139 White Oak Lane
Old Bridge, NJ 08857
732-607-2828
www.subcarrier.com**

Quick-Guide to DAS Companies

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



Advanced Frequency Engineering (AFE)

10482 Almond St.
Rancho Cucamonga, CA 91737
Dana Dulabone
813.495.0038
dana@rfawareness.com
advancedfrequencyengineering.com

Products types: DAS, small cell, Wi-Fi, backhaul

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

Other: AFE is iBwave-certified for iDAS and oDAS engineering and design.



AFL
170 Ridgeview Center Drive

Duncan, SC 29334
Brian Wheeler
678.772.6627
brian.wheeler@aflglobal.com
aflglobal.com

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

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

Alliance
70 Demarest Drive
Wayne, NJ 07470
Jay O'Connor
888.821.4797
sales@alliancecomm.com
alliancecomm.com

Product types: DAS, small cell, Wi-Fi, backhaul



Alpha Technologies
7700 Riverfront Gate
Burnaby, BC V5J 5M4
Canada
800.667.8743
sales@alpha.ca
alpha.ca/das

Services: AC, DC and line powering solutions for iDAS, oDAS and small cell deployments.

Company description: Alpha combines its expertise in base station power and outdoor broadband power equipment cabinets to deliver end-to-end distributed antenna system (DAS) power solutions from the base station to the headend and to the remote radios. Our solutions include AC and DC power and battery backup systems that match the requirements of the DAS equipment and the operator.

BUYERS GUIDE



Anritsu

envision : ensure

Anritsu

490 Jarvis Drive
Morgan Hill, CA 95037
Siiri Hage
408.201.1010
siiri.hage@anritsu.com
anritsu.com

Services: system installation, system maintenance, RF analysis.

Company description: Anritsu provides innovative communications test and measurement solutions for existing and next-generation wired and wireless communication systems and operators. Products include wireless, optical, microwave/RF, and digital instruments as well as operations support systems for R&D, manufacturing, installation, and maintenance. Anritsu also provides precision microwave/RF components, optical devices, and high-speed electrical devices for communication products and systems.

Antenna Products (Phazar)

101 S.E. 25th Ave.
Mineral Wells, TX 76067
Steve Schueler
940.325.3301 ext. 266
sschueler@phazar.com
antennaproducts.com

System types: operator-owned (neutral host)

Product types: DAS, small cell, Wi-Fi

Services: system engineering, carrier coordination, concealment solution

Company description: Antenna Products' "Phazar" brand of antennas are installed on street lights, utility poles and other types of infrastructure. Their stacked, vertically polarized omnidirectional antennas cover 700 MHz, 850 MHz, AWS, PCS, Wi-Fi and WiMAX frequencies in dual, triple or quad antennas with excellent PIM performance.



AW Solutions

300 Crown Oak Centre Drive
Longwood, FL 32750
Keith Hayter
407.260.0231 ext 105
keith.hayter@awsolutionsinc.com
awsolutionsinc.com

Product types: DAS, small cell, Wi-Fi, backhaul

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions, iDAS, oDAS, small cell, project management, right of way engineering, node and hub design, make ready, RF design, construction management and inspection, material procurement/warehousing/logistics

Company description: AW Solutions is licensed throughout the United States, Canada and the Caribbean, providing turnkey site infrastructure development and build-to-suit

services to the wireless , iDAS, oDAS, small cell, wireline and fiber industry sectors. Services include: project management, site evaluations/audits, site acquisition/land planning, engineering design/analysis, regulatory, construction management, construction, warehousing/logistics.

Axell Wireless

15950 N. Dallas Parkway
Suite 400
Dallas, TX 75248
Matthew Thompson
972.361.8038
matthew.thompson@axellwireless.com
axellwireless.com

Product type: DAS

Services: site analysis, system design, system engineering



Bird Technologies

30303 Aurora Road
Solon, OH 44139
Tom Boyle or Lynn Strube
440.248.1200
sales@birdrf.com
birdrf.com

Product type: DAS

Services: site analysis, system design, system engineering, system monitoring, RF analysis

Black & Veatch

10950 Grandview
Overland Park, KS 66210
Kristi Klohs
913.458.6271

/ DEPARTMENTS /

KlohsKM@bv.com
bv.com

Services: site analysis, permitting, system design, system engineering, system installation, system management, system monitoring, system maintenance, carrier coordination, RF analysis, concealment solutions
See ad on page 97



Black Box Network Services

1155 Kas Drive, Suite 200
Richardson, TX 75081
972.479.9898
innerwireless-sales@blackbox.com
blackbox.com/wireless

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

Product types: DAS, Wi-Fi

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

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

connected with optimal service levels

BlueStream Professional Services

3065 Chastain Meadows Parkway
Suite 100
Marietta, GA 30066
Adriane Watson
240.501.2859
awatson@bluestreampro.com
bluestreampro.com

Product types: DAS, small cell, Wi-Fi, backhaul

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



BTI Wireless

6185 Phyllis Drive
Cypress, CA 90630
Ron Poulin
714.856.9604
ronp@btiwireless.com
btiwireless.com

Product types: DAS, small cell

Company description: BTI Wireless was founded in Cypress, California, in 1999 and is an industry leader in linear power amplifier design and manufacturing for network operators and original equipment manufacturers. BTI offers the industry's most modular active DAS products in the high and mid-power categories, enabling cost-effective neutral-host DAS solutions.



C Squared Systems

65 Dartmouth Drive
Auburn, NH 03032
Caitlin Higgins
603.644.2869
Caitlin.higgins@csquaredsystems.com
csquaredsystems.com

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

Product types: DAS, small cell, Wi-Fi

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

Company description: C2 Systems is an RF engineering, consulting and software development company specializing in providing services for complete wireless coverage from RF analysis to design and implementation to monitoring support. More than just alarming, SitePortal, a customizable Web-based software, was engineered by C2 Systems to remotely monitor and manage complex multivendor environments.

Charles Industries

5600 Apollo Drive
Rolling Meadows, IL 60008
Lucia Barth
847.806.6300
mktserv@charlesindustries.com
charlesindustries.com

Product types: DAS, small cell, Wi-Fi, backhaul



JANUARY 2005

The first issue of AGL magazine, dated December 2004/January 2005, is published. First-issue authors still writing for the magazine today are Clayton Funk, David Saul and Michael Higgs.



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Clearfield

5480 Nathan Lane
Plymouth, MN 55442
Scot Bohaychyk
612.791.6844
sbohaychyk@clfd.net
clearfieldconnection.com

Product types: DAS, small cell, backhaul

Services: system design, system engineering

Company description: Lower your cost of fiber deployment with Clearfield's Fieldsmart product portfolio — the industry's most scalable and modular fiber distribution and management platform. Integrated with FieldShield microduct systems and pushable fiber, your DAS and small cell solutions will be on-budget, reliable and high-performing.

See ad on page 63

Coleman Global Telecommunications

84 Merrill Road
Clifton, NJ 07012
Marty Coleman
973.519.6416
marty@colemanglobal.com
colemanglobal.com

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

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

Connectivity Wireless Solutions

2707 Main St.
Duluth, GA 30096
Bryce Bregen, VP of Sales
888.591.9418
info@connectivitywireless.com
connectivitywireless.com

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

Product type: DAS

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

Dali Wireless

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

System types: facility-owned, public safety

Product type: DAS

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



DeltaNode Solutions

30303 Aurora Road
Solon, OH 44139
Andrew Ward
440.248.1200

award@birdrf.com
www.deltanode.com

Product type: DAS

Services: site analysis, system design, system engineering, RF analysis
See ad on page 76

Dewberry Engineers

600 Parsippany Road, Suite 300
Parsippany, NJ 07054
Greg Nawrotzki
973.739.9710
gnawrotzki@dewberry.com
dewberry.com/Engineers/SiteCivil/Telecom

Company description: Dewberry has been a telecommunications engineering industry leader for over 20 years. With dedicated telecom offices and staff covering a footprint ranging from New England to Florida, their experienced professionals have worked on thousands of new site builds, small cell and mod sites, as well as many DAS projects. Backed by the resources of a national company, Dewberry has the ability to deliver a full range of services on a fast-track basis.

Distributed Wireless Group

587 North Ventu Park Road
Suite E221
Newbury Park, CA 91320
Craig J. Stanziano
805.768.4121
craig.stanziano@distributed-wireless.com
distributed-wireless.com

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



monitoring, system maintenance, carrier coordination, RF analysis



Electric Conduit Construction

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

Services: permitting, system installation, system maintenance
See ad on page 76



ExteNet Systems

3030 Warrenville Road
Lisle, IL 60532
Sean Page
630.505.3817
Spage@extenetsystems.com
www.extenetsystems.co

System type: operator-owned (neutral host)

Product types: DAS, small cell, Wi-Fi, backhaul

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

Company description: Lisle, IL-based ExteNet Systems designs, builds, owns and operates distributed networks for use by wireless carriers and venue owners in key strategic markets. Using distributed antenna systems (DASs), small cells, Wi-Fi and other technologies, ExteNet deploys networks to enhance coverage and capacity and enable superior wireless service in both outdoor and indoor environments.

Fullerton Engineering Consultants

9600 W. Bryn Mawr Ave.
Suite 200
Rosemont, IL 60018
Frank DiVito
224.585.4430
startshere@fullertonengineering.com
fullertonengineering.com

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

Henkels & McCoy

985 Jolly Road
Blue Bell, PA 19422
Bob Dundon
215.283.7764
bdundon@henkels.com
henkels.com

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

Product types: DAS, small cell, Wi-Fi, backhaul

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

maintenance, carrier coordination, RF analysis, concealment solutions

Company description: Since 1923, Henkels & McCoy has been working with communications clients to support their ever-evolving communications needs. In addition to our DAS and small cell capability, we support the network infrastructure requirements of carriers, CLECS, ILECS, enterprise and government clients, both wireline and wireless, outside plant and inside plant.



Huber+Suhner

8530 Steele Place Drive, Suite H
Charlotte, NC 28273
Dick Schmidt
630.916.4021
dick.schmidt@hubersuhner.com
www.hubersuhner.com

Product types: DAS, small cell, Wi-Fi

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

Company description: Governed by the philosophy of "Excellence in Connectivity Solutions," Huber+Suhner develops and produces high-quality electrical and optical connections. Its commitment to reliability and focus on sophistication make the company a leader in three technologies: radio frequency, fiber-optics and low frequency. The company's customers within the mobile communications networks arena value Huber+Suhner as a specialist

/ DEPARTMENTS /

with detailed knowledge of wireless infrastructure applications with a commitment to continual innovation.

Hutton Communications

2520 Marsh Lane
Carrollton, TX 75006
Lori Blair
972.417.0268
blairl@huttoncom.com
huttononline.com

Services: system design, system engineering

Company description: Hutton Communications, established in 1967, is a leading distributor of wireless communications products including site infrastructure, DAS solutions, microwave backhaul, two-way radio accessories and power systems. Hutton supplies products from more than 125 quality manufacturers to wireless carriers, tower contractors, in-building integrators, dealers, value-added resellers, government agencies and the industrial segment.



LBA Group

3400 Tupper Drive
Greenville, NC 27834
Mike Britner
252.757.0279
mike.britner@lbagroup.com
lbagroup.com

Services: site analysis, system design, system engineering

Company description: The LBA Group companies provide the DAS/small cell world with high-level technical feasibility and performance studies, system audits, design consultation and testing. It also provides radio-frequency safety training, certification of RF safety compliance, and RF interference remediation. LBA has over 50 years of experience in radio-frequency systems.

Mercury Communications

1710 Larkin Williams Road
St. Louis, MO 63026
Jeff Fischer
314.581.0760
jfischer@mercurycom.net
mercurycom.net

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

Product types: DAS, small cell, Wi-Fi, backhaul

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

Company description: Mercury Communications, established in 2000, with headquarters in St. Louis, is a specialty wireless infrastructure services company providing DAS, small cell and cell tower construction. Mercury is providing a tilt-up tower trebuchet that can be deployed quickly and is a perfect fit for small cell installs. Mercury's customer base is increasingly diverse, consisting of

wireless carriers, tower owners and developers, and the company has recently expanded its business to serve the government, utility and public safety market segments.

PCTEL RF Solutions

20410 Observation Drive, Suite 200
Germantown, MD 20876
Chintan Fafadia
301.444.2047
chintan.fafadia@pctel.com
rfsolutions.pctel.com

Product types: DAS, small cells, Wi-Fi

Services: site analysis, system design, system engineering, RF analysis

Peabody RFTC Concealment

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

Product types: DAS, small cell, Wi-Fi

Services: site analysis, system design, system engineering, concealment

Company description: Peabody has been manufacturing RFTC telecom concealment systems since 1997. The company is an approved vendor with all major carriers, and it has vast experience working with A&E firms, site acquisition and contractors. Peabody's creative design, engineering and fabrication team can develop a high-quality, prefabricated concealment solution for your macrosites as well as DAS or small cell antenna venues.



APRIL 2005

Victoria W. Kipp, a tower climber, publishes the first of her articles for AGL. She was a frequent contributor to *Site Management & Technology*.



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/ DEPARTMENTS /



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Phillips Lytle

125 Main St.
Buffalo, NY 14203
Douglas W. Dimitroff
716.847.5408
ddimitroff@phillipslytle.com
phillipslytle.com

Services: site analysis, financing, permitting

Company description: Phillips Lytle is a corporate and commercial law firm with a dedicated telecommunications industry team. The firm's 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, and in all types of settings: large venues, campuses, public rights of way, mass transit systems, commercial multitenant environments and residential multidwelling units.



Radio Frequency Systems

200 Pond View Drive
Meriden, CT 06450
Suzanne Kasai
203.537.2741
suzanne.kasai@rfsworld.com
rfsworld.com

Product types: DAS, small cell, backhaul

Services: site analysis, system design

Solid

617 N. Mary Ave.
Sunnyvale, CA 94085
Matt Atkins
925.667.8542
matt.atkins@solid.com
solid.com

Product types: DAS, small cell, backhaul

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

Solar Communications International

8885 Rio San Diego Drive, Suite 207
San Diego, CA 92108
Steve Holborn
619.243.2750
sholborn@rftransparent.com
rftransparent.com

Types of products: DAS, small cell

Service: concealment solutions



TE Connectivity

541 E. Trimble Road
San Jose, CA 95131
408.952.2400
te.com

System types: operator-owned (neutral host), facility-owned, carrier-owned, public safety

Product types: DAS, small cell

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

Company description: TE Connectivity is a global, \$14 billion company with nearly 100,000 employees who design and manufacture products for the electronics, energy, health care, automotive and aerospace industries. As a leader in fiber-optics, DAS and other cellular network and data center solutions, TE transforms the way mobile service delivery networks are created, deployed and used for new mobile applications.



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/ DEPARTMENTS /

Product types: DAS, Wi-Fi, backhaul

Services: financing, system design, system engineering, carrier coordination, RF analysis

Other: site kitting, delivery logistics

Times Microwave Systems

358 Hall Ave.
Wallingford, CT 06492
Lou Caruso
203.949.8400
lou.caruso@timesmicrowave.com
timesmicrowave.com

Product types: DAS, small cell, Wi-Fi, backhaul

Service: system design



Trilogy Communications

2910 Highway 80 East
Pearl, MS 39208
Ryan Cole
601.933.7529
rcole@trilogycoax.com
trilogycoax.com

Product types: DAS, small cell, Wi-Fi, backhaul

Services: system design, system engineering, system installation, RF analysis

Company description: Trilogy Communications is the preferred coaxial cable of choice for in-building DAS applications. Due to Trilogy's unique air dielectric disc design, AirCell plenum cable (AP6012J50) outperforms competition

electrically and mechanically. Trilogy also offers AirCell Transline and radiating cables. One hundred percent of AirCell cables are made in the United States and are TL9000-certified.



Valmont Structures

3575 25th St. SE
Salem, OR 97302
Sean Gallagher
503.589.6616
sean.gallagher@valmont.com
valmont-towers.com

Product types: DAS, small cell

Company description: Valmont Structures, long known for its Microflect and Pirod brand towers, is the largest manufacturer of light poles in the country. Valmont Structures has an enormous catalog of designs for light poles, many of which can be readily adapted to small cell/DAS purposes.



Waterford Consultants

201 Loudoun St. SE, Suite 300
Leesburg, VA 20175
Tom Ferguson
703.596.1022
sales@waterfordconsultants.com
waterfordconsultants.com

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

Company description: Waterford Consultants is a professional services organization specializing in FCC regulatory compliance and DAS services. Its national team of field and operational personnel is knowledgeable, professional and consistently exceeds its clients' expectations while meeting both budget and project timelines. Waterford's expertise and client commitment have positioned it as an industry leader in simplifying the most complex regulatory compliance matters and providing advanced DAS solutions.

See ad on page 17



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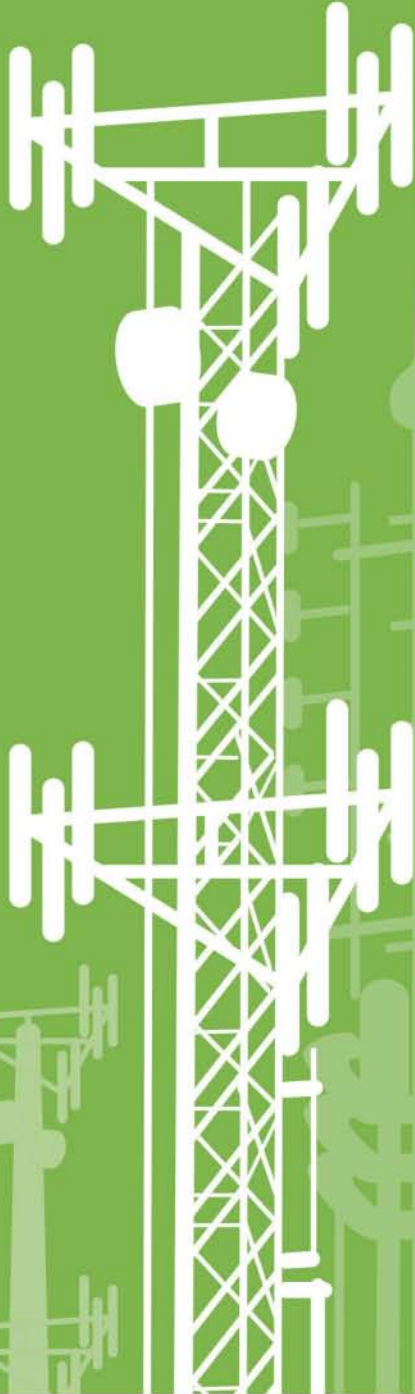
Services: system design, system monitoring

Company description: Westell Technologies is a leading provider of in-building wireless, intelligent site management, cell site optimization and outside plant solutions focused on innovation and differentiation at the edge of telecommunication networks. The comprehensive set of solutions the company offers enable telecommunication network operators to reduce operating costs and improve network performance.



AUGUST 2005

David Keckler publishes the first article in AGIL about avian mortality, an issue that continues to receive attention to this day.



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Voice over Wi-Fi and the Potential Effect on VoLTE

By Iain Gillott



Iain Gillott, founder and president of iGR and iGR Semiconductor Research

The summer of 2014 could be labeled as the “Summer of VoWi-Fi.” The service seemed to come out of nowhere and receive a lot of attention. Both Sprint and T-Mobile USA now have VoWi-Fi services in the market, and Verizon Wireless and AT&T have expressed interest. Solutions are available in the market from folks such as Mave-nir and Taqua. In fact, VoWi-Fi has been around for a while. Many enterprises have VoWLAN handsets that use the Wi-Fi network, and T-Mobile actually launched a home voice Wi-Fi service a couple of years ago as a substitute for an indoor femtocell. But the VoWi-Fi moniker has definitely received more attention in 2014.

Voice Versus Text

So what is all the fuss about? After all, Wi-Fi and voice services have been around for a while now and are certainly not new services. In fact, voice is the oldest mobile service — remember when they were called mobile phones and not smartphones? The phone actually implied the use of your voice to talk to someone; this was pre-SMS when adults actually had to converse with their teens, rather than just text them!

Wi-Fi has been commonplace in the U.S. home for many years, and now about 90 percent of homes have one or more Wi-Fi access points. Most homes with broadband Internet access now have Wi-Fi simply because their cable/U-Verse/FiOS set-top box includes a Wi-Fi access point and router. And 3G mobile voice was extended to homes with poor coverage through the use of a femtocell (AT&T and Sprint, predominantly) or a signal booster.

Sudden Interest

So why is VoWi-Fi suddenly on everyone's conference agenda and editorial calendar? The answer has much to do with VoLTE and the realization that extending VoLTE indoors may be more costly and difficult than first imagined.

Many homes in the United States

have poor indoor cellular service coverage for a variety of reasons: where the home is located, construction of the home, dense trees around the house, or the home is simply caught on the cell edge between two cells. The net result is that many consumers have problems making calls in the home. As more people have ditched their landline, this has become a bigger issue. (iGR has research on this and a range of statistics.) So the answer, in the case of AT&T and Sprint, was to give/sell femtocells to problem consumers. These are indoor small cells that give 4 to 5 bars in the home. Other people have installed signal boosters, which have the added bonus of being carrier-agnostic.

This has worked well in a 2G and 3G world. Remember that because most homes have Wi-Fi, there has been minimal need to provide mobile data service in homes; the femtocells and signal boosters have primarily been there for voice.

Options for Operators

But now the macrocellular networks are moving to LTE and, as you know, VoLTE. This means that to make a voice call in a building, LTE service must be provided in the building. In homes or buildings where indoor coverage is a problem, making a VoLTE call will be diffi-



cult. So the options for the operators are to either offer an LTE femtocell (and replace the existing 3G femtocells over time), support signal boosters (which operators in the United States are reluctant to do — less so in other countries) or use VoWi-Fi.

Existing Wi-Fi in the Home

Because the home is highly likely to have Wi-Fi already and the new smartphones include support for VoWi-Fi, offering a VoWi-Fi solution to complement VoLTE would seem to make sense. T-Mobile's service hands off VoWi-Fi calls to and from VoLTE, so from the consumer perspective it is seamless.

The issue for the mobile operator of course is that they have no control over the quality of the Wi-Fi network in the home or building. Nor do they know how it is configured, what generation of access points is used or where the dead spots are. A femtocell is a managed part of the radio access network, and the operator can “see” the device from its network. If consumers' VoWi-Fi does not work, they are more likely to contact the mobile operator and try to get a diagnosis than to address any basic Wi-Fi issues themselves. Once an operator puts its brand on a service, it owns it, in the eyes of the consumer.

Attraction for Mobile Operator

But the attraction of VoWi-Fi is obvious for the mobile operator: The implementation is based on software and capabilities already in the new devices. No hardware (femtocells)

has to be shipped to the home, installed or paid for, and this potentially reduces the cost significantly. And it makes use of an existing network (Wi-Fi). How this all works out will be interesting to see. VoWi-Fi is most likely to play some role in the indoor VoLTE service architecture, but it may not be for everyone. LTE femtocells may still be deployed

but in fewer numbers than the 3G versions and in more select environments. Either way, there are solutions to the issue of getting VoLTE indoors. It is just a matter of the who, what, where, and how.

Iain Gillott is the founder and president of iGR and iGR Semiconductor Research. His email address is iain@iGR-inc.com.

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TECHNOLOGY REVIEW



Jake MacLeod, president of Gray Beards Consulting, speaking at the Tower & Small Cell Summit in September. Photo by Don Bishop

Go Where the Puck is Going to Be

Use key data points to shape your business to meet customer needs that will stem from changes coming during the next five years.

By Jake MacLeod

I like a quote by Gordy Howe, the hall of fame hockey player. He said, “Never follow the puck. You go to where the puck is going to be, and then you score.” So, it’s my challenge to everyone in the wireless infrastructure industry to go to where the puck is going to be. Position your business for where it needs to be five years from now.

A new breed of tower entrepreneurs

is emerging that will address the key challenges and opportunities ahead both domestically and internationally. Industry consolidation will affect your business, as will future prospects for site development, planning and zoning.

We don’t want to be like the railroads. The railroads said, “We are railroads. We are not transportation. We are railroads. We’re not air cargo.

We’re not trucking. We are railroads.” And railroads almost became extinct as a result of that philosophy. We, as the tower industry, want to take advantage of adjacent markets.

We in this business are not just infrastructure providers. What are we? What about backhaul? What about fiber? Every cell site will be required to have fiber to the cell, especially with the advent of 5G,

KEY DATA POINTS



which is coming up. How can you play in that arena? We need to be planning for 2020 because that's where the puck is going to be.

Data Points

Consider the data points (see "Data Points" on this page). See how your company can use them, because this is where the puck is going. The global monthly data traffic will increase by 11 times between the end of 2013 and the end of 2018. That's a five-year period, and 2018 is only three years from now. We're going to be at 15.9 exabytes of traffic per month on a global basis.

