

ABOVE GROUND LEVEL

agl Magazine™

New York Subway DAS

Transit Wireless Brings Wireless
Service to Stations in the
New York Subway

Plus:
Test & Measurement
RF Technology
Antenna Product Showcase

March 2014 /// Volume 11 /// No. 03

YOUR SIGNAL STARTS HERE.®



IN OUR BUSINESS, IT IS ALL ABOUT THE SIGNAL.

Our clients depend on SBA to provide the wireless infrastructure that allows them to transmit the signal to their customers. As their first choice provider of wireless infrastructure solutions, we are continuously setting the standard for customer satisfaction by **“Building Better Wireless”**.



- TOWER OWNERSHIP**
- LEASING**
- SITE MANAGEMENT**
- SITE DEVELOPMENT**
- CONSTRUCTION**
- TECHNICAL SERVICES**

800.487.SITE | sbasite.com



Building Better Wireless®

ABOVE GROUND LEVEL

agl Magazine™

New York Subway DAS

Transit Wireless Brings Wireless
Service to Stations in the
New York Subway

Plus:
Test & Measurement
RF Technology
Antenna Product Showcase

March 2014 /// Volume 11 /// No. 03

TOWER SAFETY REACHES NEW HEIGHTS

VISIT: NATEHOME.COM/NATE-EXCHANGE

The **NATE EXCHANGE** is a convenient, consumer-driven, "one-stop-shop" platform for tower construction and maintenance companies and individual tower technicians to gain access to the most sophisticated and up-to-date training courses in the tower industry.

We encourage you to utilize this website tool to select the courses and training companies that best fit your specific workforce needs.





March 2014 // Volume 11 // No. 03



FEATURES

- 8 **Transit Wireless Brings Wireless Service to Stations in the New York Subway**
By Don Bishop
- 32 **PIM Requirements for Low-power Wireless Components and Subsystems**
By Dr. Murat Eron
- 36 **Fronthaul, CPRI and the Quest for Reliable Networks**
By Ted Abrams, P.E.
- 38 **Microwave Field Work with a Portable Spectrum Analyzer**
By Vents Lacars
- 44 **DAS Testing for Maximizing Quality of Service**
By James J. Zik, P.E., and Chintan Fafadia
- 50 **Where's My Site: The Mystery of Magnetic Declination Explained**
By Andy Singer

DEPARTMENTS

- 04 **Editorial Comment:**
5G Cellular Service – What's It Going to Take?
By Don Bishop
- 06 **Publisher's Note – Jumping Ship?**
By Richard P. Biby, P.E.
- 30 **AGL Tower of the Month**
Photography by Don Bishop
- 54 **Product Showcase – Antennas**
- 57 **Advertiser Index**
- 58 **Professional Directory**

AGL Magazine (Above Ground Level) is published 12 times a year by AGL Media Group Inc., 201 Loudoun St. S.E., Suite 202, Leesburg, VA 20175, and is mailed free to qualified individuals in the United States of America.

POSTMASTER: Send address change to AGL Media Group Circulation Department, 201 Loudoun St. S.E., Suite 202, Leesburg, VA 20175.

Interested in advertising with AGL Media Group's magazine, website or e-newsletters or sponsoring AGL Regional Conferences? Visit aglmediagroup.com/advertise for information.

aglmediagroup.com

5G Cellular Service - What's It Going to Take?



Oh, the headache. The misery. The woe and — wait a minute.

How does the old saying go? Out of disaster comes opportunity? Something like that. How does it feel over at Verizon Wireless, Sprint PCS

AT&T Mobility, and T-Mobile USA, to name a few U.S. wireless network operators, to learn of South Korea's plan to upgrade to 5G cellular service by 2020? Headachy? Exhilarating?

U.S. wireless network operators are spending billions of dollars to upgrade their networks from 3G to 4G cellular, and already the specter — or opportunity — of 5G service is looming. As early as 2008, South Korea formed a research and development program looking into 5G service using beam-division multiple access technology. A few weeks ago, news broke that the country plans to spend \$1.5 billion on 5G upgrades.

What's the difference? 5G will be 1,000 times faster than 4G. An example the country's science ministry gave said an 800-mega-byte movie that takes 40 seconds to download on 4G would take 1 second on 5G.

"We helped fuel national growth with 2G services in the 1990s, 3G in the 2000s and 4G around 2010," a statement from the ministry said. "Now it is time to take preemptive

action to develop 5G. Countries in Europe, China and the United States are making aggressive efforts to develop 5G technology ... and we believe there will be fierce competition in this market in a few years."

If it costs \$1.5 billion for 5G in South Korea, what would it cost in the United States? The United States has six times the population. On that basis, \$9 billion. The United States has 100 times the land area. On that basis, \$150 billion. Probably somewhere in between.

How much will 6G cost? A trillion dollars?

South Korea has a 4.4 percent share of the world's telecom infrastructure business. With 5G, the ministry said the country seeks a 20 percent share of the business by 2020.

Within South Korea, trial 5G service will start rolling out in 2017, with commercial availability in 2020.

A key to 5G lies in the use of millimeter-wave frequency bands with mobile devices, frequencies with tiny, tiny wavelengths. Something so small, leading to something so big.

Don Bishop, Executive Editor
dbishop@aglmediagroup.com



Exec. Editor/Assoc. Publisher

Don Bishop
913.322.4569
dbishop@aglmediagroup.com

Art Director

Brian Parks
423.710.3866

Copy Editor

Martha Collins

Contributing Editors

J. Sharpe Smith
515.279.2282
ssmith@aglmediagroup.com

Ernest Worthman

303.290.9700
eworthman@aglmediagroup.com

Publisher/CEO

Richard P. Biby, P.E.
540.338.4363
rbiby@aglmediagroup.com

Advertising Managers

Mercy Contreras
303.988.3515
mcontreras@aglmediagroup.com

Mary Carlile

484.453.8126
mcarlile@aglmediagroup.com

Circulation Manager

circulation@aglmediagroup.com

Corporate Office

AGL Media Group Inc.
201 Loudoun St. S.E., Suite 202
Leesburg, VA 20175
540.338.4363

Press Releases and Advertising Materials

press@aglmediagroup.com

Subscription Information

To subscribe online, go to:
www.aglmediagroup.com/signup

To subscribe by mail:
AGL Magazine Circulation Department
201 Loudoun St. S.E., Suite 202
Leesburg, VA 20175

Copyright ©2014. AGL Media Group Inc.
All Rights Reserved.

EDITORIAL COMMENT

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**

Jumping Ship?

If you are paying attention at all, you've probably seen a lot of senior people leaving some of the tower companies lately. I've received numerous calls from friends looking to move on, and from analysts and others wanting to discuss why people are "jumping ship."



The expression implies something negative, and I don't think that's a fair assessment. The large tower companies have really matured, as is evidenced by their real estate investment trust status. Publicly traded REITs can't really be very creative anymore. It's not what the tax structure is designed to do. A REIT can't make (much) money from non-real-estate activities.

Thus, some of the previous activities may be shut down or spun out, including engineering services and distributed antenna system development. It is a change, but not necessarily a bad one. I just think it spells opportunity for smaller companies. This is evolution, and it is good.

Small Cell Rage

I continue to be surprised at this overwhelming small cell and in-building wireless rage.

It's clear that the macronetworks will require offloading. We just can't build enough macrosites to address the capacity needs. So, micro/small sites are the clear alternative. So far, I'm just a little surprised that there hasn't been a more coherent plan to

deploy in-building wireless systems.

It looks a little like the Wild West out there, with very different hardware and business proposals. I'm looking for some secret sauce in all of this, but so far it looks a little chaotic.

PCIA

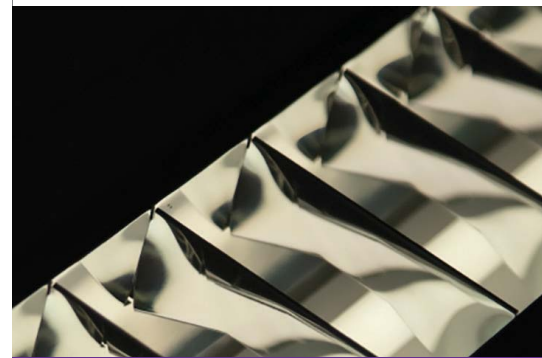
I had the pleasure of interviewing Jonathan Adelstein for AGL Media Group two weeks ago. As president and CEO, Jonathan is doing such an impressive job with PCIA. It's a pleasure to watch the success PCIA is having. I enjoyed the "PCIA to FCC: Four Key Steps to Improving Wireless Broadband Deployment" press release. Google it.

With changes at the FCC, the time could be just right for the changes suggested by PCIA to be implemented. We will be seeing many more policy changes as the network neutrality (open network) debate continues.

Complex RF Environment

Fluorescent lighting ballasts can cause RF emissions. No doubt about it. We've seen Verizon Wireless state that it is receiving interference from FM radio stations due to a 7th-order intermodulation product, and now lighting ballasts. This is going to be interesting to watch unfold. Verizon

has the right to be protected in its licensed spectrum. With so many devices emitting RF energy, managing and keeping the spectrum clean is going to be an interesting challenge.



Fluorescent lighting ballasts can cause radio frequency emissions resulting in interference.

Because of new, very sensitive receiver technology, many situations that were not significant previously are now causing performance problems. We are seeing the beginning of what will become much more complex RF environments.

Rich Biby, Publisher
rbiby@aglmediagroup.com

ENERGY STORAGE UNLEASHED



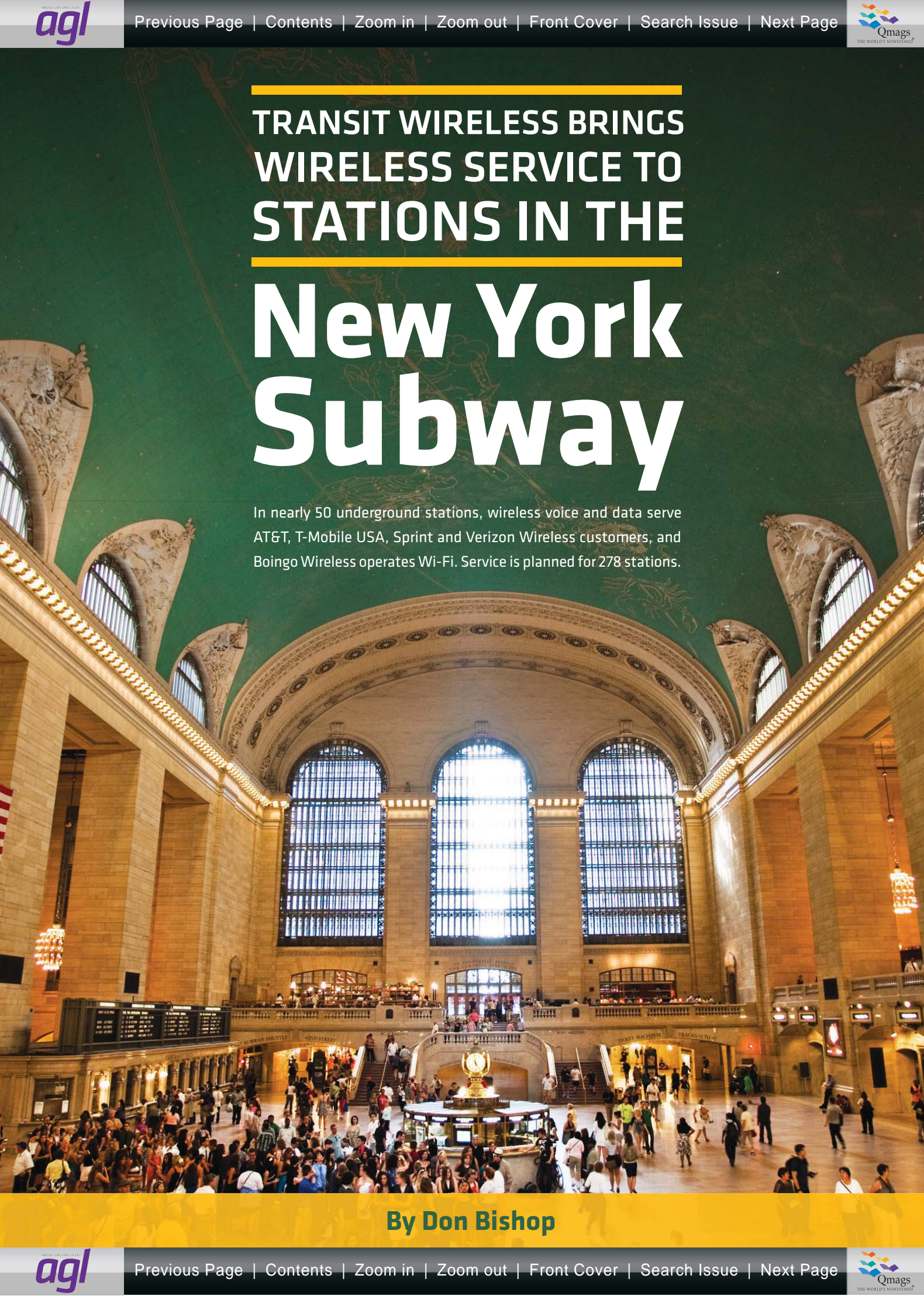
RE Renewable Energy & Hybrid Systems / Backup Power

Rely on Trojan Battery to unleash your storage needs. As a global company with local expertise, Trojan's wide range of deep-cycle flooded, AGM and Gel batteries for renewable energy, hybrid and backup power systems are backed by more than 85 years of battery innovation.

(800) 423-6569, +1 (562) 236-3000
WWW.TROJANBATTERYRE.COM

TRANSIT WIRELESS BRINGS WIRELESS SERVICE TO STATIONS IN THE New York Subway

In nearly 50 underground stations, wireless voice and data serve AT&T, T-Mobile USA, Sprint and Verizon Wireless customers, and Boingo Wireless operates Wi-Fi. Service is planned for 278 stations.



By Don Bishop

Transit Wireless and the Metropolitan Transportation Authority (MTA) of New York are in Phase Two of a seven-phase, multiyear project to build a state-of-the-art wireless network in the New York City Subway. A subsidiary of the MTA, the New York City Transit Authority (popularly known as NYCT), operates the subway. In Phase One during 2013, 30 subway stations in midtown Manhattan, including Times Square, Rockefeller Center, Lincoln Center and Columbus Circle, came online, joining the initial six in Chelsea, which went online in September 2011.

“For the past three years, the MTA has been on a clearly defined mission to bring our mass transit system into the 21st century with upgrades to the station environment through several ambitious new-technology communications projects like this one, aimed at improving the travel experiences of our customers while offering another level of security,” said then-MTA Interim Executive Director Thomas F. Prendergast during a ceremony conducted last year to demonstrate the service at the Times Square Station. Prendergast has since been named MTA chairman and CEO. During the demonstration, MTA officials were joined by executives from Transit Wireless, AT&T, T-Mobile USA, Boingo Wireless, Sprint and Verizon Wireless. “The New York City subway system is the most heavily trafficked system in the world, and now riders have wireless service,” said William A. Bayne Jr., CEO of Transit Wireless. “We have

been working closely with AT&T, Sprint, T-Mobile USA, Verizon and Boingo to bring wireless tech into one of the oldest and most historic public transportation systems in the world. This network benefits not only riders, but city workers and first responders, and it will be the backbone for future technology and safety improvements to the city’s subway stations.”