If we're going to increase throughput by 11 times, what's that going to do to the infrastructure? You're certainly not going to be able to keep the same infrastructure. At

Data Points

- Global monthly mobile data traffic will increase 11 times between the end of 2013 (1.5 EB) and the end of 2018 (15.9 EB).
- By the end of 2014, the number of mobile connected devices will exceed the number of people on the Earth.
- By the end of 2018, nearly 70 percent of global mobile traffic will be video.
- By the end of 2018, more than 50 percent of the traffic from mobile devices will be offloaded to the fixed networks by Wi-Fi and femtocells.
- By the end of 2018, 54 percent of all mobile connected devices will be smart devices, and 96 percent of mobile data traffic will be produced by these smart devices.

a minimum, you're going to have to double what you have now to accommodate an 11-times increase, assuming that the network technologies are going to become more efficient and you're going to be able

to pack 10 pounds of potatoes into a 5-pound sack.

By the end of 2014, the number of mobile connected devices will exceed the number of people on Earth. That's this year. By the end

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KEY DATA POINTS

/ HORIZONS /

of 2018, more than 50 percent of the traffic will be offloaded onto fixed networks by Wi-Fi and femtocells. That's an interesting data point, but what are you going to do about it? How can your company use that data point and extrapolate

from point A to point B and say, "In order for my company to prepare for this, I have to do x, y and z." Think about that.

By the end of 2018, 54 percent of all mobile connected devices will be smart devices, and 96 percent of

the mobile data traffic will be produced by those devices. These astounding projections come from Cisco, AT&T and other sources. By the end of 2018, four years from now, almost 70 percent of the global mobile traffic will be video. What does that mean for the infrastructure that you're building?

Fiber-optic Cable

Every cell site will be required to have fiber. There's a huge opportunity for tower companies to become fiber providers, to become a total solution for the carriers or to team with a fiber provider to offer that solution and garner revenue. How is your company going to be affected by nearly 70 percent of all data traffic being video? How do you translate that into hardware? Think about it.

That's what my team does for a lot of companies: We red-team strategies and tactics to prepare for growth. We try to stimulate the creative juices of the companies' leadership.

Here are some more data points (see "More Data Points" on the left). The mobile wireless device will become the primary personal communications device by 2020. I've been in the industry since 1978, before AT&T divested its Bell operating companies. I was with Southwestern Bell in transmission engineering. I never thought the public switched telephone network (PSTN) would go away. But the PSTN is dissolving. It's sunseting. And by 2020, there won't be much remaining of the public (circuit) switched telephone network.

Last year, I moved from Washington, D.C., after living in the area for 22 years. After we moved, we didn't

More Data Points

These data points add to the opportunities that wireless infrastructure companies will have in the next five years.

- The mobile wireless device will become the primary personal device by 2020 as the PSTN sunsets.
- Connected cars 2015
- Every new machine will be equipped with wireless
- Mobile video explosion
- Smart phones = remote control devices via apps
- Densification - macro, DAS, small cells, Wi-Fi offload
- By the end of 2015, 50 percent of wireless infrastructure rate of spend will be in small cell deployments (AT&T).
- 40,000 small cells deployed by the end of 2015 by AT&T
- Accelerated site deployment - currently 200 days, target 30 days - outdoor small cell, prenegotiated agreements
- LTE in more than 100 countries
- Virtualization of the network and services
- Virtualization drives utilization up dramatically
- Virtualization drives costs down (capex and opex)
- Accelerated cycle times for feature and functions development - six months
- SDN and NFV shift location of intelligence and functionality
- UDN = user-defined network
- Global network load 2013 = 1.5 EB; 2018 = 15.9 EB
- Traffic offload (DAS, Wi-Fi and small cell)
- 48 percent of the traffic in 2018 will be handled by small cell and DAS.

KEY DATA POINTS





Jake MacLeod: "Feature development and deployment will accelerate. Instead of taking three years to get a new feature into the system, it will take six months." Photo by Don Bishop

order a landline telephone for the house, and it was like a withdrawal of sorts. I've been in this industry for so long, I never thought I'd be without a landline telephone. But none of my kids have landlines. We cut the cord.

I have to tell you a story about new technologies. I got an iPhone, and the iPhone has a YouTube application on it. I can pull up YouTube on my iPhone, click and flick it, and it displays on my HDTV.

My 11-year-old granddaughter said, "Granddad, how did you do that?" I said, "I'm not telling you." You have to reserve some secrets, because usually she instructs me in navigating these new devices. I'm one up on her. The primary personal device is going to be a mobile phone by 2020, and we'll have connected cars by 2015. Every new machine will be equipped with wireless that will be integrated into the sensor networks to manage your home, business and just about everything else. You can use your smartphones as remote control devices to control a number of devices such as home security, a remote start on your car and your HDTV.

Traffic Offloading

Network densification will be the mantra for the next several years, bringing macrocells, DAS, small cells and Wi-Fi to offload the traffic in dense areas. It is forecasted that 50 percent of the traffic will be offloaded to small cells and DAS.

At a recent suppliers' conference, the president of AT&T Supply Chain stated that the rate of capital spend at the end of 2015 will be 50 percent on small cell infrastructure. At present, the company spends \$21 billion a year on the

network. AT&T has projected it will continue to spend \$21 billion a year for the next few years, and 50 percent of the wireless allocation will be spent on small cells.

What are you going to do to take advantage of that opportunity? AT&T said 40,000 small cells would be deployed by the end of 2015.

Faster Site Development

It takes an average of 200 days to do site development for macrocells. The new the target is going to be 30 days for outdoor small cells. AT&T stated that it would obtain prenegotiated agreements with the support structure providers. But what about all the other approvals that you need — the zoning and permitting? You can obtain agreements for pole attachments and attachments to street furniture — bus stops, billboards and traffic lights — but you still have to go through the zoning and permitting process. Thus, I'm not sure they're going easily achieve the 30-day target.

Ultrafast, AT&T's Project Velocity IP (VIP) is focusing on \$14 billion for fiber to the business, fiber to the home and fiber to the node. In preparation for 5G, which is all-IP, you must have fiber to the cell site. You cannot have 5G without fiber connectivity to the cell site because in 5G you segment the radio access network (RAN) along with the open systems interconnection (OSI) stack, so the signaling requires ultra-high speed and reliable connectivity. With 5G, RF resources are consolidated in a centralized pool. A cell site can dynam-

We don't want to be like the railroads. The railroads said, "We are railroads. We are not transportation. We are railroads. We're not air cargo. We're not trucking. We are railroads." And railroads almost became extinct as a result of that philosophy.

KEY DATA POINTS

/ HORIZONS /

Data Acquisition and Interpretation

Keep your eye on the growth of machine-to-machine (M2M) communications that will multiply even before 5G cellular systems become available.

- M2M data – global network load 2013 = 1.5 EB; 2018 = 15.9 EB
- Parsing out the data into understandable and actionable information
- Correctly interpreting the data is critical

ically request radio resources from the central pool, use the radio resources as required, and then release them back into the pool for use by other cells.

In the Washington, D.C., area, driving up and down Highway 270, the communications traffic demand on the cell sites changes according to the time of day. At 8 o'clock in

the morning, you just see a wave of traffic going into D.C., and by noon, a lot of fixed cellular communications resources become idle and are not producing revenue. Each cell site has tremendous fixed RF capacity, and in midday, no one is using it. Then, traveling back out of D.C. at the end of the day, the cell sites are jammed up as a result of the

finite RF resources. It's like a big tidal wave. With 5G, network operators will be able to centralize their RF resources and allocate them on a dynamic basis.

Virtualization

In 2020, software-defined networks and network function virtualization (NFV) will be deployed. Virtualization drives utilization up dramatically. The tsunami of video that's coming will amplify the need for fiber to the tower. Virtualization reduces cost because it allows network assets to be used dynamically, allocated as needed.

Feature development and deployment will accelerate. Instead of taking three years to develop a new feature into the system, it will take six months. The industry will speed

KEY DATA POINTS



DATA POINTS

- Mobile
 - Primary personal device by 2020 (sunset of the PSTN)
 - Connected cars 2015
 - Every new machine will be equipped with wireless
 - Mobile video explosion
 - Smart Phones – Remote control devices via apps
 - densification – Macro, DAS, Small Cells, WiFi Offload
 - EoY15, 50% of wireless infrastructure rate of spend will be in Small Cell deployments (AT&T)
 - 40K small cells deployed by EoY15 by AT&T
 - Accelerated site deployment – currently 200 days; Target 30 days – outdoor small cell, pre-negotiated agreements.



up as a result of standardization and independent developer communities. The evolution to 5G and NFV shifts the location of intelligence and functionality of the network. The OSI stack where you have a physical layer, a logical layer, the application layers, is disaggregated and becomes virtualized in the cloud. When you require a feature or function, you pull it in, use it while you need it, and it reverts to the cloud when you are finished. The method is highly efficient, and it reduces the capex by an estimated 50 percent, along with a similar reduction in opex.

Now, how are you going to use that information to your advantage? 5G will start deploying in 2020. But how are you going to prepare your company to take advantage of that?

In 2013, the global network load was 1.5 exabytes. In 2018, it will be about 11 times the 2013 level and reach 15.9 exabytes. Small cell and DAS will handle 48 percent of the traffic offload in 2018. The machine-to-machine data communications tsunami will occur before 5G becomes available, which is a problem because it will cause tremendous network congestion. But all problems bring opportunities with them.

So again, ask yourself, "Can my company take advantage of this opportunity?" When you have that much data, it's critical to parse out the data so that it's understandable and actionable. If you can't derive actionable information out of a dataset, then it's useless. Correctly interpreting the data points and the instructions is critical to success.

Jake MacLeod is president of Gray Beards Consulting. His email address is jake@graybeardsconsult.com. This article is based on remarks he made at the opening of the Tower & Small Cell Summit in September in Las Vegas. The Summit is

owned by UBM, and it is collocated with Super Mobility Week, owned by CTIA. The next Summit is Sept. 9-11, 2015, at the Sands Convention Center in Las Vegas. AGL Media Group provided programming for the 2014 Summit sessions as the conference's content partner.

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KEY DATA POINTS

The Renaissance of the Wireless Age

Dr. Theodore S. Rappaport, speaking about 5G cellular technology, calls the future of wireless The Renaissance of the Wireless Age. And the future will have a foundation in millimeter-wave technology.

By Don Bishop

In the 40 years since the first cellular telephone call was made in New York, the clock speeds in computers have gone up by six or seven orders of magnitude. Computer memory sizes have gone up by seven orders of magnitude. Yet, the frequencies used by cellular telecommunications have gone up by only three times, from 800 MHz to 2.5 GHz. These observations were made by Dr. Theodore S. Rappaport, a professor and engineer at the New York Polytechnic School of Engineering, when he spoke to an audience at an event presented by the New York State Wireless Association and sponsored by Phillips Lytle, "5G and Our Wireless Future." Rappaport said he calls the future of wireless the "Renaissance of the Wireless Age."

"What's about to change is that chip companies have now figured out how to make integrated circuits, transmitters and receivers that operate at much higher frequencies," he said. "Moore's Law has hit the wireless world in moving our carrier frequency from today's cellular frequencies up to the frequency band from 30 GHz to 300 GHz. 30 GHz is 10 times greater than where cellular and PCS operate today." Rappaport

focused attention on the 60-GHz band, which he said is the unlicensed spectrum that's been available for 10 years.

"There's a myth in the wireless world, engineers for decades have thought using millimeter-wave spectrum was impossible," Rappaport said, noting that may be true at 60 GHz where a small segment of frequencies matches the resonance of oxygen molecules and, thus, the atmosphere attenuates signals and limits their distance. "It turns out there are other frequencies up at 80 GHz, 220 GHz, up in the millimeter-wave bands where oxygen attenuation is not a problem at all. Then there are other frequen-

cies such as 380 GHz, where the wavelength is the size of a human freckle. Think about that. Wavelength is the size of a human freckle, which means you could build the antennas with hundreds, thousands of antenna elements on a cell phone on a portable device — cell phones with antennas with hundreds of elements that can steer the energy and beam it and bounce it from windows and street signs, creating energy. With frequencies this high, you can start pinpointing the energy with very, very large arrays that are physically very small, thereby obtaining a lot of gain. It would be kind of like having laser pointers on all the cell phones."



Dr. Theodore S. Rappaport. Photo courtesy of IEEE Access

WIRELESS



Responding to this potential, Rappaport said, the telecommunications authorities in Europe and in some other countries have allocated 5 gigahertz of millimeter-wave spectrum for cellular telecommunications. “That’s more than anything we’ve ever had in the whole history of wireless,” he said. “Products made to the new standards known as wireless HD, WiGig and IEEE 802.11(ad) exist today and will be shipping by the millions. They make multi-gigabit-per-second data transfers available. Governments around the world have ratified this, so that makes an international marketplace, which allows products to grow the same way Wi-Fi did in the early 2000s.”

Backhaul

Wireless carriers have to carry traffic back and forth between their switches and base stations, a process known as backhaul, and Rappaport said it is expensive when it involves site acquisition and burying fiber-optic cable. “Imagine very light, low-cost, rapidly deployable, backhaul millimeter-wave radios,” he said. “That’s already a growing but fledgling market. You could have wireless backhaul using the same frequencies that are used to provide mobility.”

Connected Mobility

Some larger companies are starting to look at connected mobility. Rappaport said early versions of the necessary technology already exist in the form of 77-GHz radar-integrated circuits placed in high-end vehicles for automatic backing and lane changing, using adapted antennas



Students using signal-measuring equipment. Photo courtesy of IEEE Access

and beam scanning. “Imagine a massive data radio downloading movies on the fly as you drive by an exit,” he said. “Information content will be delivered in such a different way.”

Rappaport said it’s called “information showers.” He said he watches students at NYU come to class with backpacks, but there’s no reason they couldn’t just have a small portable device, and when they walk in the door, the information shower would transmit huge gigabytes of information containing all the books they’d ever need for college.

Laptop computers have hard drives that contain data, but he said there’s no reason that a memory device with our computer content couldn’t travel with us and make a wireless connection with every computer we’re near. “This will decentralize computing,” Rappaport said. “We’re already looking at doing this in data centers, revealing the real motivation for data centers and computer makers to try to move to wireless. It shows wireless starting its renaissance where it pervades everything we do. A 1-watt power budget and a 10-meter link in a data

center could carry the same amount of information as today’s fiber and optical cables used in Yahoo, Google and Microsoft data centers around the world that are built in an effort to get Internet content closer to users. It would be about two orders of magnitude less expensive if you could achieve it for wireless in silicon. There’s huge interest in this area. It’s still very nascent, but it’s coming very rapidly.”

Millimeter-wave Antennas

Rappaport said that when it comes to building the millimeter-wave transmitters and receivers, you have to start with the antenna. He said that although making antennas on silicon chips is not difficult by itself, making them work well in an integrated circuit contained in a casing, both of which absorb energy, multiplies the difficulty. As little as 2 percent of the RF energy put into the antenna might make it out into the air.

The NYU professor and his students reached back to a type of antenna invented in 1931, the rhombic, an antenna used by

Questions and Answers

Following his presentation at the New York State Wireless Association meeting “5G and Our Wireless Future,” Dr. Theodore S. Rappaport responded to questions from the audience.

Question: What would a millimeter-wave phased array look like?

Rappaport: We can make phased arrays that are very flat. In fact, Samsung showed a 32-element flat antenna on the edge of cell phones. You can actually get almost 360-degree coverage just with something flat. We change the phases to create that. Phased arrays for base stations might be spherical with little lenses behind them. They'll take many different form factors.

Making suitable phased arrays is not a hard problem to solve, theoretically. It's a hard problem to solve practically, to drive the costs down to pennies. Not dollars, but pennies. That's the hard part. Phased arrays have been used in the military for decades. We know how to do it. It's just putting them into consumer electronic form factors inexpensively that's the challenge, and a lot of companies are working on that right now.

Question: What are the health effects of millimeter waves?

Rappaport: Millimeter waves are non-ionizing, just as the lower frequencies are. Millimeter waves are eight orders of magnitude below ionizing frequencies, such as x-rays and gamma rays. Thus, the

only health effects of millimeter waves, just like with cellular, involve heat. There are standards right now for non-ionizing energy, and they don't go up to millimeter-wave frequencies, but there are standards in Europe and in the United States that determine exposure limits based on how much your body temperature rises.

From our early work on this, it appears that the health effect would not be an issue. In fact, for power levels in the antennas that we contemplate, there's not going to be any issue at all compared with the regulations for lower UHF and microwave frequencies. The early news is good, but we're working on that at NYU. It's one of the nice things about also having a medical school at the university.

Question: Will base station antennas for millimeter waves be less visible than today's cell site antennas are?

Rappaport: This is a big deal. Right now, people talk about massive MIMO. Has anyone heard of massive MIMO? Massive multiple-input, multiple-output communications? Theoretically, if you can make a very large antenna manifold and put it on a building, you obtain great capacity. The trouble is, people don't

want big, ugly antennas on the sides of buildings. But when you go to millimeter waves, the wavelengths shrink. Then, you can have massive MIMO antennas that are the size of a ceiling tile or the size of a brick.

At millimeter-wave frequencies, you're going to obtain huge gains with antennas that are much more aesthetically pleasing and that have much less wind load because physically, they're going to be smaller. That's good news. Millimeter wave makes a lot of sense for small cells because you obtain a lot of gain for a given area up at the higher frequencies.

Question: Will millimeter waves improve wireless communications security?

Rappaport: Regarding security, one thing that will help when higher frequencies and directional beams are in use is that signals will be harder to intercept. If you put energy into narrow beams, that's much tougher to intercept or eavesdrop than with the omnidirectional cell phone antennas we use today. It'll be a free benefit in this spatial world.

Question: What's the potential for use of millimeter waves in rural markets?



OCTOBER 2006

Pat Tant, senior vice president, Cequel Sites, becomes the first recipient of the AGL Towering Achievement Award for individual achievement.

Rappaport: What we've been talking about is the urban market. That's where the huge capacity demand is. It's going to be tougher to justify the use of millimeter waves in rural markets where there are fewer built-up structures. Part of the key to making millimeter-wave technology work is the ability to bounce signals from buildings and use the structures to keep things in play. If the environment consists of crop canopies and farm fields, RF energy at millimeter waves would dissipate. That's my gut feeling. No one's measuring the rural markets. It

may turn out that crop canopies are great as scatterers and reflectors. No one studied that. In fact, I wouldn't be surprised if scattering keeps energy in play remarkably well just from what we've seen in New York. My hunch is it'll be much harder to make this work in rural areas.

Question: Will the advance of millimeter-wave technology cause wireless network operators to have to migrate from the cellular bands?

Rappaport: I'm sure there will be a road map that allows networks on

the cellular bands and on the new millimeter-wave bands to coexist. Network operators are not going to throw out 4G LTE. They have huge infrastructure investments. In fact, at our meeting at the Brooklyn 5G Summit, there were some discussions about a road map that would introduce millimeter wave as an extension and as part of the current 3GPP standard-setting process.

I'm sure you'll see a natural migration just the way Wi-Fi is including WiGig in 802.11(ac) into its framework. Devices will be backward-compatible as well as upward-compatible.

amateur radio operators, shortwave broadcasters and the military before the invention of satellite communications. At shortwave frequencies, the rhombic is a large, highly directional wire antenna. "I thought, 'What if we put a rhombic antenna on an integrated circuit? It's a super, highly directional antenna,'" Rappaport said. Although rhombic antennas are several miles long at high frequencies, huge rhombics are only millimeters long at millimeter-wave frequencies.

"We built a rhombic antenna, just basically a diamond of metal put on an integrated circuit, and wound up breaking the record for antenna gain," Rappaport said. "It turns out we can obtain very good efficiency, although not much gain, only about 4.2 dBi, basically an omnidirectional antenna. It doesn't have much gain because we're still losing a lot of power in the substrate, but the antenna makes up

for that by its size. We obtain some front-to-back ratio. Since we did this work, other people have figured out clever ways to notch out air holes in an integrated circuit to improve the efficiency. It shows that we'll solve the on-chip antenna problem so that your future wireless device will have antennas built into the circuits."

Signal Measurements

Rappaport said that thousands of signal measurements made by students in various projects over the years showed that signal attenuation caused by rain that makes a big difference at higher frequencies makes little difference as distances shorten, and short-distance coverage will be the rule, not the exception, with small cells. "The loss is a few dB," he said. "When you get the antenna so small, you can make very highly directional antennas and easily com-

pensate for a few dB of loss with a little bit more antenna gain. This was a wonderful revelation that people had not been thinking about — small cells, combined with the fact that millimeter waves give you much more antenna directionality."

Early on, students also measured how multipath energy bounces around inside of a building. More recently, with the interest in outdoor small cells and millimeter-wave technology, NYU students made measurements indoors to outdoors in New York's urban environment. "When you point an antenna to the receiver and the base station to mobile has a direct line, you obtain a perfect single response with no multipath," Rappaport said. "If I turn my receiver antenna about 30 degrees, I pick up multipath signals from energy scattering from the sides of buildings, unlike what we



To directoinalize the signal the way a large array antenna could, the signal appratus was fitted with a horn antenna. Photo courtesy of IEEE Access

WIRELESS

have with today's cellular frequencies. This scattering effect is going to allow the channel to work very well. The studies show there are always about three angles for multipath reception in a street. You can even combine this energy."

Rappaport said the NYU results in New York showed that 200-meter cells would work at 28 GHz and 73 GHz. "That seems to be the magic number: 200-meter cells," he said. "I call this the wireless coming into its renaissance. How do we bring this renaissance about? One of the ways is with future generations of engineers."

He said NYU Wireless has 25 faculty members and 100 students. "It started in August of 2012, so we're about a year and a half old. The program has 10 industrial affiliate sponsors that contribute \$100,000 per

year. We have a deep relationship with these companies," Rappaport said. "Also, NYU Wireless includes resources from electrical and computer engineering, computer science and radiology."

Rappaport said NYU Wireless works closely with its interdisciplinary resources and with its industrial sponsors because those companies and others in the industry will need new engineers who understand millimeter-wave technology. "It's not taught in most schools," he said. "It's a new frontier. It's a totally new technical area where the wavelengths get small, and there are new laws, new concepts." He said that with millimeter waves, engineers have to worry about things that are of little concern at lower frequencies.

"The coming era will be massively

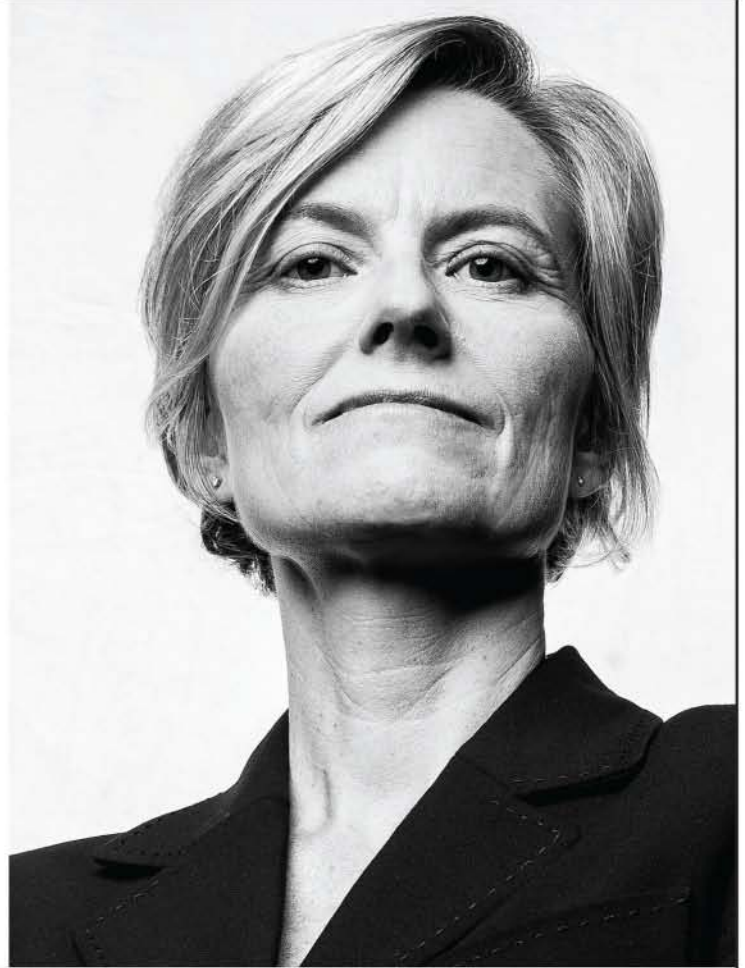
broadband," Rappaport said. "It's not here yet, but when it comes, wireless will obviate print, magnetic media and wired connections. It will bring wireless into its renaissance. It took about 30 years to go one decade higher in frequencies, from 450 MHz to 5 GHz. It took that long for Moore's Law to hit the carrier frequency of wireless. But we're about to explode. We're about to see the carrier frequencies go up in wireless. That's a rich field, and I think it's going to be exciting to see where this goes in the next decade."

Dr. Theodore S. Rappaport's presentation to the New York State Wireless Association meeting can be viewed here: youtube.com/watch?v=IcA6zKe5D_w. Visit the NYU Wireless website at nyuwireless.com.



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What's on the Horizon for Wireless Infrastructure

Public spectrum networks represent a new segment of wireless, with new operators and new business models. VoLTE handsets for consumers give operators relief from the need to sustain multiple technologies in their networks.

By Ted Abrams, P.E.

Skillful leadership by FCC Chairman Tom Wheeler may catalyze positive changes in spectrum policy. For the first time in more than a decade, we may be on the cusp of significant improvement. Clearing additional bands or rationalizing frequencies would provide network operators with more cost-effective paths to expansion.

Declining margins pinch U.S. operators between escalating consumer expectations and needed network infrastructure improvements. Personnel reductions are carving valuable experience from already lean organizations. To remain in the price war, operators may continue that trend.

The use of more sectors of coverage in more places, the trend for network densification, will continue. Venerable tri-sector arrays that served so well for so long can only support Big Data access if those arrays are closer to each other.

LTE networks are the focal point of U.S. operators' vision. Technology convergence around LTE is coming ever closer. VoLTE handsets for

consumers give operators relief from the need to sustain multiple technologies in their networks. That leads to better service, reduced churn and improved operating margins that free up more operator capital for investment.

Mature technologies may begin to circle the drain in the U.S. market. Full coverage by LTE will permit national brands to pull the plug on older radios. This coming sunset of old technology will have a greater effect than Sprint's final abandonment of iDEN did last year.

Incentive for Manufacturers

LTE standardization gives infrastructure equipment manufacturers incentive to place bigger bets. Cycles of innovation will accelerate.

Electronics miniaturization and improved heat transfer from new chipsets trend toward more compact equipment at the tower. Bucking that trend is the larger antenna surface needed to increase network sensitivity and satisfy demand for higher uplink speeds.

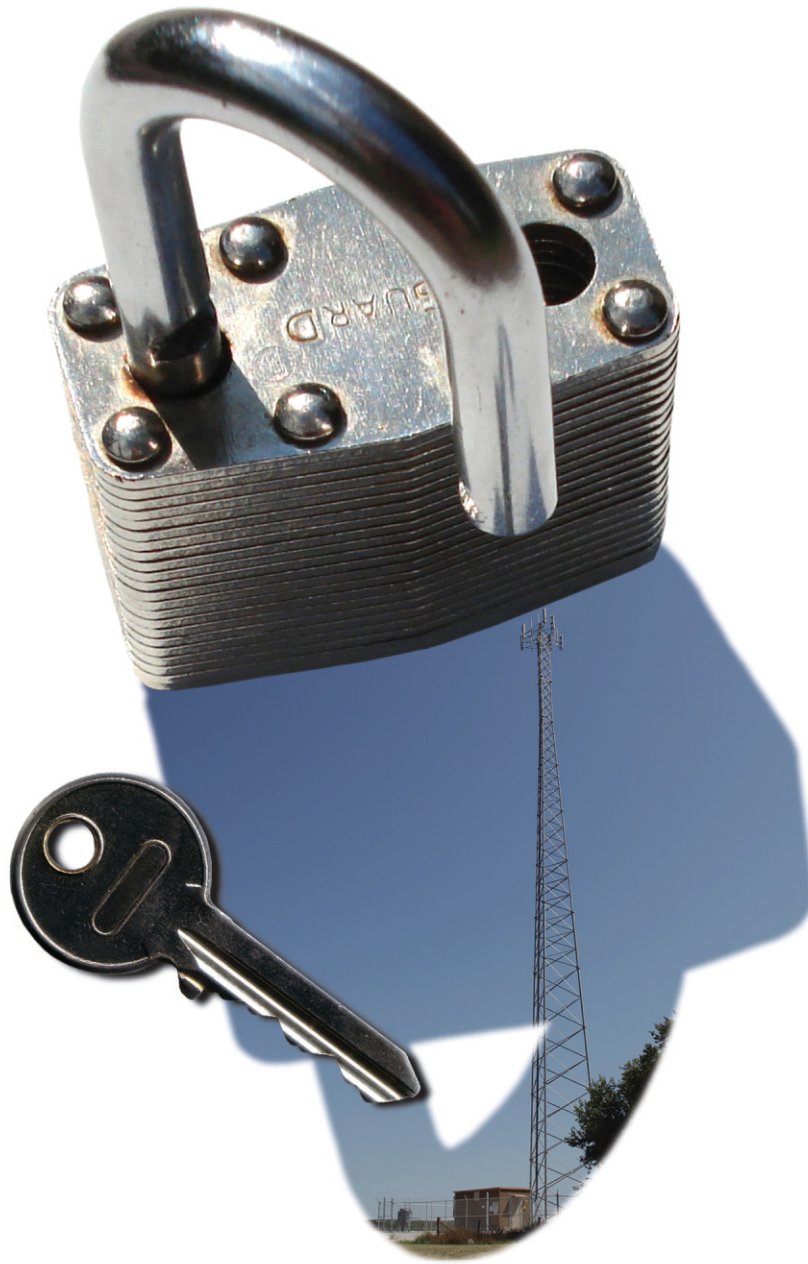
Tower streamlining, driven by

practical needs to mitigate antenna wind load and community perceptions of visual aesthetics, will change the appearance of steel in the air.

Public spectrum networks represent a new segment of wireless, with new operators and new business models. The swath of U.S. spectrum in the public domain is significantly larger than the allocation of frequencies controlled by national network operators. Even with spectrum clearing action by the FCC, network planning will increasingly emphasize the purposeful use of public spectrum for both offload and primary service. Evidence of that is already visible in the 802.11ac Wave 2 products. Beyond Hotspot 2.0, beyond the weaknesses of mesh networks, public spectrum deployments will make the best use of ISM/Wi-Fi frequency bands as well as the white space frequencies available for wider area coverage.

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Estimates Call for Less Tower Growth in 2015

By Jonathan Atkin and Brian Hyun

Carrier	2004 adds	2005 adds	2006 adds	2007 adds	2008 adds	2009 adds	2010 adds	2011 adds
AT&T new sites	2,950	3,900	2,900	930	1,454	1,889	1,822	
AT&T lease equivalents added from overlays	860	2,200	6,500	1,875	2,500	1,400	2,200	
T-Mobile new sites	2,095	3,500	3,299	2,500	3,359	3,062	2,236	
T-Mobile lease equivalents added from overlays				2,000	2,000	2,792	1,381	
Verizon Wireless new sites	1,500	2,647	2,642	2,418	2,426	1,600	327	
Verizon Wireless lease equiv. added from overlays	2,500	2,500			200	1,750	2,400	
Sprint Nextel new sites	5,875	4,900	3,400	1,450	920	175	230	
Sprint Nextel lease equivalents from overlays				1,338	420	-	125	
Alltel/ATNI	550	500	600	300	500	-	-	
Cox						200	150	
US Cellular	672	572	500	420	400	402	366	
Clearwire new sites	200	400	783	1,045	1,000	4,175	9,500	
Clearwire lease-equivalents from overlays						130	150	
Leap Wireless	100	2,800	3,600	700	2,700	2,200	150	
Leap Wireless lease-equivalents from overlays								
Metro PCS	460	315	500	1,100	1,850	1,100	150	
MetroPCS lease equivalents from overlays							150	
TOTAL	17.8K	24.2K	24.7K	16.1K	19.7K	20.9K	21.3K	

Note: Lease equivalents from overlays are based on assumptions that UMTS and LTE overlays trigger partial leases based on additional or replacement antennas and other equipment.

FORECASTS



RBC Capital Markets forecasts less cell site growth for the coming year, with 20,000 additional sites/lease equivalents from overlays, compared with 21,800 additions that were

expected in 2014. The highest growth year in the last decade occurred in 2006 when the industry added 24,700 sites or lease equivalents, which was followed by the lowest growth of 16,100 additions

in 2007. The following are break-outs of projected growth by carrier with some color on growth drivers. Data include site-equivalents from amendments/overlays but not small-cell or DAS contributions.

2011 adds	2012 adds	2013E adds	2014E adds	2015E adds	Comments
2,450	1,200	2,000	3,600	1,500	1,900 site additions in the first half of 2014, with slowing trend toward ~1,500/2,000 estimated in 2015/2016. AT&T continues LTE overlays and capacity expansion. WCS work has begun for the air-to-ground network, but not for terrestrial deployment. We expect AWS-3 overlays to commence in the second half of 2015. WCS deployment for video delivery, post-DTV closing, may be under consideration.
6,200	4,730	5,200	3,650	3,500	
1,000	559	212	600	900	LTE overlays continue, with new coverage sites ramping up in the 700-MHz band. The MetroPCS CDMA decommissioning pace varies in approximately reverse relation to market penetration. In some markets, MetroPCS LTE gear is being redeployed to rural T-Mobile sites to enhance rural coverage, but this does not drive meaningful tower revenue. We expect AWS-3 overlays to commence in the second half of 2015.
750	2,300	4,500	1,850	2,000	
1,100	1,400	2,613	3,600	3,500	1,236 site additions in the first half of 2014. LTE deployments in the AWS and 1900-MHz bands have been augmented by capacity-driven cell splits and significant increases in new search rings, which we believe will drive increased lease signings in 2014 and 2015. Verizon is also active on small cell deployments, driving in some cases a small benefit to tower leasing volumes. We expect AWS-3 overlays to commence in the second half of 2015.
2,500	2,500	2,500	3,750	3,500	
400	200	100	100	100	Ongoing projects include LTE deployments at 2.5 GHz and 800 MHz, CDMA at 800 MHz, and LTE second-carrier deployments at 1,900 MHz. We believe Sprint's equipment availability delays for 8T8R LTE deployment at 2.5 GHz have started to lift, with regional differences depending on vendor, driving increased activity in the second half of 2014. Site additions remain dormant with no search rings active to our knowledge.
500	2,700	4,600	5,100	5,000	
100					
-					
500	300	200			
1,500	200				Clearwire sites are now reflected in Sprint site totals. WiMAX decommissioning is underway.
300	150	-			
100	100				Leap Wireless has been acquired by AT&T. AT&T plans to keep 240 Leap sites. CDMA decommissioning slated for 2015 Leap sites is reflected in AT&T totals.
300	200	(22)			MetroPCS sites are being integrated into the T-Mobile USA network and reflected in T-Mobile site totals. MetroPCS CDMA has been deactivated in several Northeast and Western markets, with remaining decommissionings slated through early 2016.
150	300				
17.9K	16.8K	21.9K	22.3K	20K	2014 demand drivers feature an increased mix shift toward new leases, driven by capacity/infill requirements at AT&T and Verizon. We believe 2015 activity will slow overall, driven by a slowdown at AT&T, offset slightly by a ramp at T-Mobile, with similarly strong leasing activity at Verizon and relatively little at Sprint. We expect AWS-3 overlays to commence in the second half of 2015. Non-Big Four site-addition activity includes fixed broadband networks (mostly rural) and M2M Spectrum Networks.

Source: RBC Capital Markets estimates and company reports



FORECASTS

AT&T 2015 Projections

Sites: 1,500

Lease equivalents added from overlays: 3,500

AT&T, which had 1,900 site additions in the first half of 2014, is expected to see a slowing trend toward ~1,500/2,000 estimated in 2015/2016, according to RBC Capital Markets. The carrier continues LTE overlays and capacity expansion. Wireless Communications Service (WCS) work has begun for the air-to-ground network but not for terrestrial deployment. The firm expects Advanced Wireless Service-3 (AWS-3) overlays to commence in the second half of 2015. WCS deployment for video delivery, after closing on DirectTV, may be under consideration.

T-Mobile 2015 Projections

New sites: 900

Lease equivalents added from overlays: 2,000

LTE overlays continue at T-Mobile, with new coverage sites ramping in

the 700-MHz band. The MetroPCS CDMA decommissioning pace varies in approximately reverse relation to market penetration. In some markets, MetroPCS LTE gear is being redeployed to rural T-Mobile sites to enhance rural coverage, but this does not drive meaningful tower revenues. RBC Capital Markets expects AWS-3 overlays to commence in the second half of 2015.

Verizon Wireless 2015 Projections

New sites: 3,500

Lease equivalents added from overlays: 3,500

Verizon Wireless had 1,236 site additions in the first half of 2014. LTE deployments in the AWS and 1900-MHz bands have been augmented by capacity-driven cell splits and significant increases in new search rings, which we believe will drive increased lease signings in 2014 and 2015. Verizon is also active on small cell deployments, driving in some cases a small benefit to tower

leasing volumes. RBC Capital Markets expects AWS-3 overlays to commence in the second half of 2015

Sprint 2015 Projections

New sites: 100

Lease equivalents added from overlays: 5,000

Ongoing projects at Sprint include LTE deployments at 2.5 GHz and 800 MHz, CDMA at 800 MHz, and LTE second-carrier deployments at 1,900 MHz. RBC Capital Markets believes Sprint's equipment availability delays for 8T8R LTE deployment at 2.5 GHz have started to lift, with regional differences depending on vendor, driving increased activity in 2H14. Site additions remain dormant with no search rings active to our knowledge.

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Tower Family
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Providing Support by Standing Together

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

Chris Wener

Nevada Wireless Association President

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

John Gates

Tower Climber from ATS

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

Russ Chittendon

Vice President of Synergy Concepts, Inc.

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The Future of Wireless Infrastructure in the United States

Wall Street would love you to believe that small cells will dominate the construction environment for the next five years. But at the end of the day, it may be more macros than micros.

By Don Bishop

Speaking at a meeting of the Maryland-DC Wireless Association, Marc Ganzi, the chief executive officer of Digital Bridge, said investors and owners have as much reason to be optimistic about the tower industry as ever. Ganzi is the founder and former CEO of Global Tower Partners.

"The reasons are simple," Ganzi said. "For one thing, investors, in general, love barriers to entry. Towers have that because you're fighting zoning battles every day. This is probably the number one reason why the tower business attracts capital. If you obtain the right location, you really don't need a great sales force to lease it."

Ganzi said the next reason is visibility. Equity investors like visibility, and debt investors like it even more, he explained. It's the reason behind steps that Crown Castle International, American Tower and SBA Communications take with the long-term, 30-year commercial mortgage-backed securities they issue and why they amend their master leasing agreements to add seven and 10 years. "It provides visibility for revenue," Ganzi said. "What

debt investors want to know is that you have a stabilized cash flow growing at 3 percent a year, and that customers can't terminate for the next 10 years. Those are the key buzz metrics."

The third thing that Ganzi said investors love is growth. "Tower owners can grow their businesses in a number of ways," he said. "We can build, buy and lease towers. Then we have a choice whether to lease the towers by signing amendments or leasing for new, de novo collocations, or for microwave backhaul, or it could be for 4.5G technology or 700-MHz systems. The 700-MHz systems could represent another

amendment that's coming and that keeps on giving. The embedded notion of growth and why this is a great asset class underpins our investing thesis for the next five years."

The fourth reason Ganzi cited is operating leverage, which he said means that from a fixed-cost-base of operations, a tower owner can add revenue without adding expense.

"The way we did it in our business was we tried to keep our site-level operating cost fixed," he said. "We had great partners for site maintenance. We had David Saul doing our insurance, who kept that expense down. Making sure there wasn't a lot of unpredictable activity related to site-level operating expenses helped to improve cash flow margins at the sites. Another tactic is to buy out your ground lease."

To control sales, general and administrative expenses, Ganzi said he created silos of people to execute different functions, and he used a back office system, a database, to tie those functions together. "The right back-office system allows employees to consistently and constantly communicate

WIRELESS

What Tower Investors Love

- Barriers to entry
- Visibility for revenue
- Growth
- Operating leverage



with each other about every tower, whether it was a new build, an amendment or collocation, without having a hundred emails circulating among six people about one topic," he said.

Explosive Growth

Ganzi said investors are excited about the way tower companies grow their asset base.

"For the next several years, growth will result from the explosion in the use of mobile data," he said. "A smartphone takes up to 49 times more capacity than a feature phone. Laptop computers are the network killers. It would take 227 feature phones to replicate the data consumption of a laptop. Next-generation devices, particularly tablets, take 2.4 times more capacity than an average smartphone. For tower owners, all of our demand right now, whether it's negotiating a ground lease, upgrading a tower, building a new tower or handling a collocation application, is being driven by mobile data. AT&T calls the growth the 'data tsunami.'"

Trends to Think About

Ganzi said machine-to-machine communications will drive the mobile networks in the coming years. M2M communications include wearables and video. It also includes smart cars, houses and refrigerators.

"An example of a wearable would be a fitness band," Ganzi said. "With M2M communications, individuals no longer are involved in the transaction. It's one device talking to another device. Original equipment manufacturers are consuming themselves with how to invent devices that don't involve us making a purchasing decision.



Marc Ganzi, chief executive officer, Digital Bridge. Photo by Don Bishop

That's scary, but this is a growing part of their game."

Wearables are in their infancy, Ganzi explained, saying, "Today, there are 22 million distinct users in the wearables market. That will rise to 177 million by 2018, and you will not be involved in that conversation. That will be one of your machines talking to somebody else's machine. It's a whole new category of wireless products in which America will be the leader, because America is totally responsible for useless technology. As consumers, we love it, so we will far and away be the global leader. M2M communications will not be driving European, Latin American, African or Asian towers anytime soon."

The second trend, video, is a big consumer of traffic on the network, Ganzi said. "With video, carriers have a problem. Network engineers will tell you that if they don't migrate and separate data, voice and video traffic

into different frequencies and different bands, the networks will become choked," he said. "Already, today, we have 60 percent of video consumption as mobile video. Carrying all of that video is going to be a big problem for the network operators."

Ganzi said that mobile audio, mobile M2M, mobile file sharing and mobile Web all are growing fast and are consuming exabytes, not terabytes, of data per month.

Cell Site Growth Prospects

Ganzi said the wireless infrastructure industry ended 2012 with 294,000 macrosites in the United States. He said that absent new spectrum, without increased spectral efficiency in the radios and the handsets and without the use of small cells, network operators would need 4.3 million macrosites by 2021.

"Even though the tower companies are not going to build 4.3 million macros because there will be new spectrum and increased spectral efficiency, everyone will need to keep building macrosites as fast as they can and keep providing services to the wireless industry with infrastructure construction. In this ecosystem, we need everything to happen. There really is no single bullet that solves the problem."

Spectrum Increase

Ganzi said he believes there will be a 40 percent increase in spectrum released between now and 2021. "During my 20 years in this business, 24 months after the FCC announces selling the spectrum, the spectrum clears and falls into the carriers' hands, my phone rings. We either have to upgrade

the radios on the tower, install new lines, install new antennas or build new sites. The networks need coverage or capacity. That's not going to change."

New spectrum that may come to wireless networks include frequency bands owned by Dish Network, frequencies in Advanced Wireless Service spectrum, digital TV (DTV) channel refarming and spectrum under federal control. "We're sitting on a ton of spectrum that's unallocated," Ganzi said. "There is plenty of spectrum to build out this next data tsunami. AT&T shouldn't be worried."

Spectrum Efficiency

Ganzi said the leap in spectrum efficiency from HSPA to LTE was significant for handsets and, more importantly, the radios. He said the coming spectrum efficiency of 5G cellular technology will be needed to meet the expected 10 times demand spike in data usage and a 32 times spike in video usage.

"When we think about where we're going in the next seven years, networks are going to be changed radically," he said. "They're going to have 4G radios, 4.5G radios and 5G radios. 2.5G and 3G will be gone — deconstructed. There will be a fight over what devices use these frequency bands. We'll have wearables. We'll have autos — smart cars — a large and growing segment of network use. We'll have dongles, feature phones and smartphones. And just think, in 2021, we'll only have 138 million users on 5G. The predominance of use will be in 4.5G. So, in seven years, 4.5G use will be what 3G use was in 2011. We'll have two iterations of technology improvement."

Ganzi said that despite U.S. innovation, the United States lags in network and spectrum efficiency compared with South Korea and Japan. "In South Korea, carriers have already launched 4.5G, and they're trial-testing 5G. In Latin America, carriers are still running on 3G. So, the ecosystem hierarchy puts South Korea and Japan first. North America follows, Western Europe goes next, then Latin America, and the last is Africa. That's the original equipment manufacturer ecosystem, where they sell which devices."

DAS and Small Cells

The site construction, site maintenance and site development business could be affected by the use of technologies other than macrosites. On this subject, Ganzi reiterated that operators cannot solve their growing network capacity requirements with any single technology.

"Wall Street analysts tell you it's all about small cells," he said. "Small cell. Small cell. It is, to a certain degree. But keep in mind that distributed antenna system (DAS) networks are not the low-cost solution that so many believe they are. Carriers tell us, 'Yeah, we'd love to have small cell, but it's not priced correctly,' because you still have this last-mile problem, which is the landlord. Landlords are not going to give away real estate cheaply. The tower companies aren't giving it away. Municipalities aren't giving it away. Private real estate owners are not going to give it away."

Ganzi said that on a one-for-one basis, DAS nodes cost less than macrocells. "It will cost anywhere from \$15,000 to \$20,000 to deploy a small cell," he said "It can cost \$150,000 to

\$300,000 to deploy a macrocell. The problem is that the estimates of how many DAS nodes equal one macrosite range from eight to 12. If it costs \$20,000 per DAS node and 10 nodes equal one macrosite, you're already at \$200,000 to \$250,000 capex, and you haven't even dealt with the rent factor with the landlords. We're just talking capex. In the capex model, it is always cheaper to overlay a macrosite on an existing facility such as an existing tower or an existing rooftop site. That remains the cheaper solution."

Focusing on the rent factor, Ganzi said that cheap DAS nodes are \$175 a month, and expensive, well-located DAS nodes on Long Island or in Newport Beach, California, can rent for as much as \$400 a month.

"Take 10 DAS nodes at \$400 a month, and that's the equivalent of \$4,000 in macro rent," he said. "What would a carrier prefer? Pay \$4,000 for 10 nodes? Or go to tower company Z and pay \$1,700 a month for a collocation? That's a big difference in opex. So there's a capex consideration, and there's an opex consideration."

Ganzi said that although small cell technology is a part of the ecosystem, expect to see a blend of macrocells and small cells because both types of sites will continue to be deployed during the next five years. He said part of the reason is because coverage from macrosites and small cells alike never measures up to the theoretical, perfect-world coverage. One technology helps to fill in coverage gaps of the other, and they both have them.

"A fill-in strategy using small cells deals with gaps of coverage between macrosites that result from 4G conversions," Ganzi said. "With 4G ra-



dios at the macrosites, their coverage areas become slightly smaller, opening some coverage holes. Small cells are a perfect solution for filling coverage holes. That is the real world. This is what's happening right now with network engineers."

Prospects for Macrosites

Ganzi said that there is no one single technology that could replace the use of macrosites. "Wall Street would love you to believe that small cells will dominate the construction environment for the next five years. Not true," he said.

He offered some metrics about the wireless infrastructure industry sector as of the end of 2013. "We ended with 315,000 macrosites," Ganzi said. "We ended the year with 23,000 small cells. So, wireless infrastructure was skewed heavily toward macro. The question is, what's going to happen over the next five years?"

Ganzi said that by 2018, the United States would have 405,000 macrosites. "That's 90,000 macros to be added during the next five years," he said. "Those are new builds and collocations. It's a lot of work for everybody in the wireless infrastructure industry. Meanwhile, in 2018, we get to 36,000 small cells, and we ended 2013 with 24,000 small cells."

Thus, Ganzi observed, the use of small cells will grow, but not at the same velocity as the use of macrosites. "There's a public misconception that the growth of small cells will outpace macrocells," he said. "But talk with network engineers. Find out where the search rings are being issued for densification and where networks are being fortified. They're not being for-

tified with microcells. They're being fortified with macrocells. This is a big trend, and this is what gets us very excited — 90,000 macros to build between 2013 and 2018."

The public tower companies will get their fair share of the new macros, but Ganzi said the entrepreneurs, the small business owners and small tower developers are the ones that will benefit the most from the data tsunami effect.

The Future for Carriers

In Ganzi's view, these are early days for 4G deployment. "The United States market is nowhere in 4.5G, and no U.S. carrier has begun a trial-test of 5G in this country," he said. "There remains a lot of demand pull in the sector today. AT&T has stated publicly that it plans to deploy 40,000 small cells and unofficially more than that. But AT&T's Project Velocity IP (VIP) to expand its potential in key platforms doesn't seem to be going particularly well, at least, not on the small-cell side. The feedback we're getting is that venues want too much money for what they're willing to deploy. Typically, the carriers want to pay as low as \$75 a month for a microcell or small cell."

Then, there's the matter of differentiating between macrosites and microsities. "We've seen a hybrid configuration of two panels, six feedlines and one BTU cabinet," Ganzi said. "Is that a macro or is that a microsite?" He said if the hybrid configuration is mounted on the side of a building, on a rooftop or on a tower, it might be more macro than micro.