“For the past three years, the MTA has been on a clearly defined mission to bring our mass transit system into the 21st century...”

Public Safety Benefits

The network allows users to make and receive cell phone calls, send text messages, stream music, play online mobile games and more, all from underground subway stations. It also enables important services that improve security such as E911 that allows dispatchers to know when a call is being placed from an underground platform and the forthcoming Help Point Intercom system, which will help riders obtain basic travel information or call for help in an emergency with the push of a button, right on the platform.

“This goes beyond providing cell service underground, it brings our customers a new level of security – with the ability to dial 911 in an emergency,” said then-Acting MTA Chairman Fernando Ferrer at last year’s demonstration. “Customers now know that when they see

something, they can now say something using their device to call 911.” Ferrer is now MTA’s vice chairman.

Wireless Providers Partnership

Under agreements with the MTA and Transit Wireless, AT&T, T-Mobile, Sprint and Verizon customers can use their cell phones to make and receive calls and use wireless data in more underground subway stations.

“Bringing wireless to these busy subway platforms helps AT&T deliver on its commitment to provide our customers with the fastest and most reliable wireless service in New York City, including 4G LTE, whether above or below ground, at home, at work or in between,” said Tom DeVito, AT&T’s vice president and general manager for New York and New Jersey. “This initiative will also help spur transit innovation, which is one of the reasons AT&T is working with the MTA and NYU Poly on the AppQuest Challenge to develop the next generation of transit apps to improve the experience of every commuter.”

Tom Ellefson, T-Mobile’s regional vice president of engineering and operations, said, “Through this project, T-Mobile is extending our blazing-fast nationwide 4G network coverage into the New York City Subway, where New Yorkers often spend a significant part of the day. Our customers have really embraced the unlimited 4G experience T-Mobile offers, and now they can keep browsing, streaming and sharing when they go underground.”

Zack Sterngold, vice president at Boingo Wireless, said, “Boingo has kept commuters connected since our managed and operated services



At a demonstration of wireless service conducted at Times Square last year, Thomas Prendergast (at the lectern) was joined by executives from Transit Wireless, AT&T, T-Mobile USA and Boingo Wireless and representatives from Sprint and Verizon Wireless. Prendergast then was the Metropolitan Transportation Authority's interim executive director and now is its chairman and CEO.

launched in 2011. We look forward to expanding our network and introducing leading brands to consumers at stations across the city. Boingo's advertising and sponsorship platform allows commuters to connect to subway Wi-Fi free of charge and enables advertisers to reach the on-the-go, connected New Yorkers with location-based messages."

Greg O'Connor, vice president of network engineering and deployment at Sprint, said, "In the city that never sleeps, New Yorkers love to use their mobile devices 24/7 to stay connected to friends, loved ones and business associates. So, we are thrilled to include the subway in the buildout of our new network and deliver the robust benefits of 3G and 4G LTE to commuters, public safety representatives and first responders."

Patrick Devlin, president of the

New York Metro Region at Verizon Wireless, said, "Verizon Wireless is always exploring opportunities to provide our customers with the world-class experience of the nation's largest 4G LTE network and most reliable 3G network, no matter where they are - above ground or below."

In an interview with *AGL Magazine*, Transit Wireless' team leaders explained the network's architecture, operation and maintenance. Nathan Cornish, director of RF engineering; Saeid Malaki, director of design and construction; Eric Mercer, director of wireless business development; and Tom McCarthy, director of network operations, spoke on behalf of the company.

What follows are their remarks, edited for length and style.

Cornish: The project has seven phases. As of last year, we built coverage in 36 subway stations. We started with an initial six in the Chelsea region chosen to represent a mix of simple and complex sites to design and build. They were built at the end of 2011. We concluded Phase One with 30 stations in midtown Manhattan on April 25, 2013. Since then, we have been building Phase Two, which is another 40 stations, 11 in Manhattan and 29 in Queens.

Malaki: The network has three aspects: base station hotels, a fiber-optic network, and distributed antenna system (DAS) networks with parallel Wi-Fi networks. We used SOLiD gear for the DAS and Motorola and Westel switches for Wi-Fi.

We have a license from NYCT to own, operate and maintain wireless networks in all 278 underground New York City subway stations. The networks cover all commercial wireless bands plus unlicensed bands such as 2.4-GHz and 5.8-GHz Wi-Fi and 4.9-GHz public safety.

Mercer: We acquired a fiber-optic cable franchise to support the project instead of using existing fiber in New York streets to connect subway stations with base station hotels, and we can also feed that to the carrier switch locations. Transit Wireless will own a huge fiber network that will mirror the subway path of New York City. It will be a good infrastructure to own and to maintain for our network and potentially for other networks that we could support.

Malaki: When we designed the network, we went with the highest-fiber-count cable that we could for reasons of expansion and to have ample excess capacity. We went with



Sunsight's Antenna Alignment Tool (AAT)

- Eliminates Re-Trips
- Field proven to work in any environment you do
- RF hardened and shielded for use on live towers
- Versatile mounting options
- Light at only 8 pounds
- Measurements based on True North, no need to worry about declination
- Custom, full site closeout reports

Accurate
Versatile
Reliable
Efficient
Durable
Accessible
Customizable

Site Alignment Results
MCO-118

Phase 1 LTE Buildout

Antenna Position	Target	Real	Target	Real	Roll	Target	Real	Height	Target	Real	Custom Timeout
Alpha (1)	0	0	2.4	-0.3	0.9	-0.9	1.2	140.0	N/C	N/C	2013-05-15 15:32:27
Beta (2)	120	120	0.0	0.0	0.0	-0.2	0.2	140.0	N/C	N/C	2013-05-15 15:32:28
Gamma (3)	255	255	3.0	-0.7	2.0	0.0	-0.4	140.0	N/C	N/C	2013-05-15 15:32:27

Copyright © 2013, SunSight Instruments, LLC - version 0004-01

Measures
Latitude and Longitude of site
and each antenna

Azimuth +/- 1 degree
Tilt +/- 0.25 degree
Roll +/- 0.25 degree
Height +/- 1 foot AGL,
Exceeds all carrier's requirements

Approved by all carriers

*Field-proven, High-quality
Antenna Alignment Solution*

Sunsight

Sunsight Instruments, LLC
125 Candace Drive • Orlando, FL 32751
(321) 244-9443 • sales@sunsight.com
www.sunsight.com

864-fiber cable, which is about an inch in diameter. There are 864 fiber strands inside. That's a huge capacity coming out of the base station hotels and going to the subway stations.

McCarthy: We had to decide how much capacity to build into the switching and some of the equipment. Demand grows exponentially over short periods of time. We chose to invest in a considerable amount of capacity in our core switching technology — not to overinvest, of course, but to do so in a frugal manner, intelligently.

We chose to house everything in a box, which gives us the ability to swap out equipment as Wi-Fi manufacturers come up with new access points that have higher standards to 802.11ac.

Our switches, for example, have interchangeable connectivity with small form-factor pluggable (SFP) transceivers that brings value to our customers now. If growth becomes a future inhibitor, we can use our spare fiber or, in the interim, we could switch our 1 Gbps SFP transceivers to 10 Gbps SFP transceivers. We have

Transit Wireless Team Leaders

Interviewed for the Article

Nathan Cornish, director of RF engineering

Saeid Malaki, director of design and construction

Eric Mercer, director of wireless business development

Tom McCarthy, director of network operations

growth capability at all levels of the network from the core at the base station hotel all the way down to the access points and the DAS remote optical units (ROUs) and remote fiber nodes (RFNs).

Cornish: On the capacity side, we have the fiber in the streets, and we have additional capacity in the subway itself. We built a parallel system between the DAS and the Wi-Fi. With the DAS network, everything is distributed over coaxial cable. We have antennas connected with that coaxial cable for the carriers. For the Wi-Fi, the connection is by fiber from the aggregation switch, which is the main hub at the station, to each access point around the

station. To each access point we're using two fibers at the capacity of 12, so we can always add equipment that needs fiber at the edge.

RF Network Design

Cornish: From the RF perspective, the subway environment is unique for a DAS. The subway is a very low-noise, low-interference environment because essentially we get no coverage from aboveground, so we receive no interference from anyone else's wireless systems.

That has benefits because it provides a very good signal-to-noise ratio for the services. But it has its downside. One big challenge was that we had to design our system as an island separate from the macro network. We had to ensure that the macro outside the station could hand over to the macro inside the station.

Another challenge was ensuring that we have 95 percent RF coverage with attention to ingress and egress areas to provide coverage to users who walk into the stations. The carriers require a seamless relationship between their systems and our system. We have to avoid dropping calls. We also have to make sure the antennas aren't so far into the edge that they become targets for vandals.

Meanwhile, the subway is more than 110 years old and, unlike a new



Three antennas configured for MIMO communications.



Providing the telecommunications industry with a single turnkey solution.

Contact Sabre today for all your project needs.
800-369-6690 | www.SabreIndustries.com



/ FEATURES /

subway with big, open areas with high ceilings, the New York Subway is a small, compact environment with many metal objects, numerous signs, a lot of people and low ceilings. We had to provide enough line-of-sight coverage to get around objects, especially metal objects that are not good to have in an RF environment. Unlike an in-building DAS that allows antenna placement almost anywhere, in the subway, every single antenna location has to be approved and signed off on by the MTA. It was a long approval process for each antenna.

The service level agreement (SLA) with our carriers requires we cover 95 percent of the public access areas, which include small stairwells, passageways and corridors. Because the subway is underground, RF does

not propagate through the walls. We have to place antennas in locations that otherwise might have been covered by signals passing through the walls.

For the build for the initial six stations, we used a single coax and a single antenna system to cover the entire area, but we found that it limited the Wi-Fi coverage because Wi-Fi has a very high frequency range, and therefore, with distance, the signal levels dropped off significantly.

In Phase One, in the initial build, we made a box to house the Wi-Fi access points and also connect with the DAS. The DAS has its own antenna system, and the Wi-Fi has a separate multiple-input, multiple-output communications antenna system.

We used two types of antennas for the DAS. We used omnidirectional

antennas in most of the coverage. Where we needed to extend coverage to the ingress and egress, we used highly directional antennas with high front-to-back ratios so that the power is forwarded toward the stairwell that we need to cover for the hand-off zone with the outside macro system. We used PCTEL as the main supplier for the antennas.

Challenges Associated with System Construction

Malaki: The stations are more than 110 years old, and they differ from one another. We had multiple stations to design and build, but we were unable to take a single design and replicate it from one station to another. Every design, every layout of equipment had to be approved by NYCT.

Pepro Pan & Tilt 300

The Pepro Pan & Tilt 300 is specifically designed for the wireless communication industry; providing speed, precision and reliability for the positioning of a variety of antennas.

- ▶ Engineered to withstand 120 mph wind speeds and extreme weather conditions
- ▶ 60° of pan and 10° of tilt adjustment
- ▶ Positive positioning via electric motor
- ▶ Lightweight (15 lbs.) all-aluminum design
- ▶ AC or DC operation
- ▶ Water and dust resistant (IP67) electrical connections



PEPRO www.peprollc.com
671 Colbert Ave • Oil City, PA 16301
P:814-676-5688 • F:814-676-3729

Keep on track for RF safety



Policy on human exposure
Frequently asked questions

www.fcc.gov/oct/rfsafety

TRANSIT WIRELESS

Nationwide & Turnkey

Scalable delivery, top-ranked performance.

Wireless carriers nationwide rely on Black & Veatch to support their macro network sites or specific coverage solutions, including DAS and Small Cells, for site acquisition, architecture & engineering, program management and construction. We are the #1 ranked engineering company for telecommunications in the U.S. (*Engineering News-Record 2010, 2011, 2012 and 2013*).

We're building a world of difference. Together.

Learn more at bv.com/2012annualreview



BLACK & VEATCH
Building a world of difference.®

Consulting • Engineering • Construction • Operation | www.bv.com

/ FEATURES /




MTA's Thomas Prendergast speaks at the Times Square Launch.

We used a 360-degree video camera to film every station with a view similar to the Google street view. That helped us with designing, knowing the exact placement of equipment relative to the existing infrastructure in the ceilings because each station is unique.

Some of the subway stations are historic. Columbus Circle and Times Square are considered to be historic stations. Designs for those stations had to be approved by the state historic preservation office to ensure there was no adverse effect to the stations' historic aspects. It made the design and installation work more difficult because we had to install the equipment and cabling on the track sides of the columns above the tracks instead of on the platform side.

TRANSIT WIRELESS

IWCE 3/24-3/28
Visit booth #9084
NAB 4/5-4/10
Visit booth #C2136



UNIMAR

Brighter lighting solutions

FAA LED Obstruction Lighting
Low Power Consumption
Class I Division 2 Products Available

unimar.com
800-739-9169



Could it be any smarter?

The innovative **Times-Protect® SmartPanel™** revolutionizing the cellular base station entrance panel

Lower Installed Cost - Maximum Protection



- NO** external coaxial grounding kits required
- NO** outside copper master ground bar (to steal..)
- NO** lightning protector trapeze inside
- TRUE** single point grounding by design
- TRUE** lightning protection for your valuable equipment

How do we do it?

Vist: www.timesmicrowave.com/products/protect/downloads/smartpanel.pdf to find out!



World Headquarters: 358 Hall Avenue, Wallingford, CT 06492 • Tel: 203-949-8400, 1-800-867-2629 Fax: 203-949-8423

International Sales: 4 School Brae, Dysant, Kirkcaldy, Fife, Scotland KY1 2XB UK • Tel: +44(0) 1592655428

China Sales: No.318 Yuan Shan Road Shanghai China • Tel: 86-21-51761234 Fax: 86-21-64424098

www.timesmicrowave.com

The subway environment is dusty, and even though it is indoors, there is water from spraying and cleaning of the stations, and there is a lot of steel dust from the trains braking. The steel dust is everywhere. A challenge was finding equipment and designing enclosures that would withstand the dust and so that water would not get inside. At the same time, they had to be able to dissipate heat from the equipment so the equipment would not overheat in temperatures in excess of 125 degrees Fahrenheit.

Meanwhile, the New York City Subway operates 24 hours a day, seven days a week. Most of the subways of the world shut down for a few hours, and you can go out during the shutdown and complete construction or an installation. With NYCT, that doesn't happen. You are installing equipment at night, but there are passengers around. At all times, we had to contend with passengers, safety and trains running by where equipment was being installed. We had to get flaggers from NYCT who slowed down the trains so workers on the platform would be safe.

The access point box is a 36-inch-by-50-inch box that houses all the Wi-Fi equipment and switches. It is where the three MIMO antennas are placed. The heat dissipation is through the walls of the equipment box itself. We have enough surface area to dissipate the heat at 55 degrees to ensure that the temperature inside never rises above the equipment manufacturer-recommended temperature range. The equipment inside, in turn, had to be designed to withstand higher temperatures inside the enclosure.

Vision. Clarity. Clearfield.



Pushable fiber drop cable systems integrated with the fiber-optimized, environmentally sealed **FieldShield Multiport SmarTerminal** enclosure brings fiber to the tower in ways never seen before:

Faster - Lighter - Easier to deploy

Visit the white papers section of our website for more details on "Using the SmarTerminal to Reduce the Cost of Broadband Networks."



www.ClearfieldConnection.com
800-422-2537

Overcome Microwave Backhaul Challenges and Reduce Total Cost of Ownership with **RFS**



Radio Frequency Systems offers a complete portfolio of microwave antennas, elliptical waveguides, connectors, pressurization equipment, hardware and accessories.

NEW! SC3/SCX3 CompactLine® EASY

- Most compact and lightest 3ft microwave antenna in the industry – easier to transport, deploy and upgrade
- Best-in-class radiation pattern reduces interference and simplifies frequency coordination in congested areas
- Deep dish design, no shroud in most frequency bands, allows for very quick and easy installation and reduces antenna weight, lowering installation costs and OPEX



A worldwide leader in wireless and broadcast infrastructure

Sales: 800.321.4700

www.rfsworld.com

Tech Support: 800.659.1880

/ FEATURES /

Exceptional Enclosures



Charles Universal Broadband Enclosures (CUBE)

MADE IN THE USA



Multi-Purpose Enclosures

CUBE MP Series houses a wide range of remotely deployed copper and fiber electronics



Small Cell Enclosures

Compact cabinets for small cell / pico cell radios, routers, rectifiers and batteries

NEW!



Site Support / BBU Enclosures

CUBE SS Series supports VRLA or Ni-Cd batteries, various rectifier and power distribution options



www.charlesindustries.com

INNOVATIVE ENCLOSED SOLUTIONS



Times Square-42nd Street is among the 30 subway stations in Phase One of the Transit Wireless build out. Photo: Metropolitan Transportation Authority/ Aaron Donovan.

The SOLiD DAS equipment has a large surface area and fins on top to dissipate enough heat.

Operational Characteristics of the Subway Wireless System

McCarthy: Some of the network elements are in a constant state of improvement. For example, one of our switch manufacturers doesn't have an efficient way of remotely updating without interfacing with each device. While they meet environmental constraints, the

operational constraints leave something to be desired. We're working with them. Because we're going to have a few thousand deployed, they're willing to be accommodating.

On the other hand, with Motorola, we operate from a central Wi-Fi controller. We can potentially update 4,000 access points in an instant.

We haven't encountered any problems that seem to be a result of faulty or bad equipment.

Cornish: One big part of the

TRANSIT WIRELESS

TELEWAVE, INC.

Telewave produces the industry's toughest antenna systems. Yagi, Fiberglass Collinear, Dipole and Discone models are available from 30 MHz to 3.0 GHz, with gain from unity to 12 dBd. Our exclusive TXYLAN® coating makes Telewave Yagi, Dipole and Discone antennas impervious to the most severe environments, and our COOL BLUE® fiberglass vertical antennas blend into the skyline, while providing high flexibility and absorption of solar radiation to speed de-icing.

ANT150P2 148-174 MHz 23 dBd

ANT1000C-9 138-174 MHz 6-9 dBd

ANT450D6-9 400-512 MHz 6-9 dBd

ANT400D6-9 450-470 MHz 10 dBd

ANT220D6-9 210-252 MHz 6-9 dBd

Visit our Booth #3042 at IWCE 2014

MADE IN USA

TELEWAVE, INC. • San Jose, CA • 1-800-331-3396 • www.telewave.com
Email: sales@telewave.com

Lab-grade performance in a handheld VNA



Vector Reflectometers Planar R54 (85 MHz - 5.4 GHz) Planar R140 (85 MHz - 14 GHz)

Portable and affordable, these lightweight VNAs can be used in the field while delivering the accuracy of benchtop equipment. R54 and R140 are the first single-port VNAs that do not require a test cable, resulting in highly dependable performance and calibration stability.*



Planar TR1300
300 kHz - 1.3 GHz
2-port 1-path



Planar S5048
20 kHz - 4.8 GHz
2-port 2-path



Planar 304/1
300 kHz - 3.2 GHz
2-port 2-path



Planar 804/1
300 kHz - 8 GHz
2-port 2-path



COPPER MOUNTAIN
TECHNOLOGIES

A full range of solutions from 20 kHz to 14 GHz at
www.coppermountaintech.com

*Patent pending

Test drive the equipment at **IWCE**: Booth 4094

/ FEATURES /



59th St–Columbus Circle is one of 30 subway stations that are part of the Transit Wireless Phase One build out. The newly renovated subway complex station boasts a 13-store retail concourse, for which MTA began accepting bids on Sept. 14, 2011. Photo: Metropolitan Transportation Authority/Patrick Cashin.

design is that the equipment is generally fanless. We try to remove any requirement for ongoing maintenance of equipment located in the subway stations. By us having everything cooled by passive means,

a technician doesn't need to be in there checking filters, checking fans. That reduces quite a lot of the ongoing operations. The majority of the system is a passive system except for one active RFN or remote device,

and except for the Wi-Fi components.

McCarthy: We outsource our network operations. The network operations center monitors and responds to any escalation that is required. This is 24/7 coverage of the network because the subway runs 24/7.

Another operational challenge has to do with the diversity of technical skills required. The system reflects a marriage between some of the RF and wireless technologies we've deployed. Naturally, we take RF or Wi-Fi engineers and technicians and make sure they're trained on both sides of the house. These are the individuals who will go out there and troubleshoot and be the eyes and the ears in the event we need to replace equipment. Some of the functions are absorbed by the network operations center, and



THE TELECOM INDUSTRY'S ULTIMATE POWER CABLE.

TelcoFlex® cable is the premiere LSZH Central Office power cable used for all levels of Telecom equipment installations and battery back-up in Central Offices and Remote Locations. TelcoFlex® is compliant with Telcordia GR-347, CSA certified, UL listed, FT-4, VW-1, CT USE, RoHS & REACH compliant and meets IEC requirements. TelcoFlex® cable features TelcoHyde® insulation, a non-halogen, low smoke and environmentally friendly non-silicone and lead-free thermoset rubber insulation. TelcoFlex® cable also offers increased flexibility and durability for better cable pulling through trays. TelcoFlex® cable is available in standard and flexible strands and in both braided and non-braided. Manufactured by Southwire.



Southwire®



Scan QR Code to view the latest TelcoFlex® information on the Southwire® website

TelcoFlex@Southwire.com

©2014 Southwire Company. All Rights Reserved. ®Registered Trademark and ™Trademark of Southwire Company.

YOU CAN ACTUALLY AFFORD TO USE IT



-  Affordable
-  Bright LED Indicators
-  Loud Buzzer
-  Operable with Gloves
-  All Weather Design
-  Long Lasting Battery
-  Rugged
-  Mobile Telecoms
380 MHz- 2.7GHz

Available through the following retailers:



field:SENSE
Personal RF Monitor

fieldsense.com

/ FEATURES /



some of the functions are absorbed by technicians.

The Transit Wireless team commented about the 4.9-GHz public safety communications band network, which includes the Help Point Intercom system.

Cornish: From an RF perspective, the 4.9-GHz network is based on the 802.11n standard with a meshing component. It's not a new technology, it's just being used in a different band. It's quite difficult to cover the subway stations at 4.9 GHz because

the frequency is so high. It affects the bandwidth of the equipment and how far each antenna needs to be spaced.

Our Wi-Fi equipment is designed for both 2.4 GHz and 5.8 GHz, and the 4.9-GHz band has coverage similar to that of the 5.8-GHz Wi-Fi component, so the system is already designed to meet the desired coverage for 4.9 GHz.

Another component of the design is that our antennas are actually designed to operate at frequencies as high as 6 GHz. Although 4.9 GHz is a fairly uncommon band, it actually fits quite well in line with the system we already were designing.

McCarthy: NYCT contracted us to design, deploy and manage the 4.9-GHz network. It uses over-the-air networking for the access points without interconnecting them with a wired

Tower  Xchange

Meetup Americas 2014

May 20-22, Rosen Shingle Creek, Orlando, Florida

Co-located with the PCIA Wireless Infrastructure Show

A unique, invitation-only gathering of the top 200 decision makers in the Latin American tower industry

Identify opportunities in Latin America for your company, meet the CEOs and International Presidents of 8 of Latin America's 10 leading towercos, by attending the TowerXchange Meetup Americas. You'll also meet the infrastructure, M&A and tower strategy decision makers from the leading carriers in South and Central America and the Caribbean.

www.towerxchange.com/meetups/americas



The TowerXchange Meetup maintains strict limits to the maximum number of participants but you can apply for a pass or an exhibition booth at <http://www.towerxchange.com/meetups/americas/> or by contacting Annabelle Mayhew on amayhew@towerxchange.com / +44(0)7423512588. Please quote TXAMAGL.





The Phase One base station hotel has equipment made by SOLID.

medium such as Cat5 cable or fiber. So, you're meshing this network and slowly eating up the bandwidth with each access point you're meshing for every hop you take. Meshing enables you to extend your network into hard-to-reach places, like the subway. Also, it provides you with an easy path for building a redundant network via multiple access points. We have multiple access points in the subway stations, so this makes an ideal solution for the Help Point Intercom system that uses kiosk-like metal housings for the access points. The Help Point Intercom system runs an application so a user can press a button for help in the event of an emergency. That's going over the 4.9-GHz network. It has a backup wired link going to control rooms on NYCT's network. It is a safety-driven feature for the public from NYCT.

Cornish: NYCT also has plans to provide their employees with tablets and IP phones resulting in additional security and accessibility for their workforce to provide additional protection to the riders of the subway.

Core Competency of Transit Wireless

Maliki: Transit Wireless' core competency is the design of the overall network topology, the RF design, the infrastructure design, and the communication and correspondence with NYCT. Coordinating takes a lot of our time. NYCT has to approve everything that we install. Everything gets scrutinized as far as what gets approved and installed in their system and what doesn't.

We also select the equipment. Some of the equipment we designed ourselves. The access point box, for example, was designed in-house where we had many components and put them into an enclosure that was IP-rated, that withstood vibration and that passed all testing that was required. So I would say the core competency is in design, and in communication and correspondence with NYCT.

Conclusion

On Jan. 28, Transit Wireless announced that Verizon Wireless' voice and 3G and 4G LTE data services are

available in subway stations on the west side of Manhattan from 23rd Street to 96th Street, including Times Square, Rockefeller Center, Lincoln Center and Columbus Circle.

"At Verizon Wireless, we have a long track record of investing to provide customers the best possible service," said Patrick Devlin, regional president for Verizon Wireless. "Since 2000, we have invested more than \$4.5 billion into our wireless network across the New York Metropolitan Region. The addition of Verizon Wireless voice and data services to these New York City subway stations will only further enhance our customers' mobile experience."

The addition of Verizon Wireless service to the Transit Wireless network allows millions more New Yorkers and visitors to stay in touch with friends and family while in subway stations and on platforms. It also provides the ability to dial 911 in an emergency. A critical security improvement, E911 allows dispatchers to know when a call is being placed from an underground platform and

/ FEATURES /

direct emergency personnel to the approximate location where the call was made.

“The build out of the Transit Wireless network continues to progress on schedule, as we add carriers like Verizon Wireless and begin work on Phase Two of the project to bring service to 40 additional stations, including Grand Central Station in Manhattan, as well as all underground stations throughout Queens,” said William A. Bayne Jr., CEO of Transit Wireless. “Our network not only provides an important security improvement to riders, but also serves as the backbone for future innovations throughout the subway system.”



The access point box is a 36-inch-by-50-inch box that houses all the Wi-Fi equipment and the switch. It is where the three MIMO antennas are placed. The heat dissipation is through the walls of the equipment box itself.

Public Safety Grade Indoor and Outdoor Multi-Service DAS Solution

- Supports all major public safety and wireless carrier frequency bands
- Compact, fanless, NEMA4 (IP65) systems
- Lowest noise figure in the industry
- World class output power
- Ability to monitor, control, and test all components of DAS from single webpage
- Unique Single Net solution

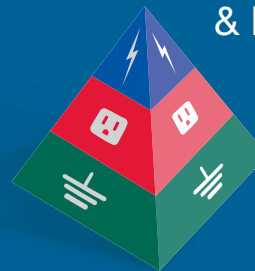


DeltaNodeTM
Wireless Technology
A Bird Technologies® Company

www.deltanode.com Tel: 866.695.4569 (USA) Tel: +46(0)8 684 480 00

TRANSIT WIRELESS

Who Does Your Grounding & Lightning Protection Systems Design?



Chances are it's ALLTEC.

Due to our extensive experience in the Telecom industry, ALLTEC has most likely provided engineered solutions for many or all of your existing sites. We solve the most difficult grounding, power quality, and lightning problems by applying the three-tiered ALLTEC Protection Pyramid™ approach.

Visit us at booth 7117 at the IWCE Conference March 26th to the 27th.

Learn more about what ALLTEC can do for you at www.alltecglob.com/agil or Toll Free 1.800.203.2658.



SOLUTION PROVIDERS FOR AN ENERGIZED WORLD™

Grounding & Bonding Solutions | Surge Protection | Lightning Protection

Optical Time Domain Reflectometers

Anritsu | Since 1895

Light it Up with Confidence

Our New Enhanced All-in-one OTDR

The ACCESS Master™ MT9083x2 enhanced model now features a 7-inch widescreen TFT-LCD display for both indoors and outdoors, enhanced battery operation time (up to 12 hours), increased operating temperature range (-10° to +50°C) and new short-cut function keys weighing in at only 5.7 pounds.

Other Features:

- > Up to 46dB dynamic range
- > < 1m dead zones
- > Up to 150,000 data points
- > Supports single mode and multimode fibers
- > PON testing up to 1x128 splits

NEW Easy to use Software

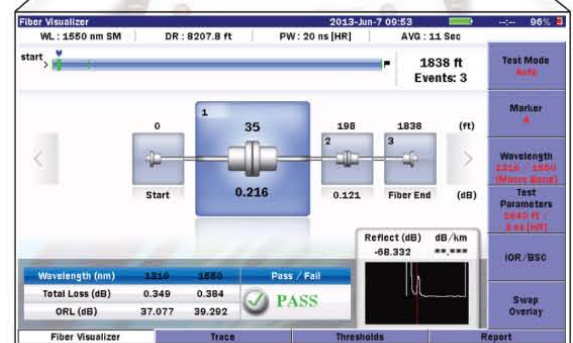
The latest MT9083 version now includes **Fiber Visualizer** – designed to simplify. It features one-button fault locate function that automatically selects testing parameters to ensure correct setup and provide a simple, graphic summary of the fiber under test within seconds.

Find out more at: www.talleycom.com/Anritsu and download our **FREE APPLICATION NOTE: Fiber Optic Testing Simplified.**

Or call **1-800-949-7079** and speak to one of our Talley sales experts.