"At the end of the day, it'll be more macros than micros," Ganzi said, re-

ferring to cell site deployment during the next five years. "It's really a function of the ecosystem of what carriers are willing to pay in opex. Opex kills their EBITDA more than capex does. The opex is what they report to the street. Carriers are focused on trying to keep infrastructure rents down."

Ganzi said AT&T's statement of its intention to deploy 40,000 microsities has been well publicized. "When you try to back them into a corner and ask, 'How many have you deployed?' they don't give you a number. So, we'll see," he said.

"With Sprint, we're looking at a budget between 5,000 to 6,000 macros," Ganzi said. "From now to 2018, we think Sprint is somewhere between 15,000 to 22,000 macrosites on the demand side. That's low, from our perspective. It really depends on how much its owner in Japan continues to fund the business."

Ganzi said Verizon Wireless adds 3,500 to 4,000 macrosites per year, thus, for the next five years, the company might be expected to add 15,000 to 20,000 macrosites.

"AT&T is talking about 8,000 macros this year," Ganzi said. "They're talking about another 6,000 to 8,000 next year. And if you ramp them out another 5,000 each, you get 26,000 macros from AT&T. If you start doing the math, you see 26,000 from AT&T, 20,000 from Sprint, 20,000 from Verizon, and then T-Mobile USA is the big unknown. At some point, T-Mobile is going to have to start reinvesting in the network because the current environment in Washington is not likely to approve a Sprint and T-Mobile merger in the next 18 months."

The Tower Climber of the Future

Working safely, delivering high-quality results and offering an adaptable skillset will be at the forefront of how the tower climber of the future will be evaluated.

By Todd Schlekeway

Tower climbers are the backbone of the wireless infrastructure industry. The LTE installations, network upgrades and broadband deployments that tower climbers conduct on a daily basis are transforming virtually all sectors of our economy — from health care to finance, energy to manufacturing, higher education to agriculture and everything in between.

For this special Horizons issue of *AGL Magazine*, I was asked to look into a crystal ball and project what the tower climber of the future may look like, considering the rapidly evolving and dynamic nature of the wireless industry.

Over the course of the past year, NATE has led efforts to bring the industry together in unprecedented fashion, actively supporting and collaborating with companies, organizations and agencies to pursue the common goal of achieving long-term, sustainable safety improvements. These collaborations have been outstanding, and the industry is united in its pursuit of fostering a safer tower site working environment for tower climbers to work in every day.

It is no secret that the scope of work required of tower climbers continues

to become more sophisticated. In addition to performing traditional tower and maintenance work, it is paramount moving forward that climbers develop a diverse skillset that allows them to perform distributed antenna system (DAS) and small cell deployments and also have the ability to adapt to future work that will be devoted to installing and maintaining

sists of top safety and operations executives representing wireless carriers, tower owners, original equipment manufacturers, turnkey and construction management firms and small contractors. The task force has developed a comprehensive skills-based training competencies matrix that outlines the minimum competencies and skills required for five categories

Over the course of the past year, NATE has led efforts to bring the industry together in unprecedented fashion actively supporting and collaborating with companies, organizations and agencies.

5G technologies and systems. These factors, combined with a current workforce shortage, have set in motion a series of initiatives that, upon completion, will help develop a larger pool of versatile, highly skilled tower climbers capable of providing the wireless industry with the safe, high-quality build outs necessary to meet present and future demand.

Skills-based Programs

In 2013, NATE founded the Wireless Industry Safety Task Force, which con-

sists of workers in the industry: helper and ground worker, ground technician, telecommunications tower technician I, telecommunications tower technician II and lead/foreman. This significant work product will serve as the impetus for developing a free market, national, wireless training standard and program that will serve as the foundation for what future climbers need to be trained to do in order to start working in the industry.

Currently, in addition to the Wireless Industry Safety Task Force initiative, there are at least three

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other programs in various stages of development that will also play a role in training the tower climber of the future.

- The Telecommunications Industry Registered Apprenticeship Program (TIRAP), currently under development, is a joint venture between the telecommunications industry and the U.S. Department of Labor. TIRAP is a competency-based apprenticeship program for entry-level occupations in the cell tower industry, including the occupation of tower technician, which encompasses a series of competencies necessary and required for successfully completing tasks. TIRAP is a voluntary program for companies that participate, and it assists them to train and help their employees gain valuable on-the-job experience.
- PCIA is developing educational programs for high-demand disciplines such as tower systems, DAS, small cells, project management, site acquisition, RF design and RF engineering that will improve the quality of training and provide a pathway for continued learning and development for those employed or seeking employment in the wireless infrastructure industry. One such effort, funded by the Trade Adjustment Assistance Community College and Career Training Grant Program from the Department of Labor, involves a PCIA-initiated pilot program at Virginia State University as a model for other training programs to bring enhanced learning to scale across the country.

- Warriors 4 Wireless helps bridge the gap between the demand for trained wireless technicians and highly valued, well-qualified men and women who have served our country so faithfully. Warriors 4 Wireless is a 501(c)3 organization that has launched training and certifica-

tion programs with educational partners such as Aiken Technical College in South Carolina and with industry partners such as Grey Wolves Telecom in Dallas to offer candidates tower training, certification and career placement. NATE recognizes that the industry

Skills-based Training Competencies Matrix

In 2014, the Wireless Industry Safety Task Force developed a matrix that outlines minimum competencies and skills for five categories of wireless industry workers:

- Telecommunications tower technician I
- Telecommunications tower technician II
- Lead/foreman
- Helper/ground worker
- Ground technician



An exhibit at a National Association of Tower Erectors convention displays personal protection equipment designed for employees who climb telecommunications towers as part of their work. *Photo by Don Bishop*

FORECASTS

is best served by having access to a variety of high-quality training program options that best fit each company's unique workforce needs. NATE also remains firm in its belief that the industry deserves a single national wireless safety-training standard that ensures that all trainees are evaluated by a single, consistent assessment. It is extremely important that future tower climbers be trained to this single standard, regardless of which of the programs they pursue for their training.

Solutions Working Group

The daily, constant use of fall-protection equipment is instrumental in keeping tower climbers safe. Many equipment manufacturers have made big strides in developing and improving personal protective equipment over the years. What kind of fall protection equipment will tower climbers of the future be using? The Wireless Industry Safety Task Force convened a Manufacturing and Engineering Solutions Working Group, and it is engaging with industry equipment manufacturers to explore what advancements can be made to fall-protection equipment to help make it safer for those who perform their work at elevation.

For example, this working group is challenging fall-protection equipment manufacturers to develop, test and market innovative fall-protection products to meet the needs of the tower climber of the future. One of the products being researched by the working group is a smart lanyard system. The concept behind a prototype smart lanyard system would be to build smart-clip sensor technology into the product to ensure that at least one of the sys-

tem's carabiner hooks is tied off to the structure at all times. The smart-clip sensor would simply not allow both hooks to be opened at the same time and would not allow the safety features to be negated by the climber. There is a sentiment among the working group participants that technology can play a vital role in removing human error from the role of the tower climber when working at elevated heights.

In order to facilitate innovation and to allow each participating fall-protection equipment company the opportunity to maintain confidentiality from their competitors, the working group is pairing NATE-member host contractors with participating equipment manufacturers to collaborate and provide real-time feedback from tower climbers who will be testing the prototype systems as they are developed.

Manufacturers and industry experts have met previous challenges facing our industry, and we are confident that tower climbers of the future will continue to have state-of-the-art

smart fall protection equipment that will ultimately make their jobs safer.

Conclusion

Working safely, delivering high-quality results and offering an adaptable skillset will be at the forefront of how the tower climber of the future will be evaluated, and achieving these attributes will be the ultimate test of what constitutes a great tower climber. NATE was founded with a mission to pursue, formulate and adhere to uniform standards of safety to ensure the continued well-being of tower industry employees. NATE believes that the recent industrywide initiatives under development are in unison to achieve the goal of zero fatalities in the industry and to ensure that present and future tower industry workers return home safely every night.

Todd Schlekeway is the executive director of the National Association of Tower Erectors. His email address is todd@natehome.com.

Skills-based Programs Under Development

In addition to the Wireless Industry Safety Task Force initiative, at least three other programs that will also help play a role in training the tower climber of the future are in various stages of development.

- The Telecommunications Industry Registered Apprenticeship Program, under development by the U.S. Department of Labor
- The Educational Framework industry training program, under development by PCIA and Virginia State University
- Tower training and certification from Warriors 4 Wireless in partnership with Aiken Technical College in South Carolina



Of all the things Shea's dog is trained to do, the most important is opening doors.

A rare muscle disease keeps Shea confined to a wheelchair. But thanks to her best friend Mercer, she's not confined *by* it. Mercer is at Shea's side 24 hours a day to help her do all sorts of things on her own, from picking things up off the floor to opening the refrigerator and turning on the lights. How inseparable are Shea and Mercer? Take a look in her school yearbook and you'll find his picture right there next to hers.

For more than 30 years, Canine Companions for Independence has been teaming people like Shea with dogs like Mercer completely free of charge. To find out more about making a donation, volunteering, or applying for a dog of your own, visit www.cci.org or call 1-800-572-BARK.



©2007 Canine Companions for Independence, Inc. Photo: Gene Pouch

The Tower Crew of the Future

Steps network installation vendors must take to be effective and profitable as wireless network operators transition to IP-based networks call for changes in logistics, crew scheduling and client communications that elicit add-on business.

By Thomas Dolislager

The wireless industry is undergoing a fundamental transition from being a circuit-based network to becoming an IP-based network. Wireless carriers and equipment manufacturers are reworking operating models as LTE deployments near completion and as small cells of all types are being deployed. 5G networks are already visible on the horizon. The industry tends to overlook the necessary transition that network installation vendors must make to be effective and profitable in this environment. To highlight these changes, let's observe a day of the tower crew of the future from the perspective of a new crew lead.

The smartphone alarm goes off at 5 a.m. Even before getting out of bed, Pat's workday begins with a quick review of assignments stacked in queue on the phone. It would be easier to get up if Pat had not been out late at the college alumni meeting. Yet it was worth it to see how just three years out of college, Pat was making more than most of the recent grads.

Crew Availability

Looking at the crew availability screen, Pat sees that one of the crew

is attending an OEM certification class for the next three days. It feels like one crew member or another is always getting trained on the latest installation, integration and troubleshooting techniques. Pulling up the unassigned crew list, Pat selects an electrician, who is also a certified climber, to fill out the four-man team for the day. This will come in handy because an indoor small cell installation is the first stop of the day.

Over breakfast, Pat reviews the logistics requirements for the day's activities on the company tablet. Comparing the materials needed with the inventory in the van shows that a stop at the warehouse will be necessary to pick up some key components and replace the stock used yesterday. Pat sends the materials list to the warehouse so the items can be pulled and ready. The second stop of the day involves some fiber installation, so Pat again uses the logistics app on the tablet to make sure the crew's other van has the fiber splicing and test gear on board.

Before heading out, Pat checks the weather report on the tablet. Seeing a cold front moving in that afternoon, Pat sends a reminder to the

crew to dress accordingly. Pat can also see that the second van is already on the road and headed to the first job site, so it is time to hit the road. At the warehouse, Pat finds the materials waiting on the loading dock, along with the electrician. They load up and head to the job site. Pat can see on the vehicle tracking app that the rest of the crew is already present.

Signal Evaluation

At the jobsite, the crew spends some time measuring the cellular signal strength at various points in the building. They decide that two small cells are needed. The building owner states that she will allow two installations if they also include Wi-Fi access points. Pat writes up a request for the second installation on the tablet's change order screen, adds pictures of the proposed installation site and taps the send button to route the request to both the project manager and the carrier. Pat notes that the crew has two combination small cell/Wi-Fi units in their vans. While waiting to hear back, the crew installs the first small cell, performs the integration checks with the network operating center (NOC) and makes sure the building owner



approves the installation.

As the crew begins taking new signal strength readings, the approval for the change order arrives. The second small cell is installed and integrated, and another round of signal strength measurements is taken. With the work complete, Pat uses the smartphone's closeout app to enter any missing data and to take the pictures required by that carrier. The app automatically sends a message to the customer's real estate group to amend the in-building agreement to include the second small cell.

Quality Control

Pat and the crew grab lunch while they wait to hear from their company quality control team that the closeout package is complete. With the QC approval granted, the crew packs up their tools and test equipment and does a final clean up before checking out of the building. Just as the vans pull onto the highway heading to the next job, Pat's phone rings.

A customer cell site is showing alarms on one sector, and the operations center has routed the problem to Pat's company to resolve the problem. The operations manager pulls up the location of all company crews on the mapping tool and finds three crews within 50 miles of the alarm site. After a quick review of the jobs in progress, due dates, and equipment on board, the operations manager decides that Pat's crew is the best choice. With the touch of a button, the job details are sent to Pat's work queue. Minutes later, Pat's fiber job is reassigned to another crew.

Upon arriving at the site, Pat calls the customer NOC to check in and to gather more details about the alarms. The problem is limited to one sector of a remote radio unit LTE installation. Suspecting an RF connector issue, Pat reports to the operations manager that a two-man team can handle the job. The operations manager insists that three climbers stay on site, because safety is always a top priority. Pat decides to join the crew's newly promoted second in command on the climb to provide some on-the-job training.

Photos for Operations

While climbing the 150-foot tower, the team notices some substandard installations at lower levels. They pause to take pictures of improper tie downs, oddly tilted antennas, loose collar bolts and cracked antenna shells. Arriving at the top of the tower, Pat takes a moment to send the pictures with simple explanations back to operations. Turning to the task at hand, the team does a thorough inspection of the LTE installation. Seeing no obvious issues, they open cable connections, make sure they are working, and check with the NOC before reapplying weatherproofing. With the alarms still active, Pat and the NOC conclude that the problem must be in the antenna. The logistics app shows the specific model of antenna is not in the van, but it is stocked in the warehouse. Pat requests the antenna, and is notified a minute later that a runner will be dispatched from the warehouse with an ETA of one hour.

Antenna Alignment

With time to kill, the climbers decide to check the orientation of the antennas using their GPS-enabled tools. Finding one antenna out of alignment, the crew takes a picture and uses a smartphone to send the picture and data to operations in the form of a change order. Upon receiving approval 30 minutes later, the crew properly aligns the antenna and submits closeout package data. Even before the QC group approves the closeout the replacement antenna arrives and installation begins.

Just as Pat completes the replacement closeout package, two new projects arrive in the work queue. Two new carriers have approved projects to fix the problems documented by the crew one hour ago while climbing the tower. These new repairs are completed and documented with each carrier's specific requirements that are preloaded in the closeout app. As the crew packs their gear and checks out with the NOC, they discuss the bonus money they earned by finding and completing additional work on the two job sites that day.

As usual, Pat arrives home before her husband and has time to cook a healthy dinner. After dinner, she fills out her insurance open-enrollment paperwork and checks on the performance of her 401K account. While relaxing that evening, Pat checks the timesheets of her crew for the day. She notes that the GPS system properly assigned the start and stop times for each crew member, so she taps the Approve button. Before drifting off to sleep, Pat takes a peek at the projects already in her queue for tomorrow.

Thomas Dolislager is president of Sell-Tower Consulting. His email address is thomasd@selltower.com.

Future Tower Workers

Public spectrum networks represent a new segment of wireless, with new operators and new business models. VoLTE handsets for consumers give operators relief from the need to sustain multiple technologies in their networks.

By Kevin R. Carter

The sad state of affairs in the communications and wireless communities continues with 11 recorded deaths among tower workers this year. Following last year's 13 fatalities, the trend has not slowed. Although some of these unfortunate accidents were related to falls from height, many more stemmed from structural overloading and rigging errors. All the accidents were preventable. Despite the fact that firemen and policemen receive much-deserved accolades for laying down their lives for our community, is enough attention paid to the tower workers who paid the ultimate price simply for cell phone coverage? What does the future hold? In five years, 10 years and 20 years, what improvements will be made, and what changes will the industry face that will alter this dangerous job?

I speak with many people across the industry daily, from safety training instructors to turf vendors to personal protective equipment manufacturers and from tower climbers to hardware distributors. When we cast our glance to the future and foresee the industry, we envision many changes stemming from alterations in work habits and technology.

Better training for workers who perform tasks at height is a current

industry focus. As the industry deploys increasingly complex equipment and as tower requirements advance, workers must become more educated and

professional, and as the trade becomes more technical, the level of sophistication of tools and training will improve. From our vantage point at Safety One, we hope

Possible Future

- SPRAT-type certification for tower workers
- Increased use of drones
- Helmets with built-in headsets
- Integrated helmets and harnesses
- Exoskeletons
- Automated emergency communications
- Altimeter-activated distress beacon
- Built-in CPR and AED devices
- Airbag systems
- Elimination of towers for wireless telecommunications



that not only the training is evaluated more carefully, but also the instructors' credentials, knowledge and ability to teach. We see a need for more expansion of rope access tools and techniques and perhaps more Society of Professional Rope Access Technicians-level training. At some point, we could envision SPRAT-type certification for tower workers.

By 2050, will the need for cell towers continue, or will they somehow be eliminated entirely? Will the use of drones or unmanned aerial vehicle systems increase? Will they not only be a new set of eyes for remote inspections but potentially even test or replace equipment? Will the equipment on towers become more and more standardized, lighter, smaller, quicker and easier to maintain, repair

and replace? Will lighter, stronger more durable helmets be made from recycled materials? What about helmets with built-in headsets? And could helmets and harnesses be integrated and customized for the worker? Some sort of exoskeletons? Will automated emergency communications be commonplace? Would automatic notification activate if certain conditions are met, such as a blow of a certain force to the helmet? Perhaps an altimeter within the harness would detect falls and automatically activate a distress beacon. Could someone develop some sort of Onstar harness? What about built-in CPR devices within harnesses? Built in AEDs? Will a harness have a built-in airbag system of some kind to save a worker who falls

from height?

The questions and the variety of potential answers call attention to the fuzzy notion of the future in our industry. We will see improvements. Although some suggestions are fanciful, some are certain to become fact. My instructors say they have some improvements in mind for specific gear, but that potential patents are coming and they do not wish to divulge their intellectual property. Many more changes are yet to be seen even on a distant horizon, and I can't wait to see them. Be safe!

Kevin R. Carter is director of business development, Safety One Training International. His email address is kevin.carter@safetyoneinc.com.

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SITE NAME
TALL TOWER

HEIGHT
1,045 FEET

WEIGHT
1.2 MILLION POUNDS

FOUNDATION
820 CUBIC YARDS
OF CONCRETE

YEAR CONSTRUCTED
1957

MANUFACTURER
LEHIGH STRUCTURAL
STEEL

BROADCASTER
KCTV CHANNEL 5
(UHF DIGITAL CHANNEL 24)

TOWER OWNER
MEREDITH

LOCATION
KANSAS CITY, MISSOURI

Photography by Don Bishop

AGL TOWER OF THE MONTH



agil
ABOVE GROUND LEVEL

DECEMBER 2014

AGL TOWER OF THE MONTH

10

YEARS OF AGL

PUTTING THE BAND BACK TOGETHER

BY DON BISHOP

The original *AGL Magazine* team drew its members from publishing veterans who previously worked together on another antenna site magazine, with backing by entrepreneur Richard P. Biby, P.E.

As *AGL Magazine* marks its 10th anniversary with this issue, let's tell how it all started. I was there, so I'll tell the story. My apologies to anyone who may remember some of this differently. All I can do is tell it the way I remember it. And as I remember those early days, it was much like Jake and Elwood Blues of "The Blues Brothers" movie — Jake Blues saying, "We're putting the band back together."

Las Vegas Connection

It was March 2004, and I was attending the IWCE convention in Las Vegas, looking for clients for my freelance writing and editing business (or a job) after having been downsized out of my long-

running gig as an editorial director with Primedia Business Magazines & Media. In a convention center hallway, I passed Richard P. Biby, P.E., an RF engineer and business owner who had at first been a reader of one of the magazines I edited, *Mobile Radio Technology*, and later, a contributing writer. "What are you doing these days?" Biby asked. "Looking," I replied. "We should start a magazine," Biby said. "Your money and my time, and we can do it," I said, not thinking he was serious. Turned out, he was.

A month later, Biby came to Liberty, Missouri, where he met with David Keckler and me at Keckler's home. Keckler was a previous colleague of mine at Primedia. I recruited him as the first additional team member to start the new magazine. Keckler became the managing editor.

The new magazine wasn't supposed to be *AGL Magazine*. It was supposed to be more like *Mobile Radio Technology*. It so happened that Keckler already had written a business plan for a magazine about antenna sites. He previously asked PCIA — The Wireless Infrastructure Association, for financial backing, but PCIA turned him down. Biby, Keckler and I decided to start publishing with the magazine Keckler envisioned, and Keckler named it *AGL (Above Ground Level)*.

AGL had even deeper roots. At Primedia, from 1997 until it ceased publication in 2002, Keckler and I edited *Site Management & Technology*, a magazine about antenna sites. Phil Cook, a former publishing company owner and at the time a Primedia advertising sales representative, conceived the idea for *Site Management & Technology*. He rejoined the band in December 2006 and sold *AGL* advertising for seven years.

The Other Magazine

Two attempts were made to start the other magazine, *Biby's Wireless Technology*, but it did not launch. Although *AGL* was not supposed to be





Paul Wrablica in July 2004. Wrablica, a site acquisition specialist, helped AGL locate concealed antenna sites to photograph for its first issue and he continues to help the magazine to this day.

the sole magazine of the new enterprise, that's the way it was for the first eight years, until *DAS and Small Cells Magazine* started in 2013.

As work toward launching *AGL* progressed, Keckler asked a former Primedia art director, Scott Dolash, to become *AGL*'s art director. Dolash previously was art director for *Mobile Radio Technology* and *Site Management & Technology*. In June, Biby, Keckler and I met at Dolash's home in Prairie Village, Kansas, where Dolash showed designs for logos and magazine pages.

Keckler and Dolash evaluated printing services vendors and selected one. I began finding contributing authors to write articles and, with help from Paul Wrablica, a site acquisition specialist, I began capturing images of antenna sites for use in the first few issues. I visited PCIA headquarters and obtained the endorsement for *AGL* to become the official magazine for PCIA.

For advertising sales, I recruited Mercy Contreras, my former publisher at Primedia, through her company, Marketing Connection. Later came another Marketing Connection partner, Karen Clark, to manage circulation. And for a circulation list, Biby purchased the rights to the TowerSource list of antenna site owners and managers. In September, Contreras attended the PCIA convention where the launching of *AGL* was announced, and she offered advertising opportunities to manufacturers and service providers.

By the end of November, all the elements were in place: the editorial content, the circulation list and a roster of 12 advertisers. The first issue went into production, and it was published

on Jan. 5, 2005, carrying the date of December 2004/January 2005.

AGL Tower of the Month

Dolash had the idea for the *AGL* Tower of the Month center spread photo feature, a parody of another magazine's monthly centerfold. Debuting in the August/September 2005 issue, "it was initially proposed as a one-time deal," Dolash said. But it became so popular, it continued in every issue that followed. It's something the magazine is known for.

Dolash said he remembers being at an *AGL* convention exhibit soon after the first center spread photo was published, and someone told him, "My wife makes me hide it under the mattress or in the garage." Readers were getting the joke.

That's the story of the original band members. Later, Mary Carlile joined the team as an advertising manager and coordinator. Keckler left, and J. Sharpe Smith joined the team as a contributing editor to *AGL* and as editor of its newsletters. Martha Collins became the copy editor. Traci Gregory came aboard to start and manage conferences, and Smith programmed them. Ernest Worthman became an *AGL* contributing editor and then editor of *DAS and Small Cells Magazine* and its successor, *AGL Small Cell Magazine*.

In April 2013, Rick Heilbrunn became CFO/COO, and Solution Seven became the marketing and public relations contractor with key roles filled by Pat Tant and Janet Gill. In February 2014, Brian Parks became the art director.

So ends my tale of how putting the band back together helped to start *AGL Magazine*. The timeline at the bottom of this issue's pages gives benchmarks of the first 10 years.

And what did Elwood Blues reply when Jake said, "We're putting the band back together"? He said, "We're on a mission from God." It might be a stretch for *AGL Magazine* to make that claim. Could be worth a try, though, for the second 10 years.



The team in 2004 as Biby Publishing prepared to launch AGL. From the top, Richard P. Biby, P.E., CEO and publisher; Don Bishop, executive editor and associate publisher; David Keckler, managing editor; Scott Dolash, art director; and Mercy Contreras, director of sales.

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YEARS OF AGL

JOHNNY MULTIPLE RIDES THE WAVES OF THE LTE BUILD OUT FOR TOWERS

BY DON BISHOP

The man who knows Johnny Multiple best is here with an update on the well-known tower developer.

If Johnny Multiple were here to speak with us today, what would he say he's been up to?