TALLEY
You Connect the World. We Make it Easy.

ACCESS Master™ MT9083x2
with Fiber Visualizer



© 2013 Anritsu Company

Anritsu
Discover What's Possible™



REGISTER NOW

Attend the March 20, 2014
AGL Conference in Nashville

Where Content Comes To Life™

EDUCATION

NETWORKING

POWER GROUP
DISCUSSIONS

EXHIBITION

Experience the Benefits of an AGL Conference...

- **Learn** from industry leaders and technology experts.
- **Interact** with existing clients and build new relationships.
- **Participate** in a hands-on industry case study.
- **Showcase** your company products and services.

TICKET COST
ONLY
\$139
FOR ALL DAY
EVENT

WHEN



Thursday
March 20
8:00 am – 4:30 pm

WHERE



Gaylord Opryland
2800 Opryland Drive
Nashville, TN

Sponsorship...

View the 2014 Media Guide for sponsorship opportunities at aglmediagroup.com or contact tgregory@aglmediagroup.com

SPONSORS



Before the Conference...

Meet and greet conference attendees at our networking social.

Wednesday, March 19

5:30 pm – 7:30 pm

Sponsored by SunSight

Choose Your Afternoon Track...

Power Group Discussion

Infrastructure & Small Cell Case Studies

Participate in an innovative, problem solving, team exercise with a small group of your peers that addresses real life situations. Share your expertise and work towards a solution that overcomes the obstacles placed in your path. This will be a fun experience where you can build relationships, see different perspectives and contribute to your team's success.

2:30 pm – 4:30 pm

NATE Tower Business Symposium

Tower Economic Session & Case Studies

Benefit from an educational session and practical discussion of tower economics from a tower contractor perspective. We will discuss topics such as tower site installations, preventing catastrophic failures, maintenance, best practices, work safety and other subjects that drive cost. Session led by Craig Snyder, past chairman of NATE.

\$45 // 2:30 pm – 4:30 pm

**Separate registration and fee*

Attend an AGL Conference Near You...

National Harbor, MD – June 19

Dallas, TX – October 9

Glendale, AZ – December 4

REGISTER ONLINE
aglmediagroup.com/aglevents



SITE NAME
THURMONT

TOWER OWNER
CTI TOWERS

TOWER TYPE
GUYED

HEIGHT
180 FEET

TOWER MANUFACTURER
ROHN

YEAR CONSTRUCTED
1998

CARRIERS
AT&T
VERIZON WIRELESS

LOCATION
THURMONT, MD.

Photography by Don Bishop

AGL TOWER OF THE MONTH



ABOVE GROUND LEVEL
agl

MARCH 2014

AGL TOWER OF THE MONTH

PIM Requirements for Low-power Wireless Components and Subsystems

It can be good design practice to have low-power systems at least be able to tolerate high power levels of 30 watts to 60 watts even with poor PIM performance but without damage.

By Dr. Murat Eron

Passive intermodulation (PIM) interference is a matter of concern for high-speed wireless networks. A good understanding of how it affects the network operation and how to detect and avoid it has been rapidly developing. This has been reflected in PIM testing procedures and limits for high-power RF components and subsystems. Because these specifications were mostly geared toward high power, +40-watt applications and components, there is a need to address the low-power PIM requirements because low-power systems are playing a bigger role in new roll outs. The following information attempts to define those reasonable limits.

The best method of ensuring good PIM performance is to start with low-PIM guaranteed components in the first place. Second, try to specify PIM as close to working conditions and power as possible to avoid needlessly expensive solutions. The closest thing to PIM standards are the IEC 62037-1 and -4 that specify the conditions for testing PIM. These documents recommend the use of 2- x 20-watt continuous-wave (CW) tones and

leave the choice of frequencies and separation to the user to meet the needs of the system in use.

Meanwhile, the wireless industry has developed ad hoc specifications for PIM levels mostly based on field tests and trial and error. A maximum PIM level of -110 dBm in the receive band is found to be

for CDMA/OFDM-type signals that resemble anything but CW.

One of the drawbacks of fixed power testing per IEC is its unsuitability for lower-power applications. Designing and manufacturing a passive component or assembly for a 2- x 20-watt test when the application is only for

The best method of ensuring good PIM performance is to start with low-PIM guaranteed components in the first place. Second, try to specify PIM as close to working conditions and power as possible to avoid needlessly expensive solutions.

sufficient in many cases, especially when base transmitter station (BTS) interfaces are involved. Many component vendors aim for -115 dBm or better depending on the type of component. Given the standard test level of 43 dBm per tone (CW), this -110 dBm of absolute IM power level corresponds to a -153 dBc of relative PIM level. Note that it may be hard to relate this analytically to an ideal state-of-the-art base station receive sensitivity of around -120 dBm range because these are defined for specific bandwidths and

2 watts results in a costly and heavier solution than required. In the absence of a standard and accepted guideline, some users are inclined to stick with the 2- x 20-watt test requirement, which results in significant cost, size and weight increase for the product. Even when the test requirement is pulled back to a 2- x 2-watt test, for example, the false expectation is for the PIM performance to be 30 dB better, around -140 dBm, based on traditional IP3 analysis as shown in Figure 1. This level is about -173 dBc from the test tone, beyond

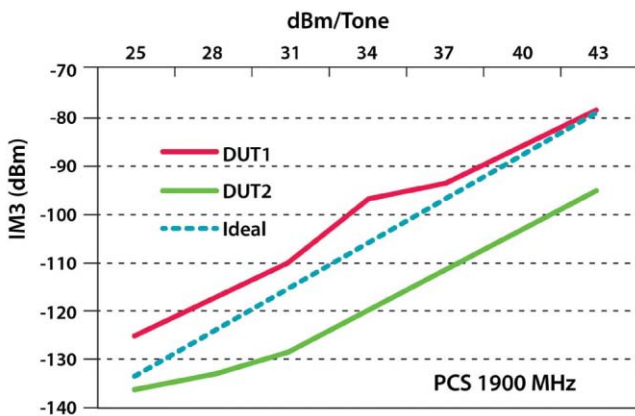


Figure 1. IM3 versus power for two passive devices compared with the ideal situation at 1900 MHz. The two have rather high PIM. Neither follows the 3:1 slope expected of IM3 products. Typical PIM IM3 rises at a rate 1.5-2.5:1. The noise floor is near -140 dBm.

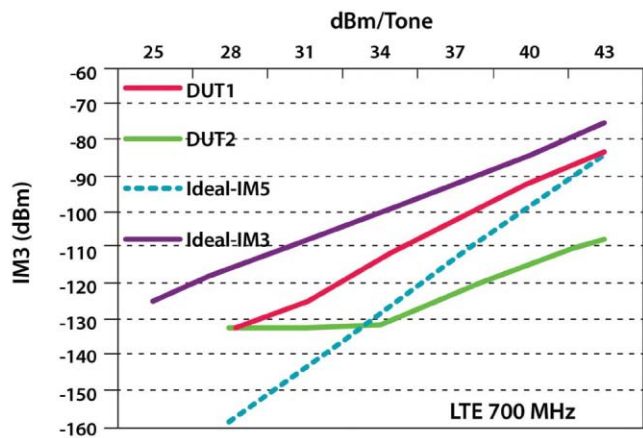


Figure 2. IM5 for PIM plotted as a function test tone power for two different devices under test (DUTs) at 700 MHz. IM5s do not follow a 5:1 slope either. IM3 for one of the devices is also included for reference.

the reliable measurement limit of most of the state-of-the-art PIM test instruments. It gets even worse if the PIM of specific interest is 5th or 7th order. In Figure 2, reducing power down to 1 watt per tone, for example, the actual IM5 measured may be about 20 dB higher than what a simple 5:1 extrapolation would predict. It is possible to lower PIM for a component to such low levels by careful design, numerous iterations and a well-controlled manufacturing process, but it is unlikely to obtain reasonable yield for commercial applications, in addition to being unnecessary for proper system operation. Thus, there is an obvious need to re-think the PIM specifications as the base stations become smaller and power outputs drop lower.

Some of the confusion can be traced directly to the convention of specifying PIM as a relative measure in dBc rather than an absolute power level. In reality, a radio receiver responds to power, not dBc. Sensitivity of the radio is not

affected by PIM or other low-level interference if the absolute levels are much below the sensitivity of the receiver. Because the power levels involved may be substantially lower than 40 watts for many new wireless infrastructure applications, one could then in theory adjust the required dBc value (based on 2 x 20 watts) and establish a new requirement in dBc appropriate for the actual power levels.

Unfortunately, this would be straightforward only if PIM behaved according to a known power law. It does not, as shown in Figures 1 and 2. So although higher power level components and systems are tested with a standard level of 20-watt tones, which has proven to be a good figure of merit, lower power system specs still remain open to interpretation and require a better knowledge of specific operating conditions, receiver sensitivity requirements and PIM test limits. Specifically, for a low-power system or component that cannot be characterized for PIM by using 2- x 20-watt tones for

physical reasons, then one may need to find out what exactly are the corresponding specifications for lower power, such as 2- x 2-watt tones.

One cannot simply extrapolate -153 dBc to -173 dBc based on a theoretical 3rd-order nonlinearity behavior. Third-order intermodulation distortion generated by 2 x 20 watts when PIM is -153 dBc down turns out to be at a -110 dBm level. This is the accepted PIM performance for a standard 2- x 20-watt test. The question is, what is the dBc requirement for low power levels that would generate the same -110 dBm distortion level? For a 2-watt test, this turns out to be -143 dBc.

On the other hand, if we expect an improvement in intermodulation distortion of 30 dB, corresponding to the 10-dB drop in tone power as one would expect in standard 3rd-order behavior, then we would be looking for -140 dBm (-173 dBc) PIM, which happens to be the noise floor of most of the respectable PIM testers available today. In fact,

/ FEATURES /

Test Tones	PIM -153 dBc	PIM -143 dBc	IMD for 1:3 Slope	IMD for 1:2 Slope	PIM -150 dBc
2 x 20 W	-100 dBm IMD	-100 dBm IMD	-100 dBm (ref.)	-110 dBm (ref.)	-107 dBm
2 x 2 W	-120 dBm IMD	-110 dBm IMD	-140 dBm	-130 dBm	-117 dBm
Noise Floor	-140 dBm				

Maximum PIM values expected in dBm for various PIM test power levels and dBc specifications.

absolute PIM measurements much less than -130 dBm or so tend to be highly unrepeatable in general.

In addition, PIM rarely follows a 3:1 slope versus power for 3rd-order components as previously shown. Considering a typical slope range of 1.5 to 2.5:1, one should then expect a PIM level of -125 dBm to -135 dBm. This is a far cry from -140 dBm estimated from basic theory. For a 2-watt test, -117 dBm (-150 dBc) seems to be a reasonable benchmark, and where -110 dBm PIM is found to be transparent to

system operation, then surely a 7-dB improvement should not be a cause for any concern. In practice, there will be many situations where the small cell or remote used may have power levels higher than 2 + 2 watts, or power combining may be in use. Even considering the worst-case scenario of an intermodulation distortion increase with power, -150 dBc guarantees low PIM up to 8 watts of total power.

One word of caution is that in many applications, high-power macros and small cells are collocated and used

together. There is always a risk of low-power elements being exposed to high power levels by accident. It would be a good design practice to have such low-power systems at least be able to tolerate high power levels of 30 watts to 60 watts even with poor PIM performance but without damage.

About the Author

Murat Eron, Ph.D., is vice president of engineering, Wireless Telecom Group, Parsippany, N.J. His email address is meron@wtcom.com.

TWR Lighting, Inc. HARK®

Enlightened Technology®

Visit us at AGL South Conference 2014 or IWCE 2014 Booth # 6015

One Source for LED Lighting & Monitoring



Over 100,000
Worldwide Installations

FCC/FAA Avian
Protection Compliant

↓

Solution

↑

Community friendly
proprietary optics

Lowest total
ownership cost

5 year complete
system warranty

Lowest Power Consumption
<95 Watts Day / < 40Watts Night

Office 713 973 6905 | sales@twrlighting.com | www.twrlighting.com

COMMUNICATIONS TECHNOLOGY FOR:



GOVERNMENT



PUBLIC SAFETY



TRANSPORTATION



UTILITIES



ENTERPRISE

- > See over 350 exhibitors showcasing the latest in communications technology solutions
- > Attend content rich education and training sessions developed by industry experts
- > Network with your peers during dedicated exhibit hall hours and a special reception



INTERNATIONAL WIRELESS COMMUNICATIONS EXPO

CONFERENCE: MARCH 24 - 28, 2014

EXHIBITS: MARCH 26 - 27, 2014

LAS VEGAS CONVENTION CENTER

FREE EXHIBIT HALL ADMISSION

Register at

www.iwceexpo.com/register
and use code H7



Organized By:



In Partnership With:



CONNECT>>>



IWCEEXPO.COM



Fronthaul, CPRI and the Quest for Reliable Networks

Fronthaul reduces the amount of energy consumed for air transport, increases the speed of mobile devices and makes mobile devices operational at more locations.

By Ted Abrams, P.E

Fronthaul is easy to say and simple to hear. Eager to find a catch phrase, a shortcut to express the latest news about the magic of wireless infrastructure, writers latched onto the term fronthaul. A popular use of the term describes Common Public Radio Interface (CPRI) links connecting remote radio units (RRUs) with a baseband unit (BBU).

The CPRI-related definition of

fronthaul is widespread and is on track for publication in future glossaries of telecom terms as it enters the wireless infrastructure industry lexicon. However, from a much earlier time, the graybeards of wireless infrastructure know the term with another meaning. A closer look at some of the technology reveals the earlier meaning, and understanding it will inform wireless professionals

about building the future's reliable networks.

Base radios are stationary. Their function is to exchange signals with mobile radios embedded in wireless devices. Adjacent circuits of the base radio formerly resided in the same cabinet.

Now, various radio circuits can be physically separated and arranged into several pieces, a configuration known as split

architecture. Moreover, an extension cord of significant length can join those pieces.

Extension Cord

CPRI represents the extension cord between radio circuits that permits flexible placement of the parts in various locations. In a different place, on different real estate, each part of the radio can be put in a position chosen to be the most efficient for license rights, energy cost and space rent, for example. Split architecture makes for a remarkable improvement in radio design. Standardizing the specifications for the extension cord to be CPRI is pure genius.

Before split architecture, the parts of the integrated base transceiver system (BTS) were inseparable and were connected with one another with factory-built wiring. The wiring, or harness, an FCC-type-certified bundle of cables and plugs that restricts distances among radio parts, is sacrosanct. Field adjustment of harness length would distort radio functions and would violate FCC rules. Between the base radio and the antenna lies a large gap whose distance is constrained by the physics of the feedline. Larry Fischer and Phil Wala solved the feedline constraint problem with digital technology. Other wireless leaders such as David Cutrer and John Georges figured out diverse solutions for the same purpose: to span the gap between antenna and radio.

Spanning the Gaps

A system of circuitry and

physical media used to span the gap is often a distributed antenna system (DAS). Where the radio includes a new style RRU or where the radio is a monolithic BTS, using fronthaul to span the gaps between the radio and antennas can be an excellent solution, especially in those circumstances involving contracts that favor multiple-operator sharing of real estate and that use cabling placed along the same path.

For a DAS, the host may purchase digital devices (TE Connectivity and, recently, Dali) or analog devices (Solid, Corning, CommScope) to use at remote locations and head-end locations. The DAS devices connect with radio equipment (RRU or BTS) owned by the macro wireless network operators. Depending upon length, fronthaul media for a DAS can be coaxial cable, fiber-optic cable, twisted-pair copper wire, free-space optics, microwave, millimeter wave and, as proven by demonstrations at Cisco Systems, something as simple as strands of a barbed wire fence.

Network Performance Benefits

CPRI cabling between RRUs and BBUs looks like regular fiber-optic network cabling. Inside the cable, at the functional level, the similarity disappears. A CPRI link operates at an equivalent of 2.5 gigabits per second, requiring dark fiber or at least 10 GigE bandwidth. CPRI is an extremely powerful link that can be used with radio building blocks to create a virtual machine with massive wireless service capability. The potential benefit to network performance derived from using a CPRI extension to distant RRUs is

immense and is unmatched by any previous network design. Principles that are baked into Sprint's Network Vision project, prudent guidance of the FirstNet network deployment and Dish Network's spectrum plans (including the company's H-Block play) will drive increased use of split-architecture radio technology with CPRI.

Successful Projects

Feasible business models for multiple-operator DAS fronthaul are well established, and thousands of successful projects are operating. Business models for RRU placement miles away from the BBU are in development. At present, the disconnect between operators and infrastructure developers regarding price points for cabling and real estate is slowing deployment of fronthaul in the CPRI context.

Society benefits from fronthaul in many ways. To name a few, fronthaul reduces the amount of energy consumed for air transport, increases the speed of mobile devices and makes mobile devices operational at more locations. Fronthaul in the CPRI context joins circuits of the radio; fronthaul in the DAS context spans the gap from the radio to antennas. In every case, customers depend upon infrastructure professionals to translate these ideas into reliable networks.

About the Author:

Ted Abrams, P.E., is the principal of Abrams Wireless, which serves clients seeking strategies for profit through wireless infrastructure. His email address is ted@abramswireless.com.



Microwave Field Work With a Portable Spectrum Analyzer

The ultimate tool for microwave engineers is a compact, portable spectrum analyzer that brings the functionality of a mobile laboratory into the field. Antenna alignment becomes quick and easy.

By Vents Lacars

Nearly all activities related to microwave link troubleshooting have involved moving back and forth between miles-long links, climbing towers and using expensive, heavy, inconvenient and complex tools. A cell phone-sized spectrum analyzer

represents a productive alternative for determining the causes of problems and for focusing on their resolution. Given how costly an hour of an installer's service is, using a portable spectrum analyzer would prove efficient in saving time and money.

Many current spectrum analyzers can be used for the same application, but they are complex to operate, they usually cost tens of thousands of dollars and, despite being marketed as mobile, they have an impractical form factor. A better alternative is a

MICROWAVE FIELD WORK



IMAGE 1



IMAGE 2



IMAGE 3



IMAGE 4

handheld spectrum analyzer that is only slightly larger than a cellphone in weight and size, yet is as functional as expensive mobile laboratories.

At SAF Tehnika, extensive knowledge of radio-related processes and issues faced by customers provided a good basis for what started out as an effort to provide

a local solution. The project morphed in unforeseen ways. The idea to create a handheld spectrum analyzer appeared as a remedy to deal with the realities of some developing markets where regulators have almost no power and users are effectively relying on self-planning and frequency allocation. These users constantly need to monitor

Image 1. The standard kit includes connectors that are compatible with most antennas.

Image 2. Look for possible interference using the Max Hold feature.

Image 3. Verify the polarity of the transmitting radio by just pointing the horn antenna in the direction of the transmitting antenna. Also try a different polarity by rotating the connector by 90 degrees to detect right polarization.

Image 4. Adjust the Antenna using the Spectrum Compact spectrum analyzer for a cross polarization interference cancellation (XPIC) application.

the frequency channels that are in use or to be used.

The small spectrum analyzer, Spectrum Compact, efficiently performs radio parameter verification, antenna alignment, interference and multipath detection, TX and RX power measurements and link troubleshooting, and saves the spectrum curves for reports and later analysis. A resistive touch screen allows the engineer to wear gloves to manipulate the device. High sensitivity (-105 dBm) and a low noise floor enable field engineers to detect exceptionally weak signals — much better than the spectrum analyzers built into the microwave radio that may have -80 dBm sensitivity.

Single Tool for Any Situation

A spectrum analyzer is a useful tool during the entire life cycle of a microwave link, from site survey to radio installation, site acceptance and, finally, maintenance and troubleshooting. It performs a multitude of tasks: searching free channels, interference detection, verification of the radio

/ FEATURES /

configuration, antenna adjustment, cross-polarization adjustment and verification, comparative measurements of received signal power, radio operation measurements, inspection of the radio-antenna connection and replacement of already installed antennas.

During the planning stage, it is possible to perform spectrum scans to determine if the chosen frequency and channel are available. This is especially important for license-free frequency bands (17-GHz and 24-GHz bands, depending on the region) and area license frequency

bands such as 28 GHz and 38 GHz, the LMDS spectrum.

Until now, the most widely used device for link installation and antenna adjustment has been the multimeter. A multimeter is affordable and allows a relatively simple antenna adjustment. Unfortunately,

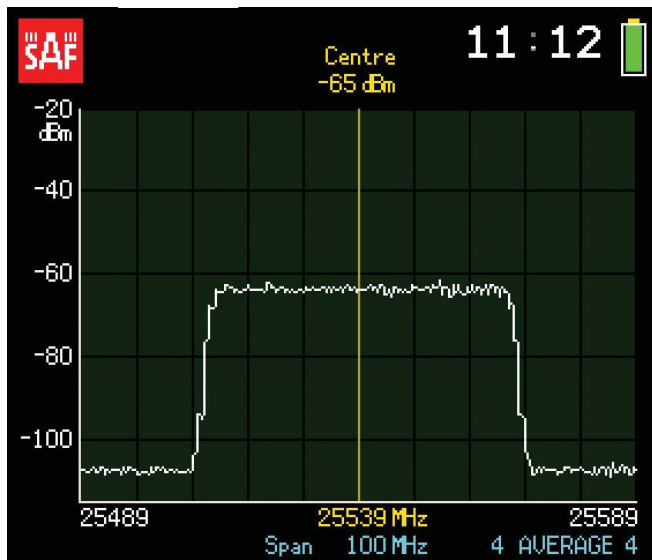


Figure 1. A spectrum scan showing a normal signal. The channel bandwidth is 56MHz; the signal strength in the center is -65 dBm.

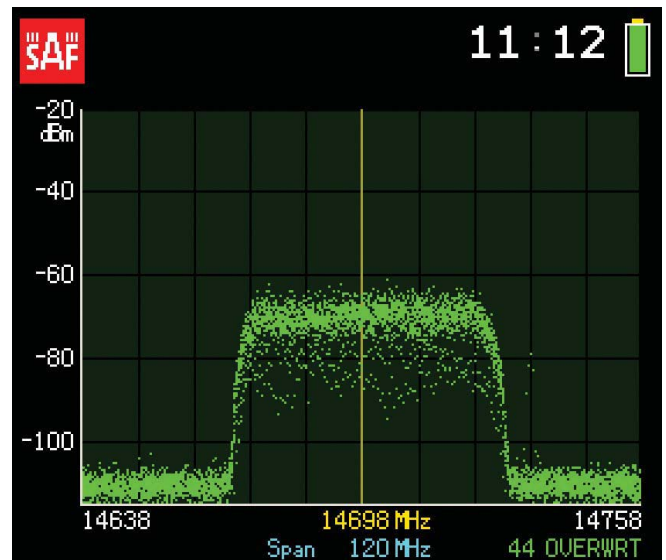


Figure 2. In real-time mode, the compact spectrum analyzer creates layers of scans to reveal multipath interference. This image shows 44 overlaid spectrum scans. The scattered dots indicate that the signal is being influenced by multipath.

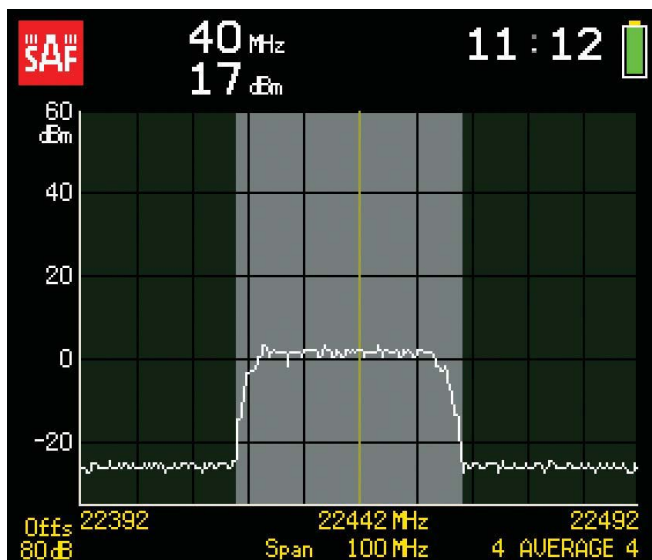


Figure 3. Power-in-band mode allows measuring absolute signal power. The gray area shows the channel bandwidth (40 MHz) with absolute

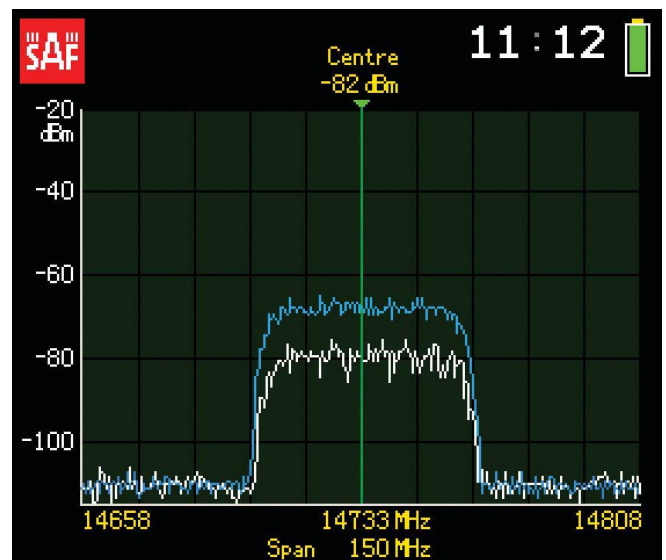


Figure 4. The Max Hold feature fixates the blue line in the received signal peak position so you can adjust the antenna accordingly.

MICROWAVE FIELD WORK

Spectrum Analyzer Advantage Compared with a Multimeter

Conventional antenna alignment was done by using a multimeter and usually took at least an hour depending on the site topology. The receiving antenna had to be aligned by using a multimeter, which has a few significant drawbacks compared with the antenna alignment using the SAF Tehnika Spectrum Compact spectrum analyzer.

Multimeter

- With a multimeter, the installer doesn't see the actual signal and thus is unable to determine its quality. It is impossible to make sure whether the received signal actually comes from your transmitting radio or from other sources.
- Possible multiple interferences cannot be detected.
- A multimeter's nonlinear RSSI scale makes understanding the actual Rx level more difficult.
- With a multimeter, it is possible to miss the signal peak level, thus increasing the risk of aligning the antenna to the side lobe.
- Multimeter measurements are limited to the maximum capacity of the radio receivers's Rx scale sensitivity, thus making it impossible to spot weaker signals. For example, the maximum signal level the radio can indicate is -90 dBm, while the spectrum analyzer can spot signals at levels as low as -105 dBm.

- On towers located near powerful transmitters, multimeter readings can be influenced by unwanted electromagnetic fields.
- Conventional antenna alignment methods do not allow saving spectrum scans for future reference and future troubleshooting.

Spectrum Analyzer

- When using the spectrum analyzer, you can align the antenna in less than 10 minutes.
- Program the frequency at which your radio is transmitting.
- Adjust the span of resolution.
- Verify the polarity of the transmitting radio by just pointing the waveguide adapter in the direction of the transmitting antenna. Also try a different polarity by rotating the connector by 90 degrees to detect right polarization. With the spectrum analyzer sensitivity of -105 dBm, even if the link is tens of miles away, you will still be able to pick up signal with this method.
- Attach the spectrum analyzer

to the antenna. Go to Trace mode and enable the Max Hold feature, which adds a blue line to the graph. It will indicate and fixate the strongest signal the spectrum analyzer has seen along the configured span.

- Next, loosen the antenna for horizontal adjustment. As you slowly move the antenna, the spectrum curve on the screen is sweeping in real time. You can actually see the signal reaching the main lobe. All you need to do is to tighten the antenna in a position where the spectrum analyzer has fixated the signal maximum, and then make the vertical adjustment.
- Perform the same steps during the vertical alignment and you will quickly find the main lobe and adjust the antenna into a position where it receives the strongest signal, meaning you have successfully aligned it to the maximum possible precision.
- Hit the Save button, which will save the screen for further analysis. And that is all you have to do. Alignment is finished in just a few minutes.

/ FEATURES /

it has shortcomings: There are situations in which it is difficult to adjust an antenna and locate the incoming radio signal peak while using a multimeter because of the poor receiver sensitivity of the microwave radio. The process tends

to be time-consuming, the multimeter's readings could be affected by unwanted electromagnetic fields, and the conversion of volts to dBm requires using conversion tables provided by manufacturers. Less-experienced engineers could

accidentally adjust the antenna to the sidelobe. In contrast, a spectrum analyzer makes it easy to adjust the antenna with maximum precision in less than 10 minutes.

Connected with the antenna and with the initial adjustments made, a spectrum analyzer visualizes the changes in the detected signal amplitude or strength. It finds the point where the received signal is strongest and adjusts the antenna accordingly, avoiding the sidelobe. During the antenna installation process, it is also possible to use the spectrum analyzer as a power and bandwidth meter. The analyzer can be attached to almost any manufacturer's antenna using standard flange waveguide adapters.

A multimeter is a fine tool for antenna installation and adjustment, but troubleshooting usually turns out to be a guessing game because there is no universal system for determining the possible causes for the encountered problems, to say nothing of situations in which an engineer has to climb a tower only to verify that the radio is functioning at all.

Checking whether the radio is turned on and operating, determining the transmitter's bandwidth and frequency, and scanning for interference can now be done from ground level with the spectrum analyzer. It also aids in inspecting radio-antenna connections. This advanced functionality is a significant time-saver because it allows the user to quickly narrow down the range of possible problems and their causes.

For site maintenance purposes,

WE UNDERSTAND EVERY TOWER OWNER FACES UNIQUE RISKS.



BB&T – Atlantic Risk Management is a large, independent insurance agency and an expert in protecting tower owners from unexpected risks. We offer complete, competitively priced programs endorsed by PCIA and tailored to suit your specific exposures, including: self-supporting, guyed or monopole towers; support equipment; shelters and fencing; plus general liability, business auto, workers' compensation, umbrella and more.