If you don't know Johnny Multiple, he is a character in a series of articles from Clayton Funk that *AGL Magazine* has published during the past 10 years. Funk, a managing director with Media Venture Partners, has been a frequent contributor of editorial content. Some of his articles involve Johnny Multiple and some don't, but either way, they have been highly informative.

Besides his other feature articles, Funk has contributed "Trends and Forecasts" articles to the Tower Market Report since his debut solo effort in 2009. He and Jason Nicolay became a writing team for the trends and forecasts articles in 2010, and Ryan Carr joined the writing team in 2013. Nicolay is a vice president at Media Venture Partners, and Carr is an associate.

Funk is one of three authors from the first issue of *AGL Magazine* who continues to write for the magazine (the others are David Saul and Michael Higgs), and I wanted him to contribute an article for this, the 10th anniversary issue. His schedule just wouldn't allow it, but he took time for an interview so I could include him in the issue. I first asked him about you-know-who.

AGL Magazine: If Johnny Multiple were here to speak with us today, what would he say he's been up to?

Funk: Like everybody else in the industry, he would be busy building towers. This is as robust of a time as it has ever been in the tower industry. He would be unable to attend conferences, sometimes. He probably would be coming home late at night from overseeing people in the field building towers, and he would consider himself swamped but excited about what the future holds.

AGL Magazine: When you look back on Johnny Multiple's career of the past 10 years, what would you say are the highlights of what he has accomplished?

Funk: He has name recognition in the industry, and he should be proud of that. One accomplishment was his ability to weather down periods when there weren't as many tower build opportunities and now being able to capitalize on the Big 4 being busy or having plans to be busy building out their networks. Another accomplishment is a continuous involvement in the industry and being around to build towers.

AGL Magazine: Has Johnny Multiple ever sold any towers?

Funk: Because Johnny Multiple is a composite of tower owners, he has been like a lot of smaller, independent tower developers. He has taken the opportunity to work closely with his customers, earn their trust, get sites on the air quickly and charge fair prices. At the same time, he has been able to save quite a bit of money by selling a handful of towers here and there to fund his development of assets, so he hasn't had to take on outside capital.

AGL Magazine: When Johnny Multiple looks ahead to the next five years, what do you think the future looks like to him?



Funk: Johnny Multiple wasn't able to make it to CTIA because he was too busy, but he caught up with a couple of other tower developers like himself who have been in the industry for over a dozen years. Both friends told him, independently of one another, that the next two years will be the best time that they've ever seen to build towers. Johnny, based on what he's already seeing in his own market as well as what other tower developers are telling him, sees the next five years as an opportunity to continue amassing a portfolio of sites, and after that, we'll see if the 4G LTE build out is largely done or if there will continue to be work to densify the networks.

AGL Magazine: Is that what's going to make the next couple of years so fruitful for Multiple, the LTE build out?

Funk: What will make the next couple of years fruitful for Johnny Multiple will include the LTE build out and the densification of networks. Although the carriers are spending money on small cells as a rifle-shot solution, they still prefer to build macrosites. If there's a macrosite to be built and a company like Johnny Multiple's can do it, by all means, he and other developers will step up and provide site solutions for carriers.

AGL Magazine: Let's turn from Johnny Multiple to Clayton Funk, an intrepid writer for *AGL Magazine* for the past 10 years. In 2004, when you started writing for the first issue, you were with Nations Media Partners. By the time your article was published, you had moved to Media Venture Partners. How have the past 10 years been for you? What have been some of your highlights?

Funk: This month marks 10 years with MVP. It's been a great move for me personally and professionally. I love working with the team, with people who are hardworking, highly ethical and a lot of fun to be around, and we've had some great successes over the last decade.

We've been able to combine the firm's experience in the wireless tower industry with experience in the wireless industry, and we brokered the sale of spectrum operating companies and raised capital for those types of businesses. It's been a great combination for our clients. We're able to understand the dynamics within the wireless industry and how they affect the shared wireless infrastructure industry.



Clayton Funk, managing director, Media Venture Partners.

Photo by Don Bishop

AGL Magazine: In the 10 years, what would you say was something that was predictable, and what was something that caught you by surprise?

Funk: What's been predictable has been the continued monetization of towers by wireless carriers and broadcasters, dating back to some of the early transactions of tower sale-leasebacks by carriers in the late 1990s. More and more carriers have come to realize that towers are an asset that they are able to sell and then invest the capital in their networks or pay down debt or whatever they choose to do with the proceeds. What's been surprising is the recession that started in late 2008, and in 2009 that intertwined with the crisis in the U.S. banking system and the mortgage securitization crisis. I don't think anyone in the wireless tower industry could have seen that coming. Perhaps people who were reviewing the credit of some of the mortgage securities they were underwriting could have predicted that some of it would be trouble. But I think that situation caught everybody off guard. It affected the tower industry; however, the industry has proven to be resilient throughout the recession that the country was in, and it has proven to be arguably recession-proof or more buffered than other industries.

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YEARS OF AGL



David Saul is executive vice president of BB&T - Atlantic Risk Management.

RISK MANAGEMENT OFFERS A RINGSIDE SEAT TO THE WIRELESS INDUSTRY'S GROWTH

BY DAVID SAUL, AAI

Look for a history of safety among construction companies, general contractors and tower contractors. Inspect and maintain aging towers to sustain insurance coverage and manage risk.

I was surprised when Don Bishop asked me to write an article for the 10th anniversary issue of *AGL Magazine*. It took me a while to digest the fact that I have been part of this industry for more than 10 years. In our industry, 10 years seems like a lifetime. I feel fortunate to be a part of such a vibrant and thriving industry.

Telecommunications plays such an important role in the global economy. Worldwide, total spending for the industry grew from \$4.7 trillion in 2012 to \$5.4 trillion in 2014. It's quite remarkable how it's affected the cultural and social aspects of our lives. At any moment, we can conduct business, shop, pay bills and even stay connected with family and friends, all from our mobile phones.

My part in telecommunications is a supporting role. Providing risk management is not the most glamorous role, but it has provided me with a ringside seat to witness the growth that has occurred during the past 10 years or more.

My observations and continued advice revolves around risk transfer and the due diligence surrounding inspecting and maintaining towers. As existing portfolios of towers age, it is vital that all towers be inspected and maintained on a regular basis. Without self-oversight, we risk involvement by local and national governmental entities adding even more rules, regulations and laws than already exist.

A product, Towerhawk, developed by Caryon Development, has been specifically designed for monitoring and remotely controlling key operational aspects of cell tower sites, enabling tower companies to increase revenue, reduce costs and be responsive to ever-increasing service demands from carriers. Part of the monitoring can even alert you to changes in the stability of the tower. This is a key factor that a visual inspection would miss after a severe weather event.

Another product, AnchorGuard, was developed to provide a solution to corrosive conditions that pose a threat to tower anchors. There have been several reports of guyed towers collapsing for this exact reason. Property policies



contain exclusions that can void coverage if corrosion, rust or decay was the cause of loss. Mitigating this claim potential could save you thousands of dollars in costly repairs or potential claims that may be denied.

Using products such as Towerhawk and AnchorGuard can provide an added source of due diligence, making a portfolio more attractive when it's up for sale.

Another issue that is plaguing our industry is the number of tower climbing fatalities. When hiring construction managers, general contractors or tower contractors on a direct basis, it's of the utmost importance to use only qualified companies with a safe history. Your vendor selection process should include contractual requirements for indemnification, hold harmless wording, and primary and noncontributory language. We are seeing an uptick in liability claims

in which the tower owner is being named in third-party lawsuits. The claims are typically caused by first-, second- and sometimes even third-tier subcontractors. Without the proper wording, your insurer will need to provide first-dollar defense and possibly even a portion of the judgment.

Not only has the industry provided my livelihood, but it has enabled me to hire six great employees who now work with me. The continued growth of the industry not only domestically but also internationally will keep us busy for the next 10 years.

We thank you, our loyal customers, and look forward to being of service.

David Saul is executive vice president of BB&T – Atlantic Risk Management, Columbia, Maryland, and is an accredited risk advisor in insurance (AAI). His email address is dsaul@bbandt.com.

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DECEMBER 2009

Attorney William J. Sill publishes the first of what become frequent articles from him about regulatory matters.



Ten years ago, standard carrier cellular deployments would routinely fetch \$1,400 to \$1,800 per month. Now, we are seeing typical macrosite broadband rents in the \$1,800 to \$2,200 range.

ALL CLEAR FOR MACROSITE FUTURE WITH MAYBE ONE EXCEPTION

BY MICHAEL L. HIGGS JR.

Small cells competing with macrosites? Several years away. Satellites? Never. Give a maybe to shared radio access networks provided by wireless infrastructure companies. One more? Read on for the surprise.

I was honored to be asked to provide an article for the first issue of a fledgling telecom infrastructure magazine, and I am doubly honored to be asked to supply an article for its 10th anniversary issue. *AGL Magazine* has become an important fixture in our industry, and cheers to another 10 years. *AGL Magazine's* 10th anniversary started me thinking about the state of the industry then and now, and how it might look in another 10 years.

The Rise of the Middle Class

At the time of *AGL Magazine's* launch, there were three major, publicly traded tower operators, and an extensive collection of small tower developers. Today, there are three major, publicly traded tower operators, and an extensive collection of smaller tower developers — and there is an extremely robust mid-tier of tower operators that are not just developing sites, but competing with the Big 3 for multiple-site acquisitions. We have seen the meteoric rise and lucrative sale of Global Tower



Partners. Mountain Union Telecom refocused its business on infrastructure, turned into InSite Towers and now acquires sites by the hundreds. This growth of the middle class in the telecom siting business has led to more robust competition for the sites being spun off by the smaller tower developers, keeping sale multiples high.

We are also seeing U.S.-based infrastructure companies rapidly expanding internationally. The U.S. business model of carriers focusing on their core service offerings and outsourcing the development and operation of non-network infrastructure is quickly taking hold in foreign markets. This trend will only accelerate. In Mexico, for instance, there is one tower for every 4,000 users, as compared with the United States where there is one tower for every 1,000 users. With the forced breakup of Carlos Slim's monopoly, we can already see U.S. towercos circling for opportunities.

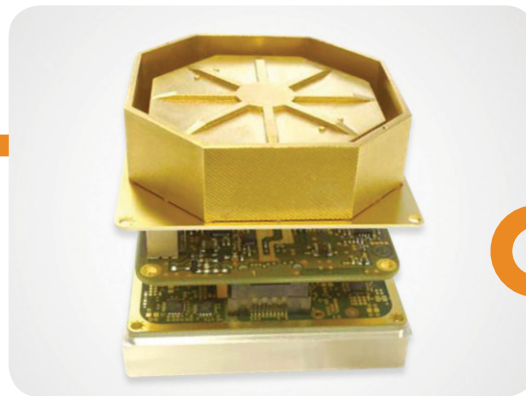
And it is not just the Big 3 that are able to take advantage of the international market. Members of the former brain trust of GTP have started several companies focused on taking advantage of the telecom infrastructure opportunities in the Americas and abroad. From Brazil to India, Africa and beyond, the U.S. model and U.S. companies are poised to dominate the worldwide marketplace for towers and telecom siting.

The Great Data Explosion

One might think that such robust competition would place downward pressure on carrier rents, but this has not been the case. Ten years ago, standard carrier cellular deployments would routinely fetch \$1,400 to \$1,800 per month. Now, we are seeing typical macrosite broadband rents in the \$1,800 to \$2,200 range. What market forces have driven carrier rents higher despite the increased supply?

The exponential growth of data usage has caused the carriers to turn from providing network coverage to the densification of their networks. Put simply, while the supply of infrastructure has steadily increased, it has not kept up with the skyrocketing spectrum and bandwidth demand.

Another important factor to consider in this



equation is that tower sites are not fungible. Two sites situated less than a quarter-mile apart may have completely different RF propagation profiles. Rarely can a carrier that doesn't like the terms offered by a tower owner simply pack up its gear and move over to the tower across town without significant negative effects. For example, possible new dead zones where customers previously had great service could cause rapid subscriber loss. Zoning regulations often complicate otherwise simple collocation requests, greatly increasing the time and costs involved in any equipment relocation.

Tower owners stood in a good competitive position 10 years ago. They stand in a *great* competitive position today.

More of the Same

Everyone loves their cellphone, but not everyone loves seeing a tower from their back porch. The NIMBY business is alive and well, just as it was 10 years ago. Site developers routinely complained then, as they do now, that too high a percentage of their site development costs are tied up with lawyers and engineering studies to convince city planners and town commissioners to approve special use permits and variances.

But there are encouraging signs on the horizon. At the federal and state levels, more legislation is being considered and passed to allow for the rapid deployment and expansion of telecom infrastructure. Municipalities and counties are pushing back, but the tide is quickly turning against their obstructionist efforts. We will increasingly see federal and state efforts pay off by restricting local control

TOP: *The Alcatel-Lucent lightRadio cube that the company said would revolutionize communications, casting doubt on the future of the tower industry.*

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over the process, thus speeding time-to-market for critical broadband infrastructure.

Look to see historic preservation regulations eased for all wireless infrastructure, as they were for the implementation of positive train control facilities. Local control over small cell placement and collocation applications will also be reduced in the coming years. It may never be a simple task to drop a 200-foot tower in the middle of a residential neighborhood, but the process for providing reliable broadband service to the public is certainly trending in the right direction.

Speaking of Small Cells

Many of us had Wi-Fi networks in our homes and offices 10 years ago, but now the unlicensed technology has become pervasive. Some feared that Wi-Fi might someday eat into so much of the carriers' profits that the whole economic model for telecommunications infrastructure siting would be turned on its head. Not only has this not come to pass, but everyone from carriers to infrastructure providers is viewing Wi-Fi as a natural adjunct to their core service offerings.

Do you remember a few years ago when AlcaLu told us that its new lightRadio cube would revolutionize communications, causing some to cast doubt on the future of the tower industry? It turns out that the cubes did not change the laws of physics, and you could not build a cellular network merely by driving down the highway and tossing these Rubik's Cubes out every mile or so. They still needed power, backhaul and decent propagation.

Some commentators also told us that small cells would eliminate the need for macrosites. Well, guess what? Small cells still need power, backhaul and decent propagation. Supplying those things to enough small cells to provide coverage equivalent to a macrosite is incredibly expensive. We are several years away, at the least, from the economics of small cell build outs competing directly with macrosites. Where there are special use cases such as stadiums, campuses and high-occupancy buildings, we have come to find that small cells are an excellent addition to a wireless network, but only

when used in conjunction with macrosites.

We will see more changes in our industry from 2014 to 2024 than we saw in the decade from 2004 to 2014. Heretofore, tower companies did one thing, and one thing only: operate towers. The recent trend has seen towercos get into the business of managing rooftop sites and deploying DAS and small cell networks. This is only a minor departure from their core business, however.

What I expect to see in the coming years will fundamentally transform the traditional role of the tower company. Providing backhaul service used to be the exclusive domain of the local telephone company and a few specialty microwave providers. Not anymore, Crown and others are starting to string fiber directly to their sites. It is a natural fit for a site owner to also capture the additional revenue of transporting traffic between the site and the network.

But where is this trend taking us next? You've probably heard of telecom data centers hosting content from major Internet companies (think Google and Netflix) so that the content is closer to the end user, thus reducing the costs associated with delivering that content. What's to stop an infrastructure provider from also hosting that same content directly in the site shelter? The closer that data is to the end user, the less network resources are taxed in its delivery.

LTE Technology Standard

With the advent of LTE as the dominant worldwide broadband technology standard, there is little to differentiate one carrier's tower-based equipment from another's. When will we see an infrastructure provider begin to provide neutral-host radio access network elements directly to carriers? We are already seeing this begin to develop in the DAS realm, so why wouldn't this also work with macrosites?

The biggest change we will see is antennas moving closer to the end users. No one knows exactly what 5G cellular technology will entail, but most analysts are confident that we will see it materialize sometime around 2020. 5G will be less about any particular spectrum band, modulation technique or error correction protocol and more about shortening the distance between the



end user and the network infrastructure.

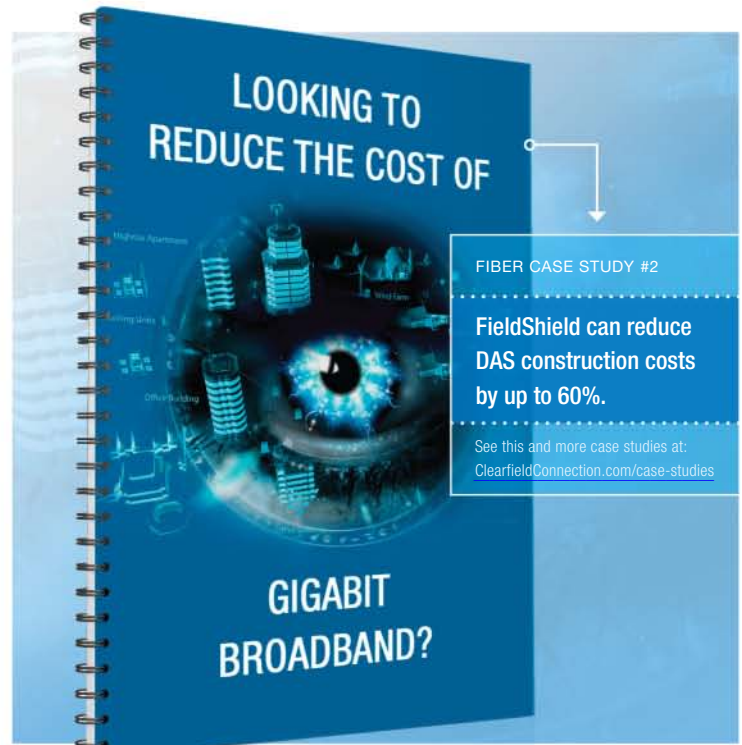
Small cells will play a large role in this evolution, but so will macrocells. A very wise man (who also happens to publish this fine magazine) recently told a Tower Summit audience that he sees a future laden with 60-foot towers. Not so tall as to have line-of-sight coverage for miles around (and raise the ire of every NIMBY within a 3-county radius), but tall enough to provide effective coverage to a large neighborhood. In places where the economics do not allow for pervasive power and backhaul cabling or placement of mass amounts of small antennas, smaller macrosites may strike just the right balance.

Possible Bleak Future

Don't get me wrong; I am absolutely bullish on the tower and siting industry. I believe that the fantastic growth curve we have seen to date will continue well into the future. But people always want to know, is anything coming down the pipeline that may derail the economic model of the industry? Satellites are never going to replace towers. Power and frequency reuse issues alone are enough to kill that idea, but there is a multitude of other reasons satellites will never work as replacements.

However, the one technology that has piqued my interest lately as a possible sign of trouble to the tower industry is mesh networking. What if every cellphone wasn't merely an end node on the network, but also a network hub? What if your phone were working in the background to relay information from someone's device down the street into your neighbor's house? Some phones will need to have a direct connection to the network backbone and servers, but in this possible version of the future, not all phones. What if we already had all of the macrosites we would ever need in populated areas? Mesh networking wouldn't be a magic bullet in truly rural settings, but for urban and suburban use cases, such a technological development could be a game changer.

Michael L. Higgs Jr. is a member of the telecommunications, privacy and cybersecurity law practices of Shulman Rogers Gandal Pordy Ecker. His email address is mhiggs@shulmanrogers.com.



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10 YEARS OF AGL

AGL debuted on Jan. 5, 2005, with an issue dated December 2004/January 2005, making this month the 10th anniversary. The tower shown on the cover is the tower on the left in the background, 10 years after. Photography by Don Bishop



TEN YEARS AFTER

BY ERNEST WORTHMAN

From its start in 2004 to becoming the wireless infrastructure industry's most respected and knowledgeable resource, *AGL Magazine* has come a long way in 10 years.

Ten years after. No, it isn't the name of the English blues-rock band popular in the late 1960s and early 1970s. In this case, it's the time that has passed since the first issue of *AGL Magazine*.

It seems like yesterday. I've known some members of the *AGL Magazine* staff since we worked together on the Primedia books *RF Design*, *Mobile Radio Technology*, *Site Management & Technology* and others in the 1990s. Many of the old publications are gone, and new ones such as *AGL Magazine* and *AGL Small Cell Magazine* have taken their place.

Come with me for a walk back in time as we revisit the evolution of the wireless infrastructure industry's foremost print publication, *AGL Magazine*.



2005: A Successful Launch

New publications typically launch on a wing and a prayer, but not *AGL*. There were 36 pages and 12 advertisers in the first issue. Having one advertiser for every three pages of print is a shout-it-from-the-rooftops moment for any first issue. Many of those advertisers are still with us today.

Issue one, dated December 2004/January 2005 and published on Jan. 5, 2005, featured stories that set the pace for the publication. PCIA was in there, and the articles covered topics ranging from aviation obstruction lighting and the FAA to tower leasing and site logistics. *AGL* was designated the official publication for PCIA.

Publisher Richard P. Biby, P.E., had his say in a column as did Executive Editor and Associate Publisher Don Bishop. And they're still in the same positions.



The March/April issue featured an article on tower safety, and 10 years later, *AGL Magazine* is at the forefront in reporting on that topic. We knew what was important then, and we know what's important now.

June/July featured the first *AGL* Tower of the Month center spread photo feature, the brainchild of Art Director Scott Dolash.

Those first six issues saw *AGL* expand its readership and double the number of advertisers. We finished that first year on a positive note, with 52 pages in the October/November issue. *AGL* was on solid footing, and our publisher was bullish on the coming

year. We announced the addition of two more issues for 2006. And Biby Publishing acquired TowerSource.

2006: PCIA

AGL featured a PCIA preshow issue as well as postshow coverage.

We also tightened our focus to concentrate on “infrastructure, regulatory and financial information for the antenna-siting community,” which became our tagline.

In April, the first single-month issue was a special one on power and grounding, including features addressing RF hazards, backup battery and generation systems, new power technologies and the latest in lightning arresting and grounding systems.

The *AGL* Tower Achievement awards were introduced in the May/June issue. In October, we included a report on the first *AGL* industry recognition award. It went to Pat Tant, then Cequel Sites' senior VP, and now president and CEO of Solution Seven, *AGL* Media Group's marketing and public relations contractor.

At the end of 2006, *AGL* was profitable and had gained the respect of the industry. Its editorial staff did a wrap on 2006 and a roll into 2007, highlighting changes such as the online site database and the first foray into distributed antenna system (DAS) networks and in-building wireless systems.

2007: NATE

AGL rang in the new year with its first-ever buyers guide in January. There's been one every year since. If you want to find just about everything industry-related from everyone who serves the industry, the buyers guide is your bible. A mid-year mini-buyers guide was also added.

For the first time, the magazine covered NATE's February convention. Little did we know how close NATE and *AGL* would become in the years to come.

A new column was added to cover environmental

DECEMBER 2010

The first *AGL* Regional Conference takes place at the Westin Hotel in San Francisco. Later renamed as *AGL* Conferences, the conferences continue with four each year.

10 YEARS OF AGL

issues surrounding towers and sites. The first DAS article in *AGL* appeared, along with letters from readers. And for the first time, what was to become one of the hottest topics of the next decade, WiMAX was addressed in a piece on using it for backhaul. There was a list of notices and fines issued by the FCC, a reminder of the regulated construction, operation and maintenance issues associated with antenna structures.

July was the first issue to touch on what was to become an increasingly important topic: concealment. Little did we know, then, just how much pressure would be put on the industry to conceal sites.

The *AGL* Achievement Award program expanded to include an individual (Alabama Wireless Association President N. Andrew Rotenstreich) and an organization (Virginia-based Invisible Towers) as recipients for 2007.

2008: Focus on Safety

February boasted an interview with NATE's Patrick Howey, one of the first *AGL* articles on tower training and equipment. A second piece from OSHA offered the federal government viewpoint. And there was more coverage on safety in the issue's departments. Of the seven April features, six were safety-focused, including one on how to keep a construction site safe, and one on NATE's



educational focus on tower climber safety.

Also in the April issue, the publisher alluded to a move to connect *AGL* with peripheral publications and information bases. Thus, May featured an article on the UtiliSite Council and its

first conference in Dallas.

AGL's first special concealment issue came in June. In July, the Tower Market Report, which had previously been a stand-alone publication, was integrated into *AGL*.

The 84-page October issue had 47 advertisers — wow! The cover feature was about green cell sites — a hot topic in light of rising energy costs and environmental impact. The issue looked at green technology from several angles, including concealed antennas and tower tubes.

November coverage included OSHA's new crane ruling that affected tower operators. The December issue looked ahead to the transition to digital TV.



2009: Leading-edge Technology

AGL's focus on safety remained strong with the first story of the year on tower-top safety. There was a case study of a 1,200-foot tower erection, a second piece on how OSHA promotes tower worker safety and one on modeling towers for construction.

Concern for the natural environment was growing. It was becoming more difficult to obtain government approval for new sites, and *AGL* covered it all.