Find out why we protect more tower owners than any other agency. Call 410-480-4413 or 410-480-4423, visit www.bbt.com or email David Saul at dsaul@bbandt.com or Kimberly Calhoun at kimberly.calhoun@bbandt.com



Insurance Services
Global Resources — Client Focused



©2012 Branch Banking and Trust Company.

Insurance.BBT.com

MICROWAVE FIELD WORK

the analyzer user can save spectrum scans, which could then later be compared with current measurements in order to detect possible changes in radio performance. This is already a common practice of several large telecommunication companies. When saving a spectrum scan, the device also makes a time stamp and allows saving the coordinates using a GPS logger. By using the spectrum analyzer's PC application, the gathered data later can be viewed in Google Maps.

Most national regulators use expensive and bulky equipment, including mobile laboratories and portable spectrum analyzers costing hundreds of thousands of dollars. However, their daily tasks of determining the presence of interferences and their causes, tracking license-free frequency and channel usage, as well as determining frequencies and bandwidths of installed radios could be efficiently performed with a spectrum analyzer in hand.

The Future Is Near

Good ideas can easily be ruined by poor execution; many ideas do not even see the light of day because of doubts and insecurities. But fortune favors the bold. Apple completely changed the cell phone market in 2007, proving with the iPhone that the future belongs to touchscreen technology. Similarly, spectrum analyzers will soon become affordable and indispensable tools, popular among engineers and installers. There will always be situations in which people opt for different methods and tools

based on different considerations. A test equipment manufacturer's task then is to bring these situations to a minimum and create products that people would increasingly choose to use for the widest range of applications.

About the Author:

Vents Lacars is vice president at SAF Tehnika. The company manufactures a spectrum analyzer, called the Spectrum Compact, described in the article. Visit saftehnika.com.

GRADUATE UP TO A SMARTER LED LIGHT.



* Patents Pending



Here's another brilliant idea from Hughey & Phillips: The **HORIZON™ LED** Series. Recipient of a 2013 CTIA Emerging Technology Award, it's simply the smartest LED in its class. With features like WIFI control and monitoring, GPS sync, built-in self-testing and precision microprocessor control. This lightweight unit (under 20 pounds) is also easy to install, can be retrofitted using existing cabling and is fully field serviceable. So graduate up to the smarter **HORIZON™** Series LED with your choice of red (L-864), white (L-865) or dual (L-864/865). Make the smart call to Hughey & Phillips at 877.285.4466 or visit hugheyandphillips.com.

HORIZON™ SMART LED

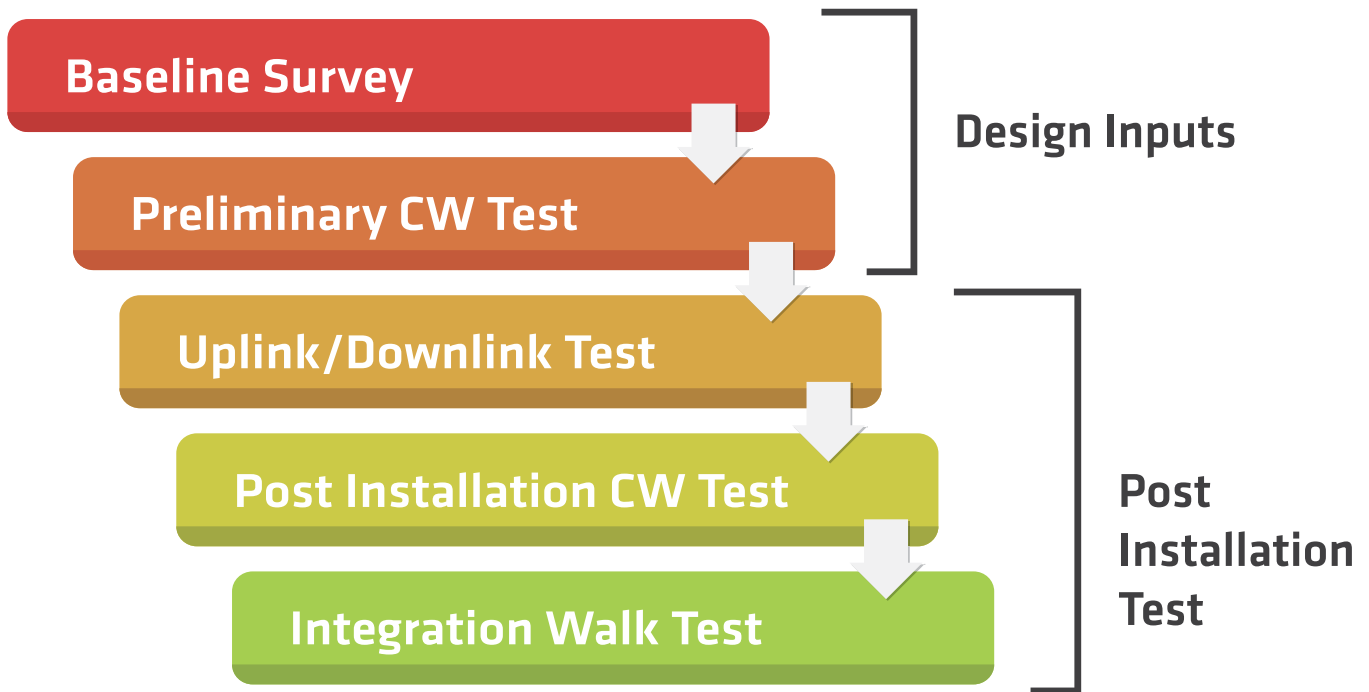
- WIFI control available
- Field serviceable
- Lightweight (under 20 lbs.)
- GPS sync available
- Built-in self-testing
- Microprocessor control
- Retrofit with existing cable

HUGHEY



PHILLIPS

HUGHEY & PHILLIPS • 877.285.4466 • HUGHEYANDPHILLIPS.COM



DAS Testing for Maximizing Quality of Service

DAS networks require a multiphased testing and optimization approach for successful deployment. Use state-of-the-art test, measurement and design tools with an emphasis on DAS and small cell systems.

By James J. Zik, P.E., and Chintan Fafadia

A growing ecosystem of applications is driving insatiable demand for mobile bandwidth, led by video streaming. People upload more than 144,000 hours of YouTube videos every day. Video constitutes nearly 80 percent of all mobile traffic. Meanwhile, radio spectrum remains a limited resource. As a result, mobile

network operators face a massive bandwidth demand in the midst of a spectrum crunch. The best solution is to optimize the data throughput capacity of existing spectrum.

However, optimizing existing macro networks is not enough to meet consumer demand. With a high-level of consumer acceptance of smartphones and tablets, most

of the industrialized world's mobile traffic has moved indoors. Consequently, mobile network operators face challenges in their efforts to ensure a high quality of service (QoS) for both data and nascent voice over Long Term Evolution (VoLTE) services. Customers expect both coverage and high data capacity for video delivery along with

high-quality voice services.

With traffic moving into buildings, mobile operators are deploying innovative, smart solutions such as distributed antenna system (DAS) networks and small cells to deliver the QoS that customers demand. Signals from outdoor macrocells may penetrate buildings to a limited degree, delivering limited wireless network capacity. Small cells and DAS can solve the penetration and capacity problems by bringing the base station right to the user. Because a DAS is a multimillion-dollar investment, it has to be planned to meet future capacity needs and to be compatible with technologies such as VoLTE, which places serious performance requirements on mobile networks.

DAS networks should also be tested and deployed carefully and efficiently. To avoid costly future upgrades, it is best to maximize the throughput of the LTE network by deploying multiple-input, multiple-output (MIMO) communications from the onset. In addition, venue owners and operators always limit installation and testing time. Hence, the DAS installers have to execute deployment flawlessly, using the right tools the first time around and testing the installation thoroughly to avoid future problems. By employing a multiphased DAS testing and optimization approach, wireless network operators can ensure timely deployments and maximize the use of their limited spectrum resources.

DAS testing and optimization are broken up into phases during the DAS planning and installation life cycle. Engineers use the baseline survey, which maps current RF

propagation, and the preliminary continuous-wave (CW) test, which determines the RF propagation characteristics of the structure, as design inputs for the DAS or small cell system. Once the system is designed and installed, a series of post-installation tests are performed. These include the uplink/downlink test to verify the cable connectivity and equipment setup, the post-installation CW test, which tests antennas and coverage, and the integration walk test, which is the final acceptance test. Following this methodical testing approach during the planning, design, installation and commissioning phases of DAS is the most effective tactic that operators can use to ensure that an in-building mobile network is optimized and meets design expectations in a timely manner.

Baseline Survey

The baseline survey provides the foundation for successfully deploying and operating a DAS network. It identifies existing macrocell coverage and quality, and creates baseline inputs for DAS design. The baseline survey accurately maps the current RF landscape for deep analysis. It must be done at multiple points of entry, such as multiple floors of the building or multiple levels as in a stadium. It detects and locates in-building signal dominance, pinpointing which macrocells might be problematic to the DAS, and it identifies potential neighbor list candidates from the macrocell to the DAS. The required engineering tools for the baseline survey are high-performance scanning receivers with high dynamic range to accurately identify in-building signal



Figure 1. Preliminary CW test setup.

penetration and that also have the ability to test multiple operators simultaneously to eliminate repetitive walk tests. The baseline survey provides the macrocell coverage parameters for in-building design tools, thus enabling a comprehensive and proper design of the DAS.

Preliminary CW Test

The preliminary CW test follows the baseline survey. It uses a CW transmitter as shown in Figure 1. The test determines the venue's RF propagation characteristics, including signals passing between floors.

The preliminary CW test identifies the complete propagation profile for antennas intended for deployment. The engineers place the antennas in the design locations to quantify the RF propagation. The test also determines soft hand-off locations and percentages, and defines any overlap

/ FEATURES /

between multiple CW transmission points. The design goal is to prevent 95 percent of the area from falling into a soft hand-off condition. Soft hand-off can severely reduce network performance because of handsets handing off back and forth to different sectors.

Engineers use the results of the preliminary CW test to modify the in-building design and possibly the antennas, if necessary. The test also requires accurate scanning measurements, such as those

placement and antenna type, which in turn affect network performance.

Uplink/Downlink Test

The uplink/downlink (UL/DL) test is the first of the post-DAS installation tests. It verifies RF cabling, infrastructure equipment, optical fiber connections and losses, and enables the installer to potentially set UL/DL gains. The purpose of this test is to bring up the equipment and to verify end-to-end connectivity. Engineers perform the test



PCTEL RF Solutions SeeGull, IBflex, EXflex, MX and EX+ scanning receivers.

equipment and verifies equipment operation before the engineers perform the post-installation CW test.

Post-installation CW Test

The post-installation CW test verifies proper installation of the antennas and coax cable, downlink coverage, power settings and LTE transmit diversity/MIMO antenna paths. LTE employs various transmission modes including transmit diversity and MIMO signals on multiple paths. Verifying signals on each path is imperative in order to ensure maximum throughput of the LTE DAS system. The post-installation CW test uses a CW transmitter and sends a signal into the DAS equipment. Engineers use a high-performance scanning receiver to detect and map the signal emitted from the

The design goal is to prevent 95 percent of the area from falling into a soft hand-off condition. Soft hand-off can severely reduce network performance because of handsets handing off back and forth to different sectors.

collected by scanning receivers with high dynamic range and a CW transmitter. Figure 2 illustrates how improper location and antenna tilt or azimuth can lead to sectors being in a soft hand-off condition. Adjusting location, tilt and even the antenna type can alleviate the soft hand-off condition. Consequently, the preliminary CW test is critical because the test results determine antenna

in both directions, from the DAS equipment to the remote unit and in the opposite direction. The test equipment they use in this phase includes CW transmitters and a spectrum analyzer, as illustrated in Figure 3. This test universally finds problems, which include unconnected or cross-connected optical fiber or cables, dirty optical fiber or defective componentry. The test debugs

DAS TESTING

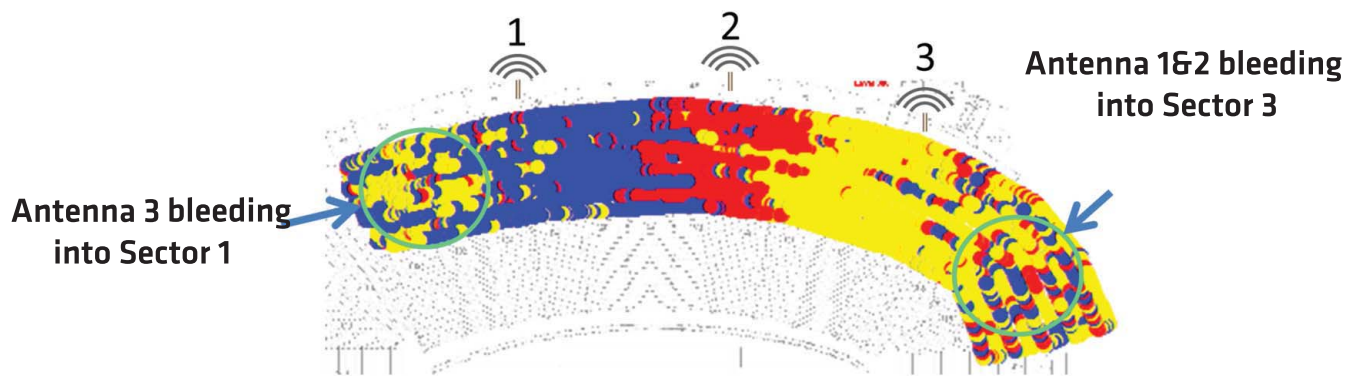


Figure 2. Undesirable RF overlap leading to a soft hand-off condition.

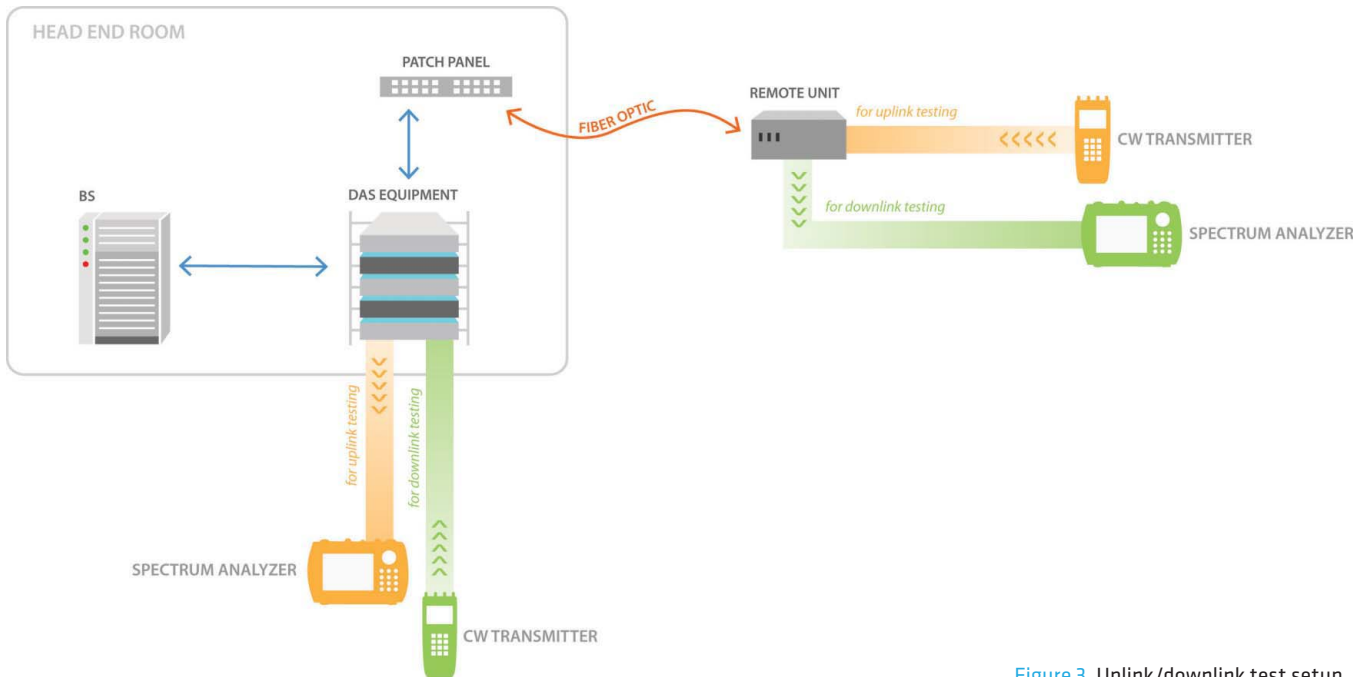


Figure 3. Uplink/downlink test setup.

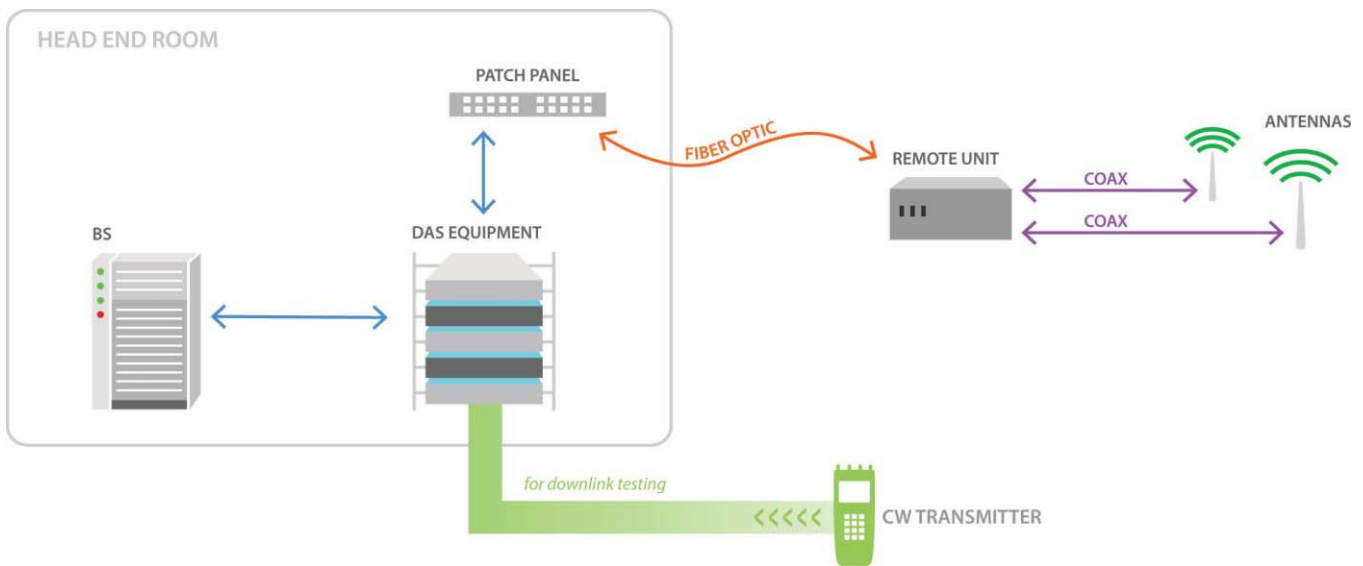


Figure 4. Post-installation CW test setup.

antennas (see Figure 4). As with the preliminary CW test, the post-installation CW test is a walk test. Engineers adjust DAS system parameters including uplink and downlink gains during this phase, along with antenna tilt and azimuth settings. The test provides crucial data on RF propagation inside the building using the newly installed DAS equipment. The test optimizes

RF propagation before the integration walk test and may require multiple iterations to achieve the desired result.

System optimization begins during the post-installation CW test because the test transmits real signals on the DAS. Remember, optimization is not a theoretical exercise; it drives competitiveness for the mobile operator. Unlike macrocell

optimization that engineers perform after the macrocell is commissioned and is running live traffic, DAS networks require optimization during the post-installation phases because access to the building may be extremely limited or prohibited once the system is carrying live traffic.

Integration Walk Test

The final phase of DAS testing is

/ FEATURES /

UE

KPI	MINIMUM	MAXIMUM	AVERAGE	ST. DEV.	COUNT
RSRP (dBm)	-102.13	-70.66	-86	5.84	986
RSRQ (dB)	-21	-6.5	-10.1	2.4	986
SNR (dB)	-21.8	29.7	11.75	10.4	986
App Throughput DL (kbits/s)	28.8	8688.75	4300	860.52	907

SCANNER

KPI	MINIMUM	MAXIMUM	AVERAGE	ST. DEV.	COUNT
RSRP (dBm)	-103.9	-63.81	-83.4	6.25	8512
RSRQ (dB)	-18.1	-6.5	-8.54	1.9	8512
SNR (dB)	-7.1	40	19.25	11.78	8512

EVENT	SHORT CALL	LONG CALL
Call Attempts	335	10
Normal Terminations	317	0
Access Failures	18	3
Setup Failures	0	0
Dropped Calls	0	0
Unclassified	0	0
EOF Calls	3	6

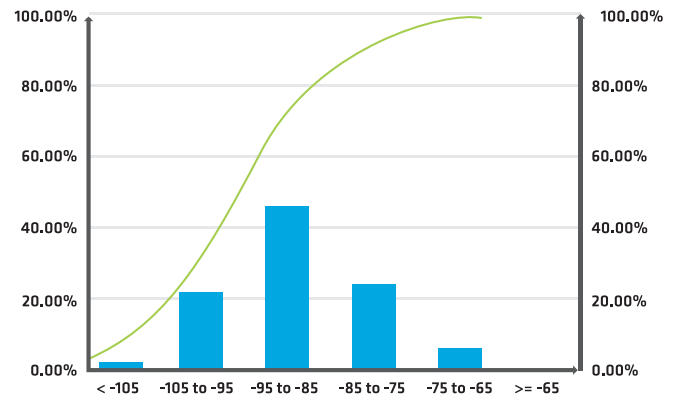


Figure 5. LTE measurement report.

the integration walk test. The test verifies system performance to design specifications including key performance indicators (KPIs) for coverage, quality, neighbor lists, soft hand-off percentages, up-link performance based on user equipment (UE) transmit power, and MIMO communications paths and throughput. In addition, if required, the test verifies macrocell power adjustments from a baseline survey. Engineers use actual cellular test traffic during this phase. The test equipment required for this phase includes both a high-performance scanning receiver for accurate engineering data and UEs to qualify the user experience.

MIMO communications is often a key element of LTE DAS networks, and it provides the bulk of LTE's peak throughput gains when compared with other technologies.

However, MIMO communications gains can only be realized on a fully optimized network to maximize capacity in a spectrum-limited world. Because MIMO communi-

provided by a MIMO-enabled LTE network. Therefore, optimizing an LTE network for MIMO communications requires a new set of scanning receiver parameters, including

PCTEL RF Solutions specializes in the design, optimization and testing of today's wireless communications networks...

cations is expensive and requires double the equipment for 2x2 MIMO deployments, it is critical to test the MIMO communications to ensure it is operating at peak capacity to maximize the return on the investment in a DAS LTE system.

MIMO communications optimization requires a different approach to traditional network optimization, with assessment of multipath conditions playing a key role in determining the potential throughput

multipath signal-to-interference-plus-noise ratio (SINR) measurements, condition number, channel quality indicator and throughput for all key MIMO transmission modes. Operators can use the knowledge gained from analyzing scanning receiver MIMO communications data to improve conditions in the current network through antenna and base station adjustments. Scanning receiver data can also be used to evaluate

the performance of UEs and eNodeB MIMO communications mode selection.

Acceptance walk test reports can include signal and KPI measurements along with the previously mentioned MIMO parameters. All technologies are tested in the DAS system, which can include, LTE, WCDMA, GSM, CDMA and EVDO. Figure 5 shows some measurements included in a typical LTE test report.

Time-saving steps for DAS deployments begin with optimizing RF propagation, followed by enhancing other characteristics such as soft hand-off optimization. A DAS system operating at peak performance requires multiple iterations of testing to obtain the best possible spectral efficiency and to meet the QoS that consumers have come to expect. Operators that maximize the performance of their LTE networks will minimize the amount of infrastructure investment and provide a clear competitive advantage in price, QoS and customer retention.

DAS networks require a multi-phased testing and optimization approach using the proper tools for successful deployment. PCTEL RF Solutions specializes in the design, optimization and testing of today's wireless communications networks, including products and services for both outdoor and in-building DAS networks. The company's engineering services team specializes in wireless network testing, optimization, design, integration, consulting and commissioning services. The team uses state-of-the-art test, measurement and design tools with an emphasis on DAS and small cell systems.

ABOUT THE AUTHORS:

James J. Zik, P.E., and Chintan Fafadia are senior product marketing managers at PCTEL's RF Solutions division. The company makes SeeGull scanning receivers, including models IBflex, MX, EXflex and EX, examples of the type of high-performance scanning receiver

with high dynamic range the authors recommend for base survey, preliminary CW, post-installation CW testing and the integration walk test. The company also provides SeeHawk drive and walk test software, and interference management solutions. The Authors can be reached at james.zik@pctel.com and chintan.fafadia@pctel.com.

Your Complete Choice for EVERYTHING WIRELESS

Get what you need from the names you trust

- Microflect™ heavy-duty lattice towers
- PiRod® solid-rod lattice towers
- Valmont® monopoles & DAS structures
- SitePro 1® wireless cell site components & equipment
- Tower analysis for retrofits & upgrades
- In-house, licensed professional engineers in all 50 states

valmont STRUCTURES

Valmont Structures
towers@valmont.com or
www.valmont-towers.com



Where's My Site: The Mystery of Magnetic Declination Explained

Resolving magnetic declination is only one aspect of installing and aligning microwave antennas, but it is a critical aspect. Here's how to compensate for the difference between true north and magnetic north

By Andy Singer

Magnetic declination is essential to understand for anyone tasked with aligning microwave antennas. Magnetic declination can have a serious effect on the ease of locating one site from a position at another site or location, yet it is a subject that

is not widely understood. Learning what magnetic declination is and how it affects locating positions at a distance helps to simplify antenna alignment and makes alignment steps more efficient.

Most maps are laid out so the point in the northern hemisphere

where all longitudinal lines meet is toward the top. The point is called true north, map north or geographic north. Magnetic north, the direction in the northern hemisphere toward which compasses point, is not the same as true north. Earth is like a giant magnet with two poles. A

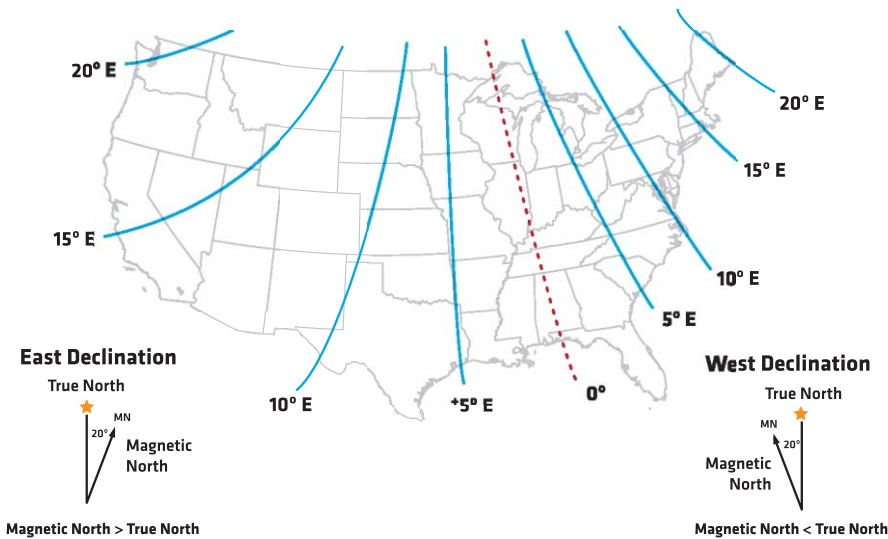


Figure 1. The lines of recent magnetic declination in the United States. Magnetic declination varies from as much as 20 degrees in parts of Maine to 0 degrees in Illinois to more than 20 degrees in Washington state. A technician attempting to align a microwave antenna without taking magnetic declination into account may never find the target site because it will be so far from where it is expected to be.

compass aligns itself with Earth's magnetic poles. Magnetic north doesn't hold still. Because of movement in the Earth's molten core, magnetic north is moving toward the north-northwest.

From any given point, the angular difference in direction between true north and magnetic north is called the magnetic declination. Figure 1 shows the lines of recent

magnetic declination in the United States. Magnetic declination varies from as much as 20 degrees in parts of Maine to 0 degrees in Illinois to more than 20 degrees in Washington state.

The movement of the magnetic north pole is rapid enough to shift the magnetic declination about 1 degree to the west every year. Thus, it is important to use a recent

magnetic declination map for accuracy in compensating for the declination.