There was a continued focus on leading-edge technology, including wireless backhaul, solar power for cell sites, remote radio heads, software-



defined radios and digital technologies in micro-cellular networks, as well as software packages to help manage interference, optimize RF patterns and manage sites. Google was getting into the act by providing data for RF path analysis and coverage assessment.

In October, the focus was back on safety with an article about NATE and OSHA presenting a cooperative approach to tower safety.

AGL hit the five-year mark. It was on a roll — successful, profitable, ever more ensconced as the voice of the tower industry, and still going strong as the official magazine for PCIA. Terms such as “multimedia,” “social networking,” “the digital wireless revolution” and “year of the data” began to show up. Change was in the wind, and AGL would continue to be in the thick of it.

2010: DAS

In February, there was a preview of the 2010 Tower Technology Summit, which was faring well, even in tough economic times.

News on the DAS front was heating up. A session at the Tower Technology Summit proved that DAS was no longer just for special projects and hard-to-fill voids. DAS was a special focus in the September issue, which included a DAS buyers guide, a case study and a special product focus. October featured a new department, “DAS and Beyond.”



Lighting started showing up as a topic of coverage as the industry developed new technologies for tower lighting. Other timely features covered lighting protection, cutting-edge adhesives to aid in tower reinforcement, microwave backhaul, fuel

cells, power in mission-critical applications, and going green.

There was section on financial services, a product showcase and a financial service company



buyers guide. One feature focused on opportunities in foreign markets in response to the globalization of the wireless infrastructure.

In the CEO forecast, top industry movers and shakers were bullish on the future of the tower business, especially with the meteoric ramp up in data and the proliferation of smartphones.

2011: A Changing Industry

As the economy gained steam, there was a build out boom in the industry and concern about whether site construction companies could meet the demand. Utilities were getting more proactive in wireless. Pressure was mounting to collocate wireline and wireless cable on utility poles. Site acquisition was becoming more difficult with more hurdles to overcome, and site real estate was becoming competitive. AGL covered it all and more.

New departments included “Law and Regulation,” “Construction,” “Renewable Energy” and “Mergers and Acquisitions,” a reflection of the rapid pace of wireless expansion. The mini-buyers guide highlighted tower construction and service companies.

10 YEARS OF AGL

AGL continued to cover the financial segment of the industry with articles on mergers, acquisitions and alliances. The mini-buyers guide featured financial service companies.

Other article topics included the controversial Alcatel-Lucent lightRadio technology, what opportunities might exist in China, and the future of backhaul in an increasingly wireless world.

Traditional features covered lessons learned from hurricanes, changes in FCC regulations on pole attachments, OSHA's campaign to make work safe in hot environments, and the continuing problem of copper theft.

2012: OSHA

OSHA stepped up the number of employer citations, and AGL published a regular series of articles



by a legal team on the subject, as well as a feature with advice on how to prepare for OSHA inspections. There were also articles on OSHA guidelines for workplace confidentiality.

Tower safety made big gains. One example of this was highlighted in an article about a fall-arrest system that eliminates the need for permanent vertical safety cables. In another story, a safety trainer wrote about techniques for saving lives during rescue operations at height.

As the value of copper continued to increase, so did copper theft. AGL covered the problems copper theft creates and what tower companies are doing about it.

DAS coverage included articles about standardizing deployment and meeting coverage and capacity requirements, as well as a case

study on the challenges of deploying DAS in the New York Subway.

The 84-page September issue featured coverage of three conventions, the DAS Congress, the New York State Wireless Association Trade Show, and the combined MoKan Trade Show and AGL Regional Conference.

2013: Another Magazine

January's Buyers Guide was the biggest issue yet at 104 pages.

DAS and Small Cells Magazine debuted as a quarterly insert in the AGL print edition and as a stand-alone digital edition. It covered issues such as Wi-Fi, backhaul, technologies for indoor networks, and using utility and light poles for small cell deployments. In 2014, the quarterly would become a completely stand-alone magazine.

AGL's Wireless Infrastructure Conference in Atlanta was highlighted with 40 pages of coverage on site acquisition, wireless business trends, ground leases, tower assessment, and the emerging technologies of small cells, DAS, Wi-Fi and LTE.



Aluminum and steel were replacing solid copper in an attempt to stifle thefts. Tower lighting was reaching new heights. Self-aligning antennas were coming onto the scene. Mobile networks were growing. Backup power was using more lithium-ion battery technology. The Supreme Court upheld the FCC's antenna-siting shot clock program. And AGL covered it all.



MARCH 2011

AGL publishes extensive coverage of the UtiliSite Council's conference about joint use and wireless collocation.



DECEMBER 2013

In December, the “Horizons” section’s “View from the Top” offered a gaze into the future by a cadre of industry visionaries. There was also a PCIA study that said the industry would add to job growth.

2014: AGL Magazine

The first issue for 2014 ushered in a whole new look. Biby Publishing was renamed AGL Media Group, and AGL was renamed AGL Magazine. The company was reborn with a new look and feel and ambitious new projects. In starting its 10th year, AGL Magazine announced it would publish 12 issues, up from its previous 11-times-a-year schedule.

The February cover displayed a photo of Bill D’Agostino, general manager of the First Responder Network Authority (FirstNet). His appearance marked the debut of a planned series of quarterly interviews with government, trade association and industry leaders. D’Agostino’s interview focused on steps to be taken toward deploying a nationwide wireless public safety communications network.

Safety was a major topic for 2014. Articles covered the NATE Exchange safety portal, tower work and its effect on mental health, how changes to workers’ compensation may threaten tower service companies, and cold weather work hazards. There was a feature on OSHA’s focus on tower safety, one on training tower workers to help them avoid falling and to survive falls if they happen, and another describing why

workers become likely to fall in the first place.

The August issue featured a special public safety communications section. There are looming questions about public safety communications and emerging wireless technologies that will complicate some areas of wireless. AGL Magazine looked at some of them, including a FirstNet update, dedicated emergency communications and cellular coexistence, and the evolution of public safety communications networks.

A September article highlighted a mission, conceived by AGL Magazine’s publisher and the executive director of NATE, to put together a project that would get a number of industry leaders to go through a tower climber safety class. Every participant came away with a new appreciation for what tower workers do.

AGL Magazine’s success over the last 10 years is a tribute to the expertise, dedication and hard work of past and present staff members alike.

New publications typically launch on a wing and a prayer, but not AGL. There were 36 pages and 12 advertisers in the first issue.



MARCH 2014

APRIL 2011

AGL covers the Alcatel-Lucent lightRadio product that at first has some worried about the future of the tower industry.

Antennas with Low PIM Specs Improve Throughput For Distributed Antenna Systems

Challenging in-building environments call for DAS solutions to achieve faster data throughput and maintain optimal wireless connectivity.

By Anthony McCray

Distributed antenna system (DAS) networks are key for providing seamless indoor coverage in offices, airports, stadiums and other public spaces and for handling the dramatic increase in photos and videos that consumers upload to social networking sites. The proof is in the numbers: According to ABI Research, worldwide DAS revenue will reach \$3.9 billion in 2014. The global DAS market is forecasted to grow at a 20 percent compound annual growth rate from 2014 to 2019, when it will top \$5.43 billion, ABI Research predicts.

DAS versus Small Cells

Enterprise small cells will grow from \$432 million in 2014 to almost \$3 billion in 2019. While the rate of growth is considerable in enterprise small cells, the spend on DAS continues through 2019 and is expected to exceed the amount spent on small cell deployments indoors. The logic behind this is simple: In-building coverage is limited. The DAS market is expected to grow

over time to provide basic coverage, while the small cell market also is anticipated to grow, owing to the need to provide additional capacity in those same buildings.

ABI also predicts that roughly 40 percent of the total spend will be in the areas defined by private and enterprise spaces from 2014 to 2019. This area has the strongest opportunity from solutions like small cells, which can be supported with non-neutral host solutions, and which have strong demands for high-capacity venues. What is clear is that DAS, distributed radio systems and small cell architectures will coexist and will be combined with today's macrosites to create heterogeneous networks, delivering ultra-broadband experiences.

LTE Drives Growth

The increasing use of LTE technology and the bandwidth-hungry features and services it delivers are the reasons behind much of that growth, because operators and site companies know that DAS is a must-have for

delivering the seamless coverage, capacity and consistently fast data rates expected by customers, including high-value business users. And as operators roll out Voice over LTE (VoLTE), DAS will help maximize call quality and minimize drops. Operators are also increasing their DAS deployments because the technology reduces their macro base station capital expense (capex) and operating expense (opex) and minimizes their need to purchase additional spectrum. Operators and site companies prefer DAS solutions that support all 2G, 3G and 4G cellular frequency bands from 700 MHz through 2.7 GHz so they can use a single product for any band in any country.

For DAS vendors, the opportunity to stand out from the pack and win business from operators and site companies does come with some challenges. Most notably, DAS for LTE networks is very complex and only vendors with extensive cellular experience are up to the task.

Not all DAS solutions are created equal, and not all DAS solutions have



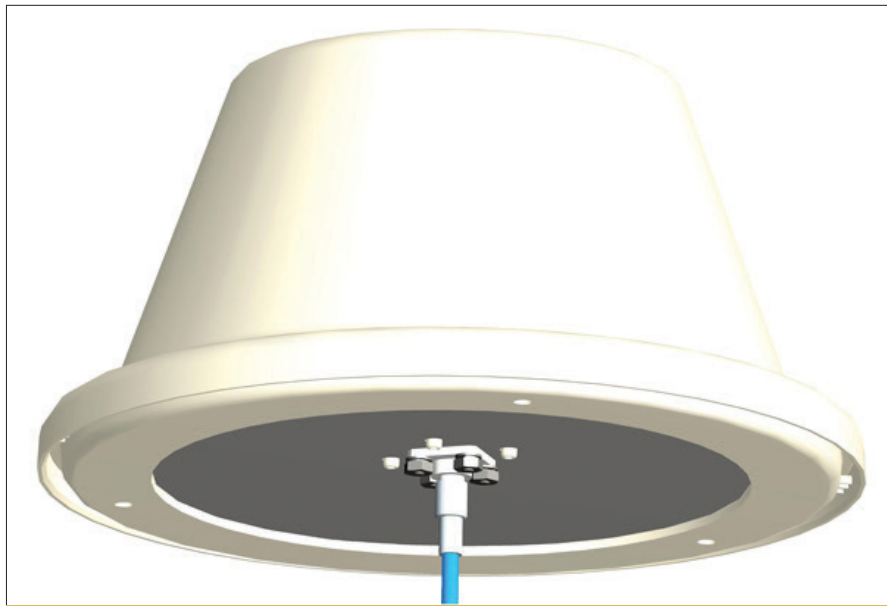
what it takes to meet LTE's demanding requirements, nor do they have what it takes to meet operators' stringent requirements — especially those dealing with passive intermodulation (PIM) interference.

PIM as a Gating Factor

Passive intermodulation interference control is one requirement that DAS vendors need to be able to meet in order to ink deals. Operators are setting stringent PIM requirements because PIM plays a critical role in determining whether a DAS solution can deliver the kind of uplink and downlink performance that helps an operator stand out from the competition. PIM control can also minimize interference, which undermines data, video and voice performance, and which saps network capacity that is noticeable to customers in the form of dropped calls, slower download speeds and other key performance indicators. This type of interference can commonly be found in heterogeneous networks where several solutions — DAS, small cells and pico-cells, for example — are being used to increase capacity in a given area. In extreme cases, poor PIM performance can knock out an entire receiver channel or network, such as a stadium or building.

Contributing Factors to PIM

PIM occurs when two or more signals are present in a passive, nonlinear device or element — in this case, a DAS solution. The signals mix with each other to generate other signals that are related to the original signals. PIM occurs in elements that would be expected to operate in a linear fashion. PIM is generally the result of spurious generation of nonlinearities — typi-



An example of the Ethertronics EtherDAS S antenna.

cally occurring in connectors, switches, isolators and the like. Because passive antennas are the main air interface for the system, they can be main contributors to poor PIM performance if not properly designed. Dissimilar materials and antenna design techniques, along with oxidation and other effects are also likely causes.

The PIM performance of an antenna designed for DAS applications can be affected by antenna radiator design, material selection and connection methods internal to the antenna. Material science knowledge and electromagnetic simulations are helpful during the design process to map the antenna's near-field characteristics to better manage field structure and intensity internal to the antenna assembly. A successful antenna design for low-PIM applications will require PIM characteristics to be regularly measured during the antenna prototyping and test phase.

Poor design and manufacturing

are also common causes of high PIM in a DAS solution. Examples include:

- Material type and plating type selected for the radiating element of the antenna design are critical because of the high currents present.
- Junctions within the system that contain dissimilar materials raise the potential for PIM. The RF connector/baseplate interface in the antenna can often be a source of PIM if material selection and plating type are not properly considered.

Many times the weakest links and highest contributors to poor PIM results come in the form of low-cost, low-performance cables and connectors. PIM can be generated if the coax cables don't have tight braids, if the braids' tinning has cracks or if the connectors are poorly assembled. DAS vendors can minimize these problems with quality control to identify cracked tinning and poorly assembled con-

Regions for Pattern Optimization

- Elevation and azimuth radiation pattern at 700 MHz

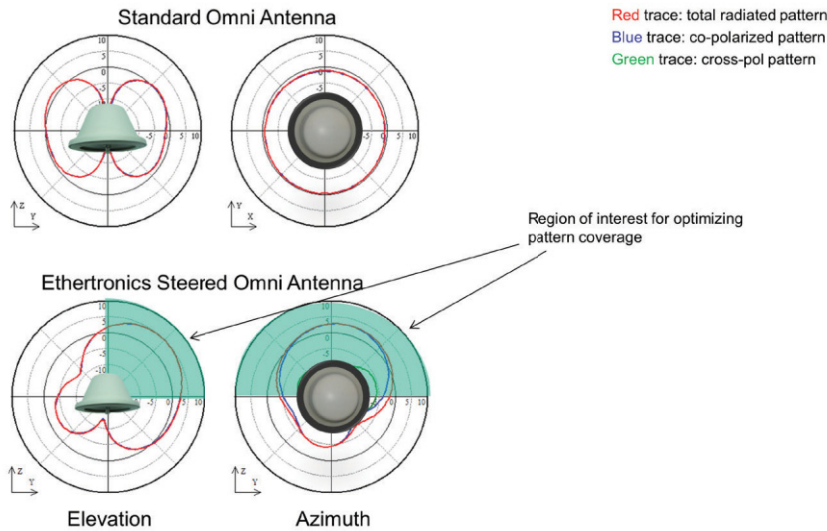


Figure 1. With a PIM spec of -153 dBc, the EtherDAS S antenna solution employs a proprietary technique to shape the antenna's radiation pattern. The result is optimal wireless coverage within the building, such as an office or hotel lobby.

nectors by putting a layer of foil under the braid. Some DAS antennas are required to have antenna cables or “pigtailed” permanently attached or integrated into the design, making proper coaxial cable selection critical for PIM performance.

The lower the PIM specification, the better performance a DAS solution will provide. How low is low enough? Vendors typically aim for -110 dBc, but state-of-the-art solutions are as low as -153 dBc. Ideally, this spec should remain constant across all 2G, 3G and 4G frequency bands from 700 MHz through 2.7 GHz to ensure consistently great performance for all customers and all devices.

Two Keys to DAS Benefits

The level of PIM can be affected both during and after installation. Improper installation can undermine even the best-engineered DAS solution. For example, rebar, suspended ceiling grids and other metal objects can block the signal path. If it's difficult, expensive or impossible to deploy the DAS away from metal objects, using a directional antenna such as the Ethertronics EtherDAS S antenna solution can mitigate the objects' effects. With a PIM spec of -153 dBc, the EtherDAS S antenna solution employs Ethertronics' proprietary technique to shape the antenna's radiation pattern (see Figures 1 and 2). The result is optimal wireless coverage within the building, such as an office or hotel lobby. Keeping the signal strength inside a given building improves connectivity within the office space and minimizes interference with other DAS signals

Front to Back (F/B) Ratio as a Metric

- Ethertronics DAS Steered Omni antenna increases radiated field strength in regions of interest to increase cellular coverage in building, while minimizing coverage exterior to the building when DAS antennas are mounted close to external walls or windows
- Front to Back (F/B) can be used to quantify extent of radiation pattern shaping

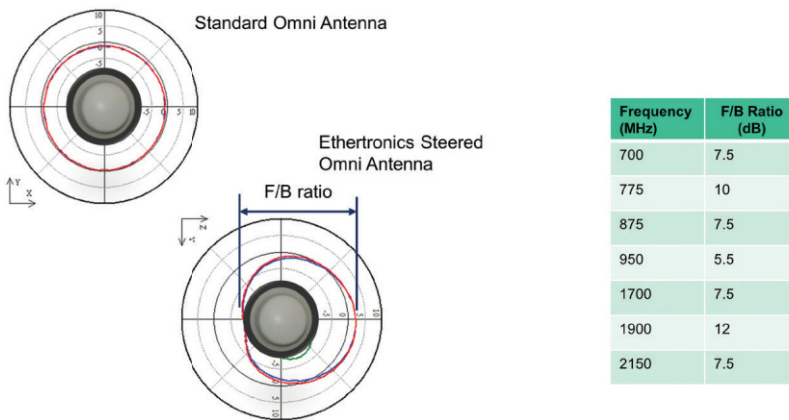


Figure 2. The Ethernet DAS steered omni antenna increases radiated field strength in regions of interest to increase cellular coverage inside a building while minimizing coverage exterior to the building when DAS antennas are mounted close to external walls or windows. A front-to-back (F/B) ratio can be used to quantify the extent of the radiation pattern shaping.

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from surrounding buildings, solving a major pain point for wireless operators and their DAS customers.

Rusty bolt syndrome — the corrosion of cables, connectors and other components — can also have a major effect on PIM. Periodic inspection of a DAS installation can identify deterioration before it elevates PIM to the point that it becomes noticeable to customers. As previously mentioned, proper plating and material selection can lead to an antenna design that maintains PIM performance during the lifecycle of the DAS system.

PIM testing is an important step in the design and installation process to ensure maximum performance from the system. Some testers are designed for use during manufacturing of DAS solutions. Others are designed for use in the field to assist with installation and troubleshooting. Field testing assesses the entire DAS installation, from the feeder cables to the antennas. It's a good

idea to test each antenna before it's installed. If subsequent testing — for instance, one year later — identifies failures, rusty bolt syndrome is one likely source.

Other technology advances in the DAS market include the EtherDAS 1.5 antenna with a voltage standing wave ratio (VSWR) of $\leq 1.5:1$ for an optimum impedance match providing higher transmit power and improved performance.

DAS antennas with a compact design and a neutral color provide installation flexibility because the building's owner is less likely to perceive them as eyesores. Their ability to blend in means that they don't have to be banished to suboptimal locations that would make it difficult to provide coverage in all of the areas where it's needed.

DAS solutions have the potential to provide a significant return on investment for operators, including reducing macro base station capex and opex, minimizing the need to purchase ad-

ditional spectrum and improving coverage and capacity for mobile users. The key to achieving this potential lies in high-performance DAS solutions including -153dBc PIM and $\leq 1.5:1$ VSWR specs, as well as new solutions that are able to shape the antenna's radiation pattern for optimal in-building coverage. Investing from the start in a high-performance, low-PIM DAS solution is critical because it eliminates the need for expensive antenna upgrades to overcome subpar performance from a high-PIM DAS system. An initial investment in low-PIM DAS solutions coupled with proper installation and periodic testing will ensure that mobile operators will be able to provide consistent, market-differentiating performance year over year so that mobile users will benefit from high-performance 4G LTE wireless services whether at work or at play.

Anthony McCray is Ethertronics' North America senior sales director (DAS and small cell specialist).

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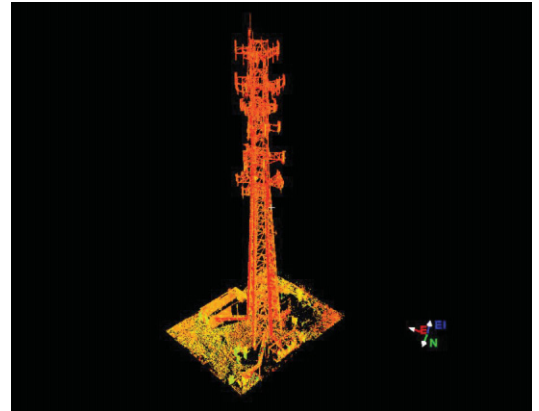
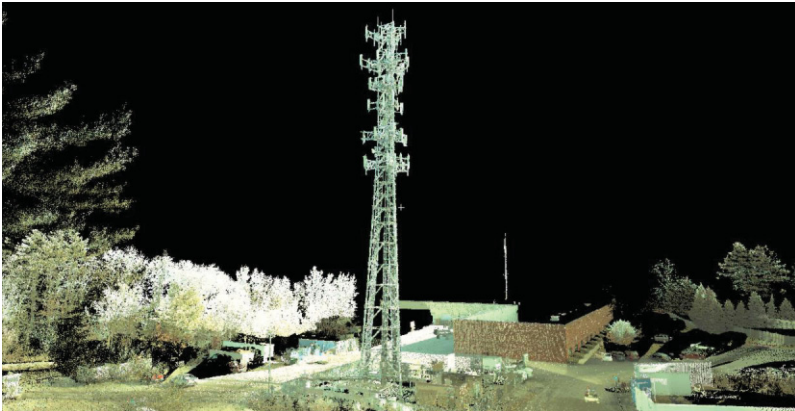
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When laser scans are completed, they are combined to make a 3-D composite tower drawing. The scanner produces a high-quality, 3-D photograph with a record of the exact location of every point on the tower that could be seen from at least two points in the scan cycle. While it is on the computer, the viewing angle of the tower can be changed, similar to flying an airplane over the tower.

Inventory Antennas with a Laser

Laser scanning helps tower owners to make sure antenna owners are paying, to identify antennas that could be removed to decrease the wind load, and to make room for additional tenant equipment.

By John Franklin

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The proliferation of cell phones and smartphones has dramatically increased the need for additional bandwidth. Added to the cell phone technology, Wi-Fi, microwave links for backhaul and optical communications place an ever-increasing wind load on towers.

Many towers are approaching or exceeding wind-loading specifications because of the increasing number and size of antennas. There is a continuing requirement to provide adequate space to accommodate additional antennas needed by site users. Twenty years ago, the most common antenna was a Stationmaster vertical, fishpole-style antenna

that presented a minimal surface area to oppose the wind. Currently, the majority of antennas are panel and parabolic, both of which expose a greater area to wind. Prior to conducting an engineering study to determine whether the tower meets the needs of site users, a detailed inventory of the antennas on the tower must be made to determine whether the tower is overloaded and, if it is, what would be the best way to improve it in order to meet the site users' requirements.

Site Visit

Determining the current wind load on a tower requires having an engineering firm make a site

visit in order to perform a mechanical study.

In some cases, a certified climber must climb the tower to obtain accurate information about the antenna type and size. If the tower is near radio and broadcast stations, arrangements must be made with the radio station operators to reduce their transmitter power in order to prevent the health risks involved when someone enters the high radio-frequency (RF) field of the broadcast stations. Because this is specialized work, it could require paying travel expenses for the person doing the inventory.

In addition to the time required to take and enter field notes, engi-



neers must input the data in the tower calculation program. An omission or possible inaccurate data obtained during the inventory can, in some cases, involve another trip to the site.

Fortunately, there is a technology solution to this vexing and expensive process. Laser technology has developed to the point that it can produce accurate, three-dimensional drawings in a fraction of the time required for a manual tower inventory. It generally can be done by a surveyor who lives near the tower and who doesn't have to be paid per diem and travel expenses.

Laser Scanning

PBS broadcast a program called "Time Scanners" that provided details on historic buildings and showed what is possible with laser scanning. The amazing detail revealed some of the secrets of old buildings. For a communications tower, information obtained by laser scanning can be invaluable for inputting data into an engineering program in order to calculate the load on an existing tower and determine what, if any, modifications could be made to the tower to determine the number of additional antennas that could be safely installed. This information also could be valuable in determining whether installing additional antennas with remote radio heads would exceed the tower's wind loading limits. Some of the newer deployments require RF amplifiers to be installed near the antennas. The antenna and remote radio head may



Making a site visit to inventory what is on the tower can easily be expensive, especially if the tower is on a mountaintop or at a remote location. The cost of having the survey done by a local surveyor located near the tower can be considerably less than having it done by a worker who travels from a faraway location. The accuracy can be easily documented because of the files produced by the laser survey.

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offer a higher wind load because of their surface area, but that may be offset by replacing the previous thicker coaxial cable with power cables and a much smaller coaxial cable.

A scanner is set on a tripod, and markers are placed at strategic points around the tower. The scan from the first location can take up to 15 minutes. Then the operator moves the scanner to another point, repeats the process, and then moves to a third point. It is important that the markers be visible to the scanner on each of the scans as fixed references. Sometimes, depending on the conditions, more than three scans

are necessary.

The scanner emits laser light that reflects from a rotating mirror. The unit rotates so the entire tower is illuminated by the laser. The distance to the tower is determined by accurately measuring the travel time to and from the contact point. The accurate distance measurement allows logging measurements from each scan. When the scans from

various locations around the tower are compiled in a computer program, the exact location of each scanned point can be determined. When the scans are completed, they are combined to make a 3-D composite tower drawing. In essence, the scanner produces a high-quality, 3-D photograph with a record of the exact location of every point on the tower that could be seen from at

Laser technology has developed to the point that it can produce accurate, three-dimensional drawings in a fraction of the time required for a manual tower inventory.

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APRIL 2012

Attorney Mark A. Lies II and his associates begin a series of safety-related articles that continues almost monthly to this day.

least two points in the scan cycle. While it is on the computer, the viewing angle of the tower can be changed, similar to flying an airplane over the tower. The advantage of the laser survey is that all points are accurately plotted, so each antenna can be accurately located on the drawing.

The cost of having the survey done by a local surveyor located near the tower can be considerably less than having it done by a worker who travels from a faraway location. The accuracy can be easily documented because of the files produced by the laser survey. With the ability to provide a high-definition picture of the tower from the survey files, the tower owner obtains a good record of what is on the tower and the location of each customer's antenna. The scanning program has a box that can be connected to each item on the tower, so a record can be kept on each antenna, including the owner, date installed, specialized use and the history of rent paid. The owner can determine whether additional antennas are on the tower without permission. This information could be used to recover revenue that otherwise would be lost because of antennas on the tower that are not included in the tower lease agreement. Many times, the rental amount charged per antenna is determined by a formula that takes into account the size of the antenna and its position on the tower. An accurate, historical tower survey provides an excellent record to use to keep track of what is on the tower and the associated revenue.

As the laser scanner becomes more popular and technical development continues, it will become even more valuable in analyzing towers for loading and for keeping track of the number and type of antennas on the tower.

In some cases, a biannual tower scan could be made to ensure that all owners of antennas on the tower are paying to use the facilities, and also to determine whether any antennas

could be removed to decrease the wind load or to make room for additional tenant equipment.

*John Franklin is vice president and general manager of BNS Electronics. His email address is franklinj@sb-tower.com. For more information, visit *Land Tech 3D* at ltc3d.com or *L.P. Cook & Company* at lpcook.com. Both companies provided photographs and technical support for this article.*



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Reinforcing Overstressed Monopoles and Towers

It's only going to get worse as wireless network operators cope with ever-increasing data transmission demands. Many towers must be reinforced to support heavier equipment and bigger wind loads.

By James D. Lockwood, P.E.

Structural reinforcing of monopole and telecommunication towers has become increasingly challenging during the past 15 years as these structures become more congested with additional equipment, coax cabling and a myriad of reinforcements to carry larger and heavier loads. The accelerated deployment of large LTE antennas, elevated power units and other new loadings required to support higher volumes of wireless data transmission compounds the challenges.

Aero Solutions began focusing on this problem in 2000 when owners sought to increase their towers' load-carrying capacities by 15 percent to enable the collocation of new antenna arrays. Today, in high data traffic areas, towers are commonly reinforced three to four times to facilitate multiple carriers and changes in building code design wind load requirements. In many of these circumstances, tower structures are carrying more than 75 percent more load than their original design capacity (see Photo 1).

It is imperative that an engineer be consistent in performing tower



Photo 1. A heavily reinforced monopole.



analysis and design, that the reinforcing solution chosen is the most efficient, and that calculations are well documented. The consolidation of tower portfolios and ever-increasing overloading underscores the importance of industry consistency in engineering and reinforcing solutions.

Safety and proven reliability are paramount in selecting a reinforcing system. Engineers engaged early in the strengthening of telecom structures in 2000 frequently specified the welding of steel plates onto monopoles and the welding of half-pipe sections onto tower legs. Welding subjects the structure itself to a fire hazard and also represents a fire hazard for surrounding neighborhoods because even a light breeze can carry slag from aerial welding across long distances. In those early days, bolt-on solutions consisted of heavy external steel frames that often made for higher wind loads than the antennas themselves.

To reverse the trend toward welding, our company launched a family of non-welded reinforcing products starting in 2003 for monopole, self-supporting and guyed towers. In 2005, as the tower industry's need for structural upgrades and increased tower loading grew, we standardized monopole solutions with bolt-on, pre-engineered reinforcements. For monopoles, standardized bolt-on reinforcements were easy to scale and required less technical field training than many other systems. Our company has deployed the bolt-on reinforcements for more than 4,000 sites in the United States.

To offer our experience and design tools to engineers seeking to optimize monopole structures, we began

licensing our proprietary engineering software, Aerosoft, in 2012. Its growing user group includes U.S. engineering firms and, more recently, an engineering firm in Chile, where the market for upgrades is well underway. A significant portion of the license proceeds goes into the continual enhancement of the software's features and flexibility.

The current family of pre-engineered reinforcing systems we offer is highly flexible and has

components designed and proven to fit well together. Each reinforcing system receives support from our company's engineers to assist the engineer of record with experienced technical support during its design to achieve the most cost-effective upgrade solution for a particular site. Once released to construction, we incorporate the actual field conditions into a set of detailed assembly drawings and bill of materials (3D) for the installer.



Photo 2. A bolted MP3 channel.

REINFORCEMENT

/ SITE ENGINEERING & TECHNOLOGY /



STEP 1



STEP 2



STEP 3



STEP 4

Photos 3–6. These photos show step-by-step how to install the Huck lock-bolt fastener.



Photo 7. Bolted MP2 flat plate using Ajax bolts.

REINFORCEMENT

The monopole reinforcing systems provide a high degree of flexibility to the specifying engineer and include custom-shaped MP3 channels made of grade 65 steel, grade 65 flat plate or grade 100 flat plate. We stock the channel system that among our products has the highest structural efficiency and advantages for its weight. The custom-shaped channel's reduced width and the reduced number of bolts required in comparison with flat plates reduces interferences with existing reinforcements, port holes and step-bolt clips, and limits the amount of field drilling on-site (see Photo 2). For the equivalent structural capacity of a flat plate, the custom-shaped channel is 20 to 25 percent lighter.

As the market for structural upgrades expands, contractors seeking field-qualified installation crews struggle to find enough workers to

meet the demand. Installers must follow stringent quality assurance procedures to ensure the upgraded structure's long-term performance. To mitigate the risk of improperly installed mechanical bolts, our company has worked closely with Alcoa and Timberline Fasteners since 2012 to approve their nonmechanical Huck lock-bolt fastener for the industry for use on custom-shaped channel and flat plate reinforcements (see Photos 3–6).

Our company has adopted both the Huck lock-bolt fastener and the Ajax one-sided bolt into our monopole reinforcing solutions. Each of these one-sided bolt systems performs well and has its advantages. For instance, the installation tool for the Huck lock bolt fastener can be expensive for the contractor to purchase in comparison with the installation tool required to install an Ajax bolt. The Huck install

equipment can be rented to reduce an initial investment. However, the installation process for the Ajax one-sided bolt requires significantly more penetration of the installation tool into the pole shaft in comparison with the Huck bolt installation before the bolt is engaged. This can be problematic in locations where internal coax cabling is tight against the pole shaft wall, providing limited space to safely install the Ajax one-sided bolt (see Photo 7).

James D. Lockwood, P.E., is a professional engineer and the chief executive officer of Aero Solutions. His email address is jllockwood@aerosolutionsllc.com. The company offers AeroSoft engineering software, PoleMax and TRS tower reinforcing systems, and engineering support services. Ajax one-sided bolts are made by Ajax Engineered Fasteners. Huck lock-bolt fasteners are made by Alcoa Fastening Systems.



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OSHA Attempts to Bypass Its Regulations through “Voluntary” Permissible Exposure Levels

Uncertainty about so-called voluntary permissible exposure levels makes it difficult for employers to craft safety programs to meet OSHA’s expectations. Meeting OSHA’s own rules may not be enough.

By Mark A. Lies II and Kerry M. Mohan

For more than three decades, OSHA has codified permissible exposure levels (PELs) that regulate employee exposure to toxic and hazardous substances. (See 29 CFR 1910.1000.) Recently, OSHA has attempted to bypass its regulations and impose more stringent PELs through its General Duty Clause. For instance, in September 2013, OSHA issued an employer a General Duty Clause violation based on employee exposure to styrene, even though employees were exposed to styrene levels lower than the established PEL in the OSHA regulation. To make matters even more complicated, on Oct. 24, 2013, OSHA published “voluntary” Annotated PELs, recommending that employers adhere to PELs much more stringent than those established in the regulations. Thus, employers now face a period of uncertainty over whether adhering to OSHA’s written regulations constitutes compliance.

A More Stringent PEL

In September 2013, OSHA issued a

Wisconsin employer, Fiberdome, Inc., a series of citations, including a General Duty Clause citation based on employee exposure to styrene. Under OSHA’s existing standard, employees cannot be exposed to more than

100 ppm of styrene over a weighted eight-hour time period. (See 29 CFR 1910.1000, Table Z-2.) Fiberdome adhered to that standard, as employees were exposed to approximately 65 ppm of styrene

Additional OSHA Compliance Obligations

If OSHA’s new compliance strategy is upheld, employers will be forced to reevaluate their existing compliance programs to avoid potential citations and will have to consider the following:

- Instituting additional industrial hygiene monitoring to determine whether the voluntary PELs are exceeded
- Conducting additional assessments to determine whether existing personal protective equipment is adequate
- Determining whether engineering controls or administrative controls may be required
- Evaluating whether a respiratory-protection program may be required
- Conducting additional training of managers and employees on the hazards created by the lower exposure levels and enforcing compliance with the reduced exposure levels, with discipline



By issuing the Annotated PELs, OSHA has specifically notified employers that they can no longer adhere to many of the current PELs without creating a work environment that is hazardous to employee health.

over a time-weighted eight-hour period. Nonetheless, after two employees experienced symptoms related to styrene exposure, OSHA issued Fiberdome a General Duty Clause citation for exposing employees to more than 50 ppm styrene over the time-weighted period, which is a voluntary recommended limit established by the National Institute for Occupational Safety and Health (NIOSH).

Thus, OSHA bypassed its codified PEL for styrene and issued the General Duty Clause citation based on the more stringent, but not mandatory, NIOSH PEL.

OSHA's Annotated PELs

Further undermining its current PEL regulations, on Oct. 24, 2013, OSHA issued its Annotated PEL tables, which provide more stringent PEL levels than those contained in the current regulations. (See osha.gov/dsg/annotated-pels). Although OSHA has publicly stated that the Annotated PELs are voluntary and cannot be enforced like the codified standards, OSHA promulgated the Annotated PELs to ensure employers are aware that many of the current PELs "are dangerously out of date [...] and do not adequately protect workers." (See Oct. 24, 2013, Press Teleconference, osha.gov/Chemical_press_call.html.) In other words, by

issuing the Annotated PELs, OSHA has specifically notified employers that they can no longer adhere to many of the current PELs without creating a work environment that is hazardous to employee health.

OSHA's Standing

Is OSHA permitted to use the General Duty Clause to impose more stringent PELs on employers?

Section 5(a)(1) of the Occupational Safety and Health Act is OSHA's so-called General Duty Clause, which requires each employer to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm." Thus, OSHA can theoretically issue a General Duty Clause citation whenever an employer fails to provide a safe workplace.

The OSHA Review Commission and OSHA's internal guidance, however, have consistently and regularly stated that OSHA cannot issue a General Duty Clause citation when a specific standard addresses the hazard(s) identified in a citation. (See *Con Agra, Inc.*, 1983 OSHRC LEXIS 206, at *17 [Rev. Comm. Jan. 31, 1983]). The rationale behind this approach is that it would be unfair and deny employers due notice for OSHA to require conformance with a requirement that is different from that

in a specific standard and, thereby, expose employers to citations.

Further, OSHA's Field Operations Manual (FOM), CPL 02-00-150 (Apr. 22, 2011), which is intended to be the guidance document for enforcement of the Act by the agency, provides that the General Duty Clause should not normally be used to impose a stricter requirement than that required by a standard. In fact, in discussing PELs, the FOM provides:

Example 4-25: A standard provides for a permissible exposure limit (PEL) of 5 ppm. Even if data establish that a 3 ppm level is a recognized hazard, Section 5(a)(1) shall not be cited to require that the lower level be achieved. If the standard has only a time-weighted average permissible exposure level and the hazard involves exposure above a recognized ceiling level, the Area Director shall consult with the Regional Administrator or designee, who shall discuss any proposed citation with the RSOL.

Thus, OSHA's internal guidance appears to specifically prohibit the use of the General Duty Clause to issue more stringent PELs, even when there may be data questioning the adequacy of the current PEL.

Forthcoming Citations

OSHA probably will use the Annotated PELs to issue more General Duty Clause citations. Even though OSHA Review Commission case law

and OSHA internal guidance recognize that OSHA cannot issue a General Duty Clause citation to impose more stringent PELs, OSHA's publication of the Annotated PELs probably means that OSHA will issue more General Duty Clause citations for an employer's failure to adhere to the more stringent "voluntary" PELs. In issuing the General Duty Clause citations, OSHA may rely on a 1987 D.C.

diverse should it be challenged in the Review Commission or the Federal Appeals Courts. What is certain, however, is that if an employer receives a General Duty Clause citation for failing to adhere to the Annotated PELs, its only remedy will be to contest the citation through litigation, asserting that it relied upon the promulgated PELs in the regulations.

Additional Concerns

In addition to potential OSHA liability, OSHA's Annotated PELs raise several issues that extend to workers' compensation and civil liability in the event an employee or contractor becomes injured or ill due to exposure to toxic or hazardous substances. In most states, workers' compensation protects employers from an employee's civil claim. Typically, an injured employee can circumvent workers' compensation's preclusive effect only if (s)he can show something akin to an intentional tort — i.e., the employer knowingly and intentionally exposed the employee to an unsafe condition. With OSHA's publication of the Annotated PELs, employees injured by toxic or hazardous substances may claim that the employer should not receive workers' compensation protection because the employer knew that OSHA's existing PELs were inadequate, but intentionally continued to expose them to this unsafe condition without adequate protections.

Further, in the event a third-party employee (i.e., outside contractor) is injured by exposure to toxic or hazardous substances, the employer is not protected by workers' compensation. In that case, an employer may no longer be able to claim that its conduct was not "negligent" and that it acted reasonably by its adherence to OSHA's PELs because OSHA has now indicated that its regulatory PELs may be inadequate. Indeed, because employers can now be presumed to know of OSHA's Annotated PELs, and the

Because OSHA has now publicly proclaimed that certain of its existing PELs are inadequate to protect employee safety, it may also claim that all employers are aware or should be aware that the PELs are unsafe.

Circuit Court of Appeals decision to claim that OSHA can issue a General Duty Clause citation in the face of a specific standard when "an employer knows a particular safety or health standard is inadequate to protect his workers against the specific hazard it is intended to address." *Int'l Union UAW v. Gen'l Dynamics Land Systems Div.*, 815 F.2d 1570 (D.C. Cir. 1987).

Here, because OSHA has now publicly proclaimed that certain of its existing PELs are inadequate to protect employee safety, it may also claim that all employers are aware or should be aware that the PELs are unsafe. In turn, OSHA may rely on the decision in the General Dynamics case to claim that it is authorized to cite the employer based on the more stringent voluntary PELs, even in the face of case law and OSHA's internal guidance.

Unfortunately, it is unclear whether OSHA's new tactic will sur-

Compliance Obligations

If this compliance strategy is upheld, employers will be forced to reevaluate their existing compliance programs to avoid potential citations and will have to consider the following:

- Instituting additional industrial-hygiene monitoring to determine whether the voluntary PELs are exceeded
- Conducting additional assessments to determine whether existing personal protective equipment is adequate
- Determining whether engineering controls or administrative controls may be required
- Evaluating whether a respiratory-protection program may be required
- Conducting additional training of managers and employees on the hazards created by the lower exposure levels and enforcing compliance with the reduced exposure levels, with discipline



APRIL 2013

Rick Heilbrunn becomes COO/CFO. Biby Publishing contracts with Solution Seven for marketing and public relations services. Pat Tant and Janet Gill of Solution Seven take on key roles.

more stringent voluntary standards, the injured individual may claim that the employer was, at a minimum, negligent for relying on the current regulations.

As all employers should know, under OSHA's Globally Harmonized System for hazard communication compliance, employers will be receiving Safety Data Sheets that will contain OSHA PELs, as well as other PELs based upon ACGIH/NIOSH and other recognized health authorities. The employer would be prudent to consider developing its program around these lower PELs rather than OSHA's PELs to avoid potential liability under OSHA, workers' compensation and civil liability.

Conclusion

As demonstrated by Fiberdome, Inc. and the recently published Annotated PELs, employers can expect OSHA to issue more General Duty Clause citations for failing to adhere to PELs that are more stringent than OSHA's existing regulations.

Though it is unclear if such citations will withstand litigation, employers should evaluate their current exposure levels and determine whether it may be appropriate to voluntarily adhere to OSHA's Annotated PELs in the interest of limiting potential OSHA, workers' compensation and civil liability.

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In the event a third-party employee (i.e., outside contractor) is injured by exposure to toxic or hazardous substances, the employer is not protected by workers' compensation.



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SAFETY

Tower Climber Fatalities: Data Mining OSHA Summaries

OSHA ascribes climber error as the leading cause of fatalities among technicians who climb towers, although that doesn't relieve employers of responsibility for ensuring workplace safety.

By Dr. Bridgette Hester

The Occupational Safety and Health Administration (OSHA) has recorded more than 300 fatalities in the telecommunications industry since 1984, and the rate of fatal incidents does not appear to be diminishing. In fact, there is no statistically significant difference in the number of fatalities from 1984 through 1998 compared with 1999 through 2013 ($t = 0.576$).

Technicians often tell me that fatalities that occurred during the early years of the industry were not as numerous as they are today. To see if this is true, I investigated summaries OSHA keeps in its database, limiting the study to 1984 to 2013. I didn't include 2014 because many investigations that recent have not been completed.

Information offered here results from reading, studying and interpreting OSHA investigation summaries, not the entire reports. OSHA makes summaries available to anyone with a summary number, inspection number, report or accident identification number. Another researcher provided me with inspection numbers. I then looked up each OSHA sum-

mary and mined data. I am in the process of ordering copies of every OSHA report dated 1984 to the present. Once I have them, I can make a more meticulous survey of the data. Each case will be read and information extrapolated to refine the preliminary findings offered here.

1984–1998 versus 1999–2013

From 1984 to 1998, there were 131 deaths, and from 1999 to 2013, there were 173 deaths. At a desired confidence level of 95 percent, there is no statistical difference between the two groups ($t = 0.576$). One would expect a difference, given the safety advances and the involvement of groups such as the Telecommunications Industry Association, the National Association of Tower Erectors and the American National Standards Institute.

Some may believe safety equipment improvements should have made a huge difference, and because there is no huge difference, safety advancements haven't made a difference. This is not a valid conclusion. There are variables that can account for the lack of a statistically significant difference, including:

- Much more work in telecommunication has been available in the second 15-year span compared with the first
- There are or may be many more green (inexperienced) tower hands in the industry than in previous years
- Subcontracting and pressurized deadlines by carriers (workers may work faster and less safely in order to make deadlines)
- Substandard or no training for technicians
- Technicians with limited experience being asked to perform duties beyond the scope of their capabilities
- Improper or poor equipment being provided by some employers

For the period from 1984 to 2013, 302 death summaries were analyzed. Two additional summaries were not analyzed because of missing or unclear information.

Fining is Complicated

When looking at the possible reasons for the fatalities extrapolated from the OSHA summaries, one



Frequency out of 302 Possible Summaries	Factors in Fatality	Percentage	sig @ .05
Improper Rigging	7	2.32%	.326
Free Climbing	3	1.0%	.523
Electrocution	12	3.9%	.194
Fall – Climber Error*	171	56.3%	.000
Tower Collapse*	31	10.2%	.031
External Cause (true accident)*	26	8.6%	.000
Riding the Line*	42	13.7	.010
Equipment Malfunction*	10	3.3%	.000
*Denotes statistically significant			

It was possible the climber was NOT tied off properly	63.5%
It was possible the climber or crew was not properly using the equipment	70%
Defective Equipment	4.6%
Climber was riding the gin or headache ball	15.8%
Climber was “free climbing” (stated in OSHA summary)	0.3%

Percentage and count totals will not match 100 percent because any one case may have fallen into more than one category (e.g., several cases may have been coded a yes to both “possibly not 100 percent tied off” and the climber or crew was not properly using the equipment).

Table 1. An analysis of 302 OSHA summaries reveals climber error as the most frequently occurring cause of fatal outcomes for workers on the job at tower sites who suffer injuries stemming from working at heights, as reported by federal investigators.

might conclude that if an accident was caused by climber or crew error, there would be no fine because penalties are assessed against employers. Yet, one could argue that an employer should be fined even if the fatality was the fault of the crew or climber because the employer is responsible for creating and maintaining a safe work environment. The reasoning behind fining the employer regardless of responsibility for the fatality is that the employer did not have measures in place to ensure that employees followed workplace safety guidelines. Although an employer cannot monitor all crews all the time, they are expected to use project managers and foremen for monitoring.

Conversely, one could argue that an employer acts on good faith that the foremen perform their jobs correctly, ensuring the safety of the crew. Unless a crew member reports that the foreman is not acting in the interest of crew safety, it wouldn't be feasible to hold the company owner responsible for a fatality, and a fine against the company owner couldn't be justified. This argument hinges on the company owner fostering a workplace culture in which employees feel free from retribution or termination for reporting a supervisor for not ensuring the safety of the crew.

One would hope that in such cases, an OSHA investigator would address whether company employ-

ees feel duress for reporting a supervisor. If the investigator finds that a company owner's workplace is not conducive to employees reporting violations or that the company culture places undue pressure on employees and foremen to complete jobs under the pressure of deadlines, thereby causing employees to perform tasks in an unsafe manner, one might argue that fining the employer would be justified even if the climber or crew were at fault.

One could argue further that the climber is responsible for his own safety and should refuse to perform the work if he believes his life is being placed in jeopardy. Regardless of the point of view, the dynamics

SAFETY

/ FEATURES /

of subcontracting, job performance and company policies for completing jobs are complicated and laced with pressure from the wireless

telecommunications carrier all the way down to the boots on the ground. There is a culture within the telecom industry that places

pressure upon the employee to complete the job no matter what. It is not unreasonable to assume that climbers respond to pressure to take unnecessary risks for fear of being fired.

OSHA FINES - DESCRIPTIVES

Average fine from OSHA (1984-2013): \$6,414.58

Amount in Dollars	Freq.	Percentage
0	66	21.7
.01 to 999	35	11.5
999 to 1,999	44	14.5
2,000 to 2,999	31	10.2
3,000 to 3,999	21	6.9
4,000 to 4,999	22	7.2
5,000 to 5,999	14	4.6
6,000 to 6,999	8	2.6
7,000 to 7,999	9	3.0
8,000 to 8,999	4	1.3
9,000 to 9,999	10	3.3
10,000 to 12,999	7	2.3
13,000 to 15,999	4	1.3
16,000 to 20,999	7	2.3
26,000 to 30,999	10	3.3
31,000 to 75,999	6	2.0
76,000 to 99,999	4	1.3
over 100,000	2	.7
Total	304	100.0

Table 2. OSHA fines issued from 1984 to 2013 in connection with the 304 fatalities noted in the OSHA summaries.

Recommendations

Further examination of the subcontracting paradigm may reveal the safety risks it creates. There is much debate within the industry as to liability (who should be held responsible and to what extent) when a fatality occurs. Research has been conducted into subcontracting and safety in the construction, mining, chemical and nuclear energy industries. Subcontracting has many benefits for those who initiate the work and rather poor consequences for those executing the work in the field. Industries that use subcontracting are more likely to see an increase in injuries and fatalities (Nunes, 2012; Mayhew & Quinlan, 1995; Ofori & Debrah, 1998). With this as a background, subcontracting becomes an even more pertinent issue, given the particularly dangerous nature of the work performed by telecommunications technicians who climb towers.

Subcontracting can lead to deadline pressure, deadline pressure can affect safety, and safety affects fatality rates. When work is executed by a second, third or fourth party, the work might be delayed for various reasons. Empirical data is needed from company owners, turf companies and technicians to determine whether pressure stemming from deadlines affects the execution of

SAFETY



safety measures in the field.

Additionally, further study is needed of the effectiveness of training new telecommunication workers and the effectiveness of continuing education for experienced climbers. Empirical data should also be collected and measurable outcomes should be utilized

Organizations, advocates, carriers, turf vendors, technicians and small business owners should devise a mechanism to address it.