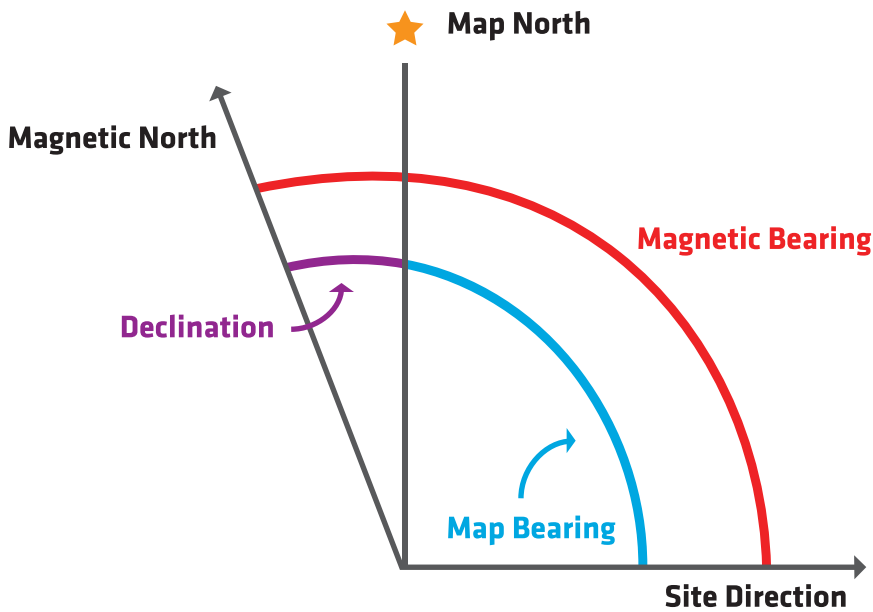
The difference between using true north versus magnetic north when aligning antennas can be significant, depending on the amount of magnetic declination for a given location. How much difference can it make? Table 1 shows the calculated potential error in distance versus the magnetic declination. If the magnetic declination is 1 degree, the resulting error in antenna alignment may not be significant. But where magnetic declination is 10 degrees, an antenna aligned with the use of a magnetic compass, without correcting for the declination, could wind up pointing 9,000 feet to the side of an intended target site 10 miles away. The error worsens as the magnetic declination increases. A technician attempting to align a microwave antenna without taking magnetic declination into account may never find the target site because it will be so far from where it is expected to be.

A map bearing, which is used for locating sites on a map, is a horizontal angle measured clockwise from north to some point on the map or in the real world. The compass is the tool most commonly utilized in the field to take a bearing measurement. You can think of true north as 12 o'clock on a clock face and any bearing clockwise, to the right, such as 2



When bearings are expressed in degrees, north is defined as 0 degrees, and the number of degrees begins rising with bearings that lie to the west of north, moving 360 degrees through east, south, west and back to north at 0 degrees.

West Declination



o'clock, is greater than true north. Any bearing to the left of true north, such as 11 o'clock, would be less than true north. Keep in mind that map north is not typically the same direction as magnetic north. Thus, when you take a bearing with a compass, it's a magnetic bearing.

So far, we have determined the difference between true north (map north) and magnetic north and how much of an effect the difference can have on determining a site location. This difference becomes critical when trying to align a pair of microwave antennas at locations miles distant from each other. How do we then calculate this difference and make adjustments for it?

Figure 2 shows the calculations for a west declination adjustment where

Figure 2. A calculation for a west declination corrects for the compass direction of magnetic north to indicate the desired direction toward a target microwave antenna.

MAGNETIC DECLINATION



Declination or Degree Off	Error Off Target at 10 Miles
1	920 feet
5	4,600 feet
10	9,170 feet

Table 1. The greater the declination or degrees off from true north, the greater the error off target for antenna alignment – in this example, at 10 miles.

magnetic north is west of true north. In this case, if you are using your map and taking a map bearing, you would subtract the declination from the compass (magnetic) bearing.

Thus, map bearing — magnetic bearing — declination. Note this is for a west declination. If you are on the West Coast of the United States,

the declination is east (your compass points east toward the 0-degree declination line), and the equation would be the opposite such that map bearing = magnetic bearing + declination.

Although magnetic declination is only one aspect of installing and aligning antennas, it is a critical aspect.

About the Author:

Andy Singer, president and CEO of Singer Development, helped develop the remote tilt antenna concept. His company offers a training course. His email is andy.singer@singerexecutivedevelopment.com.

BECAUSE of CAMP...®

"I gained self-confidence."

Justin Chambers
Actor

Camp — It's good for life.

american **CAMP** association®

www.CampParents.org • 1-800-428-CAMP

The benefits of camp extend beyond fun — offering opportunities, inspiring passions, and broadening horizons. The possibilities are endless.

MAGNETIC DECLINATION

Product Showcase

Antennas

LOW-PIM DAS IN-BUILDING ANTENNAS

Pulse Electronics offers three low-PIM DAS in-building, ceiling-mount omnidirectional antennas. The PIMinators antenna line features a PIM spec of -155 dBc at 2×20 watts, resulting in fewer dropped calls and higher data rates. The DASLTE500NF, DASLTENF and DASLTEDIN antennas have a diameter of 8.27 inches with a height of 4.81 inches. The DASLTE500NF antenna has a 500-millimeter plenum-rated coaxial pigtail with an N female connector, the DASLTENF antenna has an N female connector, and the DASLTEDIN has a female 7/16 DIN connector for easy connection with DAS networks. These antennas operate in the 698-MHz through 5900-MHz bands. www.pulseelectronics.com

ANTENNAS FOR TERRESTRIAL MICROWAVE POINT-TO-POINT APPLICATIONS

Radio Waves' ProLine antenna series is for terrestrial microwave point-to-point applications, including interconnection of PCS, GSM and cellular base stations. The series consists of single- or dual-polarized standard parabolic (SP series) and high-performance (HP series) antennas. With versions for standard frequency bands from 2 GHz to 40 GHz, the series includes antennas with diameters of 1 foot, 1.5 feet, 3 feet, 4 feet and 6 feet. The antennas are certified by CETECOM

ICT Services GmbH to European ETSI standards. They comply with FCC and Industry Canada regulations while meeting or exceeding EIA-195C and EIA-222E standards. www.radiowavesinc.com



ANTENNA ALIGNMENT TOOL WITH GPS

3ZTeleco's 3Z RF antenna aligner tool is designed to handle both panel antennas and point-to-point microwave systems. As one of the most-compact GPS antenna alignment tools, it incorporates GPS technology to calculate precise azimuth, tilt, roll and AGL measurements for a multitude of directional antenna systems. A universal antenna mounting system allows for quick antenna attachment and release. The tool is user friendly and easy to transport up any tower. www.3ztelecom.com

DAS IN-BUILDING ANTENNAS

Galtronics' Pear DAS in-building antenna line minimizes the visible size of the antenna or even conceals it from public view. The low-profile indoor antennas have been tested to operate above hard ceilings and

drop ceilings. The antenna line offers several options, including a through-ceiling mount (for the Pear S4935 and M4969 antennas), which conceals the antenna with only the nose protruding through the ceiling; an above-ceiling mount (for Pear M4772, M4969 and S4935 antennas), which conceals the antenna from view; and a flush hard-ceiling mount, where the antenna is attached to a round plastic plate that is the only visible part of the antenna after installation. www.galtronics.com



ANTENNA PORTFOLIO FOR PRESENT, FUTURE LTE

CommScope has expanded its UltraBand ultra-wideband, outdoor macrosite antenna portfolio to help wireless operators deploy LTE and to prepare for future spectrum and technology roll outs. The antenna portfolio increases the flexibility of operators to support present and future multiple frequency bands with potentially only one antenna per sector. Meanwhile, the product supports legacy 2G and 3G networks. The portfolio includes more models of the Argus UltraBand base station antenna system, including the version with internal smart bias

Register by
February 21, 2014
to take advantage
of Early Bird
savings!

CCA GLOBAL EXPO
Competitive Carriers Association
Rural • Regional • Nationwide®

ENGAGE **CONNECT** **LEARN**

Castroville San Antonio La Vernia

CCA

March 25-28, 2014 • Grand Hyatt San Antonio
Register today at www.ccaexpo.org



FROM START TO SIGNALTM

The Premier Source for Regulatory Compliance

The national Waterford Consultants team is committed to guiding and directing your projects from start to signal. Our firm understands regulatory requirements and are experts in simplifying your compliance challenges.

AM Screening & Detuning

- Fast and efficient evaluation
- Free bulk screening

RF Exposure Analysis

- Expert on-site or theoretical studies

Intermodulation Studies

- Evaluate potential interference before a problem arises

Site Services

- Tower and site mapping
- Structural analysis

FAA Certification & Filing

- 1A / 2C
- 7460-1 / 7460-2

RF Safety Training

- Corporate / occupational training



waterfordconsultants.com

703.596.1022

tee that received the Network Product Guide's 2013 Gold Award for innovation. The expanded antenna portfolio increases an operator's ability to support a variety of site configurations with multiple port options and independent beam optimization. www.commscope.com

SOFTWARE MODULES FOR LTE AND WIMAX BASE STATIONS

ArrayComm offers A-MAS software modules that deliver differentiating performance for LTE and WiMAX base stations from small-to-large-cell solutions. A-MAS modules are designed to be quickly integrated into most base station architectures to provide rapid time to market and cost-effective performance. Base station antenna signals are precisely weighted to optimize the combined signal-to-noise ratio at the target subscriber device. Beamforming can be combined with adaptive interference cancellation and MIMO transmission for additional performance gains. www.arraycomm.com



4G BASE STATION ANTENNAS FOR LTE AND WIMAX

Alpha Wireless 4G base station antennas for LTE and WiMAX optimize radiation patterns in order to improve overall network performance. Approved to ISO9001:2008, the antenna technology is designed to minimize unwanted radiation that can cause interference in neighboring cells, leading to reduced sector capacity and inferior data transfer speeds. The antennas also feature remote electrical tilt (RET) options; AISG

2.0 compliance; 60-, 90- and 120- degree beam widths; and quad-port options. www.alphaantennas.com



LOW-PROFILE 4G LTE WIDEBAND ANTENNA

The BMLPVMB/LTE low-profile vertical antenna from **Pctel** provides multiband pattern coverage for mobile or fixed applications operating in the 698-MHz to 2700-MHz band to cover LTE frequencies with minimum loss and no tuning required. The antenna features a compact housing that makes it suitable for indoor or outdoor applications requiring minimum visibility. www.antenna.pctel.com

- 58.....Advantage Funding
- 28.....AGL Regional Conferences
- 29.....AGL Regional Conferences
- 58.....Allstate Tower
- 26.....Alltec
- 53.....American Camp Association
- 27.....Anritsu
- 42.....BB&T – Atlantic Risk Management
- 15.....Black & Veatch
- 58.....BuzB
- 20.....Charles Industries
- 18.....Clearfield
- 55.....Competitive Carriers Association
- 58.....ComSites West
- 21.....Copper Mountain Technologies

- 58.....D&L Specialties
- 26.....DeltaNode
- 52.....FEMA
- 23.....FieldSense
- C3*.....GME Supply
- 43.....Hughey & Phillips
- 35.....International Wireless Expo
- C2*.....National Association of Tower Erectors
- 14.....Pepero
- 19.....Radio Frequency Systems
- 13.....Sabre Industries
- C4*.....SBA Communications
- 58.....Shulman Rogers
- 58.....Slatercom – WCD
- 22.....Southwire

- 05.....Subcarrier Communications
- 11.....Sunsight Instruments
- 20.....Telewave
- 58.....Thermo Bond Buildings
- 17.....Times Microwave Systems
- 24.....TowerXchange
- 07.....Trojan Battery
- 34.....TWR
- 16.....Unimar
- 49.....Valmont Structures
- 56.....Waterford Consultants
- 58.....White Buffalo Environmental
- 58.....Wireless Specialties

*C2, C3 & C4 indicate cover pages

Put the power of *AGL Magazine* to work for you with a professional card ad. Contact Mercy Contreras at 303.988.3515 or at mcontreras@aglmediagroup.com



BuzB Corp
Radio Communications & Engineering

Accurate & Concise Tower Mapping.

- 25 years experience
- Antenna inventory
- Post modification inspections
- Platform audits
- Compound mapping reports
- FREE sample reports available
- Midwest, MO, AR, TX, AZ, FL & PA

Fully Insured

Call 630-543-5560 • www.buzbcorp.com

Slatercom-WCD  **Dialight**

- DUAL RED-WHITE (E1/E2) LED SYSTEMS AVAILABLE FROM STOCK
- GENUINE DIALIGHT PRODUCTS & WARRANTY
- RAPID DELIVERY ON "KITTED" SYSTEMS
- UNBEATABLE PRICING

MASTER DISTRIBUTOR

SALEM, OR. (503) 581-5550 www.slatercom.com

Strong, Integrated, Customized 

Equipment shelters and cabinets designed, built, wired and delivered on time for your equipment needs.

Full equipment integration & customization

See us in booth #9088 at IWCE!

1-800-356-2686 • www.thermobond.com

THERMOBOND BUILDINGS Fast. Friendly. Focused. Flexible.

MICHAEL L. HIGGS JR.
ATTORNEY AT LAW
mhiggs@shulmanrogers.com

• Leasing • Brokerage • Enforcement • Real Estate & Zoning •

12505 PARK POTOMAC AVENUE, 6TH FLOOR, POTOMAC, MD 20854

T 301.945.9244 F 301.230.2891
ShulmanRogers.com



Manufacturer of Guyed & Self-Support Towers
Complete Line of Tower Accessories
Full Range of Maintenance & Installation Services

Kevin Roth
VP of Sales

270-830-8512 ext. 304
Fax: 270-830-8475
Mobile: 270-831-3632

P.O. Box 25 Henderson, KY 42419
kroth@allstatetower.com
www.allstatetower.com

ABRACADABRA...CASH! So good you'll think we're magic!



With AFC, what you see is what you get. We convert your accounts receivable into cash the day you send them. Other factoring companies may believe in tricks but with us, there's no more waiting 30, 60 days or longer to get paid.

- Factor 1 or more invoices
- No Term Contracts
- We Assume the Credit Risk

For a confidential, no-obligation discussion:
Call: 1-(800)-241-2274
Email: info@advantagefunding.com

AC Advantage Funding Corp. www.advantagefunding.com

WHITE BUFFALO ENVIRONMENTAL INC.

EXPERIENCED ENVIRONMENTAL COMPLIANCE PROFESSIONALS

918-660-0999 • www.whitebuffalo.com
Please see 2013 AGL Buyers Guide Listing

TOWER FOR SALE

Type: 195' Self Support

Location: Rice County, MN

Contact: H.Dave Schmidtke dba D&L Specialties

507.339.2313



265' GUYED TOWER

Anchor Tenant Included

On Historic Property

Denver, Boulder, Greeley Market

Email: supersites@hushmail.com

COMSITES WEST

Providing Wireless Communications Sites in the West since 1956!

Visit us at IWCE – Booth 8094

Charlie Feick
530-414-4376
Charlie@comsiteswest.com www.comsiteswest.com

PROFESSIONAL DIRECTORY

CLIMB HIGHER

AMERICA'S PREMIER OUTFITTER

152 pages of
GREAT GEAR!

REQUEST YOUR WINTER CATALOG TODAY
www.gmesupply.com/catalog



GME
Supply Co
(800) 940-6762

BACKGROUND PHOTO COURTESY OF COMTRAIN TEXAS, LLC

YOUR SIGNAL STARTS HERE.®



IN OUR BUSINESS, IT IS ALL ABOUT THE SIGNAL.

Our clients depend on SBA to provide the wireless infrastructure that allows them to transmit the signal to their customers. As their first choice provider of wireless infrastructure solutions, we are continuously setting the standard for customer satisfaction by **“Building Better Wireless”**.



- TOWER OWNERSHIP**
- LEASING**
- SITE MANAGEMENT**
- SITE DEVELOPMENT**
- CONSTRUCTION**
- TECHNICAL SERVICES**

800.487.SITE | sbasite.com



Building Better Wireless®