Study Obstacles

The most significant obstacle encountered during this investigation was the OSHA summary content and

Conclusion

The examination of OSHA summary reports, although limited, has provided a glimpse into the causes of fatalities within the telecommunications industry over the past 30 years. However, more data is needed to investigate fatalities more thoroughly. If they better understood the causes of fatalities among tower workers, it is more likely that government officials, company owners, carriers, turf vendors and technicians could be better equipped to find more effective strategies to contend with the causes. Possible changes to the subcontracting paradigm, data collection, training methods and programs to encourage lasting change should not be dismissed as key elements in changing the safety culture within the telecommunications industry. On the contrary, delegation of accountability, existing and emerging training and apprenticeship programs, and carrier, company and climber responsibilities should be specific and measurable to the nature of work and shared openly among all industry stakeholders.

There is a culture within the telecom industry that places pressure upon the employee to complete the job no matter what. It is not unreasonable to assume that climbers respond to pressure to take unnecessary risks for fear of being fired.

to evaluate “train the trainer” programs and the industry’s new apprenticeship program. Creating a training system based on proficiency is crucial. Internal and external training sources must teach the same subject matter to the same level of proficiency — 100 percent for safety and at least 80 percent for all other subjects. Evaluations must be objective.

Technician safety also relies on the use of standard or otherwise appropriate equipment. Because employers are responsible for providing the proper equipment, the employer must make sure the technician has safe and adequate fall protection. There is no streamlined method to ensure that all employees receive the same quality of fall protection equipment or even every necessary component for fall protection. This matter needs attention sooner rather than later.

the relative completeness of the summaries examined. Because of the sheer volume of information collected during a fatality investigation, one might expect a summary of the report to contain vital information. However, in about 30 percent of the summaries examined, little information was provided. For example, “Employee #1 apparently leaned back, causing the cross member to come off the tower. Employee #1 slid off the member, falling 240 feet to the ground. He was killed.” Although the actual OSHA report may have more information, the limited amount given on the summary forced me to code several summaries as “fall – Climber Error,” when in fact there may be clearer data within the whole OSHA report that could alter the coding data. Given this possibility, the ability to generalize accurately from the survey of summaries could be limited.

Bridgette Hester, Ph.D., is a family and workplace strategist. She is the founder and president of the Hubble Foundation, which is dedicated to promoting the safety of tower workers, site crews and all workers at heights. Her email address is bridgette@hubblefoundation.org. For additional information on the procedure, coding and the analysis of the OSHA data, see the white paper version of this article at hubblefoundation.org.



Hiding distributed antenna system antennas, a panel bearing the digit 3 and made by Stealth Concealment Solutions of North Charleston, South Carolina, delivers signals to serve sports fans who come to Spartan Stadium in East Lansing, Michigan.

DISTRIBUTED ANTENNA SYSTEM

Game On! A Stadium DAS Playbook

Spartan Stadium in East Lansing, Michigan, has a new AT&T Mobility DAS with concealed antennas fabricated in only a few weeks.

By Trey Nemeth

For decades, modern manufacturing has been defined by a company's ability to turn out identical pieces, one after another, and deliver reliable quality. But for modern wireless concealment manufacturers, customization makes the use of that high-efficien-

cy model next to impossible. A project with AT&T Mobility for Michigan State University presented an even bigger challenge than garden-variety customization.

This story opens on the field of Spartan Stadium in East Lansing, Michigan. AT&T Mobility wanted

to conceal antennas in a new distributed antenna system (DAS) designed to improve signal strength throughout the 75,000-seat stadium. What began as a project to outfit vomitory headers quickly grew into much more.

As is always the case, making a



site visit to the stadium proved a money — and headache — saver. The vomitory boxes would require custom attachments. The DAS plan included installing concealment on unique curved columns, necessitating textured boxes that blended in with the nearby press box. Finally, there was discussion of replacing sections of new scoreboards with RF-friendly materials.

What unfolded was the need to develop concepts and manufacture three concealment types unique to MSU's stadium. Months of work and numerous sets of drawings and permutations resulted in an arrangement suitable for AT&T and MSU.

The scoreboard plan was a non-starter. Officials didn't want to modify their new showpiece video and scoreboards. And the vomitory box design had become more challenging because of the existing headers' complex geometry and the need to preserve viewing angles for stadium patrons sitting behind them.

During another visit to the venue with a digital camera and other tools, we took a second set of measurements on the vomitories and columns. We worked with AT&T to design side-mounted, cantilevered boxes on the three scoreboards, which allowed the antennas to be placed in just the right position relative to the fans on game day without damaging or modifying the existing scoreboards.

And now it was game on, big time.

The now-precise information led to making final designs and manufacturing mockups for university approval. By the time final design

approval and funding came, the year-plus lead time from the first site walk had shrunk. The time available to produce numerous custom concealments was a few weeks. And this was not a flexible deadline: kick-off on Aug. 29 meant everything had to be delivered and installed without a single glitch in order to maximize signal on game day.

To make this a reality, portions of the concealments, such as antenna and box mounting structures, were required on-site almost immediately so technicians could have time to install and tweak systems. The concealment exterior boxes would not ship or install until a few weeks later, which meant it would be impossible to factory-fit each concealment for quality-control purposes.

So what happens when a modern

manufacturer is asked to create pieces it has never before produced, without the luxury of using standard quality-control practices on a project that has zero room for error? We had a team huddle that included senior management, project managers, engineers and our shop staff. The scene resembled the one in "Apollo 11," when engineers compile a box of random tools and determine how the astronauts can DIY themselves out of free fall.

Without revealing too much of the "how" (Hey, we have to retain some of our secret sauce!), let me just say this: We solved the problem of perfect replication and delivered the whole suite of concealment systems with time to spare. AT&T Mobility had key components early, allowing the company to install,



The gray box made of RF-friendly materials and mounted below the digital time display houses antennas for the distributed antenna system in Spartan Stadium.

DISTRIBUTED ANTENNA SYSTEM



Part of a suite of concealment systems delivered by Stealth Concealment Solutions, a distributed antenna system antenna enclosure hangs from the ceiling in an area of the Spartan Stadium.

DISTRIBUTED ANTENNA SYSTEM

configure and tweak as needed. On game day, the system worked seamlessly and blended perfectly with its surroundings.

One thing that made a big difference was our ability to invest heavily in the project. We had the resources to conduct two site walks. We had an experienced installation company at the ready to descend on

the stadium (twice — before and after antenna and radio installation). We had a crew in the factory ready to solve problems and create products. And we had a management prepared for up-front spending.

For customers such as AT&T Mobility, those factors translate to their advantage. The size and stability of a large concealment

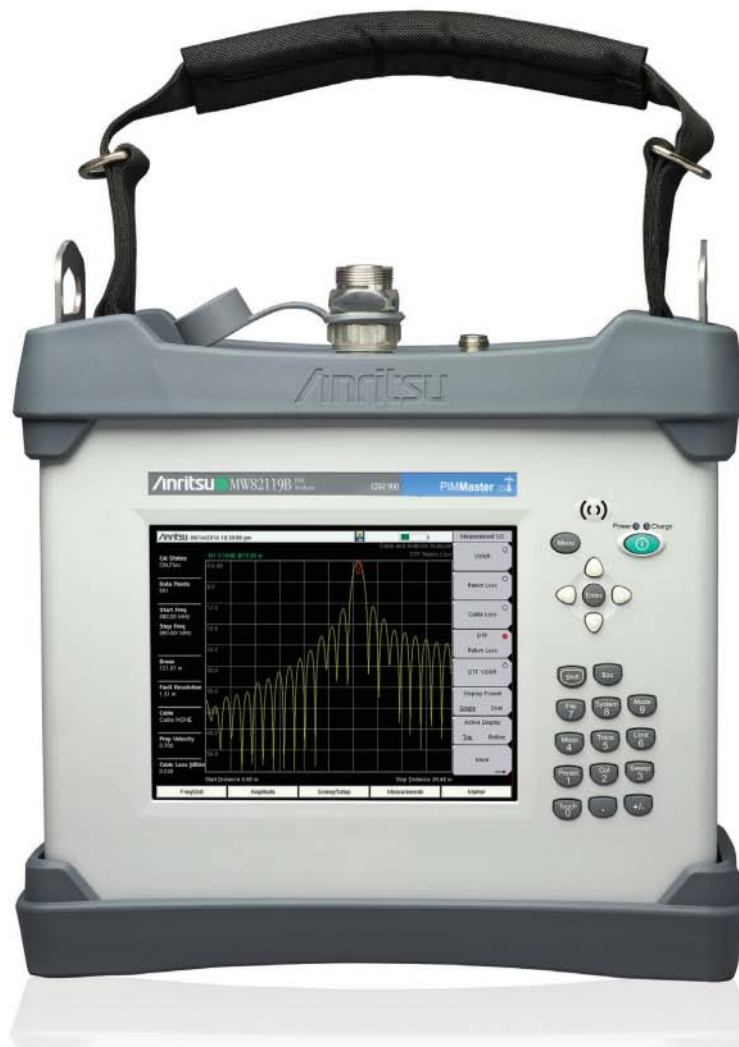
company that has long been in business makes it possible to accommodate big, last-minute projects. Making clients look good is the name of the concealment game.

Trey Nemeth is vice president of operations at Stealth, a company specializing in concealment for more than 22 years.



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Richard P. Biby, P.E. (left), interviews Dr. Derek Peterson, chief technology officer of Boingo Wireless. Photo by Don Bishop

DAS Combined with Wi-Fi Suits Large-venue Deployments

By Richard P. Biby, P.E.

On Sept. 9, at the AGL Media Group booth in the Tower & Small Cell Summit pavilion in the exhibit hall at Super Mobility Week, powered by CTIA, I interviewed Dr. Derek Peterson, chief technology officer of Boingo Wireless.

AGL Magazine: Give us a little background on Boingo Wireless.

Peterson: Boingo has been a small cell and Wi-Fi provider for 12 or 13 years. We do large venues such as airports and stadiums, and military bases represent a new vertical market for us. We make sure those large venues have wireless connectivity.

AGL Magazine: Most people who have been to an airport know a little bit about Boingo. It looks like you're also providing cellular and distrib-

uted antenna system (DAS) types of services.

Peterson: It's about making sure that the venues get what they need for wireless connectivity. That's where our focus has been all along — how do we help the venues be a part of the connectivity game. The S.M.A.R.T. network is about getting secure, multitenant, analytics-driven, responsive and tiered service.

QUESTIONS AND ANSWERS



It's about building networks for the venues and the consumers who go through those venues.

AGL Magazine: Not only do you provide DAS within some of the venues, but you also provide the radio access network. You're a DAS provider.

Peterson: We have a lot of small cell

DAS networks. We've been doing that for as long as we've been doing Wi-Fi. In 2007, when Boingo acquired Concourse Communications Group, which now is one of our subsidiaries, that's when we got the Chicago O'Hare International Airport. We also picked up a lot of the tunnels in New York.

As you've seen with our DAS deployments, we're pushing them out

everywhere. We just did the University of Houston. We got that deployment in just ahead of their big game, and the University of Arizona, as well.

AGL Magazine: With the number of venues you have and the various locations that have been installed, that makes you one of the larger DAS providers.

S.M.A.R.T. Networks Are:

Secure: All S.M.A.R.T. networks will be Passpoint-enabled, supporting WPA2-encrypted connections for some classes of service, in addition to employing security configurations that protect the core network. Boingo has been a pioneer in deploying Passpoint networks, a wireless industry standard that enables instant, secure Wi-Fi connectivity to those with a Passpoint profile on a supported device.

Multiplatform: Mobile devices have different activity and data consumption profiles – and one Wi-Fi network does not fit all. S.M.A.R.T. networks are designed to optimize the Wi-Fi experience platform by platform. Boingo's classes of service help users and service providers pick the experience they desire, while the network intelligently optimizes that experience for the platform itself.

Analytics-driven: Today, understanding utilization, traffic flow and dwell time are important to managing a quality Wi-Fi network. S.M.A.R.T. networks are location-aware, enabling venues to better serve customers with actionable business intelligence derived from historic and predictive analytics.

Responsive: Public Wi-Fi networks in large venues are complex, and network demand can vary wildly. S.M.A.R.T. networks balance flexibility, capacity and connection performance with an adaptable network infrastructure. S.M.A.R.T. networks continually evaluate the service being provided, ensuring that it's delivering the defined user experience for each class of service.

Tiered: S.M.A.R.T. networks support multiple classes of service that can be tuned for a defined user experience. The tiers of service classes create user experiences that meet the needs of casual and power users alike.

Source: Boingo Wireless

/ DEPARTMENTS /

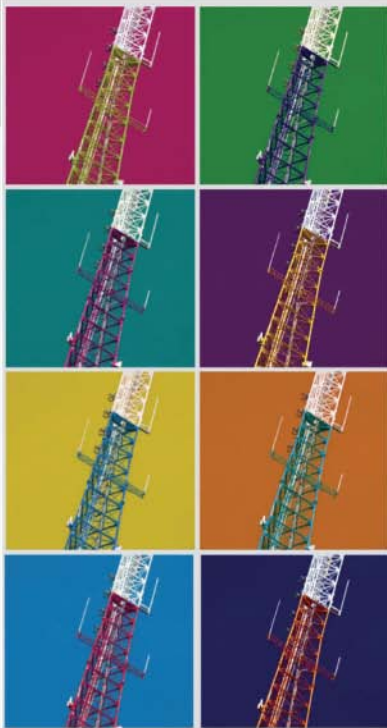
Peterson: We kind of are. We definitely have been doing DAS for a long time. We're one of the sleeping giants that's been doing DAS. We've been able to do it in the best way possible for an RF technology, to be

able to combine DAS and Wi-Fi.

One of our premier locations is the Chicago Bears stadium. That has a DAS deployment that supports more than 80,000 customers. It has Wi-Fi as an add-on. If you're there,

and you want to stream other games at that stadium, you can sign up for a plan for Wi-Fi and use Wi-Fi along with your DAS and still get your phone calls and texting — everything together. It's really a nice play of Wi-Fi and DAS together.

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AGL Magazine: In many of the hotspot areas, you also provide cable TV or television services.

Peterson: We do. One of the things we've done is, if you go to Miami, we have some TV service at the Miami airport. That's through Turner Broadcasting, primarily CNN at the airport and some of those channels.

In addition to that, for military customers, we're launching services at military bases throughout the world. Part of that offering is TV service over Wi-Fi.

AGL Magazine: As voice-over-LTE matures, you possibly would be in a position to provide your own branded telephone services or mobile virtual network operator type of service.

Peterson: There is a great opportunity there for us to do that, especially at universities. If you start thinking about students who want to get connected in their mobile, every year they go to a different dormitory. They could have an offering that's providing the triple-play solution. That's a positive offering for students.

QUESTIONS AND ANSWERS



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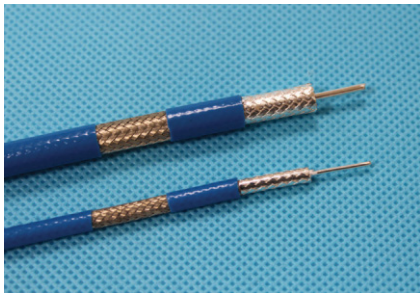


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Product Showcase

DAS and Small Cell Products



Ultra-flexible Cable for Plenum-rated Base Stations

The TFT cable from **Times Microwave Systems** is designed for highly flexible, low-PIM (better than -160 dBc, i.e., decibels relative to the carrier) plenum-rated jumpers for cellular base stations and critical DAS installations. The cable could be a superior solution compared with semiflexible (solder braid) coax and RG-142 coax. The cable may have lower loss and more flexibility and, unlike solder-braid cables, the flat-braid shield on TFT cable is not susceptible to cracking when bent. The noncracking attribute permits installation in tight spaces without the risk of compromising performance. In addition, compared with standard RG-142 cables, the flat-braid shield provides better shielding and lower attenuation. The FEP jacket offers protection in corrosive environments and is highly resistant to UV, making these cables suitable for outdoor installation. TFT cables are also CMP (plenum)-rated and printed. Also available is the TFT-LF,

an economical alternative to the standard TFT. It has all of the low-PIM performance of the standard TFT with only about 15 to 20 percent greater attenuation.

www.timesmicrowave.com



Digital Interface Unit

The CPRI digital interface unit from **TE Connectivity** allows mobile operators to reduce the time, materials and power required to connect customers in high-capacity locations, such as sports stadiums, train stations and business parks. The unit is designed to deliver the first-of-its-kind, common-digital interface between the baseband unit (BBU) and the TE FlexWave digital DAS. DAS networks deliver enhanced coverage and capacity to subscribers in high-traffic locations, but still require a connection to the macro network through base stations requiring redundant RF processing and attenuation panels that need cooling and take up a lot of space. By creating and pre-inte-

grating the first direct-baseband unit connection between BBU and the TE FlexWave DAS, the CPRI interface unit removes the need for additional RF processing and attenuation. At the BBU interface, physical equipment is reduced by greater than 50 percent and cost of materials by 40 percent. As well as saving costs, this combined solution will also save operators power (equipment consumption and cooling), space, and fiber utilization, resulting in operational improvements and meeting sustainability demands.

www.te.com/cpri



UPS System for DAS

Heterogeneous networks are the primary tool in wireless carriers' efforts to augment bandwidth capacity and overcome spectrum limitations. **Alpha Technologies**, a supplier of power and battery systems for macro cells, with +24-volt and -48-volt rectifiers and converters, now offers what could be the industry's only NEBS-certified, environmentally hardened UPS for outdoor DAS. The system combines rugged UPS and batteries in carrier-grade enclosures for

PRODUCT SHOWCASE



use in the outdoor environment. For indoor DAS and small-cell applications, the company has pioneered a 48-volt line-powering technique that enables service providers to use safe and low-cost Class 2 circuits to power remote devices from a centralized location. www.alpha.ca/das

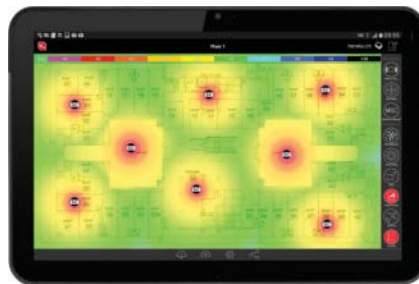


Multiband Fiber DAS

Bird Technologies offers an enhanced indoor and outdoor coverage and capacity for cellular and public safety communications. The manufacturer's multiband fiber DAS and repeaters boast up to 40 watts of output power and a NEMA4 rating. Additionally, Bird's SingleNet DAS solution is designed to seamlessly integrate multiple services, including backhaul for small cells, remote radio head digital transport, gigabit Ethernet and Wi-Fi. www.birdrf.com

Plenum-rated Copper Cable

The ClearFillLine line of 1/2-inch copper plenum-rated coaxial cables from **RFS** supports all wireless in-building applications. The cable, which includes ICA12-50JPLW and ICA12-50JPL, supports multiple RF signals, and its solid inner and outer conductors create a continuous RFI/EMI shield that minimizes system interference and virtually eliminates intermodulation interference. All RFS wideband 1/2-inch plenum cable meets the most stringent plenum-cable standards for maximum safety, including CMP, ETL listed to UL444. The cable also complies with Canadian CSA C.22.2/FT6 standard, with low-flame-spread and low-smoke characteristics. www.rfsworld.com



Small Cell Computer Platform

The **iBwave** Mobile Planner v 2.0 for indoor small cell and Wi-Fi networks allows the user to quickly and easily create system designs. The platform boasts advanced propagation capabilities, making it easier for RF engineers, IT technicians, installers, building owners and maintenance personnel to use with a few simple finger taps on their mobile devices. It reduces engineering time by as much as 60 percent. www.ibwave.com



DAS and Small Cell Testing Kit

PCTEL's RAN mobile testing suite consists of one or more SeeGull scanning receivers and transmitter, SeeHawk and SeeHawk Touch data-collection software and the SeeWave interference locating system. These parts combine into a solution that provides reliable, accurate data collection for multiple bands and technologies for DAS and small-cell testing. The SeeGull IBflex scanning receiver is designed for testing heterogeneous DAS and small cell networks. Its field-upgradeable software configuration supports all major cellular technologies, plus Wi-Fi, and bands from 570 MHz to 3.8 GHz. The IBflex can be combined with SeeHawk, PCTEL's software tool, to efficiently visualize and analyze data collected by the scanner. IBflex can also serve as a spectrum analyzer for PCTEL's SeeWave interference locating system. SeeWave is a comprehensive tool to detect interfering frequencies and locate its exact source. SeeWave utilizes the IBflex's advanced spectrum analyzer, a directional antenna and a tablet-optimized software program. This allows a single user to identify and eliminate interference, an essential step to maintain network quality of service. www.pctel.com

PRODUCT SHOWCASE



Wireless Platform

Built on an all-optical backbone, **Corning's** One wireless platform enables convergence of cellular services, Wi-Fi and Ethernet. The One wireless platform's modularity and preconnectorized fiber solutions allow it to be deployed in as little as half the time of typical wireless platforms. By converging POL, Wi-Fi and cellular, it uses about half the space of the multiple systems that would be needed in its place. With virtually unlimited bandwidth, the wireless platform may save as much as 50 percent on service upgrades.

www.corning.com

Antennas

Antenna Products' Phazar antennas have been used on many street lights and utility poles for DAS applications. The 2-inch diameter omnidirectional antennas are stacked vertically in single, dual, triple and quad configurations with a DIN 7/16



connector for each of the individual antennas. Combinations of 700 MHz 850 MHz (698 MHz to 896 MHz) and AWS/PCS (1710 MHz to 2155 MHz) antennas allow multiple carrier bands to be used in the same antenna. The Phazar Quad antenna provides two low-band and two high-band antennas for potential LTE performance.

www.antennaproducts.com

DAS and Small Cell Meter

The **LBA Group** offers model 3029 RF One inline power and VSWR meter. The meter measures forward and reflected power in the range of a few milliwatts up to 500 watts

for both analog and digital carriers in a frequency range from 30 MHz to 6 GHz. Features include sun-



PRODUCT SHOWCASE



light-clear signal spectrum display, line attenuation, peak/average power, USB, remote control, sleep mode and a rechargeable battery. www.lbagroup.com/products/rf-one-power-meter

High-density Wireless System

The **Dali Wireless** high-density system (HDS) can allocate coverage and capacity dynamically and simultaneously. This flexible and scalable solution suits many deployment scenarios that require dynamic capacity allocation, intelligent coverage and RAN virtualization. It can also serve as an end-to-end digital DAS. HDS is based on Dali Wireless' RF router technology. It is designed to deliver the high capacity of a macrocell, the flexible coverage of DAS and the tiny footprint of a picocell without traditional interference challenges, all in almost lossless conditions. www.daliwireless.com

Wireless Platform

A wireless platform from **Black Box** is intended to enable mission-critical, in-building wireless for enterprise organizations in the health care and hospitality industries, along with government users and Fortune 500 companies. The wireless platform is designed to deliver all key wireless services, including 3G/4G, fire/life/safety, 802.11 and medical telemetry, with engineered coverage and capacity to ensure all wireless devices stay connected with optimal service levels. Black Box documents every installation's wireless characteristics and deploys

mission-critical wireless with InnerWireless4G, which is managed through six key phases: scope, site survey, system design, procurement and logistics, and deployment and acceptance testing. www.blackbox.com/wireless

www.blackbox.com/wireless



Single-antenna, Multiple-GPS Outputs

GPS Networking's low-noise filter-amplifier offers single-antenna, multiple-GPS outputs for critical timing applications for a heterogeneous network or DAS project. The outputs feature splitters and fiber-optic systems that offer guaranteed precise timing; low-noise, high-isolated GPS outputs; amplified or unity-gain splitters; and 2, 4, 8, 12 or 16 outputs to ensure scalability. Model LNFA 1X4 is pictured. www.gpsnetworking.com

www.gpsnetworking.com

DAS and Small-Cell Solutions

Pinnacle Wireless, a UniTek Global Services company, offers complete, up-to-date DAS (distributed antenna systems) and small-cell solutions to help deliver coverage in challenging environments, including designing, sourcing, installing, commissioning and maintaining DAS systems for carriers, neutral-host providers as well as public safety organizations. These solutions

enable users to install one wireless infrastructure that supports all service providers and frequencies designed to meet and exceed functional and capital goals. The company maintains a large and highly qualified DAS technical organization with expertise in a myriad of technologies including small cells, a cost-effective alternative to traditional macro networks. www.pinnaclewireless.com

www.pinnaclewireless.com

Wireless Network

Henkels & McCoy has helped customers deal with their changing communications infrastructure needs from source to end user since 1923. The company performs work for telephone companies, carriers, wireless providers, government agencies, utilities, educational institutions and the private sector on projects of every scale. With wireless capabilities that span 4G rollouts and complex DAS (distributed antenna system)/small-cell installations to structural analysis and tower modifications, the company's wireless network solutions incorporate safety, quality, on-time performance and effective program and cost management. www.henkels.com

www.henkels.com

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